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HANDBOOK of CORPORATE FINANCE

EMPIRICAL CORPORATE FINANCE

Volume 1

Editor: B. Espen Eckbo

North-Holland

HANDBOOK OF CORPORATE FINANCE: EMPIRICAL CORPORATE FINANCE VOLUME 1

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EMPIRICAL CORPORATE FINANCE

VOLUME 1

Edited by

B. ESPEN ECKBO
Tuck School of Business
Dartmouth College
Hanover, New Hampshire, U.S.A.

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William T. Ziemba
University of British Columbia

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PREFACE: EMPIRICAL CORPORATE FINANCE

Judging by the sheer number of papers reviewed in this Handbook, the empirical analysis of firms' financing and investment decisions—empirical corporate finance—has become a dominant field in financial economics. The growing interest in everything "corporate" is fueled by a healthy combination of fundamental theoretical developments and recent widespread access to large transactional data bases. A less scientific—but nevertheless important—source of inspiration is a growing awareness of the important social implications of corporate behavior and governance. This Handbook takes stock of the main empirical findings to date across the entire spectrum of corporate finance issues, ranging from econometric methodology, to raising capital and capital structure choice, and to managerial incentives and corporate investment behavior. The surveys are written by leading empirical researchers that remain active in their respective areas of interest. With few exceptions, the writing style makes the chapters accessible to industry practitioners. For doctoral students and seasoned academics, the surveys offer dense roadmaps into the empirical research landscape and provide suggestions for future work.

Part 1 (Volume 1): Econometric Issues and Methodological Trends

The empirical corporate finance literature is progressing through a combination of large-sample data descriptions, informal hypothesis testing, as well as structural tests of theory. Researchers are employing a wide spectrum of econometric techniques, institutional settings, and market structures in order to distill the central message in the data. Part 1 of Volume 1 begins by reviewing econometric issues surrounding event studies, and proceeds to explain the econometrics of self-selection. It then explains and illustrates methodological issues associated with the growing use of auction theory, and it ends with a discussion of key elements of the corporate finance evidence from a behavioral perspective.

In Chapter 1, "Econometrics of event studies", S.P. Kothari and Jerold Warner review the power of the event-study method; the most successful empirical technique to date for isolating the price impact of the information content of corporate actions. The usefulness of event studies arises from the fact that the magnitude of abnormal performance at the time of an event provides a measure of the (unanticipated) impact of this type of event on the wealth of the firms' claimholders. Thus, event studies focusing on announcement effects over short horizons around an event provide evidence relevant for understanding corporate policy decisions. Long-horizon event studies also serve an important purpose in capital market research as a way of examining market efficiency. The

survey discusses sampling distributions and test statistics typically used in event studies, as well as criteria for reliability, specification and power. While much is known about the statistical properties of short-horizon event studies, the survey provides a critical review of potential pitfalls of long-horizon abnormal return estimates. Serious challenges related to model specification, skewness and cross-correlation remain. As they also point out, events are likely to be associated with return-variance increases, which are equivalent to abnormal returns varying across sample securities. Misspecification induced by variance increases can cause the null hypothesis to be rejected too often unless the test statistic is adjusted to reflect the variance shift. Moreover, the authors emphasize the importance of paying close attention to specification issues for nonrandom samples of corporate events.

Self-selection is endemic to voluntary corporate events. In Chapter 2, "Self-selection models in corporate finance", Kai Li and Nagpurnanand Prabhala review the relevant econometric issues with applications in corporate finance. The statistical issue raised by self-selection is the wedge between the population distribution and the distribution within a selected sample, which renders standard linear (OLS/GLS) estimators biased and inconsistent. This issue is particularly relevant when drawing inferences about the determinants of event-induced abnormal stock returns from multivariate regressions, a technique used by most event studies today. These regressions are typically run using samples that exclude non-event firms. The standard solution is to include a scaled estimate of the event probability—the inverse Mills ratio (the expected value of the true but unobservable regression error term)—as an additional variable in the regression. Interestingly, testing for the significance of the inverse Mills ratio is equivalent to testing whether the sample firms use private information when they self-select to undertake the event. Conversely, if one believes that the particular event being studied is induced by or reflects private information (market overpricing of equity, arrival of new investment projects, merger opportunities, etc.), then consistent estimation of the parameters in the cross-sectional regression requires the appropriate control for self-selection. What is "appropriate" generally depends on the specific application and should ideally be guided by economic theory. The survey also provides a useful overview of related econometric techniques—including matching (treatment effect) models, panel data with fixed effects, and Bayesian self-selection models—with specific applications.

In Chapter 3, "Auctions in corporate finance", Sudipto Dasgupta and Robert Hansen introduce auction theory and discuss applications in corporate finance. The authors explain theoretical issues relating to pricing, efficiency of allocation (the conditions under which the asset is transferred to the most efficient buyer), differential information, collusion among buyers, risk aversion, and the effects of alternative auctions designs (sealed-bid versus open auction, seller reserve price, entry fees, etc.). It is important for empirical research in corporate finance to be informed of auction theory for at least two reasons. First, when sampling a certain transaction type that in fact takes place across a variety of transactional settings, auction theory help identify observable characteristics that are likely to help explain the cross-sectional distribution of things like transaction/bid prices, expected seller revenues, valuation effects, and

economic efficiency. This is perhaps most obvious in studies of corporate takeovers (negotiation versus auction, strategic bidding behavior, etc.) and in public security offerings (role of intermediaries, degree and role of initial underpricing, long-run pricing effects, etc.). Second, auction theory provides solutions to the problem of optimal selling mechanism design. This is highly relevant in debates over the efficiency of the market for corporate control (negotiations versus auction, desirability of target defensive mechanisms, the role of the board), optimality of a bankruptcy system (auctions versus court-supervised negotiations, allocation of control during bankruptcy, prospects for fire-sales, risk-shifting incentives, etc.), and the choice of selling mechanism when floating new securities (rights offer, underwritten offering, fixed-price, auction, etc.).

In Chapter 4, "Behavioral corporate finance", Malcolm Baker, Richard Ruback and Jeffery Wurgler survey several aspects of corporate finance and discuss the scope for competing behavioral and rational interpretations of the evidence. The idea that inherent behavioral biases of CEOs—and their perception of investor bias—may affect corporate decisions is both intuitive and compelling. A key methodological concern is how to structure tests with the requisite power to discriminate between behavioral explanations and classical hypotheses based on rationality. The "bad model" problem—the absence of clearly empirically testable predictions—is a challenge for *both* rational and behavioral models. For example, this is evident when using a scaled-price ratio such as the market-to-book ratio (B/M), and where the book value is treated as a fundamental asset value. A high value of B/M may be interpreted as "overvaluation" (behavioral) or, alternatively, as B poorly reflecting economic fundamentals (rational). Both points of view are consistent with the observed inverse relation between B/M and expected returns (possibly with the exception of situations with severe short-selling constraints). Also, measures of "abnormal" performance following some corporate event necessarily condition on the model generating expected return. The authors carefully discuss these issues and how researchers have tried to reduce the joint model problem, e.g. by considering cross-sectional interactions with firm-characteristics such as measures of firm-specific financing constraints. The survey concludes that behavioral approaches help explain a number of important financing and investment patterns, and it offers a number of open questions for future research.

Part 2 (Volume 1): Banking, Public Offerings, and Private Sources of Capital

In Part 2, the Handbook turns to investment banking and the capital acquisition process. Raising capital is the lifeline of any corporation, and the efficiency of various sources of capital, including banks, private equity and various primary markets for new securities is an important determinant of the firm's cost of capital.

In Chapter 5, "Banks in capital markets", Steven Drucker and Manju Puri review empirical work on the dual role of banks as lenders and as collectors of firm-specific private information through the screening and monitoring of loans. Until the late 1990s, U.S. commercial banks were prohibited from underwriting public security offerings for

fear that these banks might misuse their private information about issuers (underwriting a low quality issuer and market it as high quality). Following the repeal of the Glass–Steagall Act in the late 1990s, researchers have examined the effect on underwriter fees of the emerging competition between commercial and investment banks. Commercial banks have emerged as strong competitors: in both debt and equity offerings, borrowers receive lower underwriting fees when they use their lending bank as underwriter. The evidence also shows that having a lending relationship constitutes a significant competitive advantage for the commercial banks in terms of winning underwriting mandates. In response, investment banks have started to develop lending units, prompting renewed concern with conflicts of interest in underwriting. Overall, the survey concludes that there are positive effects from the interaction between commercial banks' lending activities and the capital markets, in part because the existence of a bank lending relationship reduces the costs of information acquisition for capital market participants.

In Chapter 6, "Security offerings", Espen Eckbo, Ronald Masulis and Øyvind Norli review studies of primary markets for new issues, and they extend and update evidence on issue frequencies and long-run stock return performance. This survey covers all of the key security types (straight and convertible debt, common stock, preferred stock, ADR) and the most frequently observed flotation methods (IPO, private placement, rights offering with or without standby underwriting, firm commitment underwritten offering). The authors review relevant aspects of securities regulations, empirical determinants of underwriter fees and the choice of flotation method, market reaction to security issue announcements internationally, and long-run performance of U.S. issuers. They confirm that the relative frequency of *public* offerings of seasoned equity (SEOs) is low and thus consistent with a financial pecking order based on adverse selection costs. They also report that the strongly negative announcement effect of SEOs in the U.S. is somewhat unique to U.S. issuers. Equity issues in other countries are often met with a significantly positive market reaction, possibly reflecting a combination of the greater ownership concentration and different selling mechanisms in smaller stock markets. They conclude from this evidence that information asymmetries have a first-order effect on the choice of which security to issue as well as by which method. Their large-sample estimates of post-issue long-run abnormal performance, which covers a wide range of security types, overwhelmingly reject the hypothesis that the performance is 'abnormal'. Rather, the long-run performance is commensurable with issuing firms' exposures to commonly accepted definitions of pervasive risk factors. They conclude that the long-run evidence fails to support hypotheses which hold that issuers systematically time the market, or hypotheses which maintain that the market systematically over- or under-reacts to the information in the issue announcement.

The cost of going public is an important determinant of financial development and growth of the corporate sector. In Chapter 7, "IPO underpricing", Alexander Ljungqvist surveys the evidence on one significant component of this cost: IPO underpricing, commonly defined as the closing price on the IPO day relative to the IPO price. He classifies theories of underpricing under four broad headings: 'asymmetric information' (between the issuing firm, the underwriter, and outside investors), 'institutional' (focusing on lit-

igation risk, effects of price stabilization, and taxes), 'control' (how the IPO affects ownership structure, agency costs and monitoring), and 'behavioral' (where irrational investors bid up the price of IPO shares beyond true value). From an empirical perspective, these theories are not necessarily mutually exclusive, and several may work to successfully explain the relatively modest level of underpricing (averaging about 15%) observed before the height of the technology-sector offerings in 1999–2000. Greater controversy surrounds the level of underpricing observed in 1999–2000, where the dollar value of issuers' underpricing cost ('money left on the table') averaged more than four times the typical 7% investment banking fee. Two interesting—and mutually exclusive—candidate explanations for this unusual period focus on inefficient selling method design (failure of the fix-priced book-building procedure to properly account for the expected rise in retail investor demand) and investor irrationality (post-offering pricing 'bubble'). Additional work on the use and effect of IPO auctions, and on the uniquely identifying characteristics of a pricing 'bubble', is needed to resolve this issue.

Multidivisional (conglomerate) firms may exist in part to take advantage of internal capital markets. However, in apparent contradiction of this argument, the early literature on conglomerate firms identified a 'conglomerate discount' relative to pure-play (single-plant) firms. In Chapter 8, "Conglomerate firms and internal capital markets", Vojislav Maksimovic and Gordon Phillips present a comprehensive review of how the literature on the conglomerate discount has evolved to produce a deeper economic understanding of the early discount evidence. They argue that issues raised by the data sources used to define the proper equivalent 'pure-play' firm, econometric issues arising from firms self-selecting the conglomerate form, and explicit model-based tests derived from classical profit-maximizing behavior, combine to explain the discount without invoking agency costs and investment inefficiencies. As they explain, a firm that chooses to diversify is a different type of firm than one which stays with a single segment—but either type may be value-maximizing. They conclude that, on balance, internal capital markets in conglomerate firms appear to be efficient in reallocating resources.

After reviewing internal capital markets, bank financing, and public securities markets, Volume 1 ends with the survey "Venture capital" in Chapter 9. Here, Paul Gompers defines venture capital as "independent and professionally managed, dedicated pools of capital that focus on equity or equity-linked investments in privately held, high-growth companies". The venture capital industry fuels innovation by channeling funds to start-up firms and, while relatively small compared to the public markets, has likely had a disproportionately positive impact on economic growth in the United States where the industry is most developed. The empirical literature on venture capital describes key features of the financial contract (typically convertible preferred stock), staging of the investment, active monitoring and advice, exit strategies, etc., all of which affect the relationship between the venture capitalist and the entrepreneur. While data sources are relatively scarce, there is also growing evidence on the risk and return of venture capital investments. Paul Gompers highlights the need for further research on assessing venture capital as a financial asset, and on the internationalization of venture capital.

Part 3 (Volume 2): Dividends, Capital Structure, and Financial Distress

The first half of Volume 2 is devoted to the classical issue of capital structure choice. This includes the effect of taxes, expected bankruptcy costs, agency costs, and the costs of adverse selection in issue markets on the firm's choice of financial leverage and dividend policy. More recent empirical work also links debt policy to competition in product markets and to the firm's interaction with its customers and suppliers. There is also substantial empirical work on the effect on expected bankruptcy- and distress costs of the design of the bankruptcy code, where claim renegotiation under court supervision (such as under Chapter 11 of the U.S. code) and auctions in bankruptcy (such as in Sweden) are major alternatives being studied.

In Chapter 10, "Payout policy", Avner Kalay and Michael Lemmon refer to payout policy as "the ways in which firms return capital to their equity investors". Classical dividend puzzles include why firms keep paying cash dividends in the presence of a tax-disadvantage relative to capital gains, and why dividend changes have information contents. In contrast to increases in debt interest payments, dividend increases are not contractually binding and therefore easily reversible. So, where is the commitment to maintain the increased level of dividends? While there is strong evidence of a positive information effect of unanticipated dividend increases, they argue that available signaling models are unlikely to capture this empirical phenomenon. Moreover, there is little evidence that dividend yields help explain the cross-section of expected stock returns—which fails to reveal a tax effect of dividend policy. Recent surveys indicate that managers today appear to consider dividends as a second order concern after investment and liquidity needs are met, and to an increased reliance on stock repurchase as an alternative to cash payouts.

In Chapter 11, "Taxes and corporate finance", John Graham reviews research specifically relating corporate and personal taxes to firms' choice of payout policy, capital structure, compensation policy, pensions, corporate forms, and a host of other financing arrangements. This research often finds that taxes do appear to affect corporate decisions, but the economic magnitude of the tax effect is often uncertain. There is cross-sectional evidence that high-tax rate firms use debt more intensively than do low-tax rate firms, but time-series evidence concerning whether firm-specific changes in tax status affect debt policy is sparse. Many firms appear to be "underleveraged" in the sense that they could capture additional tax-related benefits of debt at a low cost—but refrain from doing so. Conclusions concerning "underleverage" are, however, contingent on a model of the equilibrium pricing implications of the personal tax-disadvantage of interest over equity income, a topic that has been relatively little researched. Graham also points to the need for a total tax-planning view (as opposed to studying tax issues one by one) to increase the power of tests designed to detect overall tax effects on firm value.

In Chapter 12, "Tradeoff and pecking order theories of debt", Murray Frank and Vidhan Goyal review the empirical evidence on firms capital structure choice more generally. Under the classical tradeoff theory, the firm finds the optimal debt level at the point where the marginal tax benefit of another dollar of debt equals the mar-

ginal increase in expected bankruptcy costs. This theory is somewhat challenged by the evidence of underleverage surveyed by Graham. However, corporate leverage ratios appears to be mean-reverting over long time horizons, which is consistent with firms trying to maintain target leverage ratios. This target may reflect transaction costs of issuing securities, agency costs, and information asymmetries as well as taxes and bankruptcy costs, and the available evidence does not indicate which factors are the dominant ones. They report several stylized facts about firms leverage policies. In the aggregate for large firms (but not for small firms), capital expenditures track closely internal funds, and the "financing deficit" (the difference between investments and internal funds) track closely debt issues. This is as predicted by the "pecking order" hypothesis, under which debt is preferred over equity as a source of external finance. For small firms, however, the deficit tracks closely equity issues, which reverses the prediction of the pecking order. The authors conclude that "no currently available model appears capable of simultaneously accounting for the stylized facts".

In Chapter 13, "Capital structure and corporate strategy", Chris Parsons and Sheridan Titman survey arguments and evidence that link firms' leverage policies to structural characteristics of product markets. Capital structure may affect how the firm chooses to interact with its non-financial stakeholders (customers, workers, and suppliers concerned with the firm's survival) as well as with competitors. To account for endogeneity problems that commonly arise in this setting, most papers in this survey analyze firms' responses to a "shock", whether it be a sharp (and hopefully unanticipated) leverage change, an unexpected realization of a macroeconomic variable, or a surprising regulatory change. This approach often allows the researcher to isolate the effect of leverage on a firm's corporate strategy, and in some cases, makes it possible to pinpoint the specific channel (for example, whether a financially distressed firm lowers prices in response to predation by competitors or by making concessions to its customers). There is evidence that debt increases a firm's employment sensitivity to demand shocks (perhaps perpetuating recessions), but can also protect shareholder wealth by moderating union wage demands. Excessive leverage can also inhibit a firm's ability to compete in the product market, as measured by prices and market shares. Firms that depend crucially on non-fungible investments from stakeholders are most sensitive to these losses, and choose more conservative capital structures as a result.

To avoid formal bankruptcy, financially distressed firms engage in asset sales, equity issues and debt renegotiations. In Chapter 14, "Bankruptcy and resolution of financial distress", Edith Hotchkiss, Kose John, Robert Mooradian and Karin Thorburn survey empirical work on the costs, benefits, and effectiveness of out-of-court debt workouts and of formal "one size fits all" bankruptcy procedures. Failing to renegotiate their debt claims out of court, the firm files for bankruptcy, where it is either liquidated piecemeal or restructured as a going concern under court protection. For reasons that are poorly understood, different bankruptcy systems have evolved in different countries, with a trend toward the structured bargaining process characterizing Chapter 11 of the U.S. code. The U.S. code substantially restricts the liquidation rights of creditors as filing triggers automatic stay of debt payments, prevents repossession of collateral, and allows the

bankrupt firm to raise new debt with super-priority (debtor-in-possession financing). In contrast, UK bankruptcy is akin to a contract-driven receivership system where creditor rights are enforced almost to the letter. Here, assets pledged as collateral can be repossessed even if they are vital for the firm, and there is no stay of debt claims. This makes it difficult to continue to operate the distressed firm under receivership, even if the bankrupt firm is economically viable. A third system is found in Sweden where the filing firm is automatically turned over to a court-appointed trustee who arranges an open auction (while all debt claims are stayed). The authors survey the international evidence on bankruptcies (which also includes France, Germany, and Japan). They conclude that it remains an open question whether Chapter 11 in the U.S.—with its uniquely strong protection of the incumbent management team—represents an optimal bankruptcy reorganization procedure.

Part 4 (Volume 2): Takeovers, Restructurings, and Managerial Incentives

Modern corporate finance theory holds that in a world with incomplete contracting, financial structure affects corporate investment behavior and therefore firm value. The Handbook ends with comprehensive discussions of the value-implications of major corporate investment and restructuring decisions (outside of bankruptcy) and of the role of pay-for-performance type of executive compensation contracts on managerial incentives and risk taking behavior.

In Chapter 15, "Corporate takeovers", Sandra Betton, Espen Eckbo and Karin Thorburn review and extend the evidence on mergers and tender offers. They focus in particular on the bidding process as it evolves sequentially from the first bid through bid revision(s) and towards the final bid outcome. Central issues include bid financing, strategic bidding, agency issues and the impact of statutory and regulatory restrictions. The strategic arsenal of the initial bidder includes approaching the target with a tender offer or a merger bid, acquiring a toehold to gain an advantage over potential competitors, offering a payment method (cash or stock) which signals a high bidder valuation of the target, and/or simply bid high (a preemptive strike). The survey provides new evidence on the magnitude of successive bid jumps, and on the speed of rival firm entry and the time between the first and the final bids in multi-bidder contests. The survey confirms that the average abnormal return to bidders is insignificantly different from zero, and that the sum of the abnormal returns to targets and bidders is positive, suggesting that takeovers improve the overall efficiency of resource allocation. Takeover bids also tend to generate positive abnormal returns throughout the industry of the target, in part because they increase the likelihood that industry rivals may become targets themselves (industry "in-play" effect). The evidence strongly rejects the hypothesis that horizontal mergers reduce consumer welfare through increased market power—even when the merger-induced change in industry concentration is non-trivial. However, some input suppliers suffer losses following downstream mergers that increase the downstream industry's bargaining power. The survey ends with a discussion of merger waves.

In Chapter 16, "Corporate restructurings", Espen Eckbo and Karin Thorburn review a number of financial and asset restructuring techniques—other than corporate takeovers and bankruptcy reorganizations. They distinguish between transactions that securitize corporate divisions from those that recapitalize the entire firm. Forms of divisional securitization include spinoff, splitoff, divestiture, equity carveout and tracking stock. Forms of recapitalizations of the entire firm include leveraged recapitalization, leveraged buyout (LBO), demutualization, going-private transactions, and state privatizations. They show transaction frequency, describe the financing technique, discuss regulatory and tax issues, and review evidence on the associated valuation effects. Announcement-induced abnormal stock returns are generally reported to be positive. Potential sources of this wealth creation include improved alignment of management and shareholder incentives through post-transaction compensation contracts that include divisional stock grants, the elimination of negative synergies, improved governance systems through the disciplinary effect of leverage, the avoidance of underinvestment costs, wealth transfers from old bondholders experiencing claim dilution and risk increase following new debt issues, and an "in-play" effect as divisional securitization increases the probability that the division will become a future acquisition target. Unbundling corporate assets and allowing public trade of securities issued by individual divisions also leads to a general welfare increase from increased market completeness and analyst following. The evidence indicates improved operating performance following spinoffs and LBOs, and increased takeover activity after spinoffs and carveouts, and that a minority of LBO firms goes public within five years of the going-private transaction.

Delegation of corporate control to managers gives rise to costly agency conflicts as the personal interests of managers and owners diverge. The literature on executive compensation seeks to identify the form of the employment contract that minimizes agency costs. In Chapter 17, "Executive compensation and incentives", Rajesh Aggarwal surveys the empirical findings of this literature over the past two decades, focusing in particular on evidence concerning stock options and restricted stock grants. The optimal provision of incentives in managerial compensation contracts depends on factors such as executive risk and effort aversion, managerial productivity, and information asymmetries. A key limitation on incentive provision appears to be the need to share risk between managers and shareholders. Also, while optimal contracting theory implies that firm performance should be evaluated relative to an industry or market wide benchmark, relative performance provisions (e.g. by indexing the exercise price of a stock option to the market) are rarely observed. This puzzle may be explained in part by accounting and tax rules, and in part by the cost to shareholders of indexed options (relative to other forms of compensation) when managers are risk averse. Observed compensation practices may also reflect a governance problem if the CEO has undue influence over the determination of her own level of pay. Some researchers argue that rent extraction by the CEO is a major issue of concern for shareholders, an issue that remains controversial.

For a given compensation contract, risk-averse managers have a personal incentive to limit risk exposure by lowering the volatility of the firm's cash flow ex post. If

unchecked, this incentive may lead to value-reducing overinvestment in risk-reducing technologies and projects. However, as reviewed by Clifford Smith in Chapter 18, "Managing corporate risk", it is widely accepted that active cash flow risk management can also lead to increased shareholder value. For example, if hedging alters the timing of taxable cash flows, there may be a net tax benefit. Hedging may also reduce expected costs of financial distress which in turn may allow the firm to capture additional benefits from leverage. Hedging opportunities (using various forms of derivatives and hybrid instruments) have increased substantially over the past decade, and their costs have decreased. As a result, today some form of hedging activity is common among large publicly traded firms. The evidence indicates that smaller firms—with greater default risk—tend to hedge a larger percentage of their exposures than larger firms. However, Smith points to several data problems that limit the power of the empirical research in this area.

I would like to thank all the contributors for their hard work and patience in seeing this Handbook to fruition. A special thank goes to the Series Editor William T. Ziemba for his enthusiasm for this project.

B. Espen Eckbo
Dartmouth College, 2007

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PART 1

ECONOMETRIC ISSUES AND METHODOLOGICAL TRENDS

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Chapter 1

ECONOMETRICS OF EVENT STUDIES*

S.P. KOTHARI

Sloan School of Management, E52-325, Massachusetts Institute of Technology, 50 Memorial Drive, Cambridge, MA 02142, USA
e-mail: kothari@mit.edu

JEROLD B. WARNER

William E. Simon Graduate School of Business Administration, University of Rochester, Rochester, NY 14627-0107, USA
e-mail: warner@simon.rochester.edu

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Abstract

The number of published event studies exceeds 500, and the literature continues to grow. We provide an overview of event study methods. Short-horizon methods are quite reliable. While long-horizon methods have improved, serious limitations remain. A challenge is to continue to refine long-horizon methods. We present new evidence illustrating that properties of event study methods can vary by calendar time period and can depend on event sample firm characteristics such as volatility. This reinforces the importance of using stratified samples to examine event study statistical properties.

Keywords

event study, abnormal returns, short-horizon tests, long-horizon tests, cross-sectional tests, risk adjustment

1. Introduction and background

This chapter focuses on the design and statistical properties of event study methods. Event studies examine the behavior of firms' stock prices around corporate events.[1] A vast literature on event studies written over the past several decades has become an important part of financial economics. Prior to that time, "there was little evidence on the central issues of corporate finance. Now we are overwhelmed with results, mostly from event studies" (Fama, 1991, p. 1600). In a corporate context, the usefulness of event studies arises from the fact that the magnitude of abnormal performance at the time of an event provides a measure of the (unanticipated) impact of this type of event on the wealth of the firms' claimholders. Thus, event studies focusing on announcement effects for a short-horizon around an event provide evidence relevant for understanding corporate policy decisions.

Event studies also serve an important purpose in capital market research as a way of testing market efficiency. Systematically nonzero abnormal security returns that persist after a particular type of corporate event are inconsistent with market efficiency. Accordingly, event studies focusing on long-horizons following an event can provide key evidence on market efficiency (Brown and Warner, 1980; Fama, 1991).

Beyond financial economics, event studies are useful in related areas. For example, in the accounting literature, the effect of earnings announcements on stock prices has received much attention. In the field of law and economics, event studies are used to examine the effect of regulation, as well as to assess damages in legal liability cases.

The number of published event studies easily exceeds 500 (see Section 2), and continues to grow. A second and parallel literature, which concentrates on the methodology of event studies, began in the 1980s. Dozens of papers have now explicitly studied statistical properties of event study methods. Both literatures are mature.

From the methodology papers, much is known about how to do—and how not to do—an event study. While the profession's thinking about event study methods has evolved over time, there seems to be relatively little controversy about statistical properties of event study methods. The conditions under which event studies provide information and permit reliable inferences are well-understood.

This chapter highlights key econometric issues in event study methods, and summarizes what we know about the statistical design and the interpretation of event study experiments. Based on the theoretical and empirical findings of the methodology literature, we provide clear guidelines both for producers and consumers of event studies. Rather than provide a comprehensive survey of event study methods, we seek to sift through and synthesize existing work on the subject. We provide many references and

[1] We discuss event studies that focus only on the mean stock price effects. Many other types of event studies also appear in the literature, including event studies that examine return variances (e.g., Beaver, 1968, and Patell, 1976), trading volume (e.g., Beaver, 1968, and Campbell and Wasley, 1996), operating (accounting) performance (e.g., Barber and Lyon, 1996), and earnings management via discretionary accruals (e.g., Dechow, Sloan and Sweeney, 1995, and Kothari, Leone, and Wasley, 2005).

borrow heavily from the contributions of published papers. Two early papers that cover a wide range of issues are by Brown and Warner (1980, 1985). More recently, an excellent chapter in the textbook of Campbell, Lo, and MacKinlay (1997) is a careful and broad outline of key research design issues. These standard references are recommended reading, but predate important advances in our understanding of event study methods, in particular on long horizon methods. We provide an updated and much needed overview, and include a bit of new evidence as well.

Although much emphasis will be on the statistical issues, we do not view our mission as narrowly technical. As financial economists, our ultimate interest is in how to best specify and test interesting economic hypotheses using event studies. Thus, the econometric and economic issues are interrelated, and we will try to keep sight of the interrelation.

In Section 2, we briefly review the event study literature and describe the changes in event study methodology over time. In Section 3 we discuss how to use events studies to test economic hypotheses. We also characterize the properties of the event study tests and how these properties depend on variables such as security volatility, sample size, horizon length, and the process generating abnormal returns. Section 4 is devoted to issues most likely encountered when conducting long-horizon event studies. The main issues are risk adjustment, cross-correlation in returns, and changes in volatility during the event period.

2. The event study literature: basic facts

2.1. The stock and flow of event studies

To quantify the enormity of the event study literature, we conducted a census of event studies published in 5 leading journals: the *Journal of Business* (JB), *Journal of Finance* (JF), *Journal of Financial Economics* (JFE), *Journal of Financial and Quantitative Analysis* (JFQA), and the *Review of Financial Studies* (RFS). We began in 1974, the first year the JFE was published.

Table 1 reports the results for the years 1974 through 2000. The total number of papers reporting event study results is 565. Since many academic and practitioner-oriented journals are excluded, these figures provide a lower bound on the size of the literature. The number of papers published per year increased in the 1980s, and the flow of papers has since been stable. The peak years are 1983 (38 papers), 1990 (37 papers), and 2000 (37 papers). All five journals have significant representation. The JFE and JF lead, with over 200 papers each.

Table 1 makes no distinction between long horizon and short horizon studies. While the exact definition of "long horizon" is arbitrary, it generally applies to event windows of 1 year or more. Approximately 200 of the 565 event studies listed in Table 1 use a maximum window length of 12 months or more, with no obvious time trend in the year by year proportion of studies reporting a long-horizon result.

Table 1
Event studies, by year and journal. For each journal, all papers that contain an event study are included. Survey and methodological papers are excluded

Year	*Journal of Business*	*Journal of Finance*	*Journal of Financial Economics*	*Journal of Financial and Quant. Analysis*	*Review of Financial Studies*	Grand total
1974	2		2	1		5
1975		2	2	1		5
1976		5	1	1		7
1977		5	5	1		11
1978	1	5	4	1		11
1979		7		2		9
1980	3	4	2	2		11
1981	1	3	4	2		10
1982	1	6	2	1		10
1983	2	14	18	4		38
1984		5	5	1		11
1985	2	4	7	2		15
1986	2	7	14	4		27
1987		7	18	1		26
1988	1	4	7	5	1	18
1989		11	11	1	1	24
1990	5	17	7	6	2	37
1991	5	17	2	4	1	29
1992	4	13	9	4	1	31
1993	5	7	5	5	3	25
1994	1	10	10	5		26
1995	1	8	14	11	2	36
1996	1	7	10	5	3	26
1997	3	8	12	3		26
1998	1	14	11	3		29
1999	1	7	12	1	4	25
2000	2	15	13	5	2	37
Totals	44	212	207	82	20	565

No survey of these 565 event study papers is attempted here. For the interested reader, the following are some examples of event study surveys. MacKinlay (1997) and Campbell, Lo, and MacKinlay (1997) document the origins and breadth of event studies. The relation of event studies to tests of market efficiency receives considerable attention in Fama (1991), and in recent summaries of long-horizon tests in Kothari and Warner (1997) and Fama (1998). Smith (1986) presents reviews of event studies of financing decisions. Jensen and Ruback (1983), Jensen and Warner (1988), and Jarrell, Brickley, and Netter (1988) survey corporate control events. Recently, Kothari (2001) reviews event studies in the accounting literature.

2.2. Changes in event study methods: the big picture

Even the most cursory perusal of event studies done over the past 30 years reveals a striking fact: the basic statistical format of event studies has not changed over time. It is still based on the table layout in the classic stock split event study of Fama et al. (1969). The key focus is still on measuring the sample securities' mean and cumulative mean abnormal return around the time of an event.

Two main changes in methodology have taken place, however. First, the use of daily (and sometimes intraday) rather than monthly security return data has become prevalent, which permits more precise measurement of abnormal returns and more informative studies of announcement effects. Second, the methods used to estimate abnormal returns and calibrate their statistical significance have become more sophisticated. This second change is of particular importance for long-horizon event studies. The changes in long-horizon event study methods reflect new findings in the late 1990s on the statistical properties of long-horizon security returns. The change also parallels developments in the asset pricing literature, particularly the Fama–French 3-factor model.

While long-horizon methods have improved, serious limitations of long-horizon methods have been brought to light and still remain. We now know that inferences from long-horizon tests "require extreme caution" (Kothari and Warner, 1997, p. 301) and even using the best methods "the analysis of long-run abnormal returns is treacherous" (Lyon, Barber, and Tsai, 1999, p. 165). These developments underscore and dramatically strengthen earlier warnings (e.g., Brown and Warner, 1980, p. 225) about the reliability—or lack of reliability—of long-horizon methods. This contrasts with short-horizon methods, which are relatively straightforward and trouble-free. As a result, we can have more confidence and put more weight on the results of short-horizon tests than long-horizon tests. Short-horizon tests represent the "cleanest evidence we have on efficiency" (Fama, 1991, p. 1602), but the interpretation of long-horizon results is problematic. As discussed later, long-horizon tests are highly susceptible to the joint-test problem, and have low power.

Of course these statements about properties of event study tests are very general. To provide a meaningful basis for assessing the usefulness of event studies—both short- and long-horizon—it is necessary to have a framework that specifies: (i) the economic and statistical hypotheses in an event study, and (ii) an objective basis for measuring and comparing the performance of event study methods. Section 3 lays out this framework, and summarizes general conclusions from the methodology literature. In the remainder of the chapter, additional issues and problems are considered with more specificity.

3. Characterizing event study methods

3.1. An event study: the model

An event study typically tries to examine return behavior for a sample of firms experiencing a common type of event (e.g., a stock split). The event might take place at

different points in calendar time or it might be clustered at a particular date (e.g., a regulatory event affecting an industry or a subset of the population of firms). Let $t = 0$ represent the time of the event. For each sample security i, the return on the security for time period t relative to the event, R_{it}, is:

$$R_{it} = K_{it} + e_{it}, \tag{1}$$

where K_{it} is the "normal" (i.e., expected or predicted return given a particular model of expected returns), and e_{it} is the component of returns which is abnormal or unexpected.[2] Given this return decomposition, the abnormal return, e_{it}, is the difference between the observed return and the predicted return:

$$e_{it} = R_{it} - K_{it}. \tag{2}$$

Equivalently, e_{it} is the difference between the return conditional on the event and the expected return unconditional on the event. Thus, the abnormal return is a direct measure of the (unexpected) change in securityholder wealth associated with the event. The security is typically a common stock, although some event studies look at wealth changes for firms' preferred or debt claims.

A model of normal returns (i.e., expected returns unconditional on the event but conditional on other information) must be specified before an abnormal return can be defined. A variety of expected return models (e.g., market model, constant expected returns model, capital asset pricing model) have been used in event studies.[3] Across alternative methods, both the bias and precision of the expected return measure can differ, affecting the properties of the abnormal return measures. Properties of different methods have been studied extensively, and are discussed later.

3.2. Statistical and economic hypotheses

3.2.1. Cross-sectional aggregation

An event study seeks to establish whether the cross-sectional distribution of returns at the time of an event is abnormal (i.e., systematically different from predicted). Such an exercise can be conducted in many ways. One could, for example, examine the entire distribution of abnormal returns. This is equivalent comparing the distributions of actual with the distribution of predicted returns and asking whether the distributions are the same. In the event study literature, the focus almost always is on the mean of the distribution of abnormal returns. Typically, the specific null hypothesis to be tested is whether the mean abnormal return (sometimes referred to as the average residual, AR) at time t is equal to zero. Other parameters of the cross-sectional distribution (e.g., median, variance) and determinants of the cross-sectional variation in abnormal returns are

[2] This framework is from Brown and Warner (1980) and Campbell, Lo, and MacKinlay (1997).

[3] For descriptions of each of these models, see Brown and Warner (1985) or Campbell, Lo, and MacKinlay (1997).

sometimes studied as well. The focus on mean effects, i.e., the first moment of the return distribution, makes sense if one wants to understand whether the event is, on average, associated with a change in security holder wealth, and if one is testing economic models and alternative hypotheses that predict the sign of the average effect. For a sample of N securities, the cross-sectional mean abnormal return for any period t is:

$$\mathrm{AR}_t = \frac{1}{N}\sum_{i=1}^{N} e_{it}. \tag{3}$$

3.2.2. Time-series aggregation

It is also of interest to examine whether mean abnormal returns for periods around the event are equal to zero. First, if the event is partially anticipated, some of the abnormal return behavior related to the event should show up in the pre-event period. Second, in testing market efficiency, the speed of adjustment to the information revealed at the time of the event is an empirical question. Thus, examination of post-event returns provides information on market efficiency.

In estimating the performance measure over any multi-period interval (e.g., time 0 through +6), there are a number of methods for time-series aggregation over the period of interest. The cumulative average residual method (CAR) uses as the abnormal performance measure the sum of each month's average abnormal performance. Later, we also consider the buy-and-hold method, which first compounds each security's abnormal returns and then uses the mean compounded abnormal return as the performance measure. The CAR starting at time t_1 through time t_2 (i.e., horizon length $L = t_2 - t_1 + 1$) is defined as:

$$\mathrm{CAR}(t_1, t_2) = \sum_{t=t_1}^{t_2} \mathrm{AR}_t. \tag{4}$$

Both CAR and buy-and-hold methods test the null hypothesis that mean abnormal performance is equal to zero. Under each method, the abnormal return measured is the same as the returns to a trading rule that buys sample securities at the beginning of the first period, and holds through the end of the last period. CARs and buy-and-hold abnormal returns correspond to security holder wealth changes around an event. Further, when applied to post-event periods, tests using these measures provide information about market efficiency, since systematically nonzero abnormal returns following an event are inconsistent with efficiency and imply a profitable trading rule (ignoring trading costs).

3.3. Sampling distributions of test statistics

For a given performance measure, such as the CAR, a test statistic is typically computed and compared to its assumed distribution under the null hypothesis that mean

abnormal performance equals zero.[4] The null hypothesis is rejected if the test statistic exceeds a critical value, typically corresponding to the 5% or 1% tail region (i.e., the test level or size of the test is 0.05 or 0.01). The test statistic is a random variable because abnormal returns are measured with error. Two factors contribute to this error. First, predictions about securities' unconditional expected returns are imprecise. Second, individual firms' realized returns at the time of an event are affected for reasons unrelated to the event, and this component of the abnormal return does not average to literally zero in the cross-section.

For the CAR shown in equation (4), a standard test statistic is the CAR divided by an estimate of its standard deviation.[5] Many alternative ways to estimate this standard deviation have been examined in the literature (see, for example, Campbell, Lo, and MacKinlay, 1997). The test statistic is given by:

$$\frac{\mathrm{CAR}(t_1, t_2)}{[\sigma^2(t_1, t_2)]^{1/2}}, \tag{5}$$

where

$$\sigma^2(t_1, t_2) = L\sigma^2(\mathrm{AR}_t) \tag{6}$$

and $\sigma^2(\mathrm{AR}_t)$ is the variance of the one-period mean abnormal return. Equation (6) simply says that the CAR has a higher variance the longer is L, and assumes time-series independence of the one-period mean abnormal return. The test statistic is typically assumed unit normal in the absence of abnormal performance. This is only an approximation, however, since estimates of the standard deviation are used.

The test statistic in equation (5) is well-specified provided the variance of one-period mean abnormal return is estimated correctly. Event-time clustering renders the independence assumption for the abnormal returns in the cross-section incorrect (see Collins and Dent, 1984, Bernard, 1987, and Petersen, 2005, and more detailed discussion in Section 4 below). This would bias the estimated standard deviation downward and the test statistic given in equation (5) upward. To address the bias, the significance of the event-period average abnormal return can be and often is gauged using the variability of the time series of event portfolio returns in the period preceding or after the event date. For example, the researcher can construct a portfolio of event firms and obtain a time series of daily abnormal returns on the portfolio for a number of days (e.g., 180 days) around the event date. The standard deviation of the portfolio returns can be used to assess the significance of the event-window average abnormal return. The cross-sectional

[4] Standard tests are "classical" rather than "Bayesian". A Bayesian treatment of event studies is beyond the scope of this chapter.

[5] An alternative would be a test statistic that aggregates standardized abnormal returns, which means each observation is weighted in inverse proportion of the standard deviation of the estimated abnormal return. The standard deviation of abnormal returns is estimated using time-series return data on each firm. While a test using standardized abnormal returns is in principle superior under certain conditions, empirically in short-horizon event studies it typically makes little difference (see Brown and Warner, 1980, 1985).

dependence is accounted for because the variability of the portfolio returns through time incorporates whatever cross-dependence that exists among the returns on individual event securities.

The portfolio return approach has a drawback, however. To the extent the event period is associated with increased uncertainty, i.e., greater return variability, the use of historical or post-event time-series variability might understate the true variability of the event-period abnormal performance. An increase in event-period return variability is economically intuitive. The event might have been triggered by uncertainty-increasing factors and/or the event itself causes uncertainty in the economic environment for the firm. In either case, the event-period return variability is likely to exceed that during other time periods for the event firms. Therefore, the statistical significance of the event-window abnormal performance would be overstated if it is evaluated on the basis of historical variability of the event-firm portfolio returns (Brown and Warner, 1980, 1985; Collins and Dent, 1984). One means of estimating the likely increase in the variability of event-period returns is to estimate the cross-sectional variability of returns during the event and non-event periods. The ratio of the variances during the event period and non-event periods might serve as an estimate of the degree of increase in the variability of returns during the event period, which can be used to adjust for the bias in the test statistic calculated ignoring the increased event-period uncertainty.[6]

3.4. Criteria for "reliable" event study tests

Using the test statistics, errors of inference are of two types. A Type I error occurs when the null hypothesis is falsely rejected. A Type II error occurs when the null is falsely accepted. Accordingly, two key properties of event study tests have been investigated. The first is whether the test statistic is correctly specified. A correctly-specified test statistic yields a Type I error probability equal to the assumed size of the test. The second concern is power, i.e., a test's ability to detect abnormal performance when it is present. Power can be measured as one minus the probability of a Type II error. Alternatively, it can be measured as the probability that the null hypothesis will be rejected given a level of Type I error and level of abnormal performance. When comparing tests that are well-specified, those with higher power are preferred.

3.5. Determining specification and power

3.5.1. The joint-test problem

While the specification and power of a test can be statistically determined, economic interpretation is not straightforward because all tests are joint tests. That is, event study

[6] Use of non-parametric tests of significance, as suggested in Corrado (1989), might also be effective in performing well-specified tests in the presence of increased event-period uncertainty.

tests are well-specified only to the extent that the assumptions underlying their estimation are correct. This poses a significant challenge because event study tests are joint tests of whether abnormal returns are zero and of whether the assumed model of expected returns (i.e., the CAPM, market model, etc.) is correct. Moreover, an additional set of assumptions concerning the statistical properties of the abnormal return measures must also be correct. For example, a standard t-test for mean abnormal performance assumes, among other things, that the mean abnormal performance for the cross-section of securities is normally distributed. Depending on the specific t-test, there may be additional assumptions that the abnormal return data are independent in time-series or cross-section. The validity of these assumptions is often an empirical question. This is particularly true for small samples, where one cannot rely on asymptotic results or the central limit theorem.

3.5.2. Brown–Warner simulation

To directly address the issue of event study properties, the standard tool in event study methodology research is simulation procedures that use actual security return data. The motivation and specific research design is initially laid out in Brown and Warner (1980, 1985), and has been followed in almost all subsequent methodology research.

Much of what is known about general properties of event study tests comes from such large-scale simulations. The basic idea behind the event study simulations is simple and intuitive.[7] Different event study methods are simulated by repeated application of each method to samples that have been constructed through a random (or stratified random) selection of securities and random selection of an event date to each. If performance is measured correctly, these samples should show no abnormal performance, on average. This makes it possible to study test statistic specification, that is, the probability of rejecting the null hypothesis when it is known to be true. Further, various levels of abnormal performance can be artificially introduced into the samples. This permits direct study of the power of event study tests, that is, the ability to detect a given level of abnormal performance.

3.5.3. Analytical methods

Simulation methods seem both natural and necessary to determine whether event study test statistics are well-specified. Once it has been established using simulation methods that a particular test statistic is well-specified, analytical procedures have also been used to complement simulation procedures. Although deriving a power function analytically for different levels of abnormal performance requires additional distributional assumptions, the evidence in Brown and Warner (1985, p. 13) is that analytical and simulation methods yield similar power functions for a well-specified test statistic. As illustrated below, these analytical procedures provide a quick and simple way to study power.

[7] This characterization of simulation is from Brown and Warner (1985, p. 4).

3.6. A quick summary of our knowledge

3.6.1. Qualitative properties

Table 2 highlights, in qualitative terms, what is known about the properties of event study tests. The table shows the characteristics of event study methods along three dimensions: specification, power against specific types of alternative hypotheses, and the sensitivity of specification to assumptions about the return generating process. The table also shows how these properties can differ sharply for short and long horizon studies. Much of the remainder of the chapter deals with the full details of this table.

From Table 2, horizon length has a big impact on event study test properties. First, short-horizon event study methods are generally well-specified, but long-horizon methods are sometimes very poorly specified. While much is understood about how to reduce misspecification in long horizon studies (see Section 4), no procedure in whose specification researchers can have complete confidence has yet been developed. Second, short-horizon methods are quite powerful if (but only if) the abnormal performance is concentrated in the event window. For example, a precise event date is known for earnings announcements, but insider trading events might be known to have occurred

Table 2
General characterization of properties of event study test methods

Criterion	Length of event window	
	Short (<12 months)	Long (12 months or more)
Specification	Good	Poor/Moderate
Power when abnormal performance is:		
Concentrated in event window	High	Low
Not concentrated in event window	Low	Low
Sensitivity of test statistic specification to assumptions about the return generating process:		
Expected returns, unconditional on event	Low	High
Cross-sectional and time-series dependence of sample abnormal returns	Low/Moderate	Moderate/High
Variance of abnormal returns, conditional on event	High	High
Sensitivity of power to:		
Sample size	High	High
Firm characteristics (e.g., size, industry)	High	High

only sometime during a one-month window. In contrast to the short-horizon tests, long-horizon event studies (even when they are well-specified) generally have low power to detect abnormal performance, both when it is concentrated in the event window and when it is not. That power to detect a given level of abnormal performance is decreasing in horizon length is not surprising, but the empirical magnitudes are dramatic (see below). Third, with short-horizon methods the test statistic specification is not highly sensitive to the benchmark model of normal returns or assumptions about the cross-sectional or time-series dependence of abnormal returns. This contrasts with long-horizon methods, where specification is quite sensitive to assumptions about the return generating process.

Along several lines, however, short- and long-horizon tests show similarities, and these results are easy to show using either simulation or analytical procedures. First, a common problem shared by both short- and long-horizon studies is that when the variance of a security's abnormal returns conditional on the event increases, test statistics can easily be misspecified, and reject the null hypothesis too often. This problem was first brought to light and has been studied mainly in the context of short-horizon studies (Brown and Warner, 1985, and Corrado, 1989). A variance increase is indistinguishable from abnormal returns differing across sample securities at the time of an event, and would be expected for an event. Thus, this issue is likely to be empirically relevant both in a short- and long-horizon context as well. Second, power is higher with increasing sample size, regardless of horizon length. Third, power depends on the characteristics of firms in the event study sample. In particular, firms experiencing a particular event can have nonrandom size and industry characteristics. This is relevant because individual security variances (and abnormal return variances) exhibit an inverse relation to firm size and can vary systematically by industry. Power is inversely related to sample security variance: the noisier the returns, the harder to extract a given signal. As shown below, differences in power by sample type can be dramatic.

3.6.2. Quantitative results

To provide additional texture on Table 2, below we show specific quantitative estimates of power. We do so using the test statistic shown previously in equations (5) and (6), using two-tailed tests at the 0.05 significance level.[8] Since this test statistic is well-specified, at least at short horizons, the power functions are generated using analytic (rather than simulation) procedures. The estimates are for illustrative purposes only, however, and only represent "back of the envelope" estimates. The figures and the test statistic on which they are based assume independence of the returns (both through time and in the cross-section), and that all securities within a sample have the same standard

[8] This format for displaying power functions is similar to Campbell, Lo, and MacKinlay (1997, pp. 168–172). Our test statistic and procedures are the same as for their test statistic J1, but as discussed below we use updated variance inputs.

deviation. The power functions also assume that return and abnormal return variances are the same (i.e., the model of abnormal returns is the "mean-adjusted returns" model of Brown and Warner, 1980).

3.6.3. Volatility

In calculating the test statistic in an event study, a key input required here is the individual security return (or abnormal return) variance (or standard deviation). To determine a reasonable range of standard deviations, we estimate daily standard deviations for all CRSP listed firms from 1990 to 2002. Specifically, for each year, we: (i) calculate each stock's standard deviation, and (ii) assign firms to deciles ranked by standard deviation. From each decile, the averages of each year's mean and median values are reported in Table 3. The mean daily standard deviation for all firms is 0.053. This is somewhat higher than the value of 0.026 reported by Brown and Warner (1985, p. 9) for NYSE/AMEX firms and the value of 0.035 reported by Campbell and Wasley (1993, p. 79) for NASDAQ firms. The differences reflect that individual stocks have become more volatile over time (Campbell et al., 2001). This is highly relevant because it suggests that the power to detect abnormal performance for events over 1990–2002 is lower than for earlier periods. From Table 3, there is wide variation across the deciles. Firms in decile 1 have a mean daily standard deviation of 0.014, compared to 0.118 for decile 10. The figure of 0.118 for decile 10 seems very high, although this is likely to represent both very small firms and those with low stock prices. Further, there is a strong negative

Table 3
Standard deviation of daily returns on individual securities using all CRSP common-stock securities from 1990–2002. For each year, firms are ranked by their estimated daily standard deviation. Firms with missing observations are excluded. The numbers under mean and median columns represent the average of the annual mean and median values for the firms in each decile and for all firms. The number of firms in each decile ranges from 504 in 2002 to 673 in 1997

Decile	Standard deviation	
	Mean	Median
1	0.014	0.014
2	0.019	0.019
3	0.023	0.023
4	0.028	0.028
5	0.033	0.033
6	0.039	0.039
7	0.046	0.046
8	0.055	0.055
9	0.069	0.068
10	0.118	0.098
All firms	0.053	0.053

empirical relation between volatility and size. Our qualitative results apply if ranking is by firm size, so Table 3 is not simply picking up measurement error in volatility.

3.6.4. Results

Figure 1 shows how, for a sample comprised of securities of average risk and 10% abnormal performance, the power to detect abnormal performance falls with horizon length. This level of abnormal performance seems economically highly significant. If the abnormal performance is concentrated entirely in one day (and the day in known with certainty), a sample of only six stocks detects this level of abnormal performance 100% of the time. In contrast, if the same abnormal performance occurs over six months, a sample size of 200 is required to detect the abnormal performance even 65% of the time. These various rejection frequencies are lower than those using pre-1990 volatilities (not reported), although this is not surprising.

Figure 2(a)–(c) show related results using a one-day horizon for samples whose individual security standard deviations correspond to the average standard deviation for: the lowest decile (Figure 2(a)); all firms (Figure 2(b)); and the highest decile (Figure 2(c)). For decile 1 firms, with 1% abnormal performance a 90% rejection rate requires only 21 stocks. For firms in decile 10, even with 5% abnormal performance a 90% rejection rate requires 60 stocks. These comparisons may distort the differences in actual power if high variance firms are less closely followed and events are bigger surprises. When the effect of events differs cross-sectionally, analysis of test properties (i.e., power and specification) is more complicated.

Collectively, our results illustrate that power against alternative hypotheses can be sensitive to calendar time period and sample firm characteristics, and highlight the importance already recognized in the profession of studying test statistic properties for

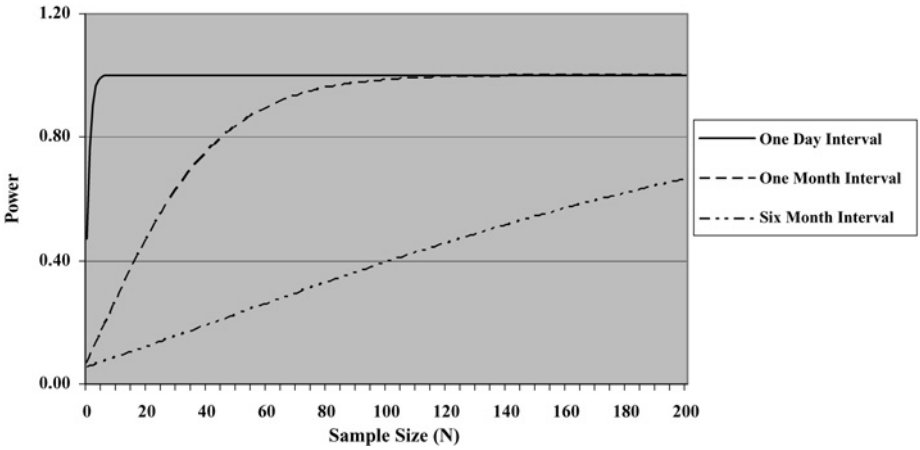
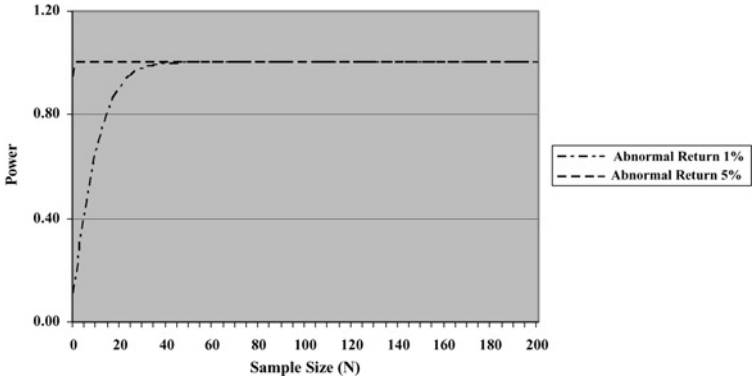
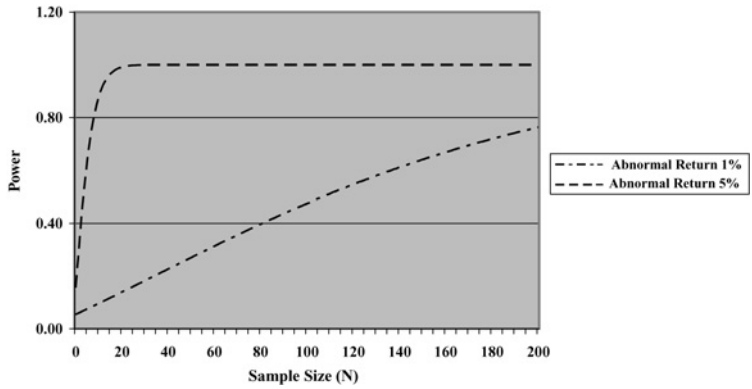


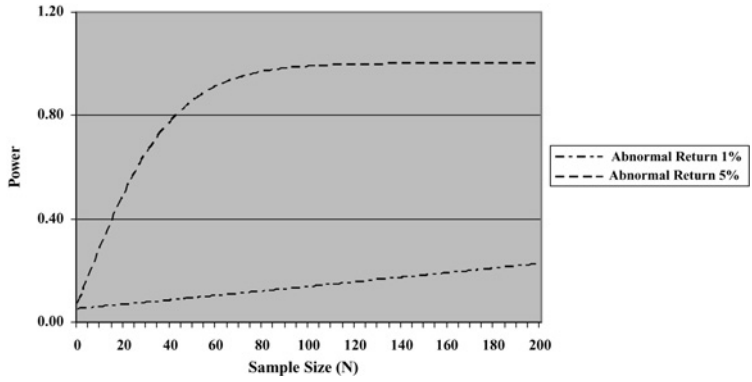
Fig. 1. Power of event study test statistic when abnormal return is 10%.



(a)



(b)



(c)

Fig. 2. (a) Power of event study for firms in the lowest volatility decile. (b) Power of event study for firms with average volatility. (c) Power of event study for firms in the highest volatility decile.

samples stratified by firm characteristics. A complete analysis of these issues would focus on abnormal return (rather than return) volatility, and study how specification (and abnormal return distributional properties such as skewness) varies across time and firm characteristics.

3.7. Cross-sectional tests

This section's focus thus far has been event study tests for mean stock price effects. These tests represent the best understood class of event study tests. To provide a more complete picture of event-related tests, we briefly call attention to cross-sectional tests. These tests examine how the stock price effects of an event are related to firm characteristics. For a cross-section of firms, abnormal returns are compared to (e.g., regressed against) firm characteristics. This provides evidence to discriminate among various economic hypotheses.

Cross-sectional tests are a standard part of almost every event study. They are relevant even when the mean stock price effect of an event is zero. In addition, they are applicable regardless of horizon length. They are simple to do, but as discussed below, "one must be careful in interpreting the results" (Campbell, Lo, and MacKinlay, 1997, p. 174).

One reason that abnormal returns vary cross-sectionally is that the economic effect of the event differs by firm. For such a situation, Sefcik and Thompson (1986) examine the statistical properties of cross-sectional regressions. They are concerned with the effects of cross-sectionally correlated abnormal returns and heteroscedasticity in the abnormal returns. They argue that accounting for each appears to be potentially important for inferences, and they suggest procedures to deal with these issues.

Abnormal returns also vary cross-sectionally because the degree to which the event is anticipated differs by firm. For example, for firms that are more closely followed (e.g., more analysts), events should be more predictable, all else equal. Further, events are endogenous, reflecting a firm's self selection to choose the event, which in turn reflects insiders' information. Recognizing these factors, and recognizing that it is the unexpected information provided by an event that determines the stock price effect, has numerous consequences. For example, standard estimates of cross-sectional coefficients can be biased (Eckbo, Maksimovic, and Williams, 1990). Appropriate procedures for treating self-selection and partial anticipation issues is the subject of an entire chapter by Li and Prabhala (2007) (Chapter 2 in this volume).

Quite apart from the issues discussed in the context of Li and Prabhala, there are several additional dimensions where our understanding of cross-sectional tests is incomplete, and where additional work is potentially fruitful. One area concerns the power of cross-sectional procedures. While specification of cross-sectional regression methods (i.e., biases in regression coefficients) has received much attention, the power of alternative procedures to detect underlying cross-sectional effects has received less study.

A related point is that a simple type of cross-sectional procedure is to form portfolios based on firm characteristics, and compare portfolio abnormal returns. Such procedures are common, but methodological comparisons to cross-sectional regressions

would prove useful. Portfolio procedures seem less amenable to multivariate comparisons than do regression procedures, but the relative empirical merits of each in an event-study context have not been investigated.

We also note that some studies focus not on the stock price effect of an event, but on predicting a corporate event (e.g., management turnover, or a security issue of a particular type), sometimes using past stock prices as one explanatory variable. These tests use cross-sectional methods in the sense that the cross-section includes both event and non-event firms. Typically, discrete choice models (e.g., probit or logit model) relate whether or not the event occurred to firm-specific characteristics. This seems intuitive, since we would like to know what factors led the firm to have the event. These methods complement standard event study methods. Methodological work on prediction models could enhance our understanding of how to best to use information about events to test economic hypotheses about firm behavior.

Finally, additional important issues to consider in an event study are: (i) whether the event was partially anticipated by market participants (e.g., a governance-related regulation might be anticipated following corporate scandals or CEO turnover is likely in the case of a firm experiencing steep stock-price decline and poor accounting performance), and (ii) whether the partial anticipation is expected to vary cross-sectionally in a predictable fashion (e.g., market participants might anticipate that managers of firms experiencing high price run-ups are likely to make value-destroying stock acquisitions, but the negative announcement effect of an actual merger announcement might have been largely anticipated for the firms who have experienced relatively high prior price run up). These issues arising from the nature of information arrival, partial anticipation of events, and cross-sectional variation in the degree of anticipation are also beyond the scope of this chapter. Interested readers will find treatments in Malatesta and Thompson (1985), Eckbo, Maksimovic, and Williams (1990), and, especially, Thompson (1995) of considerable interest.

4. Long-horizon event studies

All event studies, regardless of horizon length, must deal with several basic issues. These include risk adjustment and expected/abnormal return modeling (Section 4.2), the aggregation of security-specific abnormal returns (Section 4.3), and the calibration of the statistical significance of abnormal returns (Section 4.4). These issues become critically important with long horizons. The remainder of this chapter focuses on efforts in the long-horizon literature to deal with the issues.

4.1. Background

Long-horizon event studies have a long history, including the original stock split event study by Fama et al. (1969). As evidence inconsistent with the efficient markets hypothesis started to accumulate in the late seventies and early eighties, interest in long-horizon studies intensified. Evidence on the post-earnings announcement effect (Ball

and Brown, 1968; Jones and Litzenberger, 1970), size effect (Banz, 1981), and earnings yield effect (Basu, 1977, 1983) contributed to skepticism about the CAPM as well as market efficiency. This evidence prompted researchers to develop hypotheses about market inefficiency stemming from investors' information processing biases (DeBondt and Thaler, 1985, 1987) and limits to arbitrage (De Long et al., 1990a, 1990b; Shliefer and Vishny, 1997).

The "anomalies" literature and the attempts to model the anomalies as market inefficiencies has led to a burgeoning field known as behavioral finance. Research in this field formalizes (and tests) the security pricing implications of investors' information processing biases.[9] Because the behavioral biases might be persistent and arbitrage forces might take a long time to correct the mispricing, a vast body of literature hypothesizes and studies abnormal performance over long horizons of one-to-five years following a wide range of corporate events. The events might be one-time (unpredictable) phenomena like an initial public offering or a seasoned equity offering, or they may be recurring events such as earnings announcements.

Many long-horizon studies document apparent abnormal returns spread over long horizons. The literature on long-horizon security price performance following corporate events is summarized extensively in many studies, including Fama (1998), Kothari and Warner (1997), Schwert (2001), and Kothari (2001). Whether the apparent abnormal returns are due to mispricing, or simply the result of measurement problems, is a contentious and unresolved issue among financial economists. The methodological research in the area is important because it demonstrates how easy it is to conclude there is abnormal performance when none exists. Before questions on mispricing can be answered, better methods than currently exist are required.

We summarize some of the salient difficulties and the state-of-the-art event study methods for estimating long-horizon security price performance. More detailed discussions appear in Barber and Lyon (1997), Kothari and Warner (1997), Fama (1998), Brav (2000), Lyon, Barber, and Tsai (1999), Mitchell and Stafford (2000), Jegadeesh and Karceski (2004), Viswanathan and Wei (2004), Eckbo, Masulis, and Norli (2006) and Petersen (2005).

4.2. Risk adjustment and expected returns

In long-horizon tests, appropriate adjustment for risk is critical in calculating abnormal price performance. This is in sharp contrast to short-horizon tests in which risk adjustment is straightforward and typically unimportant. The error in calculating abnormal performance due to errors in adjusting for risk in a short-horizon test is likely to be small. Daily expected returns are about 0.05% (i.e., annualized about 12–13%). Therefore, even if the event firm portfolio's beta risk is misestimated by 50% (e.g., estimated

[9] See Shleifer (2000), Barberis, Shleifer, and Vishny (1998), Daniel, Hirshleifer, and Subrahmanyam (1998), Daniel, Hirshleifer, and Teoh (2002), Hirshleifer (2001), and Hong and Stein (1999).

beta risk of 1.0 when true beta risk is 1.5), the error in the estimated abnormal error is small relative to the abnormal return of 1% or more that is typically documented in short-window event studies. Not surprisingly, Brown and Warner (1985) conclude that simple risk-adjustment approaches to conducting short-window event studies are quite effective in detecting abnormal performance.

In multi-year long-horizon tests, risk-adjusted return measurement is the Achilles heel for at least two reasons. First, even a small error in risk adjustment can make an economically large difference when calculating abnormal returns over horizons of one year or longer, whereas such errors make little difference for short horizons. Thus, the precision of the risk adjustment becomes far more important in long-horizon event studies. Second, it is unclear which expected return model is correct, and therefore estimates of abnormal returns over long horizons are highly sensitive to model choice. We now discuss each of these problems in turn.

4.2.1. Errors in risk adjustment

Such errors can make an economically non-trivial difference in measured abnormal performance over one-year or longer periods. The problem of risk adjustment error is exacerbated in long-horizon event studies because the potential for such error is greater for longer horizons. In many event studies, (i) the event follows unusual prior performance (e.g., stock splits follow good performance), or (ii) the event sample consists of firms with extreme (economic) characteristics (e.g., low market capitalization stocks, low-priced stocks, or extreme book-to-market stocks), or (iii) the event is defined on the basis of unusual prior performance (e.g., contrarian investment strategies in DeBondt and Thaler, 1985, and Lakonishok, Shleifer, and Vishny, 1994). Under these circumstances, accurate risk estimation is difficult, with historical estimates being notoriously biased because prior economic performance negatively impacts the risk of a security. Therefore, in long-horizon event studies, it is crucial that abnormal-performance measurement be on the basis of post-event, not historical risk estimates (Ball and Kothari, 1989; Chan, 1988; Ball, Kothari, and Shanken, 1995; Chopra, Lakonishok, and Ritter, 1992). However, how the post-event risk should be estimated is itself a subject of considerable debate, which we summarize below in an attempt to offer guidance to researchers.

4.2.2. Model for expected returns

The question of which model of expected returns is appropriate remains an unresolved issue. As noted earlier, event studies are joint tests of market efficiency and a model of expected returns (e.g., Fama, 1970). On a somewhat depressing note, Fama (1998, p. 291) concludes that "all models for expected returns are incomplete descriptions of the systematic patterns in average returns", which can lead to spurious indications of abnormal performance in an event study. With the CAPM as a model of expected returns being thoroughly discredited as a result of the voluminous anomalies evidence,

a quest for a better-and-improved model began. The search culminated in the Fama and French (1993) three-factor model, further modified by Carhart (1997) to incorporate the momentum factor.[10] However, absent a sound economic rationale motivating the inclusion of the size, book-to-market, and momentum factors, whether these factors represent equilibrium compensation for risk or they are an indication of market inefficiency has not been satisfactorily resolved in the literature (see, e.g., Brav and Gompers, 1997). Fortunately, from the standpoint of event study analysis, this flaw is not fatal. Regardless of whether the size, book-to-market, and momentum factors proxy for risk or indicate inefficiency, it is essential to use them when measuring abnormal performance. The purpose of an event study is to isolate the incremental impact of an event on security price performance. Since the price performance associated with the size, book-to-market, and momentum characteristics is applicable to all stocks sharing those characteristics, not just the sample of firms experiencing the event (e.g., a stock split), the performance associated with the event itself must be distinguished from that associated with other known determinants of performance, such as the aforementioned four factors.[11]

4.3. Approaches to abnormal performance measurement

While post-event risk-adjusted performance measurement is crucial in long-horizon tests, actual measurement is not straightforward. Two main methods for assessing and calibrating post-event risk-adjusted performance are used: characteristic-based matching approach and the Jensen's alpha approach, which is also known as the calendar-time portfolio approach (Fama, 1998; Eckbo, Masulis, and Norli, 2000; Mitchell and Stafford, 2000). Analysis and comparison of the methods is detailed below. Despite an extensive literature, there is still no clear winner in a horse race. Both have low power against economically interesting null hypotheses, and neither is immune to misspecification.

4.3.1. BHAR approach

In recent years, following the works of Ikenberry, Lakonishok, and Vermaelen (1995), Barber and Lyon (1997), Lyon, Barber, and Tsai (1999), the characteristic-based matching approach (or also known as the buy-and-hold abnormal returns, BHAR) has been widely used. Mitchell and Stafford (2000, p. 296) describe BHAR returns as "the average multiyear return from a strategy of investing in all firms that complete an event and selling at the end of a prespecified holding period versus a comparable strategy

[10] More recently, considerable evidence suggests the importance of a liquidity factor in determining expected returns (Brennan and Subrahmanyam, 1996; Pastor and Stambaugh, 2003; Sadka, 2006). However, still others have begun to question the usefulness of the liquidity factor (see Chordia et al., 2006, and Ng, Rusticus, and Verdi, 2006).

[11] See Kothari, Leone, and Wasley (2005) for an extended discussion.

using otherwise similar nonevent firms". An appealing feature of using BHAR is that buy-and-hold returns better resemble investors' actual investment experience than periodic (monthly) rebalancing entailed in other approaches to measuring risk-adjusted performance.[12] The joint-test problem remains in that any inference on the basis of BHAR hinges on the validity of the assumption that event firms differ from the "otherwise similar nonevent firms" only in that they experience the event. The researcher implicitly assumes an expected return model in which the matched characteristics (e.g., size and book-to-market) perfectly proxy for the expected return on a security. Since corporate events themselves are unlikely to be random occurrences, i.e., they are unlikely to be exogenous with respect to past performance and expected returns, there is a danger that the event and nonevent samples differ systematically in their expected returns notwithstanding the matching on certain firm characteristics. This makes matching on (unobservable) expected returns more difficult, especially in the case of event firms experiencing extreme prior performance.

Once a matching firm or portfolio is identified, BHAR calculation is straightforward. A T-month BHAR for event firm i is defined as:

$$\text{BHAR}_i(t, T) = \prod_{t=1 \text{ to } T} (1 + R_{i,t}) - \prod_{t=1 \text{ to } T} (1 + R_{\text{B},t}), \tag{7}$$

where R_{B} is the return on either a non-event firm that is matched to the event firm i, or it is the return on a matched (benchmark) portfolio.[13] If the researcher believes that the Carhart (1997) four-factor model is an adequate description of expected returns, then firm-specific matching might entail identifying a non-event firm that is closest to an event firm on the basis of firm size (i.e., market capitalization of equity), book-to-market ratio, and past one-year return. Alternatively, characteristic portfolio matching would identify the portfolio of all non-event stocks that share the same quintile ranking on size, book-to-market, and momentum as the event firm (see Daniel et al., 1997, or Lyon, Barber, and Tsai, 1999, for details of benchmark portfolio construction). The return on the matched portfolio is the benchmark portfolio return, R_{B}. For the sample of event firms, the mean BHAR is calculated as the (equal- or value-weighted) average of the individual firm BHARs.

4.3.2. Jensen-alpha approach

The Jensen-alpha approach (or the calendar-time portfolio approach) to estimating risk-adjusted abnormal performance is an alternative to the BHAR calculation using

[12] Apart from similarity with the actual investment experience, the BHAR approach also avoids biases arising from security microstructure issues when portfolio performance is measured with frequent rebalancing (see Blume and Stambaugh, 1983; Roll, 1983; Ball, Kothari, and Shanken, 1995). The latter biases are also reduced if value-weight portfolio performance is examined.

[13] See Mitchell and Stafford (2000) for details.

a matched-firm approach to risk adjustment. Jaffe (1974) and Mandelker (1974) introduced a calendar time methodology to the financial-economics literature, and it has since been advocated by many, including Fama (1998) and Mitchell and Stafford (2000).[14] The distinguishing feature of the most recent variants of the approach is to calculate calendar-time portfolio returns for firms experiencing an event, and calibrate whether they are abnormal in a multifactor (e.g., CAPM or Fama–French three factor) regression. The estimated intercept from the regression of portfolio returns against factor returns is the post-event abnormal performance of the sample of event firms.

To implement the Jensen-alpha approach, assume a sample of firms experiences a corporate event (e.g., an IPO or an SEO).[15] The event might be spread over several years or even many decades (the sample period). Also assume that the researcher seeks to estimate price performance over two years ($T = 24$ months) following the event for each sample firm. In each calendar month over the entire sample period, a portfolio is constructed comprising all firms experiencing the event within the previous T months. Because the number of event firms is not uniformly distributed over the sample period, the number of firms included in a portfolio is not constant through time. As a result, some new firms are added each month and some firms exit each month. Accordingly, the portfolios are rebalanced each month and an equal or value-weighted portfolio excess return is calculated. The resulting time series of monthly excess returns is regressed on the CAPM market factor, or the three Fama and French (1993) factors, or the four Carhart (1997) factors as follows:

$$R_{pt} - R = a_p + b_p(R_{mt} - R) + s_p\,\mathrm{SMB}_t + h_p\,\mathrm{HML}_t + m_p\,\mathrm{UMD}_t + e_{pt}, \tag{8}$$

where

- R_{pt} is the equal or value-weighted return for calendar month t for the portfolio of event firms that experienced the event within the previous T months;
- R_{ft} is the risk-free rate;
- R_{mt} is the return on the CRSP value-weight market portfolio;
- SMB_{pt} is the difference between the return on the portfolio of "small" stocks and "big" stocks;
- HML_{pt} is the difference between the return on the portfolio of "high" and "low" book-to-market stocks;
- UMD_{pt} is the difference between the return on the portfolio of past one-year "winners" and "losers";
- a_p is the average monthly abnormal return (Jensen alpha) on the portfolio of event firms over the T-month post-event period,
- b_p, s_p, h_p, and m_p are sensitivities (betas) of the event portfolio to the four factors.

[14] For a variation of the Jensen-alpha approach, see Ibbotson (1975) *returns across time and securities* (RATS) methodology, which is used in Ball and Kothari (1989) and others.

[15] The description here is based on Mitchell and Stafford (2000).

Inferences about the abnormal performance are on the basis of the estimated a_p and its statistical significance. Since a_p is the average monthly abnormal performance over the T-month post-event period, it can be used to calculate annualized post-event abnormal performance.

Recent work on the implications of using the Jensen-alpha approach is mixed. For example, Mitchell and Stafford (2000) and Brav and Gompers (1997) favor the Jensen-alpha approach. However, Loughran and Ritter (2000) argue against using the Jensen-alpha approach because it might be biased toward finding results consistent with market efficiency. Their rationale is that corporate executives time the events to exploit mispricing, but the Jensen-alpha approach, by forming calendar-time portfolios, under-weights managers' timing decisions and over-weights other observations. In the words of Loughran and Ritter (2000, p. 362): "If there are time-varying misvaluations that firms capitalize on by taking some action (a supply response), there will be more events involving larger misvaluations in some periods than in others. . . In general, tests that weight firms equally should have more power than tests that weight each time period equally". Since the Jensen-alpha (i.e., calendar-time) approach weights each period equally, it has lower power to detect abnormal performance if managers time corporate events to coincide with misvaluations. As a means of addressing the problem, Fama (1998) advocates weighting calendar months by their statistical precision, which varies with sample size. Countering the criticism of Loughran and Ritter (2000), Eckbo, Masulis, and Norli (2000) point out another problem with the buy-and-hold abnormal return methods. The latter is not a feasible portfolio strategy because the total number of securities is not known in advance.[16]

4.4. Significance tests for BHAR and Jensen-alpha measures

The choice between the matched-firm BHAR approach to abnormal return measurement and the calendar time Jensen-alpha approach (also known as the calendar-time portfolio approach) hinges on the researcher's ability to accurately gauge the statistical significance of the estimated abnormal performance using the two approaches. Unbiased standard errors for the distribution of the event-portfolio abnormal returns are not easy to calculate, which leads to test misspecification. Assessing the statistical significance of the event portfolio's BHAR has been particularly difficult because (i) long-horizon returns depart from the normality assumption that underlies many statistical tests; (ii) long-horizon returns exhibit considerable cross-correlation because the

[16] The BHAR approach is also criticized for "pseudo-timing" because BHAR mechanically produces underperformance following a clustering of issues experiencing a common event, e.g., an IPO, in an up or down market (Schultz, 2003; Eckbo and Norli, 2005). The criticism assumes that those seeking to exploit the event-related market inefficiency do not have market-timing ability. The question of pseudo-timing and return predictability is a topic of intense current interest and appears currently unresolved (Baker, Talliaferro, and Wurgler, 2004, 2006; Goyal and Welch, 2003, 2005; Boudoukh, Richardson, and Whitelaw, 2006; Cochrane, 2006).

return horizons of many event firms overlap and also because many event firms are drawn from a few industries; and (iii) volatility of the event firm returns exceeds that of matched firms because of event-induced volatility. We summarize below the econometric inferential issues encountered in performing long-horizon tests and some of the remedies put forward in recent studies.

4.4.1. Skewness

Long-horizon buy-and-hold returns, even after adjusting for the performance of a matched firm (or portfolio), tend to be right skewed. The right skewness of buy-and-hold returns is not surprising because the lower bound is -100% and returns are unbounded on the upside. Skewness in abnormal returns imparts a skewness bias to long-horizon abnormal performance test statistics (see Barber and Lyon, 1997). Brav (2000, p. 1981) concludes that "with a skewed-right distribution of abnormal returns, the Student t-distribution is asymmetric with a mean smaller than the zero null". While the right-skewness of individual firms' long-horizon returns is undoubtedly true, the extent of skewness bias in the test statistic for the hypothesis that mean abnormal performance for the portfolio of event firms is zero is expected to decline with sample size.[17] Fortunately, the sample size in long-horizon event studies is often several hundred observations (e.g., Teoh, Welch, and Wong, 1998, and Byun and Rozeff, 2003). Therefore, if the BHAR observations for the sample firms are truly independent, as assumed in using a t-test, the Central Limit Theorem's implication that "the sum of a large number of independent random variables has a distribution that is approximately normal" should apply (Ross, 1976, p. 252). The right-skewness of the distribution of long-horizon abnormal returns on event *portfolios*, as documented in, for example, Brav (2000) and Mitchell and Stafford, 2000, appears to be due largely to the lack of independence arising from overlapping long-horizon return observations in event portfolios. That is, skewness in portfolio returns is in part a by-product of cross-correlated data rather than a direct consequence of skewed firm-level buy-and-hold abnormal (or raw) returns.

4.4.2. Cross-correlation

4.4.2.1. The issue Specification bias arising due to cross-correlation in returns is a serious problem in long-horizon tests of price performance. Brav (2000, p. 1979) attributes the misspecification to the fact that researchers conducting long-horizon tests typically "maintain the standard assumptions that abnormal returns are independent and normally distributed although these assumptions fail to hold even approximately

[17] Simulation evidence in Barber and Lyon (1997) on skewness bias is based on samples consisting of 50 firms and early concern over skewness bias as examined in Neyman and Pearson (1928) and Pearson (1929a, 1929b) also refers to skewness bias in small samples.

at long horizons".[18] The notion that economy-wide and industry-specific factors would generate contemporaneous co-movements in security returns is the cornerstone of portfolio theory and is economically intuitive and empirically compelling. Interestingly, the cross-dependence, although muted, is also observed in risk-adjusted returns.[19] The degree of cross-dependence decreases in the effectiveness of the risk-adjustment approach and increases in the homogeneity of the sample firms examined (e.g., sample firms clustered in one industry). Cross-correlation in abnormal returns is largely irrelevant in short-window event studies when the event is not clustered in calendar time. However, in long-horizon event studies, even if the event is not clustered in calendar time, cross-correlation in abnormal returns cannot be ignored (Brav, 2000; Mitchell and Stafford, 2000; Jegadeesh and Karceski, 2004). Long-horizon abnormal returns tend to be cross-correlated because: (i) abnormal returns for subsets of the sample firms are likely to share a common calendar period due to the long measurement period; (ii) corporate events like mergers and share repurchases exhibit waves (for rational economic reasons as well as opportunistic actions on the part of the shareholders and/or management); and (iii) some industries might be over-represented in the event sample (e.g., merger activity among technology stocks).

If the test statistic in an event study is calculated ignoring cross-dependence in data, even a fairly small amount of cross-correlation in data will lead to serious misspecification of the test. In particular, the test will reject the null of no effect far more often than the size of the test (Collins and Dent, 1984; Bernard, 1987; Mitchell and Stafford, 2000). The overrejection is caused by the downward biased estimate of the standard deviation of the cross-sectional distribution of buy-and-hold abnormal returns for the event sample of firms.

4.4.2.2. Magnitude of bias To get an idea of approximate magnitude of the bias, we begin with the cross-sectional standard deviation of the event firms' abnormal returns, AR, assuming equal variances and pairwise covariances across all sample firms' abnormal returns:

$$\sigma_{\mathrm{AR}} = \left[\frac{1}{N}\sigma^2 + \frac{N-1}{N}\rho_{i,j}\sigma^2\right]^{1/2}, \tag{9}$$

where N is the number of sample firms, σ^2 is the variance of abnormal returns, which is assumed to be the same for all firms; and $\rho_{i,j}$ is the correlation between firm i and j's abnormal returns, which is also assumed to be the same across all firms. The second term in the square brackets in equation (9) is due to the cross-dependence in the data, and it would be absent if the standard deviation is calculated assuming independence

[18] Also see Barber and Lyon (1997), Kothari and Warner (1997), Fama (1998), Lyon, Barber, and Tsai (1999), Mitchell and Stafford (2000), and Jegadeesh and Karceski (2004).

[19] See Schipper and Thompson (1983), Collins and Dent (1984), Sefcik and Thompson (1986), Bernard (1987), Mitchell and Stafford (2000), Brav (2000), and Jegadeesh and Karceski (2004).

in the data. The bias in the standard deviation assuming independence is given by the ratio of the "true" standard deviation allowing for dependence to the standard deviation assuming independence:

$$\frac{\sigma_{\text{AR}}\ (\text{Dependence})}{\sigma_{\text{AR}}\ (\text{Independence})} = \left[1 + (N-1)\rho_{i,j}\right]^{1/2}. \tag{10}$$

The ratio in equation (10) is the factor by which the standard error in a test for the significance of abnormal performance is understated and therefore the factor by which the test statistic (e.g., t-statistic) itself is overstated. The ratio is increasing in the pairwise cross-correlation, $\rho_{i,j}$. Empirical estimates of the average pairwise correlation between annual BHARs of event firms are about 0.02 to 0.03 (see Mitchell and Stafford, 2000). The average pairwise correlation in multi-year BHARs is likely to be greater than that for annual returns because Bernard (1987, Table 1) reports that the average cross-correlations increase with return horizon. Assuming the average pairwise cross-sectional correlation to be only 0.02, for a sample of 100, the ratio in equation (4) is 1.73, and it increases with both sample size and the degree of cross-correlation. Since the sample size in many long-horizon event studies is a few hundred securities, and the BHAR horizon is three-to-five years, even a modest degree of average cross-correlation in the data can inflate the test statistics by a factor of two or more. Therefore, accounting for cross-correlation in abnormal returns is crucial to drawing accurate statistical inferences in long-horizon event studies. Naturally, this has been a subject of intense interest among researchers.

4.4.2.3. Potential solutions One simple solution to the potential bias due to cross-correlation is to use the Jensen-alpha approach. It is immune to the bias arising from cross-correlated (abnormal) returns because of the use of calendar-time portfolios. Whatever the correlation among security returns, the event portfolio's time series of returns in calendar time accounts for that correlation. That is, the variability of portfolio returns is influenced by the cross-correlation in the data. The statistical significance of the Jensen alpha is based on the time-series variability of the portfolio return residuals. Since returns in an efficient market are serially uncorrelated (absent nontrading), on this basis the independence assumption in calculating the standard error and the t-statistic for the regression intercept (i.e., the Jensen alpha) seems quite appropriate. However, the evidence is that this method is misspecified in nonrandom samples (Lyon, Barber, and Tsai, 1999, Table 10). This is unfortunate, given that the method seems simple and direct. The reasons for the misspecification are unclear (see Lyon, Barber, and Tsai, 1999). Appropriate calibration under calendar time methods probably warrants further investigation.

In the BHAR approach, estimating standard errors that account for the cross-correlation in long-horizon abnormal returns is not straightforward. As detailed below, there has been much discussion, and some interesting progress. Statistically precise estimates of pairwise cross-correlations are difficult to come by for the lack of availability of many time-series observations of long-horizon returns to accurately estimate

the correlations (see Bernard, 1987). The difficulty is exacerbated by the fact that only a portion of the post-event-period might overlap with other firms. Researchers have developed bootstrap and pseudoportfolio-based statistical tests that might account for the cross-correlations and lead to accurate inferences.

4.4.2.4. Cross-correlation and skewness Lyon, Barber, and Tsai (1999) develop a bootstrapped skewness-adjusted t-statistic to address the cross-correlation and skewness biases. The first step in the calculation is the skewness-adjusted t-statistic (see Johnson, 1978). This statistic adjusts the usual t-statistic by two terms that are a function of the skewness of the distribution of abnormal returns (see equation (5) in Lyon, Barber, and Tsai, 1999, p. 174). Notwithstanding the skewness adjustment, the adjusted t-statistic indicates overrejection of the null and thus warrants a further refinement. The second step, therefore, is to construct a bootstrapped distribution of the skewness-adjusted t-statistic (Sutton, 1993; Lyon, Barber, and Tsai, 1999). To bootstrap the distribution, a researcher must draw a large number (e.g., 1,000) of resamples from the original sample of abnormal returns and calculate the skewness-adjusted t-statistic using each resample. The resulting empirical distribution of the test statistics is used to ascertain whether the skewness-adjusted t-statistic for the original event sample falls in the $\alpha\%$ tails of the distribution to reject the null hypothesis of zero abnormal performance.

The pseudoportfolio-based statistical tests infer statistical significance of the event sample's abnormal performance by calibrating against an empirical distribution of abnormal performance constructed using repeatedly-sampled pseudoportfolios.[20] The empirical distribution of average abnormal returns on the pseudoportfolios is under the null hypothesis of zero abnormal performance. The empirical distribution is generated by repeatedly constructing matched firm samples with replacement. The matching is on the basis of characteristics thought to be correlated with the expected rate of return. Following the Fama and French (1993) three-factor model, matching on size and book-to-market as expected return determinants is quite common (e.g., Lyon, Barber, and Tsai, 1999, Byun and Rozeff, 2003, and Gompers and Lerner, 2003). For each matched-sample portfolio, an average buy-and-hold abnormal performance is calculated as the raw return minus the benchmark portfolio return. It's quite common to use 1,000 to 5,000 resampled portfolios to construct the empirical distribution of the average abnormal returns on the matched-firm samples. This distribution yields empirical 5 and 95% cut-off probabilities against which the event-firm sample's performance is calibrated to infer whether or not the event-firm portfolio buy-and-hold abnormal return is statistically significant.

Unfortunately, the two approaches described above, which are aimed at correcting the bias in standard errors due to cross-correlated data, are not quite successful in their intended objective. Lyon et al. find pervasive test misspecification in non-random samples.

[20] See, for example, Brock, Lakonishok, and LeBaron (1992), Ikenberry, Lakonishok, and Vermaelen (1995), Ikenberry, Rankine and Stice (1996), Lee (1997), Lyon, Barber, and Tsai (1999), Mitchell and Stafford (2000), and Byun and Rozeff (2003).

Because the sample of firms experiencing a corporate event is not selected randomly by the researcher, correcting for the bias in the standard errors stemming from the nonrandomness of the event sample selection is not easy. In a strident criticism of the use of bootstrap- and pseudoportfolio-based tests, Mitchell and Stafford (2000, p. 307) conclude that long-term event studies often incorrectly "claim that bootstrapping solves all dependence problems. However, that claim is not valid. Event samples are clearly different from random samples. Event firms have chosen to participate in a major corporate action, while nonevent firms have chosen to abstain from the action. An empirical distribution created by randomly selecting firms with similar size-BE/ME characteristics does not replicate the covariance structure underlying the original event sample. In fact, the typical bootstrapping approach does not even capture the cross-sectional correlation structure related to industry effects. . .". Jegadeesh and Karceski (2004, pp. 1–2) also note that the Lyon, Barber, and Tsai (1999) approach is misspecified because it "assumes that the observations are cross-sectionally uncorrelated. This assumption holds in random samples of event firms, but is violated in nonrandom samples. In nonrandom samples where the returns for event firms are positively correlated, the variability of the test statistics is larger than in a random sample. Therefore, if the empiricist calibrates the distribution of the test statistics in random samples and uses the empirical cutoff points for nonrandom samples, the tests reject the null hypothesis of no abnormal performance too often".

4.4.2.5. Autocorrelation To overcome the weaknesses in prior tests, Jegadeesh and Karceski (2004) propose a correlation and heteroskedasticity-consistent test. The key innovation in their approach is to estimate the cross-correlations using a monthly time-series of portfolio long-horizon returns (see Jegadeesh and Karceski, 2004, Section II.A for details). Because the series is monthly, but the monthly observations contain long-horizon returns, the time-series exhibits autocorrelation that is due to overlapping return data. The autocorrelation is, of course, due to cross-correlation in return data. The autocorrelation is expected to be positive for $H - 1$ lags, where H is the number of months in the long horizon. The length of the time-series of monthly observations depends on the sample period during which corporate events being examined take place. Because of autocorrelation in the time series of monthly observations, the usual t-statistic that is a ratio of the average abnormal return to the standard deviation of the time series of the monthly observations would be understated. To obtain an unbiased t-statistic, the covariances (i.e., the variance–covariance matrix) should be taken into account. Jegadeesh and Karceski (2004) use the Hansen and Hodrick (1980) estimator of the variance–covariance matrix assuming homoskedasticity. They also use a heteroskedasticity-consistent estimator that "generalizes White's heteroskedasticity-consistent estimator and allows for serial covariances to be non-zero" (p. 8). In both random and non-random (industry) samples the Jegadeesh and Karceski (2004) tests perform quite well, and we believe these might be the most appropriate to reduce misspecification in tests of long-horizon event studies.

4.4.3. The bottom line

Despite positive developments in BHAR calibration methods, two general long-horizon problems remain. The first concerns power. Jegadeesh and Karceski (2004) report that their tests show no increase in power relative to that of the test employed in previous research, which already had low power. For example, even with seemingly huge cumulative abnormal performance (25% over 5 years) in a sample of 200 firms, the rejection rate of the null is typically under 50% (see their Table 6).

Second, specification issues remain. For example, as discussed earlier (Section 3.6), events are generally likely to be associated with variance increases, which are equivalent to abnormal returns varying across sample securities. Previous literature shows that variance increases induce misspecification, and can cause the null hypothesis to be rejected far too often. Thus, whether a high level of measured abnormal performance is due to chance or mispricing (or a bad model) is still difficult to empirically determine, unless the test statistic is adjusted downward to reflect the variance shift. Solutions to the variance shift issue include such intuitive procedures as forming subsamples with common characteristics related to the level of abnormal performance (e.g., earnings increase vs. decrease subsamples). With smaller subsamples, however, specification issues unrelated to variance shifts become more relevant. Moreover, the importance of examining specification for nonrandom samples cannot be overemphasized.

Given the various power and specification issues, a challenge that remains for the profession is to continue to refine long-horizon methods. Whether calendar time, BHAR methods or some combination can best address long-horizon issues remains an open question.

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Chapter 2

SELF-SELECTION MODELS IN CORPORATE FINANCE*

KAI LI

Sauder School of Business, University of British Columbia, 2053 Main Mall, Vancouver, BC, V6T 1Z2 Canada
e-mail: kai.li@sander.ubc.ca

NAGPURNANAND R. PRABHALA

Robert H. Smith School of Business, University of Maryland, College Park, MD 20742, USA
e-mail: prabhala@rhsmith.umd.edu

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Abstract

Corporate finance decisions are not made at random, but are usually deliberate decisions by firms or their managers to *self-select* into their preferred choices. This chapter reviews econometric models of self-selection. The review is organized into two parts. The first part reviews econometric models of self-selection, focusing on the key assumptions of different models and the types of applications they may be best suited for. Part two reviews empirical applications of selection models in the areas of corporate investment, financing, and financial intermediation. We find that self-selection is a rapidly growing area in corporate finance, partly reflecting its recognition as a pervasive feature of corporate finance decisions, but more importantly, the increasing recognition of selection models as unique tools for understanding, modeling, and testing the role of private information in corporate finance.

Keywords

selection, private information, switching regression, treatment effect, matching, propensity score, Bayesian selection methods, panel data, event study, underwriting, investment banking, diversification

Introduction

Corporate finance concerns the financing and investment choices made by firms and a broad swathe of decisions within these broad choices. For instance, firms pick their target capital structure, and to achieve the target, must make several choices including issue timing of security issues, structural features of the securities issued, the investment bank chosen to underwrite it, and so on. These choices are not usually random, but are deliberate decisions by firms or their managers to *self-select* into their preferred choices. This chapter reviews econometric models of self-selection. We review the approaches used to model self-selection in corporate finance and the substantive findings obtained by implementing selection methods.

Self-selection has a rather mixed history in corporate finance. The fact that there is self-selection is probably not news; indeed, many papers at least implicitly acknowledge its existence. However, the literature differs on whether to account for self-selection using formal econometric methods, and why one should do so. One view of self-selection is that it is an errant nuisance, a "correction" that must be made to prevent other parameter estimates from being biased. Selection is itself of little economic interest under this view. In other applications, self-selection is itself of central economic interest, because models of self-selection represent one way of incorporating and controlling for unobservable private information that influences corporate finance decisions. Both perspectives find expression in the literature, although an increasing emphasis in recent work reflects the positive view in which selection models are used to construct interesting tests for private information.

Our review is organized into two parts. Part I focuses on econometric models of self-selection. We approach selection models from the viewpoint of a corporate finance researcher who is implementing selection models in an empirical application. We formalize the notion of self-selection and overview several approaches towards modeling it, including reduced form models, structural approaches, matching methods, fixed effect estimators, and Bayesian methods. As the discussion clarifies, the notion of selection is not monolithic. No single model universally models or accounts for all forms of selection, so there is no one "fix" for selection. Instead, there are a variety of approaches, each of which makes its own economic and statistical assumptions. We focus on the substantive economic assumptions underlying the different approaches to illustrate what each can and cannot do and the type of applications a given approach may be best suited for. We do not say much on estimation, asymptotic inference, or computational issues, but refer the reader to excellent texts and articles on these matters.

Part II of our review examines corporate finance applications of self-selection models. We cover a range of topics such as mergers and acquisitions, stock splits, equity offerings, underwriting, analyst behavior, share repurchases, and venture capital. Our objective is to illustrate the wide range of corporate finance settings in which selection arises and the different econometric approaches employed in modeling it. Here,

we focus on applications published in the last decade or so, and on articles in which self-selection is a major component of the overall results.[1]

I. MODELING SELF-SELECTION

This portion of our review discusses econometric models of self-selection. Our intention is not to summarize the entire range of available models and their estimation. Rather, we narrow our focus to models that have been applied in the corporate finance literature, and within these models, we focus on the substantive assumptions made by each specification. From the viewpoint of the empirical researcher, this is the first order issue in deciding what approach suits a given application in corporate finance. We do not touch upon asymptotic theory, estimation, and computation. These important issues are well covered in excellent textbooks.[2]

We proceed as follows. Section 1 describes the statistical issue raised by self-selection, the wedge between the population distribution and the distribution within a selected sample. Sections 2–6 develop the econometric models that can address selection. Section 2 discusses a baseline model for self-selection, the "Heckman" selection model analyzed in Heckman (1979), a popular modeling choice in corporate finance.[3] We discuss identification issues related to the model, which are important but not frequently discussed or justified explicitly in corporate finance applications. Because the Heckman setting is so familiar in corporate finance, we use it to develop a key point of this survey, the analogy between econometric models of self-selection and private information models in corporate finance. Section 3 considers switching regressions and structural self-selection models. While these models generalize the Heckman selection model in some ways, they also bring additional baggage in terms of economic and statistical assumptions that we discuss.

We then turn to other approaches towards modeling selection. Section 4 discusses matching models, which are methods *du jour* in the most recent applications. The popularity of matching models can be attributed to their relative simplicity, easy interpretation of coefficients, and minimal structure with regard to specification. However, these gains come at a price. Matching models make the strong economic assumption that unobservable private information is irrelevant. This assumption may not be realistic in many corporate finance applications. In contrast, selection models explicitly model and incorporate private information. A second point we develop is that while matching

[1] Our attempt is to capture the overall flavor of self-selection models as they stand in corporate finance as of the writing. We apologize to any authors whose work we have overlooked: no slight is intended.

[2] The venerable reference, Maddala (1983), continues to be remarkably useful, though its notation is often (and annoyingly, to the empirical researcher) different from that used in other articles and software packages. Newer material is covered in Wooldridge (2002) and Greene (2003).

[3] Labeling any one model as "the" Heckman model surely does disservice to the many other contributions of James Heckman. We choose this label following common usage in the literature.

methods are often motivated by the fact that they yield easily interpretable *treatment effects*, selection methods also estimate treatment effects with equal ease. Our review of methodology closes by briefly touching upon fixed effect models in Section 5 and Bayesian approaches to selection in Section 6.

1. Self-selection: The statistical issue

To set up the self-selection issue, assume that we wish to estimate parameters β of the regression

$$Y_i = X_i\beta + \epsilon_i \tag{1}$$

for a population of firms. In equation (1), Y_i is the dependent variable, which is typically an *outcome* such as profitability or return. The variables explaining outcomes are X_i, and the error term is ϵ_i. If ϵ_i satisfies usual classical regression conditions, standard OLS/GLS procedures consistently estimate β.

Now consider a sub-sample of firms who self-select choice E. For this sub-sample, equation (1) can be written as

$$Y_i|E = X_i\beta + \epsilon_i|E. \tag{2}$$

The difference between equations (2) and (1) is at the heart of the self-selection problem. Equation (1) is a specification written for the population but equation (2) is written for a subset of firms, those that self-select choice E. If self-selecting firms are not random subsets of the population, the usual OLS/GLS estimators applied to equation (2), are no longer consistent estimators of β.

Accounting for self-selection consists of two steps. Step 1 specifies a model for self-selection, using economic theory to model why some firms select E while others do not. While this specification step is not often discussed extensively in applications, it is critical because the assumptions involved ultimately dictate what econometric model should be used in the empirical application. Step 2 ties the random variable(s) driving self-selection to the outcome variable Y.

2. The baseline Heckman selection model

2.1. The econometric model

Early corporate finance applications of self-selection are based on the model analyzed in Heckman (1979). We spend some time developing this model because most other specifications used in the finance literature can be viewed as extensions of the Heckman model in various directions.

In the conventional perspective of self-selection, the key issue is that we have a regression such as equation (1) that is well specified for a population but it must be estimated

using sub-samples of firms that self-select into choice E. To estimate population parameters from self-selected subsamples, we first specify a self-selection mechanism. This usually takes the form of a probit model in which firm i chooses E if the net benefit from doing so, a scalar W_i, is positive. Writing the selection variable W_i as a function of explanatory variables Z_i, which are assumed for now to be exogenous,[4] we have the system

$$C = E \equiv W_i = Z_i\gamma + \eta_i > 0, \tag{3}$$

$$C = NE \equiv W_i = Z_i\gamma + \eta_i \leqslant 0, \tag{4}$$

$$Y_i = X_i\beta + \epsilon_i, \tag{5}$$

where Z_i denotes publicly known information influencing a firm's choice, γ is a vector of probit coefficients, and η_i is orthogonal to public variables Z_i. In the standard model, Y_i is observed only when a firm picks one of E or NE (but not both), so equation (5) would require the appropriate conditioning. Assuming that η_i and ϵ_i are bivariate normal, the likelihood function and the maximum likelihood estimators for equations (3)–(5) follow, although a simpler two-step procedure (Heckman, 1979, and Greene, 1981) is commonly used for estimation. Virtually all applied work is based on the bivariate normal structure discussed above.

2.2. *Self-selection and private information*

In the above setup, self-selection is a nuisance problem. We model it because not doing so leads to inconsistent estimates of parameters β in regression (1). Self-selection is, by itself, of little interest. However, this situation is frequently reversed in corporate finance, because tests for self-selection can be viewed as tests of private information theories. We develop this point in the context of the Heckman (1979) model outlined above, but we emphasize that this private information interpretation is more general.

We proceed as follows. Following a well-established tradition in econometrics, Section 2.2.1 presents selection as an omitted variable problem. Section 2.2.2 interprets the omitted variable as a proxy for unobserved private information. Thus, including the omitted self-selection variable controls for and tests for the significance of private information in explaining ex-post outcomes of corporate finance choices.

2.2.1. *Selection: An omitted variable problem*

Suppose that firm i self-selects choice E. For firm i, we can take expectations of equation (5) and write

[4] Thus, we preclude for now the possibility that Z includes the outcome variable Y. This restriction can be relaxed at a cost, as we show in later sections.

$$Y_i|E = X_i\beta + (\epsilon_i|Z_i\gamma + \eta_i > 0) \tag{6}$$

$$= X_i\beta + \pi(\eta_i|Z_i\gamma + \eta_i > 0) + \nu_i. \tag{7}$$

Equation (7) follows from the standard result that $\epsilon_i|\eta_i = \pi\eta_i + \nu_i$ where π is the coefficient in the regression of ϵ_i on η_i, and ν_i is an orthogonal zero-mean error term.[5] Given the orthogonality and zero-mean properties of ν_i, we can take expectations of equation (7) and obtain the regression model

$$E(Y_i|E) = X_i\beta + \pi E(\eta_i|Z_i\gamma + \eta_i > 0) \tag{8}$$

and a similar model for firms choosing not to announce E,

$$E(Y_i|NE) = X_i\beta + \pi E(\eta_i|Z_i\gamma + \eta_i \leqslant 0). \tag{9}$$

Equations (8) and (9) can be compactly rewritten as

$$E(Y_i|C) = X_i\beta + \pi\lambda_C(Z_i\gamma) \tag{10}$$

where $C \in \{E, NE\}$ and $\lambda_C(.)$ is the conditional expectation of η_i given C. In particular, if η and ϵ are bivariate normal, as is standard in the bulk of the applied work, $\lambda_E(.) = \frac{\phi(.)}{\Phi(.)}$ and $\lambda_{NE}(.) = -\frac{\phi(.)}{1-\Phi(.)}$ (Greene, 2003, p. 759).

A comparison of equations (1) and (10) clarifies why self-selection is an omitted variable problem. In the population regression in equation (1), regressing outcome Y on X consistently estimates β. However, in self-selected samples, consistent estimation requires that we include an additional variable, the inverse Mills ratio $\lambda_C(.)$. Thus, the process of correction for self-selection can be viewed as including an omitted variable.

2.2.2. *The omitted variable as private information*

In the probit model (3) and (4), η_i is the part of W_i not explained by public variables Z_i. Thus, η_i can be viewed as the private information driving the corporate financing decision being modeled. The ex-ante expectation of η_i should be zero, and it is so, given that it has been defined as an error term in the probit model.

Ex-post after firm i selects $C \in \{E, NE\}$, the expectations of η_i can be updated. The revised expectation, $E(\eta_i|C)$, is thus an updated estimate of the firm's private information. If we wished to test whether the private information in a firm's choice affected post-choice outcomes, we would regress outcome Y on $E(\eta_i|C)$. But $E(\eta_i|C) = \lambda_C(.)$ is the inverse Mills ratio term that we add anyway to adjust for self-selection. Thus, correcting for self-selection is equivalent to testing for private information. The omitted variable used to correct for self-selection, $\lambda_C(.)$, is an estimate of the private information

[5] Note that $\pi = \rho_{\eta\epsilon}\sigma_\epsilon$ where $\rho_{\eta\epsilon}$ is the correlation between ϵ and η, and σ_ϵ^2 is the variance of ϵ.

underlying a firm's choice and testing its significance is a test of whether private information possessed by a firm explains ex-post outcomes. In fact, a two-step procedure most commonly used to estimate selection models follows this logic.[6]

Our main purpose of incorporating the above discussion of the Heckman model is to highlight the dual nature of self-selection "corrections". One can think of them as a way of accounting for a statistical problem. There is nothing wrong with this view. Alternatively, one can interpret self-selection models as a way of testing private information hypotheses, which is perhaps an economically more useful perspective of selection models in corporate finance. Selection models are clearly useful if private information is one's primary focus, but even if not, the models are useful as means of controlling for potential private information effects.

2.3. Specification issues

Implementing selection models in practice poses two key specification issues: the need for exclusion restrictions and the assumption that error terms are bivariate normal. While seemingly innocuous, these issues, particularly the exclusion question, are often important in empirical applications, and deserve some comment.

2.3.1. Exclusion restrictions

In estimating equations (3)–(5), researchers must specify two sets of variables: those determining selection (Z) and those determining the outcomes (X). An issue that comes up frequently is whether the two sets of variables can be identical. This knotty issue often crops up in practice. For instance, consider the self-selection event E in equations (3) and (4) as the decision to acquire a target and suppose that the outcome variable in equation (5) is post-diversification productivity. Variables such as firm size or the relatedness of the acquirer and the target could explain the acquisition decision. The same variables could also plausibly explain the ex-post productivity gains from the acquisition. Thus, these variables could be part of both Z and X in equations (3)–(5). Similar arguments can be made for several other explanatory variables: they drive firms' decision to self-select into diversification and the productivity gains after diversification. Do we need exclusion restrictions so that there is at least one variable driving selection, an instrument in Z that is not part of X?

Strictly speaking, exclusion restrictions are not necessary in the Heckman selection model because the model is identified by non-linearity. The selection-adjusted outcome regression (10) regresses Y on X and $\lambda_C(Z'\gamma)$. If $\lambda_C(.)$ were a linear function of Z, we would clearly need some variables in Z that are not part of X or the regressors

[6] Step 1 estimates the probit model (3) and (4) to yield estimates of γ, say $\hat{\gamma}$, and hence the private information function $\lambda_C(Z_i\hat{\gamma})$. In step 2, we substitute the estimated private information in lieu of its true value in equation (10) and estimate it by OLS. Standard errors must be corrected for the fact that γ is estimated in the second step, along the lines of Heckman (1979), Greene (1981), and Murphy and Topel (1985).

would be collinear.[7] However, under the assumption of bivariate normal errors, $\lambda_C(.)$ is a non-linear function. As Heckman and Navarro-Lozano (2004) note, collinearity between the outcome regression function (here and usually the linear function $X_i\beta$) and the selection "control" function $\lambda_C(.)$ is not a generic feature, so some degree of non-linearity will probably allow the specification to be estimated even when there are no exclusion restrictions.

In practice, the identification issue is less clear cut. The problem is that while $\lambda_C(.)$ is a non-linear function, it is roughly linear in parts of its domain. Hence, it is entirely possible that $\lambda_C(Z'\gamma)$ has very little variation relative to the remaining variables in equation (10), i.e., X. This issue can clearly arise when the selection variables Z and outcome variables X are identical. However, it is important to realize that merely having extra instruments in Z may not solve the problem. The quality of the instruments also matters. Near-multicollinearity could still arise when the extra instruments in Z are weak and have limited explanatory power.

What should one do if there appears to be a multicollinearity issue? It is tempting to recommend that the researcher impose additional exclusion restrictions so that self-selection instruments Z contain unique variables not spanned by outcome variables X. Matters are, of course, a little more delicate. Either the exclusions make sense, in which case these should have been imposed in the first place. Alternatively, the restrictions are not reasonable, in which case it hardly makes sense to force them on a model merely to make it estimable. In any event, as a practical matter, it seems reasonable to always run diagnostics for multicollinearity while estimating selection models whether one imposes exclusion restrictions or not.

The data often offer one degree of freedom that can be used to work around particularly thorny cases of collinearity. Recall that the identification issue arises mainly because of the 1/0 nature of the selection variable W_i, which implies that we do not observe the error term η_i and we must take its expectation, which is the inverse Mills ratio term. However, if we could observe the *magnitude* of the selection variable W_i, we would introduce an independent source of variation in the selection correction term and in effect observe the private information η_i itself and use it in the regression in lieu of the inverse Mills ratio. Exclusion restrictions are no longer needed. This is often more than just a theoretical possibility. For instance, in analyzing a sample of firms that have received a bank loan, we do observe the bank loan amount conditional on a loan being made. Likewise, in analyzing equity offerings, we observe the fact that a firm made an equity offering and also the size of the offer. In hedging, we do observe (an estimate of) the extent of hedging given that a firm has hedged. This introduces an independent source of variation into the private information variable, freeing one from the reliance on non-linearity for identification.

[7] In this case, having a variable in X that is not part of Z does not help matters. If $\lambda_C(.)$ is indeed linear, it is spanned by X whenever Z is spanned by X. Thus, we require extra variables that explain the decision to self-select but are unrelated to the outcomes following self-selection.

2.3.2. Bivariate normality

A second specification issue is that the baseline Heckman model assumes that errors are bivariate normal. In principle, deviations from normality could introduce biases in selection models, and these could sometimes be serious (for an early illustration, see Goldberger, 1983). If non-normality is an issue, one alternative is to assume some specific non-normal distribution (Lee, 1983, and Maddala, 1983, Chapter 9.3). The problem is that theory rarely specifies a particular alternative distribution that is more appropriate. Thus, whether one uses a non-normal distribution and the type of the distribution should be used are often driven by empirical features of the data. One approach that works around the need to specify parametric structures is to use semi-parametric methods (e.g., Newey, Powell and Walker, 1990). Here, exclusion restrictions are necessary for identification.

Finance applications of non-normal selection models remain scarce, so it is hard at this point of time to say whether non-normality is a first order issue deserving particular attention in finance. In one application to calls of convertible bonds (Scruggs, 2006), the data were found to be non-normal, but non-normality made little difference to the major conclusions.

3. Extensions

We review two extensions of the baseline Heckman self-selection model, switching regressions and structural selection models. The first allows some generality in specifying regression coefficients across alternatives, while the second allows bidirectional simultaneity between self-selection and post-selection outcomes.[8] Each of these extensions generalizes the Heckman model by allowing some flexibility in specification. However, it should be emphasized that the additional flexibility that is gained does not come for free. The price is that the alternative approaches place additional demands on the data or require more stringent economic assumptions. The plausibility and feasibility of these extra requirements should be carefully considered before selecting any alternative to the Heckman model for a given empirical application.

3.1. Switching regressions

As in Section 2, a probit model based on exogenous variables drives firms' self-selection decisions. The difference is that the outcome is now specified separately for firms selecting E and NE, so the single outcome regression (5) in system (3)–(5) is now replaced

[8] For instance, in modeling corporate diversification as a decision involving self-selection, structural models would allow self-selection to determine post-diversification productivity changes, as in the standard setup, but also allow anticipated productivity changes to impact the self-selection decision.

by two regressions. The complete model is as follows:

$$C = E \equiv Z_i\gamma + \eta_i > 0, \tag{11}$$

$$C = NE \equiv Z_i\gamma + \eta_i \leqslant 0, \tag{12}$$

$$Y_{E,i} = X_{E,i}\beta_E + \epsilon_{E,i}, \tag{13}$$

$$Y_{NE,i} = X_{NE,i}\beta_{NE} + \epsilon_{NE,i}, \tag{14}$$

where $C \in \{E, NE\}$. Along with separate outcome regression parameter vectors β_E and β_{NE}, there are also two covariance coefficients for the impact of private information on outcomes, the covariance between private information η and ϵ_E and that between η and ϵ_{NE}. Two-step estimation is again straightforward, and is usually implemented assuming that the errors $\{\eta_i, \epsilon_{E,i}, \epsilon_{NE,i}\}$ are trivariate normal.[9]

Given the apparent flexibility in specifying two outcome regressions (13) and (14) compared to the one outcome regression in the standard selection model, it is natural to ask why we do not always use the switching regression specification. There are three issues involved. First, theory should say whether there is a single population regression whose LHS and RHS variables are observed conditional on selection, as in the Heckman model, or whether we have two regimes in the population and the selection mechanism dictates which of the two we observe. In some applications, the switching regression is inappropriate: for instance, it is not consistent with the equilibrium modeled in Acharya (1988). A second issue is that the switching regression model requires us to observe outcomes of firms' choices in both regimes. This may not always be feasible because we only observe outcomes of firms self-selecting E but have little data on firms that choose not to self-select. For instance, if we were analyzing stock market responses to merger announcements as in Eckbo, Maksimovic and Williams (1990), implementing switching models literally requires us to obtain a sample of would-be acquirers that had never announced to the market and the market reaction on the dates that the markets realize that there is no merger forthcoming. These data may not always be available (Prabhala, 1997).[10] A final consideration is statistical power: imposing restrictions such as equality of coefficients $\{\beta, \pi\}$ for E and NE firms (when valid), lead to greater statistical power.

A key advantage of the switching regression framework is that we obtain more useful estimates of (unobserved) counterfactual outcomes. Specifically, if firm i chooses E, we observe outcome $Y_{E,i}$. However, we can ask what the outcome might have been had

[9] Write equations (13) and (14) in regression form as

$$Y_{C,i} = X_{C,i}\beta_C + \pi_C\lambda_C(Z_i\gamma), \tag{15}$$

where $C \in \{E, NE\}$. The two-step estimator follows: the probit model (11) and (12) gives estimates of γ and hence the inverse Mills ratio $\lambda_C(.)$, which is fed into regression (15) to give parameters $\{\beta_E, \beta_{NE}, \pi_E, \pi_{NE}\}$. As before, standard errors in the second step regression require adjustment because $\lambda_C(Z\hat{\gamma})$ is a generated regressor (Maddala, 1983, pp. 226–227).

[10] Li and McNally (2004) and Scruggs (2006) describe how we can use Bayesian methods to update priors on counterfactuals. More details on their approach are given in Section 6.

firm i chosen NE, the unobserved counterfactual, and what the gain is from firm i's having made choice E rather than NE. The switching regression framework provides an estimate. The net benefit from choosing E is the outcome of choosing E less the counterfactual had it chosen NE, i.e., $Y_{E,i} - Y_{NE,i} = Y_{E,i} - X_i\beta_{NE} - \pi_{NE}\lambda_{NE}(Z_i\gamma)$. The *expected* gain for firm i is $X_i(\beta_E - \beta_{NE}) + (\pi_E\lambda_E(.) - \pi_{NE}\lambda_{NE}(.))$.[11] We return to the counterfactuals issue when we deal with treatment effects and propensity scores. We make this point at this stage only to emphasize that selection models do estimate treatment effects. This fact is often not apparent when reading empirical applications, especially those employing matching methods.

3.2. Simultaneity in self-selection models

The models considered thus far presume that the variables Z explaining the self-selection decision (equations (3) and (4) or equations (11) and (12)) are exogenous. In particular, the bite of this assumption is to preclude the possibility that the decision to self-select choice C does not directly depend on the anticipated outcome from choosing C. This assumption is sometimes too strong in corporate finance applications. For instance, suppose we are interested in studying the diversification decision and that the outcome variable to be studied is firm productivity. The preceding models would assume that post-merger productivity does *not* influence the decision to diversify. If firms' decisions to diversify depend on their anticipated productivity changes, as theory might suggest (Maksimovic and Phillips, 2002), the assumption that Z is exogenous is incorrect.

The dependence of the decision to self-select on outcomes and the dependence of outcomes on the self-selection decision is essentially a problem of simultaneity. Structural selection models can account for simultaneity. We review two modeling choices. The Roy (1951) model places few demands on the data but it places tighter restrictions on the mechanism by which self-selection occurs. More elaborate models are less stringent on the self-selection mechanism, but they demand more of the data, specifically instruments, exactly as in conventional simultaneous equations models.

3.2.1. The Roy model

The Roy model hard-wires the dependence of self-selection on post-selection outcomes. Firms self-select E or NE depending on which of the two alternatives yields the higher outcome. Thus, $\{E, Y_E\}$ is observed for firm i if $Y_{E,i} > Y_{NE,i}$. If, on the other hand,

[11] This expression stands in contrast to the basic Heckman setup. There, in equation (9), $\beta_E = \beta_{NE}$ and $\pi_E = \pi_{NE}$, so the expected difference is $\pi(\lambda_E(.) - \lambda_{NE}(.))$. There, the sign of the expected difference is fixed: it *must* equal to the sign of π because $(\lambda_E(.) - \lambda_{NE}(.)) > 0$. Additionally, the expected difference in the setup of Section 2 does not vary with β or variables X that are not part of Z: here, it does. In short, the counterfactual choices that could be made but were not are less constrained in the switching regression setup.

$Y_{NE,i} \geqslant Y_{E,i}$, we observe $\{NE, Y_{NE,i}\}$. The full model is

$$C = E \equiv Y_{E,i} > Y_{NE,i}, \tag{16}$$

$$C = NE \equiv Y_{E,i} \leqslant Y_{NE,i}, \tag{17}$$

$$Y_{E,i} = X_i \beta_E + \epsilon_{E,i}, \tag{18}$$

$$Y_{NE,i} = X_i \beta_{NE} + \epsilon_{NE,i}, \tag{19}$$

where the ϵ's are (as usual) assumed to be bivariate normal. The Roy model is no more demanding of the data than standard selection models. Two-step estimation is again fairly straightforward (Maddala, 1983, Chapter 9.1).

The Roy selection mechanism is rather tightly specified on two dimensions. One, the model exogenously imposes the restriction that firms selecting E would experience worse outcomes had they chosen NE and vice versa. This is often plausible. However, it is unclear whether this should be a hypothesis that one wants to test or a restriction that one imposes on the data. Two, the outcome differential is the *only* driver of the self-selection decision in the Roy setup. Additional flexibility can be introduced by loosening the model of self-selection. This extra flexibility is allowed in models to be described next, but it comes at the price of requiring additional exclusion restrictions for model identification.

3.2.2. Structural self-selection models

In the standard Heckman and switching regression models, the explanatory variables in the selection equation are exogenous. At the other end of the spectrum is the Roy model of Section 3.2.1, in which self-selection is driven solely by the endogenous variable. The interim case is one where selection is driven by both exogenous and outcome variables. This specification is

$$C = E \equiv Z_i \gamma + \delta(Y_{E,i} - Y_{NE,i}) + \eta_i > 0, \tag{20}$$

$$C = NE \equiv Z_i \gamma + \delta(Y_{E,i} - Y_{NE,i}) + \eta_i \leqslant 0, \tag{21}$$

$$Y_{E,i} = X_i \beta_E + \epsilon_{E,i}, \tag{22}$$

$$Y_{NE,i} = X_i \beta_{NE} + \epsilon_{NE,i}. \tag{23}$$

The structural model generalizes the switching regression model of Section 3.1, by incorporating the extra explanatory variable $Y_{E,i} - Y_{NE,i}$, the net outcome gain from choosing E over NE, in the selection decision, and generalizes the Roy model by permitting exogenous variables Z_i to enter the selection equation. Estimation of the system (20)–(23) follows the route one typically treads in simultaneous equations systems estimation—reduced form estimation followed by a step in which we replace the dependent variables appearing in the RHS by their fitted projections. A trivariate normal assumption is standard (Maddala, 1983, pp. 223–239). While structural self-selection models have been around for a while in the labor economics literature, particularly

those studying unionism and the returns to education (see Maddala, 1983, Chapter 8), applications in finance are of very recent origin.

The structural self-selection model clearly generalizes every type of selection model considered before. The question is why one should not always use it. Equivalently, what additional restrictions or demands does it place on the data? Because it is a type of the switching regression model, it comes with all the baggage and informational requirements of the switching regression. As in simultaneous equations systems, instruments must be specified to identify the model. In the diversification example at the beginning of this section, the identification requirement demands that we have at least one instrument that determines whether a firm diversifies but does not determine the ex-post productivity of the diversifying firm. The quality of one's estimates depends on the strength of the instrument, and all the caveats and discussion of Section 2.3.1 apply here.

4. Matching models and self-selection

This section reviews matching models, primarily those based on propensity scores. Matching models are becoming increasingly common in applied work. They represent an attractive means of inference because they are simple to implement and yield readily interpretable estimates of "treatment effects." However, matching models are based on fundamentally different set of assumptions relative to selection models. Matching models assume that unobserved private information is irrelevant to outcomes. In contrast, unobserved private information is the essence of self-selection models. We discuss these differences between selection and matching models as well as specific techniques used to implement matching models.

To clarify the issues, consider the switching regression selection model of Section 3.1, but relabel the choices to be consistent with the matching literature. Accordingly, firms are *treated* and belong to group E or *untreated* and belong to group NE. This assignment occurs according to the probit model

$$pr(E|Z) = pr(Z\gamma + \eta) > 0, \tag{24}$$

where Z denotes explanatory variables, γ is a vector of parameters and we drop firm subscript i for notational convenience. The probability of being untreated is $1-pr(E|Z)$. We write post-selection outcomes as Y_E for treated firms and Y_{NE} for untreated firms, and for convenience, write

$$Y_E = X_E\beta_E + \epsilon_E, \tag{25}$$

$$Y_{NE} = X_{NE}\beta_{NE} + \epsilon_{NE}, \tag{26}$$

where (again suppressing subscript i) ϵ_C denotes error terms, X_C denotes explanatory variables, β_C denotes parameter vectors, and $C \in \{E, NE\}$. We emphasize that the basic setup is identical to that of a switching regression of Section 3.1.

4.1. Treatment effects

Matching models focus on estimating *treatment effects*. A treatment effect, loosely speaking, is the value added or the difference in outcome when a firm undergoes treatment E relative to not undergoing treatment, i.e., choosing *NE*. Selection models such as the switching regression specification (equations (11)–(14)) estimate treatment effects. Their approach is indirect. In selection models, we estimate a vector of parameters and covariances in the selection equations and use these parameters to estimate treatment effects. In contrast, matching models go directly to treatment effect estimation, setting aside the step of estimating parameters of regression structures specified in selection models.

The key question in the matching literature is whether treatment effects are significant. In the system of equations (24)–(26), this question can be posed statistically in a number of ways.

- At the level of an individual firm i, the effectiveness of a treatment can be judged by asking whether $E(Y_{E,i} - Y_{NE,i}) = 0$.
- For the group of treated firms, the effectiveness of the treatment for treated firms is assessed by testing whether the *treatment effect on treated* (TT), equals zero, i.e., whether $E[(Y_E - Y_{NE})|C = E] = 0$.
- For the population as a whole whether treated or not, we test the significance of the *average treatment effect* (ATE) by examining whether $E(Y_E - Y_{NE}) = 0$.

The main issue in calculating any of the treatment effects discussed above, whether by selection or matching models, is the fact that unchosen counterfactuals are not observed. If a firm i chooses E, we observe outcome of its choice $Y_{E,i}$. However, because firm i chose E, we do not explicitly observe the outcome $Y_{NE,i}$ that would occur had the firm instead made the counterfactual choice *NE*. Thus, the difference $Y_{E,i} - Y_{NE,i}$ is never directly observed for any particular firm i, so its expectation—whether at the firm level, or across treated firms, or across treated and untreated firms—cannot be calculated directly. Treatment effects can, however, be obtained via selection models or by matching models, using different identifying assumptions. We discuss selection methods first and then turn to matching methods.

4.2. Treatment effects from selection models

Self-selection models obtain treatment effects by first estimating parameters of the system of equations (24)–(26). Given the parameter estimates, it is straightforward to estimate treatment effects described in Section 4.1, as illustrated, e.g., in Section 3.1 for the switching regression model. The key identifying assumption in selection models is the specification of the variables entering selection and outcome equations, i.e., variables X and Z in equations (24)–(26).

Two points deserve emphasis. The first is that the entire range of selection models discussed in Section 2 through Section 3.2 can be used to estimate treatment effects. This point deserves special mention because in received corporate finance applications, the

tendency has been to report estimates of matching models and as a robustness check, an accompanying estimate of a selection model. With virtually no exception, the selection model chosen for the robustness exercise is the Heckman model of Section 2. However, there is no a priori reason to impose this restriction—any other model, including the switching regression models or the structural models, can be used, and perhaps ought to at least get a hearing. The second point worth mentioning is that unlike matching models, selection models always explicitly test for and incorporate the effect of unobservable private information, through the inverse Mills ratio term, or more generally, through *control functions* that model private information (Heckman and Navarro-Lozano, 2004).

4.3. Treatment effects from matching models

In contrast to selection models, matching models begin by assuming that private information is irrelevant to outcomes.[12] Roughly speaking, this is equivalent to imposing zero correlation between private information η and outcome Y_E in equations (24)–(26).

Is irrelevance of private information a reasonable assumption? It clearly depends on the specific application. The assumption is quite plausible if the decision to obtain treatment E is done through an exogenous randomization process. It becomes less plausible when the decision to choose E is an endogenous choice of the decision-maker, which is probably close to many corporate finance applications except perhaps for exogenous shocks such as regulatory changes.[13] If private information can be ignored, matching methods offer two routes to estimate treatment effects: dimension-by-dimension matching and propensity score matching.

4.3.1. Dimension-by-dimension matching

If private information can be ignored, the differences in firms undergoing treatment E and untreated NE firms only depend on observable attributes X. Thus, the treatment effect for any firm i equals the difference between its outcome and the outcome for a firm $j(i)$ that matches it on all observable dimensions, Formally, the treatment effect equals $Y_{i,E} - Y_{j(i),NE}$, where $j(i)$ is such that $X_{i,k} = X_{j(i),k}$ for all K relevant dimensions, i.e., $\forall k$, $k = 1, 2, \ldots, K$. Other measures such as TT and ATE defined in Section 4.1 follow immediately.[14]

Dimension-by-dimension matching methods have a long history of usage in empirical corporate finance, as explained in Chapter 1 (Kothari and Warner, 2007) in this book.

[12] See, e.g., Wooldridge (2002) for formal expressions of this condition.

[13] Of course, even here, if unobservable information guides company responses to such shocks, irrelevance of unobservables is still not a good assumption.

[14] One could legitimately ask why we need to match dimension by dimension when we have a regression structure such as (25) and (26). The reason is that dimension-by-dimension matching is still consistent when the data come from the regressions, but dimension-by-dimension matching is also consistent with other data generating mechanisms. If one is willing to specify equations (25) and (26), the treatment effect is immediately obtained as the difference between the fitted values in the two equations.

Virtually all studies routinely match on size, industry, the book-to-market ratio, and so on. The "treatment effect" is the matched-pair difference in outcomes. There is nothing inherently wrong with these methods. They involve the same economic assumptions as other matching methods based on propensity scores used in recent applications. In fact, dimension-by-dimension matching imposes less structure and probably represents a reasonable first line of attack in typical corporate finance applications.

Matching on all dimensions and estimating the matched-pair differences in outcomes poses two difficulties. One is that characteristics are not always exactly matched in corporate finance applications. For instance, we often match firm size or book-to-market ratios with 30% calipers. When matches are inexact, substantial biases could build up as we traverse different characteristics being matched. A second issue that proponents of matching methods frequently mention is dimensionality. When the number of dimensions to be matched goes up and the matching calipers become fine (e.g., size and prior performance matched within 5% rather than 30%, and 4-digit rather than 2-digit SIC matches), finding matches becomes difficult or even infeasible. When dimension-by-dimension matching is not feasible, a convenient alternative is methods based on propensity scores. We turn to these next.

4.3.2. Propensity score (PS) matching

Propensity score (PS) matching methods handle the problems caused by dimension-by-dimension matching by reducing it to a problem of matching on a single one: the probability of undergoing treatment E. The probability of treatment is called the *propensity score*. Given a probability model such as equation (24), the treatment effect equals the outcome for the treated firm minus the outcome for an untreated firm with equal treatment probability. The simplicity of the estimator and its straightforward interpretation makes the propensity score estimator attractive.

It is useful to review the key assumptions underlying the propensity score method. Following Rosenbaum and Rubin (1983), suppose that the probability model in equation (24) satisfies

- PS1: $0 < pr(E|Z) < 1$.
- PS2: Given Z, outcomes Y_E, Y_{NE} do not depend on whether the firm is in group E (NE).

Assumption (PS1) requires that at each level of the explanatory variable Z, some firms should pick E and others pick NE. This constraint is frequently imposed in empirical applications by requiring that treated and untreated firms have common support.

Assumption (PS2) is the *strong ignorability* or conditional independence condition. It requires that unobserved private information should not explain outcome differentials between firms choosing E and those choosing NE. This is a crucial assumption. As Heckman and Navarro-Lozano (2004) show, even fairly mild departures can trigger substantial biases in treatment effect estimates.

Given assumptions (PS1) and (PS2), Rosenbaum and Rubin (1983) show that the treatment effect is the difference between outcomes of treated and untreated firms hav-

ing identical treatment probabilities (or propensity scores). Averaging across different treatment probabilities gives the average treatment effect across the population.[15]

4.3.3. Implementation of PS methods

In light of Rosenbaum and Rubin (1983), the treatment effect is the difference between outcomes of treated and untreated firms with identical propensity scores. One issue in implementing matching is that we need to know propensity scores, i.e., the treatment probability $pr(E|Z)$. This quantity is not ex-ante known but it must be estimated from the data, using, for instance, probit, logit, or other less parametrically specified approaches. The corresponding treatment effects are also estimated with error and the literature develops standard error estimates (e.g., Heckman, Ichimura and Todd, 1998; Dehejia and Wahba, 1999; Wooldridge, 2002, Chapter 18).

A second implementation issue immediately follows. What variables do we include in estimating the probability of treatment? While self-selection models differentiate between variables determining outcomes and variables determining probability of being treated (X and Z, respectively, in equations (24)–(26)), matching models make no such distinction. Roughly speaking, either a variable determines the treatment probability, in which case it should be used in estimating treatment probability, or it does not, in which case it should be randomly distributed across treated and untreated firms and is averaged out in computing treatment effects. Thus, for matching models, the prescription is to use all relevant variables in estimating propensity scores.[16]

A third issue is estimation error. In principle, matching demands that treated firms be compared to untreated firms with the same treatment probability. However, treatment probabilities must be estimated, so exact matching based on the true treatment probability is usually infeasible. A popular approach, following Dehejia and Wahba (1999), divides the data into several probability bins. The treatment effect is estimated as the average difference between the outcomes of E and NE firms within each bin. Heckman, Ichimura and Todd (1998) suggest taking the weighted average of untreated firms, with weights declining inversely in proportion to the distance between the treated and untreated firms. For statistical reasons, Abadie and Imbens (2004) suggest that the counterfactual outcomes should be estimated not as the actual outcomes for a matched untreated firm, but as the fitted value in a regression of outcomes on explanatory variables.[17]

[15] This discussion points to another distinction between PS and selection methods. The finest level to which PS methods can go is the propensity score or the probability of treatment. Because many firms can have the same propensity score, PS methods do not estimate treatment effects at the level of the individual firm, while selection methods can do so.

[16] This statement is not, of course, a recommendation to engage in data snooping. For instance, in fitting models to estimate propensity scores, using quality of fit as a model selection criterion leads to difficulties, as pointed out by Heckman and Navarro-Lozano (2004).

[17] The statistical properties of different estimators has been extensively discussed in the econometrics literature, most recently in a review issue devoted to the topic (*Symposium on the Econometrics of Matching*, Review of Economics and Statistics 86 (1), 2004).

5. Panel data with fixed effects

In self-selection models, the central issue is that unobserved attributes that lead firms to self-select could explain variation in outcomes. In panel data settings, we have multiple observations on the same firm over different periods. If the unobservable attributes are fixed over time, we can control for them by including firm fixed effects. Applications of fixed effect models in corporate finance include Himmelberg, Hubbard and Palia (1999), Palia (2001), Schoar (2002), Bertrand and Mullainathan (2003), and Çolak and Whited (2005). There are undoubtedly many more. One question is whether the use of such fixed effect models alleviates self-selection issues. Not necessarily, as we discuss next.

There are two main issues with using firm fixed effects to rule out unobservables. One is that the unobservables should be time invariant. When time invariant effects exist and ought to be controlled for, fixed effect models are effective. However, time invariance is unlikely to be an appropriate modeling choice for corporate events where unobservables are not only time varying but also related to the event under consideration. Furthermore, unobservables often have a causal role in precipitating the corporate finance event being studied. For instance, in the framework of Maksimovic and Phillips (2002), firms diversify or focus because they receive an unobserved shock that alters the optimal scope of the firm. Thus, in studying conglomerate diversification or spinoffs, the central unobservable of importance is the scope-altering shock. It is time varying and it leads to the event of interest—diversification. Including time-invariant firm fixed effects does nothing to address such event-related unobservable shocks. This point also applies to the difference-in-difference methods related to fixed effects. They do not account for event-related self-selection. Such methods are just not designed to capture time-varying and event-related unobservables, which are, in contrast, the central focus of selection models.[18]

A second issue with fixed effect models is statistical power. Models with fixed effects rely on time variation in RHS variables and LHS outcomes for a given firm. Thus, fixed effect models often have limited power when the underlying variables vary slowly over time. In this scenario, causal effects, if any, are primarily manifested in the cross-section rather than time series. Zhou (2001) presents an argument on these lines with an empirical application. Thus, it appears especially important to take a more careful look at the lack of power as an explanation for insignificant results when using fixed effects. It should also be pointed out that the regression R^2 in fixed effects regressions could easily lead to misleading impressions of the strength of an economic relation.[19]

[18] A related issue is the use of period-by-period estimates of Heckman-style selection models in panel data. Imposing such a structure imposes the assumption that the period-by-period disturbances are pairwise uncorrelated with next-period disturbances, which may not necessarily be realistic.

[19] Most cross-sectional studies in corporate finance with reasonable sample sizes report a modest R^2 when there are no fixed effects. However when one adds fixed effects, there is often an impressive improvement in

6. Bayesian self-selection models

Thus far, our discussion covered inference via classical statistical methods. An alternative approach towards estimating selection models involves Bayesian methods. These techniques often represent an elegant way of handling selection models that are computationally too burdensome to be practical for classical methods. We review the Bayesian approach briefly and illustrate their potential value by discussing a class of selection models based on Markov Chain Monte Carlo (MCMC) simulations (see Poirier (1995) for a more in-depth comparison between Bayesian and classical statistical inferences).

6.1. Bayesian methods

The Bayesian approach begins by specifying a prior distribution over parameters that must be estimated. The prior reflects the information known to the researcher without reference to the dataset on which the model is estimated. In time series context, a prior can be formed by looking at out of sample historical data. In most empirical corporate finance applications, which are cross-sectional in nature, researchers tend to be agnostic and use non-informative diffuse priors.

Denote the parameters to be estimated by θ and the prior beliefs about these parameters by the density $p(\theta)$. If the observed sample is y, the posterior density of θ given the sample can be written as

$$p(\theta|y) = \frac{P(y|\theta)p(\theta)}{p(y)}, \tag{27}$$

where $p(y|\theta)$ denotes the likelihood function of the econometric model being estimated. Given the prior and the econometric model, equation (27) employs Bayes rule to generate the posterior distribution $p(\theta|y)$ about parameter θ. The posterior density $p(\theta|y)$ summarizes what one learns about θ after seeing the data. It is the central object of interest that Bayesian approaches wish to estimate.

A key difficulty in implementing Bayesian methods is the computation of the posterior. Except for a limited class of priors and models, posteriors do not have closed-form analytic expressions, which poses computational difficulties in implementing Bayesian models. However, recent advances in computational technology and more importantly, the advent of the Gibbs sampler and the Metropolis–Hastings algorithm, which are specific implementations of MCMC methods, simplify implementation of fairly complex Bayesian models. In some cases, it even provides a viable route for model estimation where classical methods prove to be computationally intractable. Chib and Greenberg (1996) and Koop (2003) provide more detailed discussions of these issues.

R^2 (see, e.g., Campa and Kedia, 2002, and Villalonga, 2004, for interesting illustrations of this point). The high R^2 should not be misattributed to the explanatory power of the included variables, because they often arise due to the (ultimately unexplained) fixed effects.

6.2. Bayesian methods for selection models

To illustrate the implementation of the Bayesian approach to selection models, consider the switching regression model of Section 3.1. For notational convenience, rewrite this model as the system of equations

$$I = 1_{Z_i\gamma+\eta_i>0}, \tag{28}$$

$$Y_{E,i} = X_{E,i}\beta_E + \epsilon_{E,i}, \tag{29}$$

$$Y_{NE,i} = X_{NE,i}\beta_{NE} + \epsilon_{NE,i}, \tag{30}$$

where $1_{\{.\}}$ denotes the indicator function and the other notation follows that in Section 3.1. As before, assume that the errors are trivariate normal with the probit error variance in equation (28) normalized to unity.

The critical unobservability issue, as discussed in Section 4, is that if a firm self-selects E, we observe the outcome $Y_{E,i}$. However, we do not observe the counterfactual $Y_{NE,i}$ that would have occurred had firm i chosen NE instead of E. Following Tanner and Wong (1987), a Bayesian estimation approach generates counterfactuals by augmenting the observed data with simulated observations of the unobservables through a "data augmentation" step. When augmented data are generated in a manner consistent with the structure of the model, the distribution of the augmented data converges to the distribution of the observed data. The likelihood of both the observed and the augmented data can be used as a proxy for the likelihood of the observed data. Conditional on the observed and augmented data and given a prior on parameters γ, β and the error covariances, approximate posteriors for the model parameters can be obtained by using standard simulation methods. The additional uncertainty introduced by simulating unobserved data can then be integrated out (Gelfand and Smith, 1990) to obtain posteriors conditional on only the observed data.

Explicitly modeling the unobserved counterfactuals offers advantages in the context of selection models. The counterfactuals that are critical in estimating treatment effects are merely the augmented data that are anyway employed in Bayesian estimation. The augmented data also reveal deficiencies in the model that are not identified by simple tests for the existence of selectivity bias. In addition, one can obtain exact small sample distributions of parameter estimates that are particularly useful when sample sizes are small to moderate, such as self-selection involving relatively infrequent events. Finally, we can impose parameter constraints without compromising estimation. In later sections, we review empirical applications that employ the Bayesian approach towards estimating counterfactuals (Li and McNally, 2004; Scruggs, 2006). We also illustrate an application to a matching problem (Sørensen, 2005) in which the tractability of the conditional distributions given subsets of parameters leads to computationally feasible estimators in a problem where conventional maximum likelihood estimators are relatively intractable.

II. EMPIRICAL APPLICATIONS

This part reviews empirical applications of self-selection models in corporate finance. We limit our scope to papers in which self-selection is an important element of the econometric approach or substantive findings. We begin with applications in event-studies. Here, the specifications are related to but differ from standard selection models. We then review applications in security offerings and financial intermediation, where more conventional selection models are used to characterize how private information affects debt issue pricing. We then turn to the diversification discount literature, where a range of methods have been used to address self-selection issues. The remaining sections include a collection of empirical applications based on selection and propensity score based matching methods. A last section covers Bayesian techniques. As will be clear from the review, most applications are relatively recent and involve a reasonably broad spectrum of approaches. In most cases, the model estimates suggest that unobserved private information is an important determinant of corporate finance choices.

7. Event studies

Event studies are a staple of empirical corporate finance. Hundreds of studies routinely report the stock market reactions to announcements such as mergers, stock splits, dividend announcements, equity issues, etc. Evidence in these studies has been used as a basis for testing and generating a wealth of theories, policies, and regulations. Chapter 1 in this volume (Kothari and Warner, 2007) overviews the literature.

Self-selection entered the event-study literature relatively recently. Its main use has been as a tool to model private information revealed in events. The basic idea is that when firms announce events, they reveal some latent "private" information. If the private information has value, it should explain the announcement effects associated with an event. Selection models are convenient tools to model the information revelation process and estimate "conditional" announcement effects.

7.1. Conditional announcement effects: Acharya (1988)

Acharya (1988) introduces the self-selection theme to event-studies, using a version of the standard Heckman specification to model calls of convertible bonds. In Acharya's model, firms decide whether to call an outstanding convertible bond (event E) or not (event NE) according to a probit model, viz.,

$$E \quad \text{if } W_i = Z_i\gamma + \eta_i > 0, \tag{31}$$

$$NE \quad \text{if } W_i = Z_i\gamma + \eta_i \leqslant 0, \tag{32}$$

where Z denotes known observables and η, the probit error term, is private information. Ex-ante, private information has zero mean, but ex-post, once the firm has announced

E or NE, markets update expectations. If the private information affects stock prices, the stock price reaction y to the firm's choice should be related to the updated value of private information. Assuming that (η, y) are bivariate normal with mean, variances, and correlation equal to $(0, 0, 1, \sigma_y^2, \rho)$, we can write

$$E(y|E) = \pi E(\eta_i|\eta_i > -Z_i'\gamma) = \pi\lambda_E(Z_i'\gamma), \tag{33}$$

where $\pi = \rho\sigma_\epsilon$ and $\lambda_E(Z_i'\gamma) = \pi\phi(Z_i'\gamma)/\Phi(Z_i'\gamma)$, the inverse Mills ratio. Equation (33) gives the *conditional* announcement effect associated with event E. It is a specialized version of the Heckman (1979) model (e.g., equation (10)) in which there are no regressors other than the inverse Mills ratio.[20]

The empirical application in Acharya (1988) is conversion-forcing calls of convertible bonds (event E) while NE denotes the decision to delay forced conversion. Acharya finds that the coefficient π in equation (33) is statistically significant, suggesting that the markets do react to the private information revealed in the call. The coefficient is negative, consistent with the Harris and Raviv (1985) signaling model. A legitimate question is whether testing for the significance of unconditional announcement effects and running a linear regression on characteristics Z could yield inferences equivalent to those from Acharya's model. Acharya (1993) offers simulation evidence and the question is formally analyzed in Prabhala (1997). Self-selection models add most value when one has samples of firms that chose *not* to announce E because these methods offer a natural way of exploiting the information in samples of silent non-announcers.

7.2. *Two announcements on the same date:* Nayak and Prabhala (2001)

In the Acharya model, there is one announcement on an event-date. Nayak and Prabhala (2001) analyze a specification in which two announcements are made on the same date. They present a model to recover the individual impact of each announcement from the observed announcement effects, which reflect the combined impact of both announcements made on one date.

The empirical application in Nayak and Prabhala is to stock splits, 80% of which are announced jointly with dividends. Nayak and Prabhala model the joint decisions about whether to split a stock and whether to increase dividends using a bivariate probit model, which can be specified as

$$SPL_i = \gamma_s Z_{si} + \psi_{si}, \tag{34}$$

$$DIV_i = \gamma_d Z_{di} + \psi_{di}. \tag{35}$$

If SPL_i exceeds zero, a firm splits, and if DIV_i exceeds zero, it increases dividends. The private information components of these two latent variables are ψ_{si} and ψ_{di}, and these have potentially non-zero correlation ρ_{sd}. The announcement effect from the two

[20] The absence of other regressors is dictated by the condition that announcement effects should not be related to ex-ante variables under the efficient markets hypothesis.

decisions is

$$E(AR_{sdi}) = \gamma_{sd} + \beta_d E(\psi_{di}|C, S) + \beta_s E(\psi_{si}|C, S). \tag{36}$$

The question of substantive interest is to decompose the joint split-dividend announcement effect into a portion due to the dividend information implicit in a split and the portion unrelated to the dividend information in the split. This decomposition cannot be inferred directly from equation (36) because the term relating to splits ($\beta_d E(\psi_{di}|C, S)$) incorporates both the dividend and the non-dividend portion of the information in splits. However, this decomposition is facilitated by writing the split information ψ_{si} into dividend and non-dividend components. Accordingly, write $\psi_{si} = \rho_{sd}\psi_{di} + \psi_{s-d,i}$, in which case the joint announcement effect is

$$E(AR_{sdi}|C, S) = \gamma_{sd} + (\alpha_d - \rho_{sd}\alpha_{s-d})E(\psi_{di}|C, S) + \alpha_{s-d}E(\psi_{si}|C, S), \tag{37}$$

where α_d and α_{s-d} denote the reaction to the dividend and pure split components of the information in splits. Given these, Nayak and Prabhala show that the market's reaction to a hypothetical "pure" split unaccompanied by a dividend is

$$E(AR_{si}) = \left(1 - \rho_{sd}^2\right)\alpha_{s-d}\psi_{si} + \rho_{sd}\alpha_d\psi_{si}. \tag{38}$$

The first component in equation (38) represents the market's reaction to pure split information orthogonal to dividends and the second represents the reaction to the dividend information implied by a split. Estimating the model is carried out using a two-step procedure.[21] Using a sample of splits made between 1975 and 1994 divided into two sub-samples of ten years each, Nayak and Prabhala report that about 46% of split announcement effects are due to information unrelated to the dividend information in splits.

The Nayak and Prabhala analysis has interesting implications for sample selection in event studies. In many cases, an event is announced together with secondary information releases. For instance, capital expenditure, management, or compensation announcements may be made together with earnings releases, creating noisy samples. The conventional remedy for this problem is to pick samples in which the primary announcement of interest is not accompanied by a secondary announcements by firms. However, the analysis in Nayak and Prabhala suggests that this remedy may not cure the ill, since markets can form expectations about and price secondary announcements even when they are not explicitly announced on the event date. A different approach is to model both announcements and extract the information content of each. Selection methods are useful tools in this regard because they explicitly model and incorporate the latent information from multiple announcements.

[21] The parameter ρ_{sd} is obtained as the correlation coefficient in the bivariate probit model (34) and (35). The inverse Mills ratios for equation (37) follow (they require modification from standard expressions to incorporate non-zero correlation between bivariate latent variables). The other coefficients can be estimated from regression (37).

7.3. *Takeovers:* Eckbo, Maksimovic and Williams (1990)

Eckbo, Maksimovic and Williams (1990)—henceforth EMW—propose variants of the "truncated regression" specification, rather than the Heckman selection model used in Acharya (1988) model to analyze announcement effects. Their empirical application is to takeovers, the subject of Chapter 15 (Betton, Eckbo and Thorburn, 2007).

EMW develop two models for announcement effects. In both models, managers announce event E if the stock market gain, $y_i = x_i\gamma + \eta_i$ is positive. As before, η_i is private information, normally distributed with mean zero and variance ω^2 and x_i denotes publicly known variables. In model 1, event E completely surprises the capital markets. In this case, the bidder's announcement effect is

$$\begin{aligned} F(x_i) &= E(y_i | y_i = x_i\gamma + \eta_i > 0) \\ &= x_i\gamma + \omega \frac{\phi(x_i\gamma/\omega)}{\Phi(x_i\gamma/\omega)}. \end{aligned} \tag{39}$$

In model 2, the market learns about the impending takeover on a prior rumor date. The probability that the takeover will be announced is the probability that the takeover gain is positive, i.e., $Pr(x_i\gamma + \eta_i > 0) = \Phi(x_i\gamma/\omega)$. If the takeover occurs, the gain is $F(x_i)$, while the absence of the takeover is assumed to lead to zero gain. Thus, the expected stock return on the rumor date is $F(x_i)\Phi(x_i\gamma/\omega)$. On the actual merger announcement date, the takeover probability rises to 1 and the announcement effect is

$$G(x_i) = \left[x_i\gamma + \omega \frac{\phi(x_i\gamma/\omega)}{\Phi(x_i\gamma/\omega)} \right] \left[1 - \Phi(x_i\gamma/\omega) \right]. \tag{40}$$

The EMW expression in equation (40) is different from the Acharya model because EMW assume that private information has value only conditional on the takeover E, but has no value if there is no takeover. Thus, EMW model the real gains specific to mergers rather than non-specific information modeled by Acharya. In the actual empirical application. EMW find that bidder gains decrease with the size of the bidder relative to the target, the concentration of firms in the industry, and the number of previous takeovers in the industry. As a model diagnostic, they show that OLS estimates differ from those of the non-linear model (40), which is supported by the Vuong (1989) test statistics. EMW also report that ω^2 is significant, indicating that bidders' private information is valued by capital markets.

The EMW framework has been widely applied in other event-studies with cross-sectional regressions. Eckbo (1990) examines the valuation effects of greenmail prohibitions and finds that the precommittment not to pay greenmail is value enhancing. Maksimovic and Unal (1993) estimate the after-market price performance of public offers in thrift conversions recognizing that management's choice of issue size reflects the value of growth opportunities and conflicts of interest between managers and investors. Servaes (1994) relates takeover announcement effects to excess capital expenditure. Hubbard and Palia (1995) find an increasing and then decreasing relation between merger announcement effects and managerial ownership levels. Bohren, Eckbo and

Michalsen (1997) use it to explain why rights flotations are not favored over public offerings despite the greater direct costs of the latter. Li and McNally (2006) apply the EMW method to open market share repurchases in Canada and find evidence supporting a signaling interpretation of repurchase announcement effects. We study one particular extension of EMW, Eckbo (1992), in greater detail next.

7.4. *Takeover deterrence:* Eckbo (1992)

Eckbo (1992) extends the EMW framework to account for the fact that regulatory challenges and court decisions on these could affect merger gains. To the extent these decisions also involved unobserved private information, they introduce additional selection bias terms into the final specification. Eckbo develops these models and applies them to horizontal mergers and price effects of rivals not involved in takeovers.

As in EMW, horizontal mergers occur if the acquirer's share of the synergy gains, $y_j = x_j\gamma + \eta_j > 0$. Under the EMW assumptions, the model for the announcement effects is equation (40). Additionally, regulators can choose whether to initiate antitrust actions or not, and subsequently courts can decide whether to stop a merger or not. These actions are modeled using additional probit models.

$$R = x_i\phi_r + \eta_r > 0, \tag{41}$$

$$C = x_i\phi_c + \eta_c > 0. \tag{42}$$

Merger gains are realized if mergers are not challenged or they are challenged but challenges are unsuccessful. Assuming that challenges have a cost c proportional to merger gains, conditional announcement effects of merger announcements can be written as

$$E(AR_i|E) = \left[(1 - p_{ri}\,p_{ci})\left(x_i\gamma + \omega\frac{\phi(x_i\gamma/\omega)}{\Phi(x_i\gamma/\omega)}\right) - p_{ri}c\right] \times \left[1 - \Phi(x_i\gamma/\omega)\right]. \tag{43}$$

Eckbo applies the truncated regression models to U.S. and Canadian data. For Canadian data, Eckbo uses the EMW models (39) and (40) because there is no regulatory overhang. He uses equation (43) in U.S. horizontal mergers where regulatory overhang exists. The explanatory variables include the ratio of the market values of the bidder and target firms, the number of non-merging rival firms in the industry of the horizontal merger, the pre-merger level of and merger-induced change in industry concentration. Eckbo finds that bidder gains are positively related to the pre-merger concentration ratio and are negatively related to the merger-induced changes in the concentration ratio. These do not support the collusion explanation for merger gains. In an interesting innovation, Eckbo also estimates the models for non-merging rivals. He reports similar and even sharper findings in challenged deals where court documents identify rivals more precisely. Changes in concentration are negatively related to rival gains in the regulatory overhang free environment in Canada, further refuting the collusion hypothesis.

8. The pricing of public debt offerings

Companies making a debt issue must make several decisions related to the offering such as the terms and structure of the offering, the type of the underwriter for the issue. Private information held by the issuer or the intermediaries participating in the offering could affect the choices made by firms. If such information has value, it affects the prices at which issues can be sold. A fairly wide range of self-selection models have been used to address the existence of private information and its effect on the pricing of debt issues. We review some of the applications and the key findings that emerge.

8.1. Bank underwritings and the Glass–Steagall Act: Puri (1996)

The choice of an underwriter is an area that has been extensively analyzed using self-selection models. An early application is Puri (1996), who investigates the information in a firm's choice between commercial banks and investment banks as underwriters of public debt offerings. Commercial banks are often thought to possess private information about their borrowers. If they use the private information positively, commercial bank underwritten offerings should be priced higher (the "certification" hypothesis). Alternatively, banks could use their information negatively to palm off their lemons to the market, in which case the markets should discount commercial bank underwritten offerings (the "conflicts of interest" hypothesis). Selection models are natural avenues to examine the nature of these private information effects.

Puri models the private information in the underwriter choice using a probit model, viz.,

$$C = CB \equiv W_i = Z_i\gamma + \eta_i > 0, \tag{44}$$

$$C = IB \equiv W_i = Z_i\gamma + \eta_i \leqslant 0, \tag{45}$$

where CB denotes a commercial bank, IB denotes an investment bank, and η_i is the private information in offering i. Markets price issue i at yield y_i where

$$y_i = x_i\beta + \epsilon_i, \tag{46}$$

$$E(y_i|C) = X_i\beta + \pi\lambda_C(Z_i\gamma). \tag{47}$$

Equation (47) follows from equation (46) and the assumption that ϵ and η are bivariate normal. The above system is, of course, the standard Heckman model of Section 2, so the sign of the covariance coefficient π determines the impact of private information on offer yields. If $\pi > 0$, markets demand higher yield for CB offerings, consistent with a conflicts of interest hypothesis, while $\pi < 0$ supports the certification hypothesis.

The data in Puri (1996) are debt and preferred stock issues prior to the passage of the 1933 Glass–Steagall Act. She includes issue size, credit rating, syndicate size, whether the security is exchange listed, whether it is collateralized, and the age of the issuer as determinants of the offer yield. She finds that $\pi < 0$, consistent with the certification hypothesis. Additionally, π is more negative for information sensitive securities, where

the conflicts of interest hypothesis predicts the more *positive* coefficient.[22] Gande et al. (1997), and Gande, Puri and Saunders (1999) report similar findings for debt issues offered after the 1989 relaxation of the Glass–Steagall Act. Underwritings by commercial banks convey positive information that improves the prices at which debt offerings can be sold.[23]

8.2. *Underwriting syndicate structure:* Song (2004)

Song (2004) analyzes debt offerings as in Puri (1996), Gande et al. (1997), and Gande, Puri and Saunders (1999) but there are some important differences in her specifications. Song uses a switching regression instead of the Heckman model. Second, she focuses on the effect of the syndicate structure rather than the commercial/investment banking dichotomy on debt issue spreads.

In Song's model, commercial banks could enter as lead underwriters or be part of a hybrid syndicate with investment banks. Alternatively, issues could be underwritten by a pure investment bank syndicate. For each outcome, we observe the yield of the debt offering, which is modeled as a function of public information and (implicitly) the private information conveyed in the firm's choice of a syndicate structure. The resulting specification is a variant of the switching regression model of Section 3.1, and can be written as

$$A_i = 1 \quad \text{if } (-Z_{Ai}\gamma_A + \eta_{Ai}) > 0, \tag{48}$$

$$B_i = 1 \quad \text{if } (-Z_{Bi}\gamma_B + \eta_{Bi}) > 0, \tag{49}$$

$$C_i = 1 \quad \text{if } (-Z_{Ci}\gamma_C + \eta_{Ci}) > 0, \tag{50}$$

$$Y_{1i} = X_{1i}\beta_1 + \eta_{1i}, \tag{51}$$

$$Y_{2i} = X_{2i}\beta_2 + \eta_{2i}, \tag{52}$$

$$Y_{3i} = X_{3i}\beta_3 + \eta_{3i}, \tag{53}$$

where we have adapted Song's notation for consistency with the rest of this chapter.[24] In equations (48)–(50), the counterfactuals are $A = 0$, $B = 0$, and $C = 0$, respectively.

In Song's model $A_i = 1$ if a lead investment bank invites a commercial bank to participate in the syndicate. $B_i = 1$ if the commercial bank joins the syndicate, and zero otherwise. $C_i = 1$ if a commercial bank led syndicate is chosen and $C_i = 0$

[22] Of course, it is possible that investors paid more for bank underwritten issues but were fooled into doing so. Puri (1994) rules out this hypothesis by showing that bank underwritten offerings defaulted less than non-bank issues.

[23] Chiappori and Salanie (2000) use similar methods to analyze the role of private information in insurance markets. Liu and Malatesta (2006) is a recent application of self-selection models to seasoned equity offerings. They analyze the availability of a credit rating on the underpricing and announcement effects of SEOs.

[24] Song's usage of signs for coefficients and error terms illustrates some confusing notation in the limited dependent variable literature. Her notation follows Maddala (1983) where the selection criterion is often written as $Z\gamma - \eta > 0$, while the more modern textbook convention is to use $Z\gamma + \eta > 0$.

if a pure investment bank syndicate is chosen. Thus, a hybrid syndicate is observed (regime 1) when $A_i = 1$ and $B_i = 1$; a pure investment bank syndicate (regime 2) is observed when $A_i = 0$ and $C_i = 0$, while a commercial bank led syndicate (regime 3) is observed when $B_i = 0$ and $C_i = 1$.[25] Song assumes that the latent errors η are i.i.d. normal, correlated with yields Y with regression coefficients $\sigma_{\omega j}$ where $\omega \in \{A, B, C\}$ and $j \in \{1, 2, 3\}$. The yields in each regime can be expressed in regression form as

$$E(y_{1i}|A_i = 1, B_i = 1) = X_{1i}\beta_1 + \sigma_{A1}\frac{\phi(Z_{Ai}\gamma_A)}{1 - \Phi(Z_{Ai}\gamma_A)} + \sigma_{B1}\frac{\phi(Z_{Bi}\gamma_B)}{1 - \Phi(Z_{Bi}\gamma_B)}, \tag{54}$$

$$E(y_{2i}|A_i = 0, C_i = 0) = X_{2i}\beta_2 - \sigma_{A2}\frac{\phi(Z_{Ai}\gamma_A)}{\Phi(Z_{Ai}\gamma_A)} - \sigma_{C2}\frac{\phi(Z_{Ci}\gamma_C)}{\Phi(Z_{Ci}\gamma_C)}, \tag{55}$$

$$E(y_{3i}|B_i = 0, C_i = 1) = X_{3i}\beta_3 - \sigma_{B3}\frac{\phi(Z_{Bi}\gamma_B)}{\Phi(Z_{Bi}\gamma_B)} + \sigma_{C3}\frac{\phi(Z_{Ci}\gamma_C)}{1 - \Phi(Z_{Ci}\gamma_C)}. \tag{56}$$

Song's sample comprises 2,345 bond issues offered between January 1991 and December 1996. In the first step probit estimates, Song reports that compared to pure investment bank syndicates, hybrid syndicates underwrite small firms that have made smaller debt issues in the past, have low S&P stock rankings, invest less, and use more bank debt. These findings are reminiscent of those in Gande et al. (1997) and Gande, Puri and Saunders (1999) that commercial banks underwrite informationally sensitive companies. Compared to commercial bank led syndicates, hybrid syndicates underwrite smaller firms with lower stock rankings that issue to refinance debt and lower ranked firms, consistent with the claim that these underwritings potentially alleviate conflicts of interest with commercial banks. Only two out of six private information coefficients in equations (54)–(56) are significant. Pricing benefits are seen in pure investment banking syndicates (equation (55)) where excluding a commercial bank leads to higher yields, consistent with a certification hypothesis. On the other hand, picking an investment bank to run the syndicate increases yields, because the coefficient σ_{C2} in the same equation (55) is positive. Thus, the ex-ante effect of awarding a syndicate to an investment bank cannot be a priori signed.

Relative to prior work, Song (2004) has very different sample, sample period, and explanatory variables, not to mention the changes in underwriter classification, which is based on syndicate structure rather than on classification into commercial/investment bank or on bank reputation. Thus, it is hard to pinpoint the specific value added by her elaborate selection model. In addition, absent additional diagnostics, it is also difficult to interpret whether the general insignificance of most selection terms reflects coefficients that are truly zero, the lack of power, perhaps due to collinearity, or perhaps an unmodeled correlation between errors in equations (48)–(50) that are assumed to be

[25] Song does not explicitly write out the extensive form of the model she estimates. It is unclear whether pure investment bank syndicates should also include the node at which an investment bank is awarded the mandate and chooses to invite a commercial bank but the bank declines to join.

i.i.d. for the purposes of estimation. As Song points out, additional data may not help shed light on interpretation or robustness because there have been structural changes in the banking industry since 1996, due to several mergers and further relaxation of the Glass–Steagall Act.

8.3. *Underwriter reputation:* Fang (2005)

Like the other papers reviewed in this section, Fang (2005) also studies the role of underwriter choice in explaining at-issue bond spreads. Unlike the other papers in the section, however, Fang draws on an earlier literature and classifies underwriters by reputation rather than by organization into commercial or investment banks. Fang examines whether the information in the choice of a reputed underwriter impacts underwriting spreads and yields.

Fang uses a probit specification to model underwriter-issuer matching. If issue i is underwritten by a reputed underwriter, the yield is $Y_{E,i}$ and if not, the yield is $Y_{NE,i}$. Yields are specified as a function of regressors x_i with different regression coefficients across the two choices. Thus, Fang's model is exactly the switching regression of Section 3.1. Fang also estimates an auxiliary regression where the dependent variable is gross spread rather than offer yield.

Fang finds that reputed underwriters underwrite higher grade, less risky issues of large and frequent issuers, and are more likely to be associated with longer maturity callable issues that she interprets as being more complex. The self-selection term in the yield equation is negative. Thus, the unobserved information that leads firms to choose reputed underwriters leads to lower bond yields or better offer prices. In the specification analyzing gross spreads, Fang finds that issue size increases fees more rapidly but risk variables matter less for reputed underwriters, indicating greater marginal costs and superior risk bearing capacity of reputed underwriters. Most importantly, the coefficient for the inverse Mills ratio in the gross spread equation is positive, suggesting that reputed underwriters charge greater fees to issuers.

Taken together, the yield and gross spread specifications show that reputed underwriters charge issuers greater fees and lower the offer yields (i.e., increase the offer price) to borrowers. Fang shows that the benefit of lowered debt yields typically outweighs the higher commissions paid by issuers. The pattern of results is shown to strengthen in lower yield bonds, so that reputation matters more for more informationally sensitive issues.

8.4. *Debt covenants:* Goyal (2005)

While the papers reviewed in this section study and model information in underwriter choice, Goyal (2005) examines the information in the choice of covenants attached to debt issues. Goyal argues that commercial banks often enjoy franchise value because of regulations that deter free entry. Banks with more valuable franchises are less likely to engage in excessive risk taking, so they should have less need to include covenants in

their debt issues. This incentive is recognized and priced by the market, and the pricing differential again feeds back into firms' decisions about whether to include covenants. In other words, the decision to include covenants influences and is influenced by the expected pricing benefits from doing so. Goyal implements the structural self-selection model of Section 3.2 to model the simultaneity.

Goyal estimates the structural model on a sample of 415 subordinated debt issues made by firms between 1975 and 1994. He finds that yields are negatively related to franchise value. This finding is consistent with the hypothesis that banks with greater franchise value have less incentives to take risk, latent information that is recognized and priced by financial markets. The inverse Mills ratio term is significant in the no-covenant sub-sample but not in the sample with restrictive covenants. In the equation explaining whether firms use covenants or not, the coefficient for the yield differential with/without covenants is significant in explaining covenant choice, suggesting that anticipated pricing benefits do influence whether firms select covenants or not in their debt issues. Many of Goyal's results are more prominent in the 1981–1988 sub-period, when the risk-taking activity in the U.S. was more elevated.[26]

8.5. Discussion

The public debt issue pricing area is interesting for the wide range of selection models employed. One issue, however, is that it is a little difficult to place the literature in perspective because the sources of self-selection modeled vary across papers. An additional issue is, of course, that there is probably self-selection on other dimensions as well, such as maturity, collateral, or the callability of an issue, not speaking of the decision to issue debt in the first place. This raises another thorny question, one that probably has no easy answer. What dimensions of self-selection should one control for in a given empirical application? Modeling every source of selection seems infeasible, while studying some sources of bias while ignoring others also seems a little ad-hoc. Embarking on a purely empirical search for sources of selection that matter is certainly undesirable, smacking of data snooping. A happy middle way is likely to emerge as the literature matures.

9. Other investment banking applications

9.1. Underwriter compensation in IPOs: Dunbar (1995)

Dunbar (1995) presents an interesting application of a Roy (1951) style self-selection model to the study of underwriter compensation. Some IPO issuers offer warrants to compensate their underwriters while other issuers do not. Dunbar examines the role

[26] Reisel (2004) provides an interesting extension, a structural self-selection model applied to debt covenants included in industrial bonds.

of self-selection in explaining this choice, and in particular, whether firms choose the alternative that minimizes their underwriting costs.

Let W denote the decision to use warrants to compensate underwriters and N if not, subscripts w and n denote the costs if warrants are used or not, respectively, U denote underpricing costs and C the other costs of going public. If firm i chooses underwriter warrant compensation, we observe the pair $\{U_{wi}, C_{wi}\}$ while we observe $\{U_{ni}, C_{ni}\}$ if it chooses just straight cash compensation. The key self-selection issue is that we observe the choice made by firm i but not the costs of the alternative not chosen by firm i. Without knowing the unchosen counterfactuals, we cannot tell how much a company saved by choosing to include or exclude warrants to compensate its underwriters.

Dunbar models the decision to use warrants using a probit model

$$W = \xi(U_{ni} + C_{ni} - U_{wi} - C_{wi}) - \varepsilon_i > 0, \tag{57}$$

$$N = \xi(U_{ni} + C_{ni} - U_{wi} - C_{wi}) - \varepsilon_i \leqslant 0. \tag{58}$$

The expression in parentheses in equation (57) is the reduction in offering costs if warrants are used as compensation instead of straight cash compensation. Each component of costs is written as a function of observables and unobservables as follows:

$$U_{ni} = X_{ni}\beta_n + \varepsilon_{uni}, \tag{59}$$

$$U_{wi} = X_{wi}\beta_w + \varepsilon_{uwi}, \tag{60}$$

$$C_{ni} = Z_{ni}\gamma_n + \varepsilon_{cni}, \tag{61}$$

$$C_{wi} = Z_{wi}\gamma_w + \varepsilon_{cwi}. \tag{62}$$

Assuming that the errors in equations (59)–(62) are i.i.d. normal but potentially correlated with the probit error term, Dunbar's system is a version of the Roy (1951) self-selection model.

Dunbar reports that variables such as offering size, underwriter reputation, and a hot issue dummy explain underpricing in the warrant and cash compensation samples. The self-selection term is significant in the non-warrant sample but not in the warrant compensation sample. Most interesting are Dunbar's estimates of unobserved counterfactuals. For firms that do not use warrants, underpricing (other costs) would be 11.6% (19.2%) on average had warrants been used compared to actual underpricing (other costs) of 12.8% (9.8%). For firms that do use warrants, underpricing (other costs) would be 36.4% (14.6%) if warrants had not been used, compared to actual costs of 23.3% (23.9%). While warrants are associated with high underpricing in reduced form cross-sectional regressions, it is incorrect to conclude that warrants result in higher underpricing. Estimates of the self-selection model indicates that the use of warrants actually *reduces* underpricing compared to what it would be without warrants. Firms appear to use warrants to reduce underpricing costs.

9.2. *Analyst coverage:* Ljungqvist, Marston and Wilhelm (2006)

Ljungqvist, Marston and Wilhelm (2006) examine the relation between the decision to award an underwriting mandate to a bank and the coverage offered by the bank's analyst. The self-selection issue in Ljungqvist et al. is that banks self-select on whether they cover a stock or not. If the bank covers a stock, we observe the nature of the stock recommendation and we can tie it to the decision to award an underwriting mandate. However, if a bank does not elect to cover a stock, we do not know what the nature of its recommendation might have been had it chosen to cover the stock. Ljungqvist et al. model this source of self-selection in testing whether a firm with more positive coverage of a firm is more likely to win the firm's underwriting mandates.

Ljungqvist et al. model the probability that bank j covers firm i's stock as a probit model

$$\begin{aligned} y_C &= 1 \quad \text{if } y_C^* = X_C\beta_C + u_C > 0, \\ y_C &= 0 \quad \text{if } y_C^* = X_C\beta_C + u_C \leqslant 0, \end{aligned} \tag{63}$$

where all subscripts are suppressed for notational convenience. If there is coverage, the tie between coverage and the award of an underwriting mandate is established by the equations

$$\left.\begin{aligned} y_A &= \beta_A X_A + u_A \\ y_L &= I_{\beta_L X_L + \delta_L y_A + u_L > 0} \end{aligned}\right\} \quad \text{if } y_C^* > 0. \tag{64}$$

If there is no coverage, we have

$$\left.\begin{aligned} y_A &= 0 \\ y_L &= I_{\beta_{LNC} X_L + u_{LNC} > 0} \end{aligned}\right\} \quad \text{if } y_C^* \leqslant 0, \tag{65}$$

where y_A is the nature of an analyst's recommendation, y_L is a $1/0$ dummy for whether an underwriting mandate is awarded to a bank, I is the $1/0$ indicator function, and X's are explanatory variables. Equations (63)–(65) represent a switching regression system, similar to the type analyzed in Section 3.1. The difference here is that we have two recursive equations observed in each regime instead of just one regression in Section 3.1.

Ljungqvist et al. find that the decision to cover a stock is positively related to the type of coverage offered by an analyst for debt underwriting transactions. Prior relationships in the underwriting and loan markets are the other most significant explanatory variables. There is no evidence that the type of coverage influences the decision to award equity underwriting mandates. Even when it is significant, the coefficient for analyst recommendation β_A in equation (64) is negative. Ljungqvist et al. interpret this finding as evidence that even if analysts are overly biased, issuers refrain from using them for underwriting.

The analysis of Ljungqvist et al. has appealing features. The choice of instruments is carefully motivated, with both economic intuition and tests for instrument strength suggested by Staiger and Stock (1997). Their analysis also suggests some natural extensions. One issue is that the very decision to cover a stock—rather than the type of

coverage—might affect the probability of winning an underwriting mandate. A second and perhaps more difficult issue is that of cross-sectional correlation. The 16,000+ transactions in the Ljungqvist et al. sample occur over overlapping periods, which leads to commonality across transactions and potential cross-sectional correlation in the disturbance terms.

10. Diversification discount

The scope of the firm is an issue that has occupied economists since Coase (1933). One issue in this literature has been whether firms should diversify or not. While the question can be examined from several perspectives, a now well developed literature in finance investigates the diversification question from a valuation perspective. Does diversification impact firm value, and if so, in what direction, and why does diversification have this effect? Our review of this literature focuses on self-selection explanations for diversification. Chapter 8 (Maksimovic and Phillips, 2007) provides a more complete review of the now vast literature on diversification.

The recent finance literature on diversification begins with the empirical observation that diversified firms trade below their imputed value, which is the weighted average value of stand-alone firms in the same businesses as the divisions of the diversified firm (see, e.g., Lang and Stulz, 1994, Berger and Ofek, 1995, and Servaes, 1996). The difference between the actual and imputed values is called the diversification discount. The existence of a diversification discount is frequently interpreted as a value destroying consequence of diversification, although there is no consensus on the issue (e.g., Chevalier, 2000, and Graham, Lemmon and Wolf, 2002). We review three papers that discuss the role of self-selection in explaining the source of diversification discount.

10.1. Unobservables and the diversification discount: Campa and Kedia (2002)

Campa and Kedia (2002) argue that firms self-select into becoming diversified and that self-selection explains the diversification discount. They model the decision to become diversified using a probit model

$$D_{it} = 1 \quad \text{if } Z_{it}\gamma + \eta_{it} > 0, \tag{66}$$

$$D_{it} = 0 \quad \text{if } Z_{it}\gamma + \eta_{it} \leqslant 0, \tag{67}$$

where D_{it} is a diversification dummy that takes the value of 1 if the firm operates in more than one segment, and 0 otherwise, and Z_{it} is a set of explanatory variables. The notations are adapted to match that in Section 2. Excess value V_{it} is specified as

$$V_{it} = d_0 + d_1 X_{it} + d_2 D_{it} + \epsilon_{it}, \tag{68}$$

where X_{it} is a set of exogenous observable characteristics of firm i at time t. Coefficient d_2 is the key parameter of interest. If it is negative, becoming diversified causes

the diversification discount. If not, the diversification discount could not be due to diversification. Under the assumption that the error terms in equations (67) and (68) are bivariate normal, the system is akin to and is estimated just like the basic Heckman selection model.[27]

In the empirical application, Campa and Kedia measure the LHS variable in equation (68), as the difference between the actual value of the firm and the sum of the imputed value of each of its segments. Segment imputed values are estimated using multipliers based on market value to sales or market value to book value of assets of peer firms. The explanatory variables for equation (68) include profitability, size, capital expenditure, and leverage. The additional instruments used in the probit specification equations (66) and (67) include industry instruments such as the fraction of firms (or their sales) in an industry that are diversified, time instruments, macroeconomic indicators such as the overall economic growth and economic expansion/contraction, and firm specific instruments such as being listed on a major exchange or being included in a stock index. Campa and Kedia extensively discuss their choices for instruments.

Campa and Kedia show that in OLS specifications, d_2 is negative, so that diversified firms do appear to trade at a discount. However, once they include the inverse Mills ratio to correct for self-selection, the coefficient d_2 becomes positive. The negative sign seen in OLS estimates is soaked up by the coefficient for the inverse Mills ratio. This indicates that diversified firms possess private information that makes them self-select into being diversified. The information is negatively associated with value and leads to the diversification discount. After accounting for unobserved private information, there is no diversification discount: in fact, there is a premium, implying that diversification may well be in shareholders' best interests.

The flip in the sign of d_2 when the selection term is introduced does raise the question of robustness of results, particularly with respect to potential collinearity between the dummy variable for diversification and the inverse Mills ratio that corrects for selection. Campa and Kedia address this issue by reporting several other models, including a simultaneous questions system that instruments the diversification dummy D_{it} and evidence based on a sample of refocusing firms. The main results are robust: there is indeed a diversification discount as found by Lang and Stulz (1994) or Berger and Ofek (1995) when using OLS estimates. However, this discount is not due to diversification, but by private information that leads firms to become diversified. In fact, the Campa and Kedia self-selection estimates suggest that diversified firms trade at a premium relative to their value had they not diversified.

[27] Compared to the standard Heckman model, there is one additional variable in the second stage equation (68), specifically, the dummy variable D_{it}. The Heckman model with the additional dummy variable is called a "treatment effects" model. The panel data setting also requires the additional assumption that the unobserved errors be i.i.d. period by period. Campa and Kedia estimate fixed effects models as an alternative to Heckman-style selection models to handle the panel structure of the data.

10.2. *Observables and the discount:* Villalonga (2004)

While Campa and Kedia (2002) attribute the diversification discount to unobservables causing firms to diversify, Villalonga (2004) offers an explanation based on differences in observables. Villalonga uses a longitudinal rather than cross-sectional analysis, focusing on *changes* in excess value around diversification rather than the level of the excess value itself.

Villalonga's main sample comprises 167 cases where firms move from being one segment to two segments. She tracks the changes in the diversification discount around the diversification event compared to a control group of non-diversifying firms, using propensity score (PS) based matching to construct matched control firms. Following the methods discussed in Section 4.3.2, Villalonga fits a probit model to estimate the probability that a given firm will diversify using variables similar to those in Campa and Kedia (2002). She matches each diversifying firm with a non-diversifying firm with a similar propensity score, i.e., diversifying probability. Her final sample has five quintiles of firms based on their estimated propensity scores and having a common support.

Villalonga estimates the "treatment effect" caused by diversification as the difference between the change in excess value of a diversifying firm and the excess value change of a comparable non-diversifying firms with the closest propensity score. She reports that while the treatment effect is negative, it is not significant whether she uses the Dehejia and Wahba (1999) or the Abadie and Imbens (2004) technique for estimation. Villalonga also reports similar findings when using a Heckman correction, presumably a treatment effect model on the lines of Campa and Kedia (2002).[28]

Two aspects of Villalonga's results deserve comment. One issue is perhaps semantic, the use of the term *causal inference*. In reading the work, one could easily come away with the impression that matching methods somehow disentangle causality from correlation. This is incorrect. Matching methods rule out correlation by arbitrary fiat: causality is an *assumption* rather than a statistically tested output of these methods. This fact is indeed acknowledged by Villalonga but easy to overlook given the prominence attached to the term "causal inference" in the paper.

A second issue is that some point estimates of treatment effects are insignificant but not very different in economic magnitude from those in Lang and Stulz (1994) and Berger and Ofek (1995)—and indeed, from the baseline industry-adjusted estimates that Villalonga herself reports. Thus, in fairness to Lang and Stulz and Berger and Ofek, Villalonga's results do not necessarily refute their earlier work. Nevertheless, Villalonga's

[28] In reviewing applications, we often found references to "the" Heckman model or "standard" Heckman models to be quite confusing. Campa and Kedia (2002) and Çolak and Whited (2005) use it to denote a treatment effects model, and focus on the coefficient for the diversification dummy variable. However, the Heckman (1979) model is not a treatment effects model. Also, it is not clear from the papers whether the coefficient of interest is the coefficient for the dummy variable in a treatment effects model or for the inverse Mills ratio term. It is perhaps a better practice not to use labels but instead describe fully the specification being estimated.

work does make an important point. Specifically, the statistical significance of discount based on industry/size matching methods is not a given fact, but is an open question in light of her results.

10.3. Refocusing and the discount: Çolak and Whited (2005)

If one accepts the diversification discount as a fact, then the question is what causes the discount. One view is that conglomerates (i.e., diversified firms) follow inefficient investment policies, subsidizing inefficient divisions with cash flow from the efficient divisions. Çolak and Whited (2005) evaluate the efficiency of investment in conglomerate and non-conglomerate firms by comparing investments made by focusing firms with those made by firms that do not focus. The focusing sample in Çolak and Whited (2005) consists of 267 divestitures and 154 spinoffs between 1981 and 1996. Control non-focusing firms are multi-segment firms in similar businesses that do not focus in years -3 through $+3$ where year 0 is the focusing event for a sample point.

The main specification used in Çolak and Whited (2005) employs propensity scores to match focusing and non-focusing firms. As in standard propensity score method implementations, Çolak and Whited (2005) estimate the propensity score as the probability that a given firm will focus in the period ahead. The probit estimates broadly indicate that firms are more likely to focus if they are larger, have less debt, diversity in segments (entropy), and have had recent profit shocks.

The central issue in Çolak and Whited is, of course, on change in investment efficiency after a focusing activity. Çolak and Whited use several measures of change in investment efficiency, including investment Q-sensitivity, the difference in adjusted investment to sales ratio between high and low growth segments, and the relative value added, which is akin to weighted investment in high minus low Q segments. Çolak and Whited find that the changes in these measures are not significant relative to changes in firms that do not focus and that have similar propensity scores, using the Dehejia and Wahba (1999) matching procedure and the Abadie and Imbens (2004) implementation. There is no evidence that post-spinoff efficiency improves once the focusing firms are matched by propensity score to the non-focusing firms.

For robustness, Çolak and Whited also report estimates of a treatment effects model, equation (68) of Campa and Kedia (2002). There is little evidence for efficiency gains, except for one case in which the investment efficiency has a significance level of 10% for focusing firms. This could, however, arise due to pure chance given the wide number of dependent variables and specifications examined. While the paper does not report the coefficient for the inverse Mills ratio in the treatment effects model, Toni Whited confirms to us in private communication, that this selection term *is* significant. This suggests that self-selection is the main explanation for why firms experience efficiency gains after focusing. The unobserved private information that leads firms to focus explains post-focusing improvements in efficiency; controlling for self-selection, there is little evidence of any additional efficiency gains.

10.4. Discussion

A key advantage of the diversification discount literature is that it has reasonably similar datasets, so it is easier to see the changes due to different econometric approaches. By the same token, it becomes easier to raise additional questions on model choice. We raise these questions here for expositional convenience, but emphasize that the questions are general in nature and not particular to the diversification discount literature.

One issue is statistical power. The diversification discount is significant using conventional industry-size matching but it is insignificant using PS based matching methods. Is this because the latter lack power? Çolak and Whited offer some welcome Monte Carlo evidence with respect to their application, simulating data with sample sizes, means, covariance matrix, and covariates with third and fourth moments equal to that observed in the actual data. They confirm that their tests have appropriate size, and at the level of the treatment effects in the sample, there is a better than 20% chance of detecting the observed treatment effect. More on these lines would probably be useful.

A second issue is the use of PS based matching methods as primary means of inference about treatment effects. There are good reasons to be uncomfortable with such an approach. The main issue is that propensity score methods assume that private information is irrelevant. However, this assumption is probably violated to at least some degree in most corporate finance applications. In fact, in the diversification literature, private information does empirically matter. Thus, using PS methods as the primary specification seems inappropriate without strong arguments as to why firms' private information is irrelevant. Heckman and Navarro-Lozano (2004) stress and show explicitly that even small deviations from this assumption can introduce significant bias. Thus, the practice followed in the finance literature of reporting private information specifications in conjunction with matching models is probably appropriate, although more full discussion on reconciling the results from different approaches would be useful.

A final comment is about the self-selection specifications used to control for private information. While the literature has used versions of the baseline Heckman (1979) model, we emphasize that this restriction is neither necessary nor desirable. Other models, such as switching regressions and structural models are viable alternatives for modeling self-selection and private information. Because these models come with their own additional requirements, it is not clear that they would always be useful, but these issues are ultimately empirical.

11. Other applications of selection models

11.1. Accounting for R&D: Shehata (1991)

Shehata (1991) applies self-selection models to analyze the accounting treatment of research and development (R&D) expenditures chosen by firms during the period of the introduction of FASB ruling SFAS No. 2. This ruling pushed firms to expense rather

than defer R&D expenditures. Other studies examined the issue by comparing observed changes in R&D expenditures for a sample of capitalizing firms with those of expensing firms. If firms self-select into the choice they prefer, it is inappropriate to treat the choice as exogenous and assess its impact by comparing differences between capitalizers and expensers. Shehata uses a switching regression instead.

Shehata uses a probit specification to model how firms choose an accounting method, and two regressions to determine the level of the R&D expenditure, one for each accounting choice. This is, of course, the switching regression system of Section 3.1. Shehata estimates the system using standard two-step methods. As discussed in Section 3.1, one useful feature of the system is the estimation of counterfactuals: what the R&D spending would be for firms that expensed had they elected to defer and vice-versa. Shehata reports that capitalizers are small, highly leveraged, have high volatility of R&D expenditures, more variable earnings, and spend a significant portion of their income on R&D activities. The second stage regression shows that the two groups of firms behave differently with respect to R&D spending. For instance, R&D is a non-linear function of size and is related to the availability of internally generated funds for capitalizers but the size relation is linear and internally generated funds do not matter for expensers. Thus, it is more appropriate to use a switching regression specification rather than the Heckman (1979) setup to model selection.

The inverse Mills ratio that corrects for self-selection matters in the second stage regression for both groups. Thus, standard OLS estimates tend to understate the impact of SFAS No. 2 on R&D expenditures. Finally, Shehata (1991) reports predictions of the expected values of R&D expenditures for both expensing and capitalizing samples had they elected to be in the other group. The mean value of R&D for each group is lower under the unchosen alternative. The decline is more pronounced for the capitalizing group, where it declines from $ 0.69 mm to $ 0.37 mm, while the decline is from $ 0.85 mm to $ 0.79 mm for the expensing group.

11.2. Bankruptcy costs: Bris, Zhu and Welch (2006)

Bris, Zhu and Welch (2006) analyze the relative costs of bankruptcy under the Chapter 11 and Chapter 7 procedures in the U.S., codes that are discussed more fully in Chapter 14 (John et al., 2007). The sample consists of close to 300 bankruptcy filings in Arizona and Southern New York, the largest sample in the literature as of this writing.

The specification is the basic Heckman model of Section 2, with treatment effects in some specifications. Step 1 is a probit specification that models the choice between Chapter 11 and Chapter 7, conditional on deciding to file for bankruptcy. Bris et al. show that the procedural choice is related to firm characteristics such as size, managerial ownership, and the structure of debt including variables such as the number of creditors, whether the debt is secured or not, and the presence of banks as a company creditor. Step 2 involves modeling the costs of bankruptcy. Bris et al. analyze four metrics to specify the LHS dependent variable: the change in value of the estate during bankruptcy; the time spent in bankruptcy; the expenses submitted to and approved by

the bankruptcy court; and the recovery rates of creditors. These are modeled as a function of a comprehensive set of regressors that include linear and non-linear functions of firm size, various proxies for the structure of the filing firm and managerial ownership. Because the variables in the two stages are similar, the study essentially relies on non-linearity for identification.

Bris et al. find no evidence that firms that were more likely to self-select into Chapter 11 were any faster or slower in completing the bankruptcy process. Controlling for self-selection, Chapter 11 cases consumed more fees, not because Chapter 11 is intrinsically the more expensive procedure, but because of intrinsic differences in firms that choose to reorganize under this code. After controlling for self-selection, Chapter 11 emerges as the cheaper mechanism, and Bris et al. report that self-selection explains about half of the variation in bankruptcy expenses. With self-selection controls, Chapter 11 cases had higher recovery rates than Chapter 7 cases. In sum, selection has a significant impact on estimates of reorganization costs under different bankruptcy codes. After controlling for selection, Chapter 7 takes almost as long, consumes no less and probably more in professional fees, and creditors rarely receive as much, so there is little evidence that it is more efficient than Chapter 11 reorganizations.

11.3. Family ownership and value: Villalonga and Amit (2006)

Villalonga and Amit (2006) examine the effect of family ownership, control, and management on value for a sample of Fortune 500 firms from 1994 to 2000. The specification is a standard Heckman style selection model of Section 2 with a treatment effect.

The first step is a probit specification that models whether a firm remains family owned or not. Family ownership is defined as firms in which the founding family owns at least 5% of shares or holds the CEO position. In the second step, value, proxied by Tobin's Q, is regressed on a dummy variable for family ownership, industry dummy variables, the Gompers, Ishii and Metrick (2003) shareholder rights index, firm-specific variables from COMPUSTAT, outside block ownership and proportion of non-family outside directors, and, of course, the inverse Mills ratio that corrects for self-selection. To assist in identification, Villalonga and Amit include two additional instruments in the selection equation lagged Q and idiosyncratic risk. Idiosyncratic risk is presumably related to family ownership but not to Q if only systematic risk is priced by the market.

Villalonga and Amit report that family ownership has a positive effect on value in the overall sample and in sub-samples in which the founder is the CEO. Interestingly, the sign is negative when the founder is not the CEO. Villalonga and Amit interpret their findings as evidence that the benefits of family ownership are lost when the family retains control in the post-founder generation. Their results strengthen when they incorporate a control for self-selection. In the self-selection specification, the inverse Mills ratio is significant and negative in the overall specification and sub-samples in which the CEO is the founder. In these samples, family ownership appears to be associated with

unobserved attributes that are negatively related to value. These unobserved attributes positively impact value if the founder is not the CEO.[29]

12. Other applications of matching methods

12.1. Bank debt versus bonds: Bharath (2004)

Debt financing by a corporation gives rise to conflicts of interest between creditors and shareholders that can reduce the value of the firm. Such conflicts are limited more effectively in bank loans than in public debt issues if banks monitor. Bharath (2004) measures the size of agency costs by calculating the yield spread between corporate bonds and bank loans (the Bond-Bank spread) of the same firm at the same point in time. To quantify the difference, Bharath needs to match bonds with bank loans of the same firm at the same point in time and having substantively identical terms. The matching problem is complicated by the fact that bank loans and public bonds are contractually very different on multiple dimensions such as credit rating, seniority, maturity, and collateral.

Bharath argues that because bank loans and bonds are matched at the same point of time and for the same firm, matching based on observables should adequately control for differences between bank debt and public debt. Thus, propensity score based matching methods are appropriate tools to control for differences between bank loans and public debt. Bharath uses the propensity score matched difference between bank and bond credit spreads as the treatment effect, or the value added by banks. The spread can be interpreted as the value added by banks in enforcing better investment policies, or more generally, as the price of the "specialness" of banks due to their ability to monitor, generate information, or better renegotiate loans, or even perhaps other explanations such as monopoly rents.

Using a sample of over 15,000 yield observations, Bharath finds that the Bond-Bank spread is negative for high credit quality firms and positive for low credit quality firms. He interprets his findings as being consistent with the view that for high quality firms, the benefits of bank monitoring are outweighed by the costs of bank hold-up. This causes the spread to be negative, indicating that bank debt offers few benefits for high quality firms. For low quality firms, the opposite is true, causing the spread to be positive. The magnitude of the potential agency costs mitigated by banks is more important for poor quality firms, justifying the decision to borrow from banks.

[29] An interesting question raised by this study is survivorship (e.g., Brown, Goetzmann and Ross, 1995). Perhaps family owned firms that survived and made it to Fortune 500 status are of better quality, and hence these firms are valued more. This question can perhaps be resolved by looking at broader samples that incorporate smaller firms outside the Fortune 500 universe. Bennedsen et al. (2006) take a step in this direction.

12.2. *Matching and long-run performance:* Cheng (2003), Li and Zhao (2006)

A vast literature on market efficiency examines the long-run stock return after events such as IPOs, SEOs, share repurchases, listing changes, etc. The semi-strong version of the efficient markets hypothesis predicts that long-run returns should be zero on average. However, several papers report empirical evidence against the efficiency hypothesis (Fama, 1998). In most studies, post-event buy-and-hold returns are systematically positive or negative relative to benchmarks over periods of three to five years. Chapter 1 (Kothari and Warner, 2007) offers an overview of this literature. We focus on applications of matching models to assess long-run performance.

To test whether abnormal returns are zero or not, one needs a model of benchmark returns. As discussed in Chapter 1, the standard approach, is to match an event firm with a non-event firm on between two and four characteristics that include size, book-to-market, past returns, and perhaps industry. This method runs into difficulties when the number of dimensions becomes large and the calipers become fine, when it becomes difficult to generate matching firms. Propensity score (PS) based matching methods reviewed in Section 4.3.2 are potentially useful alternatives in this scenario. Two recent papers, Cheng (2003) and Li and Zhao (2006) use PS methods to reexamine the long-term performance of stock returns after SEOs. Both papers find that while characteristic-by-characteristic matching results in significant long-term abnormal returns after SEOs, abnormal returns are insignificant if one uses propensity score based matching methods instead.

Cheng (2003) studies SEOs offered between 1970 and 1997 for which necessary COMPUSTAT data are available on firm characteristics. She finds significant buy-and-hold abnormal returns of between -6% and -14% over three to five years in the full sample and various sub-samples when matches are constructed on size, industry and book-to-market. She then uses three logit models, one for each decade, to predict the probability of issuance. Several firm characteristics such as size, book-to-market, industry, R&D, exchange, as well as 11-month past returns predict the issuance decision. Cheng matches each issuer with a non-issuer in the SEO year with a similar propensity score (i.e., predicted probability). She finds little evidence of significant abnormal returns except for one sub-sample in the 1970s.

Li and Zhao undertake an exercise similar to that in Cheng (2003) for issuers from 1986 to 1997. They show that characteristic-by-characteristic matching produces inadequate matches between issuers and non-issuers in terms of average size.[30] They estimate propensity scores with size, book-to-market, and past returns in three quarters prior to issuance, one model per year, and add interaction terms for better predictions and delete firms as necessary to have a common support. In their final sample, conventional matching gives average three-year buy-and-hold abnormal returns of -16%, but this drops to an insignificant -4% with PS matching.

[30] Medians are not reported, so it is hard to assess the role of outliers.

Cheng (2003) and Li and Zhao (2006) emphasize that PS methods are merely substitutes for characteristic-by-characteristic matching of observables. This perspective is probably appropriate. The main issue in these applications is the data driven nature of the exercise in fitting probit models. Characteristics and interaction terms are added as needed to achieve balance in characteristics and propensity scores. While we recognize that a reasonable probit model seems necessary to place faith in treatment effect estimates, the search required to achieve balance, however transparent, nevertheless raises data dredging concerns and even inconsistency of estimates (Heckman and Navarro-Lozano, 2004). The general use of PS methods in studies of long-term stock return or operating performance as an alternative to methods studied in Barber and Lyon (1996, 1997), Barber, Lyon and Tsai (1999), and Kothari and Warner (1997) remains an open question.

13. Bayesian methods

13.1. Matching: Sørensen (2005)

Investors differ in their abilities to select good investments, and in their ability to take a given investment and monitor and manage it so as to add value to what they invest in. A key question in the venture capital literature is the differentiation of selection from value-addition. To what extent are better performing venture capitalists more successful because of their ability to select good investments rather than their ability to value-add to their investments? Sørensen (2005) employs a matching-selection model to separate these two influences, using Bayesian MCMC (Markov Chain Monte Carlo) methods to estimate it.

In Sørensen's model, there is a set of venture capital investors indexed by i. Each investor evaluates a set of potential investments indexed by j and ultimately invests (i.e., becomes the lead investor) in a subset of these. Once an investment occurs, its outcome is specified as the variable *IPO* which equals one if the investment results in a public offering and zero otherwise. In Sørensen's model, feasible investments for each investor are partly determined by the characteristics of the other agents in the market. These characteristics are related to the investment decision but unrelated to the investment outcome, so they provide the exogenous variation used for identification of the model. On the other hand, this type of sorting also causes interaction between investment decisions by different venture capitalists, which leads to a dimensionality problem and considerable numerical difficulties in estimation. Bayesian methods offer feasible routes for estimation.

Sørensen specifies normally distributed and diffuse prior beliefs with prior variances that are over 300 times the posterior variance. He assumes that error terms for different deals are independent. There are three sets of exogenous variables. The characteristics of the company includes the stage of development of the company and industry dummies. The characteristics of the venture capital investor include his experience and amount of

capital he has available. The characteristic of the market is the year of the investment. There are two parameters of central interest. One is the access of better venture capitalists to deal flow, which is captured by the experience of the venture capitalist. The other is the synergy between venture capitalists and their target investments or the value added by venture capitalists, which is captured by the correlation between the private information in the decision to invest and the probability of going public.

Sørensen's final sample includes 1,666 investments made by 75 venture capitalists between 1975 and 1995 in the states of California and Massachusetts. Experience is proxied by the total and stage-of-life-cycle-specific number of deals done since 1975. Sørensen reports a number of interesting findings. He finds evidence for sorting. Experienced investors are more likely to have access to the better deals whose probability of going public (and doing so faster) increases by about two-thirds. This type of sorting explains about 60% of the increased probability of success, leaving about 40% for the synergies, or the value added by venture capital investors. Sørensen explains why one might get different results from estimating a standard selection model compared to one with sorting.

13.2. Switching regressions: Li and McNally (2004), Scruggs (2006)

Li and McNally (2004) and Scruggs (2006) offer interesting applications of Bayesian methods to estimate switching regression models of self-selection. Both papers emphasize that the value of the Bayesian approach is not merely the difference in philosophy or technique; rather, the techniques offer insights not readily available through classical methods. The application in Li and McNally (2004) is the choice of a mechanism to effect share repurchases, while the application in Scruggs relates to whether convertibles are called with or without standby underwriting arrangements. For convenience, we focus on Li and McNally, but substantially similar insights on methodology are offered in the work by Scruggs.[31]

Share repurchases started becoming popular in the 1980s as a way to return excess cash to shareholders in lieu of dividends. Repurchases tend to be more flexible in timing and quantity relative to the fixed cash flow stream expected by markets when companies raise dividends. Share repurchases can be implemented in practice as a direct tender offer or more open-ended open market repurchases. Li and McNally (2004) investigate the choice between the two mechanisms and their impact on share price reactions to announcements of repurchases using Bayesian self-selection methods.

Li and McNally propose the following system of equations to analyze the choice of a repurchase mechanism

$$I^* = Z_i\gamma + \eta_i, \tag{69}$$

[31] Wald and Long (2006) present an application of switching regression using classical estimation methods. They analyze the effect of state laws on capital structure.

$$p_1^* = X_1\beta_1 + \epsilon_1, \tag{70}$$

$$p_2^* = X_2\beta_2 + \epsilon_2, \tag{71}$$

$$y_1^* = W_1\alpha_1 + v_1, \tag{72}$$

$$R_1^* = V_1\theta_1 + u_1, \tag{73}$$

$$R_2^* = V_2\theta_2 + u_2, \tag{74}$$

where I^* is an unobserved latent variable representing the incremental utility of tender offers over open market repurchases, p_1^*, y_1^*, R_1^* are the percentage of shares sought, tender premium and announcement effects under the tender offer regime, and p_2^*, R_2^* are the proportion sought and announcement effects in an open market repurchase regime. The error terms in equations (69)–(74) are assumed to have a multivariate normal distribution.

The system of equations (69)–(74) represents a switching regression system discussed in Section 3.1, but with more than one regression in each regime. The key issue in estimating the system is the lack of information on unobserved counterfactuals. We observe outcomes in the repurchase technique actually chosen by a firm but do not explicitly observe what would happen if the firm had chosen the alternative technique instead. Li and McNally employ MCMC methods that generate counterfactuals as a natural by-product of the estimation procedure. This approach involves a data augmentation step in which the observed data are supplemented with counterfactuals generated consistent with the model structure. The priors about parameters are updated and posteriors obtained using standard simulation methods after which the additional uncertainty due to the data augmentation step can be integrated out. Observations on counterfactual choices and outcomes are generated as part of the estimation procedure. These can be directly used to examine the impact of choosing a given type of repurchase mechanism not just in isolation, but also relative to the impact of choosing the unchosen alternative.

The sample in Li and McNally comprises 330 fixed price tender offers, 72 Dutch auction tender offers, and 1,197 open market repurchases covering time periods from 1962 to 1988. In terms of findings, Li and McNally report that firms choose the tender offer mechanism when they have financial slack and large shareholders that monitor management. Firms prefer the open market repurchase in times of market turbulence or weak business conditions. Unobserved private information affects both the type of the repurchase program and the repurchase terms and is reflected in the stock market announcement effects. The estimates of counterfactuals are quite interesting. For instance, if the open market repurchasers had opted for tender offers, the proportion of shares sought would have been 36% (versus actual of about 7%) and the tender premium would have been 33% compared to 0% actuals, and the five-day announcement effect would be 16% compared to the actual announcement effect of 2.2%. Likewise, tender offer firms would have repurchased 10.6% (actual = 19.7%) and experienced announcement effects of 3.7% (actual = 10.2%). Firms appear to have a comparative advantage in their chosen repurchase mechanisms.

14. Conclusions

Our review suggests that self-selection is a growth area in empirical corporate finance. The rapidly expanding number of applications undoubtedly reflects the growing recognition in the finance profession that self-selection is an important and pervasive feature of corporate finance decisions. The range of econometric models in use is also growing as techniques diffuse from the econometrics literature to finance. However, the key issue in implementing self-selection models still remains the choice of specification, particularly the economic assumptions that make one model or another more appropriate for a given application. One size does not fit all. Each self-selection model addresses a different kind of problems, places its own demands on the type of data needed, and more importantly, carries its own baggage of economic assumptions. The plausibility of these assumptions is perhaps the primary criterion to guide what is used in empirical applications.

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Chapter 3

AUCTIONS IN CORPORATE FINANCE*

SUDIPTO DASGUPTA

Department of Finance, Hong Kong University of Science and Technology, Clear Water Bay, Kowloon, Hong Kong
e-mail: dasgupta@ust.hk

ROBERT G. HANSEN

Tuck School of Business, Dartmouth College, Hanover, NH 03755, USA
e-mail: robert.g.hansen@dartmouth.edu

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Abstract

This paper reviews the applications of auction theory to corporate finance. It starts with a review of the main auction theory frameworks and the major results. It then goes on to discuss how auction theory can be applied, in the context of the market for corporate control, not only to "inform" a company's board or regulators, but also to understand some of the observed empirical evidence on target and bidder returns. It then considers the role of preemptive bidding, stock versus cash offers, the effect of toeholds on bidding behavior, the effect of bidder heterogeneity and discrimination in auctions, merger waves, bankruptcy auctions, share repurchases and "Dutch" auctions, IPO auctions, and the role of debt in auctions. It concludes with a brief discussion of the econometrics of auction data.

Keywords

bidders, targets, private value, common value, winner's curse, auctions, bidding, takeovers, mergers and acquisitions, toeholds, bankruptcy auctions, IPO auctions

1. Introduction

This paper reviews developments in auction theory, with a focus on applications to corporate finance. Auctions, viewed broadly, are economic mechanisms that transfer control of an asset and simultaneously determine a price for the transaction.[1] Auctions are ubiquitous across the world. Formal auctions are used to buy and sell goods and services from fish to mineral rights and from logging contracts to lawyers' services in class action lawsuits. In the world of finance, auctions are used to buy and sell entire firms (in bankruptcy and out of bankruptcy) as well as securities issued by governments and companies. In the most recent and public example of auctions in corporate finance, the internet search firm Google sold its shares via a Dutch auction method in its initial public offering.

Auction theory has developed to explore a variety of issues, with the most important ones relating to pricing, efficiency of the allocation, differential information, collusion, risk aversion, and of course a very large topic, the effects of different auction rules (sealed-bids versus open auctions, reserve prices, entry fees, etc.) on the revenue to the seller.[2] Concomitant with theoretical work, there has been significant work in applications of auction theory, with many of these being related in some way to corporate finance. On one level, application of auction theory to corporate finance is very natural, for corporate finance sometimes directly involves auctions (e.g., auctions in bankruptcy). At another level, though, auction theory should serve to inform corporate finance because the underlying primitive issues are the same: pricing of assets, exchange of control, uncertainty especially in regard to asset valuation, heterogeneity of agents, asymmetric or disparate information, and strategic behavior. Given this similarity in the underlying frameworks, one should expect auction theory to have significant influence, both direct and indirect, on corporate finance research. There has also been, particularly in recent years, much work in the estimation of auction models. The econometrics of this work is very sophisticated, utilizing structural estimation methods that can retrieve estimates of the underlying distribution of bidders' valuations from bid data. While these techniques have not yet been applied to data from finance-related auctions, there would seem to be room for application to, for instance, corporate bankruptcy auctions. The broad lesson from these econometric studies is also very relevant for empirical work in financial auctions: use the restrictions from the theory to learn more from the data than non-structural methods will reveal. For this reason, empirical finance researchers studying auctions should have a good knowledge of auction theory.

[1] Throughout this survey, we will normally consider auctions where an item is being sold. Reverse auctions, where an auction is used to purchase an item, can generally be modeled by simply reversing the direction of payment.

[2] Krishna (2002) provides an excellent, comprehensive review of all existing auction theory. Klemperer (2000) is a shorter, recent review of auction theory, while McAfee and McMillan (1987) is thorough but a bit dated by now.

A careful review of the literature shows that auction theory has had a significant but not overwhelming influence on corporate finance. Perhaps the more insightful applications have been in the context of corporate takeover bidding: pre-emptive bidding, means of payment (takeover auctions are not always financed with cash), bidder heterogeneity, and discrimination amongst bidders. Application of auction theory to these contexts has at times produced new insights. Overall, however, while the applications have extended our understanding of the inefficiencies that are due to the underlying primitive construct of private information, they have not changed that understanding in any fundamental way.

The survey proceeds as follows. Section 2 reviews the simplest auction setting, that of independent private values. Many key insights can be developed from this simplest model: the basic pricing result that an auction's expected price equals the expected second-highest value; general solution methodology; effects of more bidders' risk aversion, reserve prices; revenue equivalence of the different auction forms; revenue enhancement from ex-post means-of-payment; and the solution of auction models via the Revelation Principle. Section 3 considers the interdependence amongst bidders' valuations (including the special case of a "common value" for the object) and reviews Milgrom and Weber's (1982a, 1982b) generalized auction model. Critical insights in this section pertain to the effects of the winner's curse; that lack of disclosure by the seller can lower expected prices; and that the different auction forms are no longer revenue-equivalent. With the basic theory developed in these sections, Section 4 turns to the applications most relevant to corporate finance. Section 5 ends with some thoughts about future applications and further development of auction theory that would make it more relevant for corporate finance.

2. The most basic theory: Independent private values

2.1. Initial assumptions

Auction theory begins with assumptions on how bidders value the asset for sale; the model then shows how an auction converts valuations into a price and an exchange of control. Valuation assumptions are absolutely key to auction theory. However, as we will argue later, the existing paradigms are not complete as they do not consider certain sets of valuation assumptions that are particularly relevant in corporate finance.

Independent preference (sometimes called independent private values) assumptions are straightforward: each bidder is simply assumed to know her value for the asset. For bidder i, denote this value as v_i. While each bidder knows her own value, to make the situation realistic and interesting, we assume that a bidder does not know other bidders' values. To model this uncertainty, we assume that each bidder believes other bidders'

values to be independent draws from a distribution $F(v)$. We have therefore introduced a degree of symmetry in the model, that of symmetric beliefs.[3]

Fix a particular bidder, and focus on the highest value among the remaining $N-1$ values from the other $N-1$ bidders, and denote this value as v_2. Since v_2 is the highest among $N-1$ independent draws from the same distribution, its probability distribution $G(v_2)$ (i.e., the probability that $N-1$ independent draws are less than a value v_2) is

$$G(v_2) = F(v_2)^{N-1}. \tag{1}$$

Notice that the distribution $G(v_2)$ has a density function $g(v_2) = (N-1)F(v_2)^{N-2} \times f(v_2)$. If $F(v)$ is uniform over the unit interval, i.e., $F(v) = v$ for $0 \leqslant v \leqslant 1$, then note that

$$G(v_2) = F(v_2)^{N-1} = v_2^{N-1}. \tag{2}$$

2.2. First-price sealed-bid auctions

We are now in a position to evaluate any specific set of auction rules. Turn first to the common first-price sealed-bid auction, where bidders submit sealed bids and the highest bidder wins and pays the amount of her bid (hence the "first-price" qualifier). For now we assume a zero reserve price (a price below which the seller will keep the asset rather than sell).

In placing a bid b, bidder i has expected profit of

$$E(\pi_i) = \Pr(\text{win})(v_i - b), \tag{3}$$

where one can note that in the case that bidder i loses, her profit is zero. While (3) does not make it explicit, Pr(win) will be a function of b, normally increasing. This creates the essential tension in selecting an optimal bid: increasing one's bid increases the chance of winning, but the gain upon winning is less.

To solve this model, we need just a bit more structure. Let us use an intuitive version of the so-called Revelation Principle. Fix a bid function $b(v)$, and think of bidder i as choosing the v she "reports" rather than choosing her actual bid. So long as $b(v)$ is properly behaved, we have not restricted bidder i's choice in any way, for she could get to any bid b desired by simply "reporting" the requisite v.

Looking ahead, we are searching for a symmetric Nash equilibrium in bidding strategies. In terms of our $b(v)$ function, symmetry means that all bidders use the same $b(v)$. Nash equilibrium requires that, given other bidders' strategies, bidder i's bid strategy is optimal. In terms again of our $b(v)$ formulation, equilibrium requires each bidder to report $v = v_i$, i.e., "honest" reporting. Our requirement for Nash equilibrium will therefore be as follows. Suppose that the other bidders are using $b(v)$ and honestly reporting,

[3] Several papers examine the effects of asymmetric beliefs, for example, Maskin and Riley (2000a, 2000b). See also Krishna (2002).

so that bidder j's bid is $b(v_j)$. If $b(v)$ represents a (symmetric) bidding equilibrium, then bidder i's optimal decision will be to report $v = v_i$, so that her bid is $b(v_i)$.

In the situation where the other $N - 1$ bidders are both using $b(v)$ and reporting honestly, we can re-write (3) as

$$\begin{aligned} E(\pi_i) &= \Pr(\text{win})(v_i - b) \\ &= G(v)\big(v_i - b(v)\big), \end{aligned} \tag{4}$$

where we assume bidder i is using $b(v)$ but not requiring $v = v_i$. Note that bidder i wins if all other $N - 1$ values are less than the v that bidder i reports, hence the conversion of Pr(win) into $G(v)$, the distribution for the highest value among the remaining $N - 1$ values.

Now we simply require that bidder i's optimum decision is also honest reporting. Taking the first derivative of (4) with respect to v, we have

$$\frac{dE(\pi_i)}{dv} = g(v)\big(v_i - b(v)\big) - G(v)\frac{db(v)}{dv} = 0. \tag{5}$$

The first term of (5) shows the marginal benefit of bidding higher while the second term shows the marginal cost. Re-arranging, we have

$$G(v)\frac{db(v)}{dv} = g(v)\big(v_i - b(v)\big). \tag{6}$$

For equilibrium, we require that (6) hold at $v = v_i$. Hence we get

$$G(v)\frac{db(v)}{dv} = g(v)\big(v - b(v)\big). \tag{7}$$

Equation (7) is a standard first-order differential equation that can be solved via integration-by-parts.[4] Doing this yields

$$b(v) = \frac{1}{G(v)}\int_0^v yg(y)\,dy. \tag{8}$$

Equation (8) can be easily interpreted. As $G(x)$ is the distribution for the highest value among the remaining $N - 1$ values, $g(x)/G(v)$ is the density of that value conditional on it being lower than v. Equation (8) tells a bidder to calculate the expected value of the highest value among the remaining $N - 1$ bidders, conditional on that value being less than bidder i's own, and to bid that amount. This is about as far as intuition can take us: the expected value of the second-highest value is in some sense bidder i's real competition, and equilibrium bidding calls for her to just meet that competition. (One other intuitive approach involves marginal revenue; we will turn to this view below.)

[4] Rewrite (7) as $G(y)\,db + b\,dG = y\,dG$ or $d(G(y)b(y)) = y\,dG$. Integrating, and using the fact that $G(0) = 0$, we get $b(v) = \int_0^v y\,dG/G(v) = \int_0^v yg(y)\,dy/G(v)$.

If beliefs on values are governed by the uniform distribution, then $G(v) = v^{N-1}$, $g(v) = (N-1)v^{N-2}$, and (8) becomes

$$\begin{aligned} b(v) &= \frac{1}{v^{N-1}} \int_0^v y(N-1)y^{N-2}\,dy \\ &= \frac{N-1}{v^{N-1}} \int_0^v y^{N-1}\,dy \\ &= \frac{N-1}{N} v. \end{aligned} \tag{9}$$

In the particular case when $N = 2$, (9) implies that equilibrium bidding calls for bidding half of one's value—a significant "shading" of one's bid beneath true value. Note that in this case, however, the lowest the competitor's value could be is zero. If the distribution of values was instead uniform over [8, 10], the equilibrium bid would be $(8 + v)/2$—halfway between the lower bound and one's own valuation.

To see that in general, there is bid shading, notice that we can write

$$\begin{aligned} b(v) &= \frac{1}{G(v)} \int_0^v yg(y)\,dy = \frac{1}{G(v)} \int_0^v y\,dG(y) \\ &= \frac{1}{G(v)} \left[yG(y)\big|_0^v - \int_0^v G(y)\,dy \right] \\ &= v - \int_0^v \frac{G(y)}{G(v)}\,dy \\ &= v - \int_0^v \left[F(y)/F(v)\right]^{N-1} dy, \end{aligned}$$

where we have used integration-by-parts in the third line.[5] Notice that while $b(v) < v$, since $F(y) < F(v)$ within the integral, as $N \to \infty$, $b(v) \to v$. In other words, intense competition will cause bidders to bid very close to their true values, and be left with little surplus from winning.

How does the seller fare in this first-price auction? We can construct the seller's expected revenue by calculating the expected payment by one bidder and then multiplying that by N. Sticking to the uniform [0, 1] distribution for clarity, we have the expected payment by bidder i as

$$\begin{aligned} E(\text{Payment}_i) &= \int_0^1 \Pr(\text{win}) b(y)\,dy \\ &= \int_0^1 y^{N-1} \frac{N-1}{N} y\,dy = \frac{N-1}{N(N+1)}. \end{aligned} \tag{10}$$

[5] Since $d(uv) = u\,dv + v\,du$, we can write $\int u\,dv = uv - \int v\,du$. This handy trick is used very commonly in the auction literature.

Multiplying this by N gives the seller's expected revenue as

$$E(\text{Revenue to seller}) = \frac{N-1}{N+1}. \tag{11}$$

Intuitively, since each bidder is bidding her expectation of the highest value among the remaining $N-1$ bidders, conditional on her value being the highest, the expected payment received by the seller should be the unconditional expected value of the second-highest value. In general, the density for the second-highest value is, from the theory of order statistics,[6]

$$f_2(y_2) = N(N-1)\big(1-F(y_2)\big)F(y_2)^{N-2}f(y_2). \tag{12}$$

In the case of the uniform [0, 1] distribution, the expected value of the second-highest value is then

$$\begin{aligned} E(y_2) &= \int_0^1 xN(N-1)(1-x)x^{N-2}\,dx \\ &= \frac{N-1}{N+1} \end{aligned} \tag{13}$$

as expected.[7] To reiterate and emphasize, the seller's expected revenue from the auction is exactly the expected value of the second-highest value. This result, of course, extends beyond the uniform distribution.

2.3. Open and second-price sealed-bid auctions

As compared to the first-price sealed-bid auction, the open auction and second-price sealed-bid auctions are considerably easier to solve. For this reason, they are often chosen to model any kind of auction mechanism; the Revenue Equivalence Theorem discussed below ensures that, in many cases, the results for one auction form extend to others.

In an open auction, bidders cry out higher and higher bids until only one bidder, the winner, remains. It is easy to see that "staying in the auction" until the bid exceeds one's

[6] To see this, first note that the distribution function $F_2(y_2)$ of the second-highest value y_2 is the probability that either: (a) all N values are less than or equal to y_2 or (b) *any* $N-1$ values are less than y_2 and the remaining value is greater than y_2. Note that this latter event can happen in N possible ways. Thus, the probability is $F_2(y_2) = F^N(y_2) + NF^{N-1}(y_2)(1-F(y_2))$. Differentiating this expression with respect to y_2, we get the expression for $f_2(y_2)$.

[7] This interpretation of the expected revenue holds for any distribution. Notice that the expected payment from any bidder is $\int_0^{\bar{v}}[\text{Prob(win)}\cdot\text{Amount Bid}]f(v)\,dv = \int_0^{\bar{v}} G(v)b(v)f(v)\,dv = \int_0^{\bar{v}}(\int_0^v yg(y)\,dy)\,dF(v)$ from (8). Integrating by parts, this expression becomes $\int_0^{\bar{v}} yg(y)\,dy - \int_0^{\bar{v}} F(v)vg(v)\,dv = \int_0^{\bar{v}} yg(y)\,dy - \int_0^{\bar{v}} F(y)yg(y)\,dy = \int_0^{\bar{v}} y(1-F(y))g(y)\,dy = \int_0^{\bar{v}} y(1-F(y))(N-1)F^{N-2}(y)f(y)\,dy$. N times this expression is the expected revenue to the seller in the auction, and is exactly the expected value of the second-highest valuation.

value is a dominant strategy.[8] Staying in the auction beyond the point of the bid equaling one's value cannot be rational. Likewise, if the item is about to be won by someone else at a bid less than v_i, then bidder i should be willing to bid a bit higher than the current bid, for if such a bid wins the auction it will yield a profit.

An open auction therefore will quite easily find the second-highest valuation and establish that as the price—for bidding will cease once the bidder with the second-highest valuation is no longer willing to bid more.[9] The expected price in the open auction is therefore the expected value of the second-highest valuation, the same as for the first-price sealed-bid auction. This result is an implication of the Revenue Equivalence Theorem; we return to a more general statement of that below.

Turn now to a second-price sealed-bid auction: in such an auction, sealed bids are submitted and rules call for the highest bid to win but that the price paid will be the second-highest bid submitted. With these rules it is again a dominant strategy to submit a bid equal to one's valuation. Bidding more than one's value would mean possibly winning at a price in excess of value. Bidding less than one's value will mean possibly forgoing an opportunity to buy the object at a price less than value. The key to understanding the second-price auction is to note that the linkage between one's bid and the price one pays has been severed; bidding equal to value to maximize the probability of profitable wins becomes optimal. Thus, as is the case for the open auction, the second-price sealed bid auction will also yield as a price the second-highest value out of the N values held by the bidders.[10]

All three auctions therefore yield the same expected price.[11] Note, however, that the first-price and second-price (including the open auction as essentially a second-price auction) auctions have equilibrium strategies that are easy to compute for both the modeller and the bidder. Note also that the first-price auction gives a different (and less volatile) price for any given set of bidders. It is also important that all three auctions are efficient in that the bidder with the highest valuation is the winner. Auctions can be seen as accomplishing two distinct tasks: reallocating ownership of an asset and determining a price for the transfer of ownership. Efficiency is an important characteristic of any sales procedure, and auctions under private value assumptions should get the asset

[8] A (weakly) dominant strategy in game theory is a strategy which does at least as well as any other strategy no matter what strategies other agents use.

[9] This neglects effects (usually unimportant) of a minimum bid increment.

[10] Therefore, the second-price and the open (also called English or Ascending) auctions are "equivalent" in the sense that they lead the bidders to bid or drop out at their private value for the object. However, this "equivalence" holds only in the private values setting. If the other bidders' signals or valuations are relevant for a given bidder's valuation of the object, this equivalence breaks down, as the open bids by the other bidders conveys additional information.

[11] The first-price auction is "strategically equivalent" to yet another auction known as the Dutch auction, which an open descending price auction in which the auctioneer starts with a high price and then gradually lowers the price until some bidder accepts the price. Provided that the object has not been sold yet, a bidder will accept an asking price that equals her bid in the first-price auction. Strategic equivalence is a stronger notion than the equivalence between the open and the second-price auctions.

to its most highly-valued use. Reserve prices, considered below, may hamper this efficient transfer. Efficiency of auctions under asymmetric beliefs is also not assured (see Krishna, 2002, for further discussion).

2.4. Revenue equivalence

The result that the second-price auctions and the first-price auction yield the same expected revenue to the seller is a consequence of the so-called "Revenue Equivalence Theorem". What is fascinating about the revenue equivalence of these two auctions is that such sophisticated models confirm a result which is really quite intuitive: different mechanisms all yield what is really a "competitive" price, that being the second-highest valuation. The seller cannot, under these standard auction rules, extract any more revenue than the valuation of the second-highest bidder.

The revenue equivalence result in this independent private value context can be generalized—not only to encompass a broader class of auctions, but also a more general value environment. Suppose that each bidder i privately observes an informational variable x_i. To simplify notation, we assume $N = 2$. Assume that x_1 and x_2 are independently and identically distributed with a distribution function $F(x_i)$ and density $f(x_i)$ over $[0, \bar{x}]$ for $i = 1, 2$. Let $v_i = v(x_i, x_j)$ denote the value of the object to bidder i, $i = 1, 2$ and $i \neq j$.

Consider a class of auctions in which the equilibrium bid function is symmetric and increasing in the bidder's signal, and let A denote a particular auction form. Let $\Pi_i^A(z, x)$ denote the expected payoff to bidder i when she receives signal $x_i = x$ and bids as if she received signal z. Then

$$\Pi_i^A(z, x) = \int_0^z v(x, y) f(y)\, dy - P_i^A(z),$$

where $P_i^A(z)$ denotes the expected payment conditional on bidding as if the signal were z, and we have used the assumption that the bidders have symmetric and increasing bid functions, so that i wins if and only if $x_j < z$. Differentiating with respect to z, we get:

$$\frac{\partial \Pi_i^A(z, x)}{\partial z} = v(x, z) f(z) - \frac{dP_i^A(z)}{dz}.$$

In equilibrium, $\frac{\partial \Pi_i^A(z,x)}{\partial z} = 0$ at $z = x$, and hence

$$\frac{dP_i^A(y)}{dy} = v(y, y) f(y).$$

Integrating, we get

$$P_i^A(x) = P_i^A(0) + \int_0^x v(y, y) f(y)\, dy.$$

Notice that $P_i^A(0)$ is the expected payment made by bidder i with the lowest draw of the signal. Since the seller's expected revenue is simply 2 times $\int_0^{\bar{x}} P^A(x) f(x)\, dx$, it follows that all auctions in which the bid functions are symmetric and increasing, and in which the bidder drawing the lowest possible value of the signal pays zero in expected value, are "revenue equivalent".[12]

The model considered here is one in which the values of the bidders are "interdependent" in the sense that one bidder's signal affects the value (estimate) of the other bidders. The signals themselves, however, are statistically independent. An example of the value function we considered here would be, for example, $v_1 = \alpha x_1 + (1-\alpha)x_2$ and $v_2 = \alpha x_2 + (1-\alpha)x_1$, where $1 \geqslant \alpha \geqslant 0$. Clearly, the independent private values model is a special case, in which $\alpha = 1$. The case of $\alpha = 1/2$ corresponds to a case of the "pure common value" model, for which $v(x, y) = v(y, x)$, i.e., the bidders have identical valuations of the object as a function of both bidders' signals.

2.5. Reserve prices

As reserve prices have figured in some of the corporate finance literature, it is worthwhile to consider analysis of reserve prices in auctions. Sticking with independent private values, consider an open auction with two bidders. Suppose that bidder 1 has valuation $v_1 > 0$ and bidder 2 has valuation $v_2 = 0$. Then the open auction will yield a price of zero. Better in this case would be for the seller to have a reserve price set in-between 0 and v_1 so that bidder 1 would still win but pay the reserve. Of course, the problem with a reserve price is that if it is set above v_1 no sale will result.

To understand how the reserve price is chosen,[13] let us return to the independent private values model with N bidders. Consider any auction form A in the class of auctions with symmetric increasing bid functions. As above, denote by $P^A(z)$ the expected payment by a given bidder in auction A when she bids $b^A(z)$. If the bidder's private value of the object is v, her expected profit is

$$\Pi^A(z, v) = G(z)v - P^A(z),$$

where $G(z) = F^{N-1}(z)$. As above, in equilibrium, it must be optimal for the bidder with valuation v to bid $b(v)$, which requires that $\Pi^A(z, v)$ is maximized at $z = v$. This implies that

$$g(y)y = \frac{dP^A(y)}{dy}. \tag{14}$$

Let us suppose now that a bidder with private value v^* is indifferent between bidding and not bidding. For such a bidder (known as the "marginal bidder"), by definition

[12] Absent reserve prices, the bidder drawing the lowest possible signal will typically be indifferent between bidding and not bidding.

[13] Our treatment of the problem here follows that in Riley and Samuelson (1981).

$\Pi^A(v^*, v^*) = G(v^*)v^* - P^A(v^*) = 0$. Now from (14), integrating, we get for $v \geqslant v^*$

$$\begin{aligned} P^A(v) &= P^A(v^*) + \int_{v^*}^{v} yg(y)\,dy \\ &= G(v^*)v^* + \int_{v^*}^{v} y\,dG(y) \\ &= vG(v) - \int_{v^*}^{v} G(y)\,dy, \end{aligned} \tag{15}$$

where in the last step, we used integration by parts.

The expected revenue for the seller from a single bidder is $\int_0^{\bar{v}} P^A(v)f(v)\,dv$. Again, using integration by parts, this can be written as

$$\begin{aligned} E(R_i^A) &= \int_0^{\bar{v}} P^A(v)f(v)\,dv \\ &= \int_{v^*}^{\bar{v}} P^A(v)f(v)\,dv \\ &= \int_{v^*}^{\bar{v}} vG(v)f(v)\,dv - \int_{v^*}^{\bar{v}} \left[\int_{v^*}^{v} G(y)\,dy\right] dF \\ &= \int_{v^*}^{\bar{v}} vG(v)f(v)\,dv - \int_{v^*}^{\bar{v}} G(y)\,dy + \int_{v^*}^{\bar{v}} F(v)G(v)\,dv \\ &= \int_{v^*}^{\bar{v}} \big[vf(v) - \big(1 - F(v)\big)\big]G(v)\,dv. \end{aligned} \tag{16}$$

Given equal treatment of all N buyers, the expected revenue to the seller is simply N times the above expression.

Notice that what we have shown is that all auction forms in the class of auctions being considered must provide the seller with the same expected revenue if the marginal bidder is the same. The reserve price will determine the marginal bidder. If no bidder has a valuation above that of the marginal bidder, the seller keeps the object. Assume that the seller values the object at v_0. Then for any auction, the seller should choose the marginal bidder to maximize

$$\int_{v^*}^{\bar{v}} \big[vf(v) - \big(1 - F(v)\big)\big]G(v)\,dv + F(v^*)v_0.$$

From the first-order condition with respect to v^*, we get

$$v^* = v_0 + \frac{1 - F(v^*)}{f(v^*)}. \tag{17}$$

Since the optimal marginal bidder is the same in all auctions—all auctions in the class of auctions we are considering provide the seller with the same expected *profit* as well as revenue. The revenue equivalence result survives when a reserve price is introduced.

It remains to characterize the reserve prices in different auction settings. Suppose the reserve price is r. Notice that in both the first-price and the second-price auctions, no bidder with a value less than r can make any positive profit, as they have to bid at least r to win the object. On the other hand, the profit of a bidder with value greater than r must be strictly positive (in the second price auction, if no other bidder bids higher than r, the bidder pays r). Thus, by continuity, the marginal bidder must have a value $v^* = r$.

Note from (17) that the optimal reserve price exceeds the seller's own valuation and is independent of the number of bidders. This latter point makes sense given that the optimal reserve price is only aimed at making the high bidder pay more in the instance when all other valuations are beneath the reserve price. Note also that a reserve price destroys the assurance of an efficient allocation; in the case where the highest valuation among the bidders is less than v^* but greater than v_0, the seller will retain possession even though one of the bidders has a valuation greater than the seller.

Notice also that *entry fees* are an alternative way of implementing a positive reserve price. By setting an entry fee equal to the expected profit of a bidder with value r when the reserve price is 0,[14] the seller can ensure that a bidder participates if and only if her value exceeds r.

2.6. Optimal selling mechanisms

Auctions are best thought of as "selling mechanisms"—ways to sell an object when the seller does not know exactly how the potential buyers value the object. There is obviously a very large number of ways in which an object could be sold in such a situation: for example, the seller could simply post a price and pick one bidder randomly if more than one buyer is willing to pay that price; post a price and then negotiate; use any one of the common auctions; use any of the *less* common forms of auction such as an "all pay" auction in which all bidders pay their bids but only the highest bidder gets the object; impose non-refundable entry fees; use a "matching auction" in which one bidder bids first and the other bidder is given the object if he matches the first bidder's bid, and so on. The search for an optimal selling scheme in a possibly infinite class of selling schemes would indeed seem like a daunting task. The major breakthrough, however, was the insight that without loss of generality, one could restrict attention to selling mechanisms in which each buyer is induced to report her valuation (often called "type") truthfully. This is the so-called "Revelation Principle" (Myerson, 1981; Dasgupta, Hammond and Maskin, 1979; Harris and Raviv, 1981), and it greatly simplified the formulation of the problem.

Armed with the Revelation Principle, one can attack the problem in a more general setting than we have discussed so far. While we will still remain within the confines of the independent private values framework,[15] we can dispense with the assumption

[14] From (15), this is $\int_0^r G(y)\,dy$.

[15] Myerson's (1981) framework is slightly more general in that he allows the value estimate of a bidder as well as the seller to depend on the signals of all other bidders, i.e., his model is one in which the signals are independent and private, but the valuations are interdependent.

that all bidders' valuations are drawn from identical distributions, i.e., one can accommodate asymmetries among bidders. Asymmetries are important in many real world situations—for example, in procurement, when both domestic and foreign bidders participate, and especially in corporate finance, in the context of takeover bidding.

Before proceeding further, however, we need to introduce some notation. Let $\mathbf{v} = (v_1, v_2, \ldots, v_N)$ denote the set of valuations for bidders $1, \ldots, N$ and let $\mathbf{v} \in \mathbf{V} \equiv (\times V_i)_{i=1}^{N}$, where V_i is some interval $[0, \bar{v_i}]$. Likewise, let $\mathbf{v_{-i}} = (v_1, v_2, \ldots, v_{i-1}, v_{i+1}, \ldots, v_N)$, and $\mathbf{v_{-i}} \in \mathbf{V_{-i}} \equiv (\times V_i)_{j=1, j\neq i}^{N}$. Let $f(\mathbf{v})$ denote the joint density of the values; since the values are independently drawn, we have $f(\mathbf{v}) = f_1(v_1) \times f_2(v_2) \times \cdots \times f_N(v_N)$, and $f_{-i}(\mathbf{v_{-i}}) = f_1(v_1) \times \cdots \times f_{i-1}(v_{i-1}) \times f_{i+1}(v_{i+1}) \times \cdots \times f_N(v_N)$ is similarly defined.

The seller picks a mechanism, i.e., an allocation rule that assigns the object to the bidders depending on messages sent by the latter. By appealing to the Revelation Principle, we can restrict attention to *direct* mechanisms, i.e., mechanisms that ask the bidders to report their values v_i. Thus, the mechanism consists of a pair of functions $\langle Q_i(\mathbf{v}'), P_i(\mathbf{v}')\rangle_{i=1}^{N}$ for each i which states the probability Q_i with which the object would go to bidder i and the expected payment P_i that bidder i would have to make for any vector of *reported* values of the bidder valuations. Of course, the mechanism has to satisfy two conditions: (i) it must be Incentive Compatible, i.e., it must be (weakly) optimal for each bidder to report her value truthfully given that all others are doing the same, and (ii) it must be Individually Rational, i.e., the bidders must be at least as well off participating in the selling process than from not participating.

Thus, the probability that bidder i gets the object when she reports her value to be z_i and all other bidders report truthfully is

$$q_i(z_i) = \int_{\mathbf{V_{-i}}} Q_i(z_i, \mathbf{v_{-i}}) f_{-i}(\mathbf{v_{-i}})\, d\mathbf{v_{-i}},$$

and the expected payment he makes is

$$p_i(z_i) = \int_{\mathbf{V_{-i}}} P_i(z_i, \mathbf{v_{-i}}) f_{-i}(\mathbf{v_{-i}})\, d\mathbf{v_{-i}}.$$

It can be shown[16] that (i) Incentive Compatibility is equivalent to the requirement that the $q_i(v_i)$ functions are non-decreasing, i.e., the probability that a bidder gets the object is non-decreasing in her reported value of the object, and (ii) Individual Rationality is equivalent to the requirement that the $p_i(v_i)$ functions satisfy $p_i(0) \leqslant 0$, i.e., the bidder with zero value has non-positive expected payment. It can also be shown that in the optimal selling mechanism, the $Q_i(\mathbf{v})$ need to be chosen to maximize the following

[16] For details, please see Myerson (1981) or Krishna (2002).

expression:

$$\sum_{i=1}^{N} p_i(0) + \sum_{i=1}^{N} \int_{\mathbf{V}} \left(v_i - \frac{1 - F_i(v_i)}{f_i(v_i)} \right) Q_i(\mathbf{v}) f(\mathbf{v})\, d\mathbf{v}$$
$$= \sum_{i=1}^{N} p_i(0) + \int_{\mathbf{V}} \left(\sum_{i=1}^{N} J_i(v_i) Q_i(v_i) \right) f(\mathbf{v})\, d\mathbf{v} \tag{18}$$

and the payment made by bidder i needs to satisfy

$$P_i(\mathbf{v}) = Q_i(\mathbf{v}) v_i - \int_0^{v_i} Q_i(z_i, \mathbf{v}_{-\mathbf{i}})\, dz_i. \tag{19}$$

The quantities $J(v_i) = v_i - \frac{1-F_i(v_i)}{f_i(v_i)}$ are known as "virtual valuations" for reasons that will become clear below. Notice that $\frac{1-F_i(v_i)}{f_i(v_i)}$ is the inverse of the hazard rate $\frac{f(v_i)}{1-F_i(v_i)}$. If the hazard rate is increasing, then the virtual valuations are increasing in v_i. This is known as the "regular case" in the literature.

Ignoring the Incentive Compatibility and Individual Rationality constraints for the moment, it is clear that the objective function (18) is maximized pointwise if $Q_i(\mathbf{v})$ is set equal to the maximum value (i.e. 1, since it is a probability) when $J_i(v_i)$ is the highest for any realized $\mathbf{v}$, and zero otherwise. Two implications immediately follow.

First, notice that the allocation rule implies that if the bidders are symmetric (i.e., the private values are drawn from the same distribution $F(v_i)$ for all i), then the bidder with the highest value gets the object with probability one. Moreover, from (19), any two selling procedures that have the same allocation rule must also result in the same expected payment made by the bidders and thus result in the same expected revenue for the seller. In particular, when the bidders are symmetric, all the standard auctions—since they result in the highest value bidder getting the object with probability 1—are optimal selling mechanisms and result in the same expected revenue for the seller.

Second, if the bidders are not symmetric, then the object need not go to the bidder with the highest v_i. For example, suppose $f_i(v_i) = \frac{1}{b_i - a_i}$. Then $J_i(v_i) = 2v_i - b_i$. Thus, $v_i > v_j \Rightarrow J_i(v_i) > J_j(v_j)$ if and only if $v_i - v_j > (b_i - b_j)/2$. In other words, the high-value bidder may not get the object if the upper bound on her value for the object is sufficiently high. The intuition is that the potential for such a bidder to under-represent her value is high; thus, by discriminating against her in terms of the likelihood of being awarded the object, the seller induces her to report truthfully when her valuation is high. The basic message here is of considerable importance, as we will see in more detail later: when bidders are asymmetric, it may pay to discriminate against the stronger bidder.[17]

[17] Notice that in the regular case, since the virtual valuations are non-decreasing, the q_i's are non-decreasing as well. Moreover, it is easily checked that $P_i(0, \mathbf{v}_{-\mathbf{i}}) = 0$ for all $\mathbf{v}_{-\mathbf{i}}$; hence $p_i(0) = 0$ for all i. Thus, incentive compatibility and individual rationality conditions are satisfied.

2.7. Interpreting the optimal auction: The marginal revenue view

Bulow and Roberts (1989) provide an intuitive interpretation of the "virtual valuations" $J_i(v_i)$ according to which the object is allocated in the optimal selling scheme. Interpret v_i as a "price" and $1-F_i(v_i)$ as a demand curve: if a price p is set as a take-it-or-leave-it price, $1-F_i(p)$ gives the probability of a sale, i.e., the "quantity" $q(p)$ sold at price p. We can then calculate a marginal revenue curve in the usual way, but using $1-F_i(v_i)$ as the demand curve:

$$\begin{aligned}
&\text{Total Revenue} = v_i q(v_i)\\
&\Rightarrow (\text{Marginal Revenue}) = \frac{d(\text{Total Revenue})}{dq}\\
&\qquad\qquad = v_i + q(v_i)\frac{dv_i}{dq}\\
&\qquad\qquad = v_i + \big(1-F_i(v_i)\big)\frac{1}{dq/dv_i}\\
&\qquad\qquad = v_i - \frac{1-F_i(v_i)}{f_i(v_i)}. \qquad (20)
\end{aligned}$$

Thus, the virtual valuations are marginal revenues, and the optimal mechanism awards the good to the bidder with the highest marginal revenue. Bulow and Roberts (1989) in fact provide the following "second marginal revenue" auction interpretation of the optimal selling scheme. Each bidder is asked to announce her value, and the value is converted into a marginal revenue. The object is awarded to the bidder with the highest marginal revenue (M_1), and the price she pays is the lowest value that she could have announced without losing the auction (i.e., $MR_1^{-1}(M_2)$).[18]

Why does the "second marginal revenue" auction call for the winner to pay the lowest value she could announce without losing the auction? This is, in fact, a property of the optimal selling mechanism discussed in the previous section. To see this, define $s_i(\mathbf{v_{-i}})$ as the smallest value (more precisely, the infimum) of v_i for which i's virtual valuation (marginal revenue) would be no less that the highest virtual valuation from the rest of the values. Clearly, $Q_i(z_i, \mathbf{v_{-i}}) = 1$ if $z_i > s_i(\mathbf{v_{-i}})$ and 0 otherwise. Thus, $Q_i(z_i, \mathbf{v_{-i}})$ is a step function, and this implies that $\int_0^{v_i} Q(z_i, \mathbf{v_{-i}})\, dz_i = v_i - s_i(\mathbf{v_{-i}})$ if $v_i > s_i(\mathbf{v_{-i}})$ and 0 otherwise. Since $v_i > s_i(\mathbf{v_{-i}})$ implies $Q_i(\cdot,\cdot) = 1$ and $\int_0^{v_i} Q(z_i, \mathbf{v_{-i}})\, dz_i = v_i - s_i(\mathbf{v_{-i}})$, from (19) we get $P_i(v_i, \mathbf{v_{-i}}) = s_i(\mathbf{v_{-i}})$ for the winning bidder. Thus, the bidder with the highest marginal revenue pays the lowest value that would win against all other values when the object is allocated according to the marginal revenue rule.

[18] If no bidder has positive marginal revenue, the seller keeps the object; if only one bidder has a positive marginal revenue, then she pays the price at which her marginal revenue is zero. It is easy to check that truthful reporting is a dominant strategy in this auction.

3. Common-value auctions

3.1. Common value assumptions

To this point we have mostly considered auctions where bidders' preferences were described by the independent private values assumptions. Clearly, in this framework, given their signals, bidders have complete information about the value of the object to themselves. We turn now to another class of models where each bidder has information that, if made public, would affect the remaining bidders' estimate of the value of the object. The general model could be described as each bidder having a value $V_i = v_i(t_1, t_2, \ldots, t_N)$, where t_i represents bidder i's signal. However, before we turn to the general model, it is useful to focus on a particularly important special case—the case of the "pure common value" model. In this scenario, every bidder has the same valuation for the item, hence the phrase "common value". In other words, we have

$$V_i = v(t_1, t_2, \ldots, t_N) \tag{21}$$

for each bidder i. Such an assumption is reasonable for auctions of many assets. The sale of a company, for instance, is sure to exhibit common-value characteristics, for the company's underlying cash flows will be uncertain but, at least to the first consideration, will be the same for all potential acquirers.[19]

Common or interdependent-value auctions involve a certain form of adverse selection, which if not accounted for by bidders, leads to what has been called the "winner's curse". Auctions are wonderful at selecting as winner the bidder with the highest valuation. However, the highest of several value estimates is itself a biased estimate, and this fact would cause the winner to adjust downward her estimate of the value of the object. For example, suppose that there are two bidders, the object is worth $v = t_1 + t_2$ to each, where each t_i is an independent draw from the uniform [0, 1] distribution. Based on her signal alone, each bidder's estimate of the value is $t_i + 1/2$. However, if the bidders are symmetric, after learning that she is the winner in a first-price auction, bidder i's estimate of the value will change to $t_i + E(t_j | t_j < t_i) = t_i + t_i/2 < t_i + 1/2$.

The point to emphasize here is that under almost any reasonable bidding scenario, the high bidder will be the one with the highest value estimate. While each bidder's estimate is an unbiased ex-ante estimate of the common value, the highest of those estimates is biased high. Or to put it another way, winning an auction gives a bidder information that they had the highest estimate of value. If one respects the fact that the other bidders are as good at estimating value as oneself, then the information that $N - 1$ other bidders thought the item is worth less should give one pause for reflection (and of course this pause should have been taken before the bid was submitted).

[19] The classroom "wallet game" mimics this particular common value auction model. In this game, two students are picked and each is asked to privately check the amount of money in his wallet. The teacher then announces that a prize equal to the combined amount of money in the wallets will be auctioned. The auction method is a standard ascending auction in which the price is gradually raised until one student drops out. The winner then gets the prize by paying that price. See Klemperer (1998).

3.2. Optimal bidding with a common value

We begin with the illustrative example introduced above, and show how the principles apply.

Suppose there are only two bidders and the value to each bidder is given as

$$v = t_i + t_j, \tag{22}$$

where t_i and t_j are each bidder's privately known signals. We will suppose that the signals are independently distributed according to a uniform distribution on [0, 1].

Consider first a second-price auction. It is easy to show that in this auction, it is optimal for each bidder to bid $2t_i$. Suppose bidder j is following this strategy, and bidder i bids b. Then bidder i wins the auction if $2t_j = b_j < b$, i.e., $t_j < b/2$. Her expected gain is $\int_0^{b/2}(t_i + \tilde{t} - 2\tilde{t})\,d\tilde{t} = t_i\frac{b}{2} - \frac{1}{2}\frac{b^2}{4}$. Maximizing with respect to b, one gets $b_i = 2t_i$, as claimed.

With two bidders, the second-price auction is equivalent to an ascending auction. Thus, it should be no surprise that the equilibrium bidding strategies in an ascending auction are identical to the one derived above. To see this, suppose bidder j has a bidding strategy of $b_j = 2t_j$. If bidder i continues to be in the auction at a price $b > 2t_i$, her profit if j ended the auction by dropping out would be $t_i + b/2 - b = t_i - b/2 < 0$, and thus it cannot be optimal for her to be in the auction at that price. Similarly, if $b < 2t_i$ her profit if j ends the auction would be $t_i + b/2 - b > 0$, and thus it cannot be optimal for her to quit at that price. Consequently, she must stay in the auction until the price reaches $2t_i$.

Notice that the bidders do take into account winner's curse in equilibrium. If the price reaches a level $b = 2t_i$, the value of the object is at least $t_i + b/2 = 2t_i$, since j is still in the auction. Thus, the expected value is strictly higher than $2t_i$. However, i would still quit at this price, because *if the auction had ended* at this price because j quit, she would be breaking even. As we saw above, she would lose if the auction ends at any higher price and she is the winner.

A first-price auction is more complicated, but similar results hold. One can think of the optimal bid in a first-price auction as being the result of a two-stage process: first, adjust one's expected value for the bias associated with being the highest out of N signals; and second, further lower the bid to account for the strategic nature of an auction.

3.3. Milgrom and Weber's (1982a, 1982b) generalized model

3.3.1. Core assumptions

While both the independent private value and the pure common value model capture many key aspects of real auctions, they are obviously polar cases. Many real auctions will contain both private value and common value characteristics. In an auction of a company, for instance, the company's "core" cash flow will be a common value for all

bidders, but synergies will likely differ across bidders and therefore contribute an element of independent private values. In a seminal paper, Milgrom and Weber (1982a, 1982b) developed analysis of a generalized valuation model for auctions. The key valuation assumption in Milgrom and Weber's general *symmetric* model is that the value of the item to bidder i is given by

$$v_i = u(t_i, \mathbf{t_{-i}}). \tag{23}$$

In (23), t_i is the signal privately observed by bidder i, and $\mathbf{t_{-i}}$ denotes the vector of signals $(t_i, t_2, \ldots, t_{i-1}, t_{i+1}, \ldots, t_N)$. The function $u(\cdot, \cdots)$ is non-decreasing in all its variables. The model is symmetric in the sense that interchanging the values of the components of $\mathbf{t_{-i}}$ does not change the value of the object to bidder i. In this symmetric model, note that both the private and pure common value models are special cases: if $v_i = u(t_i)$ for all i, we have the private value model, and if $v_i = u(t_1, t_2, \ldots, t_N)$ for all i (i.e., $u(\cdot, \cdots)$ is symmetric in *all* the signals, then the model is a common value model. The interdependent values model with independent signals discussed earlier is also obviously a special case, in which the signals are i.i.d.

The symmetric model assumes that the joint density of the signals, denoted by $f(\cdot, \cdots, \cdot)$ is defined on $[0, \bar{t}\,]^N$, and is a symmetric function of its arguments. The density functions are also assumed to have a statistical property known as "affiliation", which is a generalized notion of positive correlation among the signals.

It will be convenient to work in terms of the expected value of the object to bidder i conditional on her own signal t_i and the highest among the remaining $N - 1$ signals. Without any loss of generality, we will focus on bidder 1, and accordingly, let us define

$$v(t, y) = E\big[v_i(\cdots)|t_1 = t, Y_1 = y\big], \tag{24}$$

where Y_1 is the highest signal among the remaining $N - 1$ signals of bidders $2, \ldots, N$. We will denote the distribution function of Y_1 by $G(y)$ and its density by $g(y)$. Notice that because of symmetry, it does not matter who among the remaining bidders has the highest signal, and moreover, by virtue of symmetry with respect to the way in which a bidder's own signal affects the value of the object to the bidder, the function is the same for all bidders. Because of affiliation, it follows that $v(\cdot, \cdot)$ is non-decreasing function in t and y.

3.3.2. Equilibrium bidding

It is convenient to begin with the second-price auction. Generalizing the example in Section 3.2, we shall show that the symmetric equilibrium bid function is given by $v(t, t)$. Recall that the function $v(t, t)$ is the expected value of the bidder's valuation, conditional upon the bidder having signal t and on the bidder with the second-highest signal also having signal t.

To see that $v(t, t)$ is the symmetric equilibrium bid function, notice that if bidder 1 bids b_1 assuming that all other bidders are following the proposed equilibrium bidding

strategy, then her expected payoff is

$$\int_0^{b^{S^{-1}}(b_1)} \big(v(t, y) - v(y, y)\big) g(y|t)\, dy.$$

Differentiating, it is immediate that the first-order condition is satisfied if $b_1 = b^S(t)$ so that $b^{S^{-1}}(b_1) = t$.

Turning now to the ascending auction, suppose that the bidding is at a stage where all bidders are still active. Suppose bidder with signal t has the strategy that she will remain in the bidding until the price $b^N(t) = u(t, t, \ldots, t)$ is established, provided no bidder has dropped out yet. If the first bidder to drop out does so at the price p_N, let t_N be implicitly defined by $b^N(t_N) = p_N$. Then suppose every remaining bidder with signal t has the strategy of staying until the price reaches $b^{N-1}(t, p_N) = u(t, t, \ldots, t, t_N)$. Let p_{N-1} be the price at which the next bidder drops out. Then let t_{N-1} be implicitly defined by $b^{N-1}(t_{N-1}, P_N) = p_{N-1}$. Now every remaining bidder has a strategy of remaining in the bidding until the price reaches $b^{N-2}(t, p_{N-1}, p_N) = u(t, t, \ldots, t_{N-1}, t_N)$. Proceeding in this manner, the bidding strategies of the bidders after each round can be written down until two bidders remain. Clearly, these strategies entail that each bidder drops out at that price at which, given the information revealed by the bidding up to that point, the expected value of the object would be exactly equal to the price if all remaining bidder except herself were to drop out all at once at that price.

We shall argue that these strategies constitute an equilibrium of the ascending auction. If bidder 1 wins the auction, then t_1 must exceed all other signals. Now, from the construction of the bidding strategies, it is clear that the bidder with highest signal among the remaining bidders quits at a price $u(y_1, y_1, y_2, y_3, \ldots, y_{N-1})$, where y_i denotes the value of the ith highest signal among the rest of the bidders, i.e., excluding bidder 1. Thus, bidder 1 gets $u(t, y_1, y_2, y_3, \ldots, y_{N-1}) - u(y_1, y_1, y_2, y_3, \ldots, y_{N-1})$, which is strictly positive. Quitting earlier, she would have obtained zero, and any other strategy that makes her drop out after the bidder with signal y_1 cannot give her any higher payoff. Consider now a situation in which bidder 1 does not have the highest draw. For her to win the auction, she must have to pay $u(y_1, y_1, y_2, y_3, \ldots, y_{N-1})$; however, this exceeds the value of the object to her, which is $u(t, y_1, y_2, y_3, \ldots, y_{N-1})$. Thus, she cannot do better than drop out as prescribed by the equilibrium strategy.

To find the equilibrium bid in the first-price auction, assume that each of the other $N - 1$ bidders follow a bidding strategy $b^F(z)$, and that bidder 1 bids as though her private signal were z. Since the bids are increasing, the expected profit for bidder 1 whose signal is t is

$$\Pi(z, t) = \int_0^z \big(v(t, y) - b^F(z)\big) g(y|t)\, dy.$$

The derivative of this expression with respect to z is

$$\big(v(t, z) - b^F(z)\big) g(z|t) - b^{F'}(z) G(z|t),$$

which should be zero at $z = t$. Thus, we get

$$\big(v(t,t) - b^F(t)\big)\frac{g(t|t)}{G(t|t)} = b^{F'}(t). \tag{25}$$

Since $v(0,0) = 0$, we have the boundary condition $b^F(0) = 0$. The differential equation can then be solved[20]

$$b^F(t) = \int_0^t v(y,y)\,dL(y|t), \tag{26}$$

where $L(y|t) = \exp(-\int_y^t \frac{g(x|x)}{G(x|x)}\,dx)$.

It is easy to check that $L(\cdot|t)$ is in fact a probability distribution function on $[0,t]$, so that the expression for the equilibrium bid is an expected value with respect to some probability measure.

3.3.3. Revenue ranking and the linkage principle

With affiliated signals, revenue equivalence no longer holds. The ascending auction generates at least as much expected revenue to the seller as the second-price auction, which in turn generates at least as much expected revenue as the first-price auction. While a direct comparison is possible, the so-called "Linkage Principle" provides a fundamental insight. Consider an auction A in which a symmetric equilibrium exists, and suppose that all bidders are bidding in accordance with this symmetric equilibrium except possibly bidder 1, who has a signal t but bids as though her signal were z (z could equal t). Suppose $W^A(z,t)$ denotes the expected price that is paid by that bidder if she is the winning bidder. Then the Linkage Principle says that of any two auctions A and B with $W^A(0,0) = W^B(0,0)$, the auction for which $W_2^i(t,t)$ (i.e., the partial derivate with respect to the second argument evaluated with both arguments at t) is higher will generate the higher expected revenue for the seller.

With the benefit of the Linkage Principle, it is easy to see why the first-price auction generates higher revenue than the second-price auction. In the first-price auction, a bidder with signal t bidding as if the signal were z would pay $b^F(z)$ conditional on winning, i.e., $W_2^F(z,t) = 0$ for all t and z. On the other hand, in the second-price auction, the corresponding expected payment is $E[b^S(Y_1)|t_1 = t, Y_1 < z]$, where Y_1 is the highest signal among the other $N-1$ bidders. It can be shown that given that $b^S(\cdot)$ is an increasing function, affiliation implies that $E[b^S(Y_1)|t_1 = t, Y_1 < z]$ is increasing in t. Hence, the second-price auction generates higher expected revenue.

An important implication of the Linkage Principle—especially for corporate finance purposes—is that the seller can raise her expected price (revenue) by committing to release to all bidders any information relevant to valuations. More formally, if the

[20] The first-order condition is only a necessary condition. It can be shown that $P_i(z,t)$ is indeed maximized at $z = t$ if the signals are affiliated.

seller releases an informative variable that is affiliated with the other variables, then the expected equilibrium price (for all auction forms) is at least as high as when the information is not released.

3.4. Limitations of the common-value and general symmetric auctions

For corporate finance situations especially, issues of information and efficiency in auctions should be important. Existing models do not allow for full consideration of some of these issues.

In the independent private values auction, efficiency has only one dimension: whether the item is sold to the bidder with the highest valuation. In the pure common value model, there is no real allocation problem so that from an efficiency standpoint, one might as well allocate the item randomly. While a random allocation may not provide optimal revenue for the seller, one should be suspicious of a model focused only on wealth-transfer and not efficiency considerations. One can imagine a variety of economic forces outside of the auction process itself that will tend to cause efficient processes to develop (competition between auctioneers, or even the law). Models that assume away any possibility of inefficiency may cause us to lose sight of the true economic issues in comparing alternative selling mechanisms.

The Milgrom and Weber (1982a, 1982b) model brings an allocation problem back into the picture, in that bidders' valuations differ, so there are efficiency implications of the allocation. On another level, though, this relatively general model still fails to permit a complete role for economic efficiency. As pointed out by Hirshleifer (1971), information can have both private and social value. For information to have social value, it must have the capability to affect the allocation of resources. One would expect that in an auction context, information would not only allow bidders to refine their estimates of value, but since the bidders do have inherently different valuations, one would also expect that information would possibly change relative valuations. That is, with one information set, bidder i might have the highest expected value; but with a different information set, bidder j might have the highest expected value.

The Milgrom and Weber model does not permit this kind of role for information. A simple example suffices to show this as well as to illustrate why it is important to allow information to play an efficiency role. Consider the following two-bidder, two-state model:

	State	
	A	B
Bidder 1	100	200
Bidder 2	200	100

In State A, the asset is worth 100 to bidder 1 and 200 to bidder 2, with the valuations reversing for State B. Recall that a major result from the Milgrom and Weber (1982a, 1982b) model is that the expected price increases upon the seller's release of additional information. In the example above this result does not hold. Consider an open auction, and let the information on state initially be diffuse, with each state believed to be

equally likely. Then each bidder has an expected value of 150, and an open auction will yield a price of 150. Now let the seller release public information which discloses precisely which state prevails. In either state, an open auction will yield a sale price of only 100, the second-highest valuation. Release of information therefore lowers the expected price, contrary to the Milgrom and Weber findings. Interestingly, there is also now a tension between the seller's objective and economic efficiency: additional information improves efficiency by allocating the asset to its highest-valued use, but it lowers the seller's revenue. Little work has been done on the relative efficiency of auctions under circumstances such as this, but see Krishna (2002) for an excellent summary of efficiency in auctions. In corporate finance, it would seem that the issue of information and efficiency will be closely related: does additional information increase the efficiency of an auction (bearing in mind the cost of producing the information, possibly by multiple bidders) and does this create a conflict between revenue maximization and efficiency?

4. Applications of auction theory to corporate finance

4.1. Introduction

We now turn to survey the more important applications of auction theory to corporate finance. We begin with the market for corporate control and auctions in bankruptcy, which are the two largest areas of application. Then we turn to share repurchases, IPOs, and a limited review of corporate finance issues in the Federal Communication Commission's auction of radio spectrum. We do not cover applications of auctions to capital markets finance, for instance to models of the stock trading process or to auctions of bonds by governments and companies. Our intent in this survey is to go beyond a simple review and to point out how well auction theory can actually be used to "inform" corporate finance.

4.2. Applications to the market for corporate control

Auctions of one form or another typically occur in the market for corporate control. The field has proved fruitful for a variety of auction-based models to be constructed that explain many aspects of the market. One aspect is to explain the wealth gains to bidders and targets, as well as the combined wealth gains, on announcements of acquisitions.

4.2.1. Returns to bidders and targets

Many studies have documented the evidence on stock returns to bidders and targets in corporate acquisitions, and the overall evidence is that returns to targets are large and positive, while returns to acquirers are generally negative but statistically insignificant. Jarrell, Brikley and Netter (1988) provide evidence prior to 1988; Andrade, Mitchell and Stafford (2001) provide a recent update: over the period 1973–1998, with a database of

3688 acquisitions, the average two-day abnormal return around the announcement of an acquisition was 16% (statistically significant at the 5 percent level) for the target; −0.7% for the acquirer (statistically insignificant); and the combined gain was 1.8% (statistically significant at the 5% level). Boone and Mulherin (2003) further update the recent evidence; they find for a sample of acquisitions between 1989 and 1999 that target returns were on average 21.6%, and that the return to acquirers was an insignificant −0.7%.

Further cuts on the data provide interesting results on the returns to bidders. Returns to bidders are generally more negative the more is the competition from other bidders (although see Boone and Mulherin, 2006b, discussed below). All-stock offers generally yield lower returns to bidders than do all-cash offers (see discussion below). Returns to bidders are generally more positive when the acquisition is large relative to the acquirer's size (Loderer and Martin, 1990; Eckbo and Thorburn, 2000; Moeller, Schlingemann and Stulz, 2004). One strong empirical regularity is that the total profit to bidders and targets (as measured by the event studies) is greater for auctions than for merger negotiations. This is true for both bidders and targets. This may point to a particular measurement problem: merger bids are often a more drawn-out and partially anticipated takeover process than auctions—which means profits in auctions are more easily measured. It is also possible that tender offers are more profitable because they tend to remove old management (to a greater extent than mergers).

The most recent evidence come from the large-sample studies of Betton, Eckbo and Thorburn (2005, 2006). They study more than 12,000 publicly traded targets of merger bids and tender offers over the period 1980–2004. Following the approach of Betton and Eckbo (2000), bids are organized sequentially to form contests for a given target, and they focus in particular on the first and on the winning bidder (which need not be the same). Since the surprise effect of the initial bid is greater than that of subsequent bids, and since the initial bidder starts the contest, studying abnormal returns to the initial bidder yields additional power to test hypotheses concerning the sign and magnitude of bidder gains. Moreover, since bids are studied sequentially in calendar time, they present a natural laboratory for testing auction-theoretic and strategic bidding propositions (toehold bidding, bid preemption, bid jumps, target defenses, etc.).

Initially, Betton, Eckbo and Thorburn follow the tradition and report average abnormal returns for samples of offer outcomes, including "successful" and "unsuccessful" bids. In the traditional analysis, abnormal returns to "success" (AR_s) is found by cumulating abnormal returns from the first bid announcement through completion of the takeover process which may take several months. The lengthy cumulation adds noise to this estimate of AR_s. Therefore, Betton–Eckbo–Thorburn also report ex-ante estimates of AR_s using the more precisely measured market reaction to the initial bid announcement only. To illustrate, let x denote a set of offer characteristics (e.g., bid premium, the payment method, toehold purchases), and $p(x)$ the probability that the bid will succeed as a function of x. The market reaction Γ in response to the initial announcement of bid i is

$$\Gamma_i(x_i) = AR_s\, p(x_i) + AR_u\big(1 - p(x_i)\big), \tag{27}$$

where AR_u is the average abnormal return conditional on the offer being unsuccessful. Here, AR_s and AR_u are estimated as regression parameters in a cross-sectional regression involving *all* sample bids, whether ultimately successful or not.[21] Using the right-hand side of equation (27), they conclude that the expected value of the initial bid (conditional on x) is statistically indistinguishable from zero. As in the earlier literature, targets expected returns are positive and significant, as is the value of the sum of the gains to targets and bidders. Thus, the data do not support theories predicting value-destruction.

Betton, Eckbo and Thorburn also report that the magnitude and distribution of abnormal returns to bidders and targets depends significantly on whether they are private or publicly traded companies. Bidder gains are larger, and target premiums smaller, when the bidder is public but the target is a private firm. Moreover, private bidder firms have a significantly lower probability of succeeding with their bids for public targets. They also report that, in contests where no bids succeed, the target share price reverts back to the level where it was three calendar months prior to the initial bid in the contest. As noted by Bradley, Desai and Kim (1983) as well, this share price reversal is what one would expect if the market conditions the initial target stock price gain on a control change in fact taking pace (where control may be acquired by either the initial or some rival bidder).

Overall, the evidence suggests that auctions tend to yield great results for targets but that competition in the auction (or something else) tends to ensure that gains to bidders are at best minimal. From the standpoint of auction theory, this is surprising: certainly in a private values context, and even in a common value context, the strategic equilibrium of an auction should still yield an expected profit for the winning bidder. The fact that gains to bidders are minimal suggests that the pure auction models do not capture the richness of the process, and that other forces are likely at play. As Boone and Mulherin (2003) suggest, the evidence is in favor of two-stage models such as that of French and McCormick (1984) which analyze costly entry. While pure auction models imply an expected surplus for participating bidders, entry of additional bidders will cause that expected surplus to be dissipated through costly entry.

Roll (1986) first used the idea of the winner's curse to explain the empirical evidence that acquiring firms appear to over-bid for targets in that acquiring firms' stock prices fall (or stay at best constant) upon announcement of acquisitions. If bidders ignore the winner's curse, they may well over-pay (in a common value setting, which is not unreasonable in the corporate acquisition market). The problem, of course, is that equilibrium theory does not permit expected over-bidding, so Roll is relying upon acquirers making mistakes. Proponents of behavioral finance will find it quite convincing to think that bidders may not properly adjust their strategy for the pitfalls inherent in common value

[21] The estimation is in three steps: (1) estimate AR_i using time series of returns to the bidder up to the first bid announcement, (2) estimate $p(x)$ using the cross-section of bids, and (3) run regression (27) to produce AR_s and AR_u.

auctions, for avoidance of the winner's curse requires some careful analysis. Those inclined towards rational, equilibrium based models of behavior will be wary of models that assume incomplete strategic adjustment. Boone and Mulherin (2006b) use unique data that allows them to characterize sales of companies as either auctions or negotiations, and for the auctions, to say how many potential bidders were contacted in the sales process and how many actually submitted bids. Finding no relationship between bidder returns and these measures of competition, Boone and Mulherin conclude that their findings do not support the existence of a winner's curse.

A large literature attributes the acquirer wealth losses to managerial agency problems or "empire building" tendencies. For example, in a sample of 326 U.S. acquisitions between 1975 and 1987, Morck, Shleifer and Vishny (1990) find that three types of acquisitions have systematically lower and predominantly negative announcement period returns to bidding firms: diversifying acquisitions, acquisitions of rapidly growing targets, and acquisitions by firms whose managers performed poorly before the acquisition. The authors argue that these results are consistent with the view that managerial objectives may drive acquisitions that reduce bidding firms' values. Lang, Stulz and Walkling (1991) present related results. Jensen (2004) provides a new angle to this argument by hypothesizing that high market valuations increase managerial discretion, making it possible for managers to make poor acquisitions when they have run out of good ones.

Another recent approach to overbidding is based on the idea that when bidders own initial stakes or "toeholds" in the target firm, they are essentially wearing two hats—that of a buyer for the target's remaining shares, and that of a seller of their initial stakes to the rival bidder. We review the theory-based work in this area more fully below. For now, we note that in an independent private values model, Burkart (1995) and Singh (1998) show that a bidder with toehold will bid above her private value in a second-price auction. Similar results are also obtained in alternative value environments and under alternative auction procedures (Bulow, Huang and Klemperer, 1999; Dasgupta and Tsui, 2003). Evidence on the empirical relevance of toeholds, however, is mixed. In Jennings and Mazzeo's (1993) sample of 647 tender offers and mergers, the mean toehold is 3%, but only about 15% of the bidders own an initial stake. Betton and Eckbo (2000) study toeholds for initial and rival bidders in a sample of 1,250 tender offer contests over the period 1972–1991. They find that toeholds increase the probability of single-bid success and lower the price paid by the winning bidders.

Betton, Eckbo and Thorburn (2005) delve more deeply into the subtleties of various facts about toeholds. In their sample of 12,723 bids for control (3,156 tender offers and 9,034 mergers), 11% of the bids involved toeholds. The percentage was significantly higher for tender offers than for mergers, both for non-hostile targets (21% and 6%, respectively, for tender offers and mergers) and for hostile targets (62% and 31%, respectively). The mean and median toehold sizes conditional on being positive were 21% and 17%, respectively, for the overall sample. However, a majority of these toeholds were "long-term toeholds", i.e., acquired before 6 months prior to the bid. The percentage of bids involving short-term toeholds for the entire sample was only

about 2%. Betton, Eckbo and Thorburn (2005) argue that since toeholds are likely to deter competition, the target might turn hostile if the bidder acquires toeholds when private negotiations might be going on. Thus, it is unclear to what extent toeholds are used strategically in bidding contexts. It is worth recalling in this context, however, Shleifer and Vishny's (1986) analysis of the role of large shareholders in the target firm: even when they are not bidders, the presence of large shareholders in the target firm who are willing to split the gains on their shares with a bidder has the same effect as the bidder having an initial stake in the target.

Another approach to reconciling the existing findings on loss of value to acquirers, the gains to targets, and joint value losses is presented by Jovanovic and Braguinsky (2004), even though their model is not explicitly auction-based. The model incorporates uncertainty over the skill of corporate managers, the value of projects that companies have, and the takeover market. In equilibrium, the takeover market facilitates the exchange of "good" projects from firms with "bad" managers to firms with "good" managers but "bad" projects. Ex-ante values of firms represent investors' knowledge of management type but uncertainty over project type. If a firm puts itself up for sale, which it does only if its project is good and its management is bad, then investors learn that the firm does have the property right to a good project and its value increases—hence the positive return to targets. A firm becomes an acquirer only if its own project is bad. Upon learning that a firm will be an acquirer, investors learn that the firm's own project is bad—hence the negative return to acquirers. For reasonable parameter values, including a cost incurred in the takeover process, joint values of the target and acquirer fall. Even so, the mergers in the model are welfare-enhancing.

4.2.2. The auction process in the market for corporate control

As our previous discussion shows, takeover models help understand some of the observed empirical evidence on bidder and target returns. Another major role of auction theory, in so far as it facilitates our understanding of the takeover bidding process, has been to "inform" a company's board or regulators about the impact of selling processes or rules on shareholder wealth, efficiency and welfare. However, here, for the prescriptions to be useful, the auction models must at least reasonably mimic the takeover bidding environment. The question we address now is the extent to which this is the case.

First, it is important to note that auction theory has developed in the spirit of mechanism design, or the design of optimal selling schemes. Any auction model assumes a degree of commitment power on the part of the seller. There are clear "rules of the game" that the seller and the bidders are required to abide by. For example, in a first-price auction, in which bidders shade their bids, the losing bidders might want to submit a bid higher than the winning bid after the latter is disclosed. The seller must be able to commit not to entertain such bids. A similar argument applies to the reserve price. Casual observation, however, suggests that many bids (even when they are friendly) are not seller initiated. It might appear that many control contests are not really formal auc-

tions, in which the seller is trying to secure the best price for the firm's shareholders by committing to a selling mechanism.

This perspective is misleading, for several reasons. First, the board has a formal responsibility to be an "auctioneer". Under Delaware law,[22] a company's board must act as "auctioneers charged with getting the best price for the stock-holders at a sale of the company". In several well-publicized cases, after potential bidders had indicated their interest in acquiring the company, the board of directors of the target company have conducted an auction.[23] Although procedures similar to the ascending auction are most commonly used, boards have also held single, and sometimes even multiple, rounds of sealed-bid auctions (e.g., in the well-documented case of RJR Nabisco).

The commitment issue discussed above may influence the board's choice of auction mechanism. For example, the board might have a preference for ascending auctions because, under alternative auction rules such as the sealed-bid auction, should a losing bidder offer a higher subsequent bid, it may be difficult to reject that bid if the board is required to obtain the "best price for the shareholders". In other words, it may be difficult to commit to a single round of bidding.

Legal scholars, however, have taken the view that whether or not it is feasible for the board to pursue a particular auction mechanism depends, ultimately, on how the courts view it. If, in a given context, the courts consider that a particular auction mechanism can generate higher revenue for the shareholders ex-ante than the more commonly used ones, there is no reason why a board cannot adopt it as a selling scheme. Further, if the shareholders do not perceive a particular selling scheme to be against their interests *ex-ante*, there is no reason why a board cannot secure shareholder approval prior to conducting a sale. It is exactly in this spirit that legal scholars have looked at alternative selling procedures (see, for example, Cramton and Schwartz, 1991). The focus of this literature has very much been on what one can learn from economic theory (in particular, auction theory) to "inform" takeover regulation or selling practices.

Second, the board's commitment power is sometimes underestimated. Boards can commit to awarding an object to a "winner" from a given round of bidding even when better bids might subsequently emerge—thereby undermining the auction—in a variety of ways. The most common practice is to enter into a lock-up arrangement[24] with the declared winner, together with an agreement to pay a break-up fee should the sale be

[22] The Delaware law is significant because many U.S. public companies are incorporated in Delaware.

[23] For example, in the takeover battle for Paramount between Viacom and QVC, the Paramount board eventually conducted an auction in an effort to "select the bidder providing the greatest value to shareholders".

[24] Lockups are "*agreements that give the acquirer the right to buy a significant division, subsidiary or other asset of the target at an agreed (and generally favorable) price when a competing bidder acquires a stated percentage of the target's shares*" (see Herzel and Shepro, 1990). They may also involve options to buy a block of target shares from the target that may make acquisition by a competing bidder more difficult. Lockup agreements are quite common in takeover contests. The legal status of lockups is unclear, as some courts have upheld them, while others have not. For an account of the legal literature on lockups, see Kahan and Klausner (1996a, 1996b).

terminated.[25] Another possibility is for the target board to refuse to rescind poison pills for any but the declared winning bidder. While it is unclear whether the courts will allow such poison pills to stand, the legal costs of challenging the poison pills and the possibility that the board might switch to an ascending auction (so that the challenger is by no means assured of winning the contest) may deter further challenge from a losing bidder.

Third, formal or informal auctions are much more common than is usually assumed. Boone and Mulherin (2006a) analyze a sample of 400 takeovers of U.S. corporations in the 1989–1999 period and find evidence consistent with the idea that boards act as auctioneers to get the best price for the shareholders in the sale of a company. Based on information from the SEC merger documents, the authors provide new information on the sale process. The most important evidence is that there is a significant *private* takeover market prior to the public announcement of a bid. The authors document that almost half of firms in their sample were auctioned among multiple bidding firms, and the rest conducted negotiations with a single bidder. A third of the firms in the former category went through a formal auction, in which the rules were clearly laid out. In all cases, the process usually began with the selling firm hiring an investment bank and preparing a list of potential bidders to contact. After the bidders agreed to sign a confidentiality/standstill agreement, they received non-public information. Subsequently, a subset of the bidders indicating preliminary interest was asked to submit sealed bids.[26]

Another issue relevant for the applicability of auction models to control contests concerns the complexity of the environments in which takeovers are conducted, compared to the standard auction environments. Auction models are nicely classified as belonging to different value environments, and results differ depending on which value environment is under consideration. The takeover environment is considerably more complicated. The motives for takeover bids could be varied. The early takeover models (e.g., Grossman and Hart, 1980) assumed that the benefit from a takeover comes from an improvement in the operational efficiency of the target company. As the authors showed, this could lead to a "free-rider" problem and the market for corporate control could fail. However, later models have focused on "merger synergies" as the source of gain from takeovers. If the synergies accrue to the bidding firm, then the standard auction environment is more applicable. Here, however, there are issues about whether "private values" or "common values" assumptions are more relevant. Since bidders are different and the synergies are likely to have idiosyncratic components, a private values model does not appear unreasonable. However, common value elements will also undoubtedly exist. Synergies can have common value components if their magnitudes

[25] For example, Viacom's initial offer for Paramount in 1993 was associated with (a) an option to buy 20% of Paramount's outstanding shares and (b) a termination fee of $150 million plus expenses, should the transaction not be concluded.

[26] Betton, Eckbo and Thorburn (2005) show that of the 12,000 contests, about 3,000 (25%) start out as tender offers (which subsequently turn into auctions). Some initial merger bids also end up in auctions, so the overall percentage of auctions maybe closer to 30%.

depend on the quality of the target's assets, or if the bidders plan to bundle these assets with other assets that they own and eventually sell these assets.[27,28]

Other complexities also arise when applying the auction framework to the analysis of takeover bidding. Bidders could bid for the company, or they could bid for a fraction of the company's shares. Different regulatory regimes permit different types of bids. Bids could be exclusionary, discriminatory, conditional, and so on. Bids can be in cash, or in shares of the target company. Bidders may have different toeholds, and they might have different degrees of expertise in the target industry (a factor that could affect the degree of information conveyed by their bids in common value environments). Finally, if the bidders are competing with each other in the same industries, then the outcome of the auction may impose externalities on the bidders. As we will argue below, while existing takeover models, drawing on auction theory, have evolved to deal with these many of these complexities, significant gaps still exist in the literature.

4.2.3. Auctions versus negotiations

Several papers use auction theory to further refine our theoretical and empirical understanding of the auction process in corporate takeovers. Starting at the most basic level, Bulow and Klemperer (1996) show that in an English auction, it is always better to have $N+1$ bidders in a formal auction than to have N bidders but with a follow-on (optimal) negotiation between the winning bidder and the seller. If $N = 1$, this shows that it is better to have an auction with two bidders than to sell by posting a reserve price.[29] Very simply, the auction process is extremely efficient at extracting value from the high bidder, more so than even an optimally conducted negotiation. This theoretical result does conflict with a stylized fact that companies do frequently avoid auctions and instead negotiate with just one buyer (Boone and Mulherin, 2006a).

4.2.4. Pre-emptive bidding

Fishman (1988, 1989) considers models where one bidder has incentive to make a "preemptive" bid. In the main model of Fishman, a first bidder has incentive to put in a high bid that discourages the second bidder from bidding. The reason for this is that a high bid can signal a high valuation on the part of the first bidder, and a second bidder will

[27] Models of takeover bidding, when making common values assumption about the target's "true worth", have often tended to assume away the free-rider problem. If a bidder obtains a large majority of the shares, she may be able to "freeze out" the remaining minority shareholders. Also, the loss of liquidity on any remaining shares can have the same effect as "dilution" (see Grossman and Hart, 1980) that reduce the post-takeover value of the minority shares.

[28] Betton and Eckbo (2000) show that the average number of days from the initial tender offer bid to the second bid is 15 days (counting only auctions with two or more bids). They suggest that this very short period is evidence of correlated values. Of course, the vast majority of all cases develop a single bid only, which may be taken as evidence of private (uncorrelated) values, or preemptive bidding (see below).

[29] See Krishna (2002) for an analysis of this case.

then infer that the gain from participating in the auction is low (they are not likely to win in the final English auction). Since participation in the auction requires a bidder to spend resources to determine her own value, the second bidder can be discouraged from even entering the auction. Fishman (1989) extends this initial work by including the possibility of non-cash offers.

Fishman's (1988) model works as follows. The value of the target assets to the bidders depends in part on the realization of a state of nature which is observed only by the target. Conditional on the target's information, the value of the assets to the bidders is increasing in the bidders' independent private signals. The means-of-payment can be either cash or debt that is backed by the target's assets. Each bidder has to incur some cost to learn the private signal. Bidder 1 identifies a target by accident, and then incurs some cost to learn his signal (bidding is assumed to be not profitable if the true signal is unknown). If bidder 1 submits a bid, the target is "put in play", and a second bidder is aware of the target. This bidder then decides whether or not to compete for the target and incur the cost of learning her signal.

There is a stand-alone value of the target that is public information, and the target rejects all bids below this value. Since the bidders do not know completely how much the target assets are worth to them (recall that the target privately observes part of this information), bidders could end up overpaying for the target. Paying with debt mitigates the overpayment because the value of the debt is contingent on the value of the target assets (since the debt is backed by these assets). However, if bidder 1 draws a high private signal, a cash offer—though costly—will separate it from a bidder with low signal: the latter will prefer to pay only with debt since his own private signal is not sufficiently high. Thus, by bidding with cash, the first bidder can signal to the second bidder that the latter's likelihood of winning the ensuing auction is low: hence, the second bidder may decide not to incur the cost of learning her signal. This, then, is a "pre-emptive" bid. On the other hand, if the first bidder's signal is low, bidding high with a cash offer is too costly. Thus, such a bidder would decide not to preempt and instead bid with debt to mitigate the potential loss from buying a target with low synergy. Notice that one prediction of this model is that more competing offers should be forthcoming with non-cash offers than with cash offers.[30]

4.2.5. Modelling auctions of companies

Hansen (2001) reviews the formal auction process used for selling private companies and divisions of public companies. The model explains the common practices of limiting the number of bidders and limiting the disclosure of information to bidders (Boone and Mulherin, 2006a), even though theory suggests that both practices would reduce

[30] Betton and Eckbo (2000) find that the average offer premium in successful single-bid contests is greater than the average offer premium in the *first* bid in multiple-bid contests. This what consistent with preemptive bidding.

prices. Hansen argues that some information in a corporate sale is competitive in nature, and that its broad release can destroy value in the selling company. The seller therefore faces a tradeoff between having many bidders and full disclosure versus protecting value by limiting disclosure, as well as the number of bidders. While not modeling negotiations formally, the analysis implies that negotiation with a single bidder may be optimal if the "competitive information cost" is high enough. The model also explains the practice of a two-stage auction, with a first stage calling for non-binding "indications of interest" (value estimates for the target) which are used to select bidders for the second round and giving them access to more information on the selling company. If the selling company uses the initial value estimates for the target to set a reserve price that is an increasing function of the estimates, bidders in the initial round will reveal their private valuations honestly and the selling company can select the most highly-valued bidders for the final, binding, round (see the discussion below on the process for pricing IPOs for an earlier similar finding).

4.3. Means-of-payment

Hansen (1985a, 1985b, 1986) has considered the role of non-cash means of payment in the market for corporate control; this work has now been extended by DeMarzo, Kremer and Skrzypacz (2005). In one model, Hansen shows that ex-post means of payment can increase the seller's revenue beyond what cash payments can do. Take an independent private values context, where v_i represents bidder i's valuation of the target company. An ascending auction with cash as the means of payment will yield v_2—the second highest value—as the price. Consider, however, bidding using bidders' stock as the means-of-payment. Let each bidder have a common value, v, of her stand-alone equity. Then each bidder will be willing to bid up to s_i, where s_i is the share of firm i offered (implicitly through an offer of equity) and is defined to make the post-acquisition value of the bidder's remaining equity equal to its pre-acquisition value:

$$v = (v + v_i)(1 - s_i),$$

which implies

$$s_i = \frac{v_i}{v + v_i}. \tag{28}$$

The bidder with the highest valuation of the target will win this auction (s_i is increasing in v_i) and she will have to offer a share defined by v_2, the valuation of the second-highest bidder. However, the value of this bid to the target will be

$$s_2 * (v + v_1) = \frac{v + v_1}{v + v_2} v_2 > v_2$$

since $v_1 > v_2$. The stock-based bidding therefore extracts more revenue from the high-bidder than does cash bidding. DeMarzo, Kremer and Skrzypacz (2005) generalize this result, showing that expected revenues are increasing in the "steepness" of the security

design, where steepness refers, roughly, to the rate of change of a security's value in relation to the underlying true state. This paper also compares auction formats in a world where bids can be non-cash; it turns out that revenue equivalence does not always hold. Overall the paper concludes that the optimal auction is a first-price auction with call options as the means-of-payment.

Ex-post pricing mechanisms also yield benefits in common-value contexts. The reason for this follows from the return of the adverse selection problem inherent in the winner's curse: the problem arises because the price for the asset is being determined before the value of the asset is known. Any kind of pricing mechanism that determines all or part of the price ex-post can alleviate the problem. Using the acquiring firm's stock is an ex-post pricing mechanism, for that stock's value will depend upon the actual value of the target firm. Hansen (1986) builds on this insight and shows that stock and cash/stock offers can be used efficiently in mergers and acquisitions. However, in offering stock as the means-of-payment, acquiring firms bring in their own adverse selection problem—acquiring firms may offer stock when they have information that their own value is low. Taking into account both the ex-post pricing advantage of stock and the "reverse" adverse selection problem, it turns out that higher-valued acquirers will offer cash while low-valued acquirers offer stock. Fishman (1989) reaches a similar conclusion, in that non-cash offers induce the target firm to make more efficient sell/don't sell decisions, but that cash offers have an advantage in pre-empting other bids.[31]

Several studies on U.S. data show results consistent with Hansen and Fishman's work, that acquirers' returns are higher for cash offers than for stock offers (see Eckbo, Giammarino and Heinkel, 1990, for a brief summary). The first paper to explicitly model the choice of mixed offers is Eckbo, Giammarino and Heinkel (1990). These authors prove the existence of a fully separating equilibrium in which the market's revaluation of the bidder firm is increasing and convex in the proportion of the offer that is paid in cash. Since one can estimate the revaluation, and since the proportion paid in cash is observable, this theory is testable. Using over 250 Canadian takeovers (where tax issues do not confound the choice of payment method), the authors find empirical support for the "increasing" part but not for convexity.

4.4. Toeholds

Recently, a number of theoretical papers have examined how toeholds affect takeover bidding. The main result that emerges from this literature is that the presence of makes bidders more aggressive, with the result that bidders can bid above the value of the object. The result holds for the second-price auction in both the independent private values as well as a common value environment.

[31] Rhodes-Kropf and Viswanathan (2000) consider a general model of non-cash auctions for a bankrupt firm. We discuss this model later.

Burkart (1995)[32] considers a two-bidder and independent private values model. The private values are best interpreted as synergies. The auction form is a second-price auction, which in this context is strategically equivalent to an ascending auction (Lemma 1 in the paper). From standard arguments, it follows that (i) it is a dominant strategy for the bidder with no toeholds to bid exactly her valuation, and (ii) it is a *dominated* strategy for the bidder with positive toehold to bid below her valuation. A general result is that any bidder with positive initial stake will bid strictly above her valuation. The model is then specialized to the case in which one bidder—call her bidder 1—has an initial stake of θ while the other bidder—bidder 2—has no initial stake.

Since bidder 2 will bid her value, we have $b_2(v_2) = v_2$. Thus, bidder 1's problem is to choose b_1 to maximize

$$\text{Max}_{b_1} \Pi_1(v_1, b_1, \theta) = \int_0^{b_1} \big[v_1 - (1-\theta)v_2\big] f_2(v_2)\, dv_2 + \theta b_1 \big(1 - F_2(b_1)\big). \quad (29)$$

The first-order condition is

$$\big(v_1 - (1-\theta)b_1\big) f_2(b_1) + \theta\big(1 - F_2(b_1)\big) - \theta b_1 f_2(b_1) = 0.$$

Re-arranging, we get

$$b_1 = v_1 + \theta \frac{1 - F_2(b_1)}{f_2(b_1)} > v_1. \quad (30)$$

If one assumed that the hazard function $\frac{f_2(\cdot)}{1-F_2(\cdot)}$ is increasing, then a number of results follows immediately. First, bidder 1's equilibrium bid is increasing in her valuation and the size of her toehold. Therefore, the probability that bidder 1 wins the auction is also increasing in her toehold. It is also clear that the auction outcome can be inefficient: since bidder one bids more aggressively than bidder 2, it is clearly possible that $v_1 < v_2 < b_1(v_1)$, i.e., bidder 1 has the lower valuation but wins the auction. This result is similar to the inefficiency in the standard auctions where the seller sets a reserve price. In fact, the intuition for the overbidding result is exactly that of an optimal reserve price from the point of view of a seller. Indeed, with a toehold, a bidder is a part-owner and we should not be surprised to find that she wants to "set a reserve price" in excess of her own value.

It is interesting to note that winning can be "bad news" for bidder 1. Suppose $v_1 = 0$ with probability 1. Then bidder 1 still bids a positive amount (equal to bidder 2's value) but since her bid exceeds the value of the synergy, she always overpays when she wins the auction. By continuity, the same conclusion holds for $\bar{v_1}$ (the upper bound of the support of the distribution of bidder 1's synergy) sufficiently small, and for bidder 2's valuation in some interval $[v_2', b_1(\bar{v_1})]$.[33]

[32] Singh (1998) has essentially similar results.

[33] Using Burkart's private value setting with two bidders, Betton, Eckbo and Thorburn (2005) also show optimal overbidding when the bidder has a lock-up agreement with the target. Moreover, they show optimal underbidding when the bidder has a breakup fee agreement with the target.

Bulow, Huang and Klemperer (1999) examine the effect of toeholds in a pure common value environment. They make a significant contribution to the literature on toeholds by deriving bid functions for both the second and first-price auctions when both bidders have positive toeholds. They examine how (for small positive toeholds) bidder asymmetry affects the takeover outcome in each auction, and compare expected revenues in the two auctions when the toeholds are symmetric as well as asymmetric. We first discuss their setup in some detail, before discussing the intuition for the main results.

Bulow, Huang and Klemperer (1999) consider a "pure common value" model with two bidders where each bidder draws an independent signal t_i from a uniform [0, 1] distribution. The value of the target to each bidder is $v(t_1, t_2)$. Bidder i owns initial stake θ_i in the target, where $1/2 > \theta_i > 0$, for $i = 1, 2$. Each bidder bids for the remaining $1 - \theta_i$ fraction of the shares of the target.

In the second-price auction, bidder i's problem is to choose b_i to maximize

$$\text{Max}_{b_i} \Pi_i(t_i, b_i) = \int_0^{b_j^{-1}(b_i)} \big[v(t_i, \alpha) - (1-\theta_i) b_j(\alpha)\big]\, d\alpha + \int_{b_j^{-1}(b_i)}^{1} \theta_i b_i \, d\alpha. \quad (31)$$

The first-order condition is

$$\frac{1}{b_j'}\big[v\big(t_i, b_j^{-1}(b_i)\big) - (1-\theta_i) b_j\big(b_j^{-1}(b_i)\big)\big] + \big[1 - b_j^{-1}(b_i)\big]\theta_i - \theta_i b_i \frac{1}{b_j'} = 0.$$

Let us now define $\phi_j(t_i) = b_j^{-1}(b_i(t_i))$, i.e., this defines the pair of signals for bidders i and j for which they have the same bid, since $b_j(\phi_j(t_i)) = b_i(t_i)$. Similarly, we can define $\phi_i(t_j) = b_i^{-1}(b_j(t_j))$. Using these definitions, we can rewrite the first-order condition as

$$b_j'\big(\phi_j(t_i)\big) = \frac{1}{\theta_i} \frac{1}{(1 - \phi_j(t_i))}\big[b_i(t_i) - v\big(t_i, \phi_j(t_i)\big)\big], \quad (32)$$

where we have replaced t_j by $\phi_j(t_i)$.

The corresponding first-order condition for bidder j is

$$b_i'\big(\phi_i(t_j)\big) = \frac{1}{\theta_j} \frac{1}{(1 - \phi_i(t_j))}\big[b_j(t_j) - v\big(\phi_i(t_j), t_j\big)\big], \quad (33)$$

where we have used the fact that $v(\phi_i(t_j), t_j) = v(t_j, \phi_i(t_j))$. Consider a pair of t_i and t_j that in equilibrium bid the same, then we must have $t_i = \phi_i(t_j)$ and $t_j = \phi_j(t_i)$. Using this, the last equation can be rewritten as

$$b_i'(t_i) = \frac{1}{\theta_j} \frac{1}{(1 - t_i)}\big[b_j\big(\phi_j(t_i)\big) - v\big(t_i, \phi_j(t_i)\big)\big]. \quad (34)$$

Since $b_j(\phi_j(t_i)) = b_i(t_i)$ and $b_i'(t_i) = b_j'(\phi_j(t_i))\phi_j'(t_i)$, dividing (34) by (32), we get

$$\phi_j'(t_i) = \frac{\theta_i}{\theta_j} \frac{1 - \phi_j(t_i)}{1 - t_i}. \quad (35)$$

Integrating, and using the boundary condition $b_i(0) = b_j(0)$ (see Bulow, Huang and Klemperer, 1999, for a proof), we get

$$\phi_j(t_i) = 1 - (1 - t_i)^{\theta_i/\theta_j}. \tag{36}$$

Since the probability that bidder i wins the object is $\int_0^1 \int_0^{\phi_j(t_i)} dt\, dt_i = \frac{\theta_i}{\theta_i+\theta_j}$, it is clear that bidder i is more likely to win the auction as her stake increases and that of bidder j decreases. Remarkably, a bidder's probability of winning goes to 0 as her stake becomes arbitrarily small, given that the other bidder has a positive stake. The intuition for this result is that while bidder i with zero stake has no incentive to bid above $v(t_i, \phi_j(t_i))$ given the equilibrium bidding strategy of j, as we shall see below, bidder j with $t_j = \phi_j(t_i)$ and a positive stake will strictly bid above this value.[34]

Now, equation (34) can be integrated to give

$$b_i(t_i) = \frac{\int_{t_i}^1 v(t, \phi_j(t))(1-t)^{\frac{1}{\theta_j}-1}\, dt}{\int_{t_i}^1 (1-t)^{\frac{1}{\theta_j}-1}\, dt}, \tag{37}$$

where the boundary condition $b_i(1) = b_j(1) = v(1, 1)$ is used (see Bulow, Huang and Klemperer, 1999).

From (36), we then get

$$b_i(t_i) = \frac{\int_{t_i}^1 v(t, 1-(1-t)^{\theta_i/\theta_j})(1-t)^{\frac{1}{\theta_j}-1}\, dt}{\int_{t_i}^1 (1-t)^{\frac{1}{\theta_j}-1}\, dt}. \tag{38}$$

Bidder j's bid function is derived similarly. From (37), it is clear that for $t_i < 1$, $b_i(t_i) > v(t_i, \phi_j(t_i))$. Thus, when bidder i wins the auction, she is paying more than the target is worth to her. Moreover, bidder i's bid is increasing in her stake θ_i, i.e., a higher stake makes the bidder act more like a seller and causes her to bid higher.

Bulow, Huang and Klemperer (1999) extend the analysis in two main directions. First, they consider the effect of a more asymmetric distribution of the toeholds and find that subject to an overall constraint on the toeholds of the two bidders that is sufficiently small, a more uneven distribution of toeholds leads to lower expected sale price for

[34] Klemperer (1998) demonstrates in the context of the "Wallet Game" how a very small asymmetry in a common value model can give rise to very asymmetric equilibria. This is a consequence of the fact that in the standard Wallet Game, there are in fact a continuum of asymmetric equilibria. A small toehold—like a small bonus to one of the players in the Wallet Game—introduces a slight asymmetry that can have a major impact on the equilibrium, i.e., one of the bidders essentially having a zero probability of winning. With a slight advantage, the stronger player bids slightly more aggressively, but that increases the winner's curse on the weaker player. The latter then bids less aggressively, which reduces the winner's curse on the stronger player, who then bids still more aggressively, and so on. With slight entry or bidding costs, this prevents the weaker player/players from entering the auction, so that very low prices result. Klemperer (1998) provides several illustrative examples from Airwaves Auctions.

the target. This result is a consequence of the fact that as the toeholds become more asymmetric, the bidder with the higher toehold bids more aggressively, i.e., further away from the value. For the bidder with a smaller toehold, this implies that the target is worth less conditional on winning. Exposed to this "winner's curse", the bidder with the smaller toehold therefore bids lower. Since in the second-price auction the winner pays the lower of the two bids, the expected sale price is adversely affected when the toeholds become asymmetric.

Bulow, Huang and Klemperer (1999) next consider first-price auction and derive the equilibrium bid functions using methods similar to those described above for the second-price auction. In this case, we have $\tilde{\phi}_j(t_i) = t_i^{(1-\theta_i)/(1-\theta_j)}$. The probability that bidder i with signal t_i and toehold θ_i wins the auction in this case is given by $\frac{1-\theta_j}{(1-\theta_i)+(1-\theta_j)}$, which is increasing in θ_i. It is easily checked that for $\theta_i < \theta_j$, the probability of bidder i winning the auction is lower in the second-price auction than in the first-price auction. Since in both auctions the probability is exactly $1/2$ when $\theta_i = \theta_j$, this implies that the winning probability falls more steeply with a decrease in a bidder's toehold the second-price auction than in the first-price auction.

The incentive for bidders with toeholds to bid high in the first-price auction are not as strong as in the second-price auction. This is because in the in the first-price auction (unlike the second-price auction), bidding high does affect the bidder's cost, although a higher toehold does lower that cost since fewer shares need to be purchased.

Unlike the second-price auction, the expected sale price can increase in the first-price auction as the toeholds become more asymmetric. Revenue comparisons indicate that with *symmetric* toeholds, the expected sale price is higher in the second-price auction. This is because as the winner's curse problem is mitigated with symmetric toeholds, both bidders can bid more aggressively and essentially set a higher reserve price for their stakes in the second-price auction. With asymmetric toeholds, as we saw above, the second-price auction generates low expected sale prices due to the winner's curse.[35]

4.5. Bidder heterogeneity and discrimination in takeover auctions

Bidder asymmetry is common in the context of corporate control contests and can take several forms. Asymmetry in initial stakes or toeholds, discussed in the previous section, is one form of bidder asymmetry. Bidder asymmetry can also arise when bidders draw their signals from different distributions, or when (in a common value environment) the bidder signals have asymmetric impact on the value function.

In Section 2.6, we saw that when bidders are asymmetric, the optimal mechanism may not allocate the object to the bidder with the highest valuation. For example, in the independent private value context, an allocation rule that discriminates against a

[35] The analysis of toeholds can be extended to models that include the private value model and the common value model of Bulow, Huang and Klemperer (1999) as special cases. Dasgupta and Tsui (2004) analyze auctions where bidding firms hold toeholds in each other in the context of such a model.

stronger bidder may provide a higher expected profit to the seller. Thus, standard auctions are no longer optimal in the presence of various forms of bidder heterogeneity.

To increase the expected sale price when bidders are asymmetric, the seller has essentially two alternative responses. Both involve "levelling the playing field". When the asymmetry is due to differences in toeholds or access to information, the target's board may decide to restore symmetry by allowing the disadvantaged bidder increase his toehold cheaply or provide access to additional information.[36] Alternatively, the board may decide to design the auction rules in a way that discriminates against the strong bidder.

An especially simple way to discriminate is to impose an order of moves on the bidders. Since bidding games are price-setting games, there is usually a "second-mover advantage" associated with bidding games (see Gal-Or, 1985, 1987). Thus, to discriminate against the strong bidder, the seller could ask this bidder to bid first. This bid could then be revealed to a second bidder, who wins the auction if she agrees to match the first bid. Otherwise, the first bidder wins. In the context of takeover bidding, this "matching auction" has been studied by Dasgupta and Tsui (2003), who note that since courts are more concerned about shareholder value than whether the playing field is level or not, it is unlikely that the matching auction will run into trouble because it does not treat the bidders symmetrically.[37]

To see that the matching auction can generate a higher expected sale price than the second-price auction in the independent private value setting, let us return to the private values model introduced in Section 4.4. Assume that the private values of both bidders are drawn from the uniform [0, 1] distribution. From equation (30), we get the bid of bidder 1 who has a toehold of θ to be

$$b_1(t_1) = \frac{t_1 + \theta}{1 + \theta}.$$

Thus, the expected bid from bidder 1 is $P_1 = \int_0^1 \int_0^{(t_1+\theta)/(1+\theta)} t_2 \, dt_2 \, dt_1 = \frac{1}{6}\frac{3\theta^2+3\theta+1}{(1+\theta)^2}$ and that from bidder 2 is $P_2 = \int_0^1 \int_0^{(1+\theta)t_2-\theta} \frac{t_1+\theta}{1+\theta} \, dt_1 \, dt_2 = \frac{1}{6}\frac{1-2\theta^2+2\theta}{1+\theta}$. Thus, the expected sale price in the second-price auction is

$$P^S = P_1 + P_2 = \frac{(2\theta + 1)(2 + 2\theta - \theta^2)}{6(1 + \theta)^2}. \tag{39}$$

Now consider the matching auction. Given a bid b_1 from bidder 1, bidder 2 will match if and only if $t_2 > b_1$. Thus, bidder 1 chooses b_1 to maximize

$$\int_0^{b_1} \big(t_1 - (1 - \theta)b_1\big) \, dt_2 + \theta(1 - b_1)b_1.$$

[36] Betton and Eckbo (2000) note that when a rival (second) bidder enters the auction with a toehold, the toehold is of roughly the same magnitude as the initial bidder's toehold (about 5%). This is consistent with the "leveling the playing field" argument of Bulow, Huang and Klemperer (1999).

[37] Herzel and Shepro (1990) note: "Opinion in several cases in the Delaware Chancery court has noted that the duty and loyalty [of managers] runs to shareholders, not bidders. As a result, 'the board may tilt the playing field if it is in the shareholder interest to do so' ".

From the first-order condition, one readily gets $b_1(t_1) = (1/2)t_1 + (1/2)\theta$. Thus, the expected sale price in the matching auction is

$$P^M = \frac{1}{4} + \frac{1}{2}\theta. \tag{40}$$

Comparing (39) and (40), it can be verified that $P^M > P^S$ if and only if $\theta > 0.2899$. Thus, if the toeholds are sufficiently asymmetric, asking the strong bidder to move first increases the expected sale price.

The matching auction's properties in the context of a common value model with independent signals similar to Bulow, Huang and Klemperer (1999) have been explored by Dasgupta and Tsui (2003). The authors show that there exists a perfect Bayesian Nash equilibrium in which bidder 1 with stake θ_1 bids

$$b_1(t_1) = v\big(t_1, F_2^{-1}(\theta_1)\big) \tag{41}$$

and bidder 2 matches if and only if $t_2 \geqslant F_2^{-1}(\theta_1)$.[38] Here, bidder i's signal is drawn from the distribution $F_i(t_i)$. Notice that the expected sale price is then

$$P^M = E_{t_1}\big(v\big(t_1, F_2^{-1}(\theta_1)\big)\big). \tag{42}$$

Notice that (i) conditional on her bid, losing is better than winning for bidder 1, since her payoff in the former event is $\theta_1 v(t_1, F^{-1}(\theta_1))$, and her payoff in the latter event is at most $v(t_1, F^{-1}(\theta_1)) - (1-\theta_1)v(t_1, F^{-1}(\theta_1))$, and (ii) as a consequence, winning is "bad news" for bidder 1, i.e., if she wins, there would be a negative effect on the stock price. In contrast, winning is always "good news" for the second bidder.

It is also immediate that the expected sale price increases in the first bidder's toehold. In contrast, bidder 2's stake has no effect on the expected sale price. The probability of bidder 1 winning the auction is $F_2^{-1}(\theta_1)$ and is therefore increasing in θ_1. However, the common value feature of the model is apparent in that if bidder 1's toehold is 0, then her probability of winning is also 0; moreover, in this case, she bids $v(t_1, 0)$, i.e., the lowest possible value conditional on her own signal. This is because the bidder who moves first is subjected to an extreme winner's curse problem.

How can the matching auction improve the expected sale price compared to the standard auctions? Recall that in the second-price auction with asymmetric toeholds, the smaller toehold bidder is exposed to an extreme winner's curse problem. The matching auction is a way to shield the low toehold bidder from this extreme winner's curse by asking her to move second. This, of course, imposes a winner's curse on the first bidder. However, if the asymmetry is large, the first bidder with a higher toehold will act more like a seller, and this the sale price will not suffer as much. Dasgupta and Tsui (2003) show that, for the case of a value function that is symmetric and linear in the signals (i.e., $v(t_1, t_2) = t_1 + t_2$) that are drawn from the uniform distribution, the matching

[38] For a derivation and a complete characterization of the equilibrium, see Dasgupta and Tsui (2003).

auction generates a higher expected sale price than both the first- and the second-price auctions when the toeholds are sufficiently asymmetric and not too small.

Another type of bidder asymmetry arises in the common value framework if the value function is not symmetric, e.g., $v(t_1, t_2) = \alpha t_1 + (1 - \alpha)t_2$ and $\alpha > 1/2$. Dasgupta and Tsui (2003) show that with symmetric toeholds, the matching auction generates a higher expected sale price than the first-price auction if the value function is sufficiently asymmetric (i.e., α sufficiently close to 0 or 1); and it generates a higher expected sale price than the second-price auction if the value function is sufficiently asymmetric and the toeholds are not too large. Povel and Singh (2006) characterize the optimal selling mechanism for the zero toeholds case and show that discrimination against the strong bidder is optimal. However, to implement the optimal mechanism, the seller needs to know the precise value of α as well as the distribution of the signals. This is not required in the matching auction, for which only the identity of the stronger bidder is needed. In other words, the matching auction is a "detail-free" mechanism. This is an especially appealing property given that for sufficiently large asymmetry, the matching auction does almost as well as the optimal mechanism in extracting the surplus.

4.6. Merger waves

There is no question that merger and acquisition activity goes in waves. Rhodes-Kropf and Viswanathan (2004) give the following perspective: in 1963–1964, there were 3,311 acquisition announcements while in 1968–1969 there were 10,569; during 1979 to 1980 and also from 1990 to 1991 there were only 4,000 announcements while in 1999 alone there were 9,278 announcements. The 1980s were generally a period of high merger and acquisition activity, and saw the emergence of the hostile takeover and corporate raiders, but activity dropped off in the early 90s only to rebound again late in the 90s. Holmstrom and Kaplan (2001) review the evidence on merger waves and offer a macro explanation based on changing regulatory and technological considerations which created a wedge between corporate performance and potential performance, along with developments in capital markets which gave institutional investors the incentives ands ability to discipline managers.

Rhodes-Kropf and Viswanathan (2004) offer an alternative explanation for merger waves based on an auction-theoretic model rich in informational assumptions. They note that periods of high merger activity tend to be periods of high market valuation, and the means of payment is generally stock. For example, the percentage of stock in acquisitions as a percentage of deal value was 24% in 1990, but 68% in 1998. They focus on mergers where stock is the means-of-payment. The essence of the argument is as follows: stock values of both targets and acquirers can become over-valued on a market-wide basis. These are economy-wide pricing errors that managers of neither targets nor acquirers have information on, but they do know they occur. Managers of targets know when their own stocks are overvalued; however, they do not know how much of that is due to economy-wide pricing errors and how much is firm-specific. When a stock offer is made *in an overvalued market*, target managers, knowing their

own firms are overvalued but not knowing whether this is due to market-wide or firm specific factors, will overestimate potential synergies with acquirers. This is similar to search-based explanations of labor market unemployment, whereby workers think that a decrease in demand for their labor at one firm is firm-specific (when it is in fact business cycle related) and therefore accept unemployment, thinking that their economy-wide opportunities have not been affected. Thus, in times of economy-wide overvaluation, target firms will accept more bids, for they rationally infer that synergy with the bidder is high. Of course, with each merger, the market should rationally lower the price, taking the possibility of overvaluation into account. However, this does not rapidly lead to an end of a wave: if synergies are correlated, then merger waves can occur, because the market also revises upward the probability that synergies for *all* firms are high. Correlation of synergies can arise out of the sort of considerations that Holmstrom and Kaplan discuss, for example, changes in technology which increase the efficient scale of firms. Thus, a merger wave that begins when the market becomes overvalued may end only when the market realizes that the synergies that were anticipated are actually not there—i.e., the wave ends with a market crash.

Rhodes-Kropf and Viswanathan's model is one of an open auction with bidders offering shares of the combined firm, similar to that of Hansen (1985a, 1985b). Multiple bidders and cash offers are possible. High bids by other bidders imply more likely misvaluation in stock offers; however, since synergies are correlated, this does not cause the wave to end. Stock-based deals are also more likely than pure cash deals in times of economy-wide overvaluation because of the valuation errors that targets make given the information structure. Thus, the model explains not only merger waves but also the stylized fact that in times of intense merger activity, stock is more likely to be used as the means-of-payment.

Shleifer and Vishny (2003) propose a theory of mergers and acquisitions which has a similar flavor. They argue that merger activity is driven by the relative valuations of bidders and targets and perceptions of synergies from merger activity. Suppose that acquirer and target have K_1 and K units of capital, respectively. The current market valuations per unit of capital are Q_1 and Q, respectively, where $Q_1 > Q$. The long-run value of all assets is q per unit. If the two firms are combined, then the *short-run* value of the combined assets is $S(K + K_1)$, where S is the "perceived synergy" from the merger. In other words, "S is the story that the market consensus holds about the benefits of the merger. It could be a story about [the benefits of] diversification, or consolidation, or European integration". Suppose P is the price paid to the target in a merger. If the means of payment is stock, it is easily checked that *long-run* benefit to the bidding firms' shareholders is $qK(1 - P/S)$ and that to the target shareholders is $qK(P/S - 1)$.[39] Thus, if $S > P > Q$, bidding firms' shareholders benefit in the long run but target

[39] Since the synergy is only in the mind of the beholder (the market), the long term benefit to the bidding firms' shareholders from a cash offer would be $q(K + K_1) - PK < qK_1$ since $P > Q > q$. On the other hand, if the synergy were real, a bidding firm would have no reason to prefer stock over cash. Thus, a large number of stock offer during a particular period should reveal to the market that the synergies are

shareholders benefit in the short run. Shleifer and Vishny (2003) argue that if target shareholders or managers have shorter horizons, they may be willing to trade off the short run benefits for the long run losses. For example, target management may be close to retirement or own illiquid stock and options.[40] Shleifer and Vishny (2003) argue that the example of family firms selling to conglomerates and entrepreneurial firms selling to firms such as Cisco and Intel in the 1990s fit this story very well. Alternatively, the bidding firm could simply "bribe" target management—Hartzell, Ofek and Yermack (2004) find that target management receive significant wealth gains in acquisitions, and acquisitions with higher wealth gains for target management are associated with lower takeover premia.

Overall, the theory predicts that cash offers will be made when perceived synergies are low but the target is undervalued ($Q < q$). This is likely to be a situation where the firm needs to be split up and/or incumbent management replaced to improve value, and will be associated with target management resistance and poor pre-acquisition target returns. In contrast, stock offers will be made when market valuations are high, but there is also significant dispersion in market values. Finally, for stock offers to succeed, there must be a widely accepted "story" about synergies, and target management must have shorter horizons. Notice that the model also predicts that the short term returns to bidders in stock offers would be negative if the synergies are not extremely high ($S > Q_1$, i.e., the bidder essentially has a money machine) and the long-run returns would also be negative. For cash offers, both short and long-term returns should be positive.

Shleifer and Vishny (2003) argue that the three most recent merger waves nicely fall into their framework. The conglomerate merger wave of the 1960s was fuelled by high market valuations and a story about the benefits of diversification through better management. The acquisition of firms in unrelated businesses might have been more attractive because target firms in the same industry would also have high market valuations. The targets were often family firms whose owners wished to cash out and retire. However, since there was really no synergy from diversification, the wave of the 1960s gave rise to the bust-up takeovers of the 1980s—acquisitions that were in cash, hostile, and of undervalued targets. Rising stock market prices ended this wave of takeover activity as undervalued targets became more difficult to find. The most recent wave of the 1990s was ushered in by the rising market valuations. The story of synergy was reinvented: technological synergies, the benefits of consolidation, and the European integration.

more apparent than real. It is precisely this kind of inference that is carefully modelled in Rhodes-Kropf and Viswanathan's (2004) model discussed above. Shleifer and Vishny (2003) brush aside these issues by assuming that the market is irrational.

[40] Cai and Vijh (2006) find that in the cross-section of all firms during 1993–2001, CEOs with higher illiquidity discount are more likely to get acquired. Further, in a sample of 250 completed acquisitions, target CEOs with higher illiquidity discount accept lower premium and are more likely to leave after acquisition. They also put up lower resistance and speed up the process.

4.7. Auctions in bankruptcy

One of the most fruitful areas for the application of auction theory in corporate finance is in the context of corporate bankruptcy. The theoretical efficiency of auctions in allocating assets to their most highly-valued use has led many scholars to propose auctions as a means to resolve some of the issues in bankruptcy. As an auction also yields a price for the corporation, the question of determining value (for the purpose of settling claims) is also solved. Unfortunately, the informational issues in bankruptcy are quite severe; so any complete auction-based model of the process which will yield predictions on total cost must include the cost of information acquired by bidders. There is also a fairly prevalent view that credit markets may not always allocate financing efficiently to potential buyers of bankrupt companies, so prices may be low because of a dearth of bidders. Some of these issues have been addressed empirically by examining the bankruptcy process in Sweden, where auctions of bankrupt companies are mandatory (see related discussion below).[41]

Baird (1986) was one of the first to point out that auctions may be preferable to the court-supervised reorganization process of the United States' Chapter 11 bankruptcy code. Baird, among others, used the auction processes and results of the corporate takeover market as an analogy to estimate the gains that may be achieved if auctions were used to transfer control of bankrupt companies' assets. Other researchers, Weiss (1990) in particular, turned to estimating the direct cost of Chapter 11 procedures—with those costs being estimated at between 2.8% and 7.5% of assets. Easterbrook (1990) argues against auctions, maintaining that the costs associated with the IPO process is a good analogy for estimating the costs of determining a firm's value, and calculates IPO direct costs at roughly 14% of proceeds. Hansen and Thomas (1998) argue that Easterbrook's figures need to be adjusted and put on a total asset, not proceeds, basis, and that the so-called "dealer's concession" built into IPO costs should also be subtracted as it is a cost of distribution, not of the auction process per se. Their resulting figure of 2.7% is then roughly equal to Weiss' estimates of the direct cost of bankruptcy. Thus, auctions and Chapter 11 would seem to have similar direct costs, leaving their relative efficiency to be determined by either theory or further empirical work.

On the empirical side, Thorburn (2000) has exploited the Swedish bankruptcy experience to draw important conclusions on the relative efficiency of cash auctions of bankrupt firms. In Sweden, the typical procedure has been for a bankrupt firm to be taken over by a court-appointed trustee who supervises a cash auction of the firm, either piecemeal or as an ongoing combination. These data therefore allow for direct examination of how auctions work in bankruptcy. Thorburn (2000) finds that three-quarters of the 263 bankrupt firms are auctioned as going-concerns, which compares favorably to Chapter 11 survival rates. As to cost, direct costs average 6.4% of pre-filing assets, with the one-third largest firms experiencing costs of only 3.7% of assets. As to debt recovery, the recovery rates are comparable to Chapter 11 reorganizations of much larger

[41] See Eckbo and Thorburn (2003, 2005).

firms: on average, creditors received 35% of their claims, with secured creditors receiving 69% and unsecured creditors only 25%. Thorburn finds that APR is maintained by the auction procedure.

Eckbo and Thorburn (2005) construct an auction-based model to examine the incentives of the main creditor bank in a bankruptcy auction. Their work addresses one fear of bankruptcy auctions, that credit market inefficiencies will sometimes limit credit and cause bankrupt companies to be sold at "fire-sale" prices, possibly to the benefit of the original owner/managers. Eckbo and Thorburn show that the main creditor bank has an incentive to provide financing to one bidder and to encourage that bidder to bid higher than would be in their private interest. The reason for this follows from the analysis of an optimal reserve price (see also the discussion of toeholds in Section 4.4) in an auction, for the main creditor bank is essentially a partial owner of the bankrupt company. Just as an optimal reserve price exceeds the seller's own valuation (see above), the optimal bid for a main-bank financed bidder exceeds that bidder's own valuation. The equation specifying the optimal bid in Eckbo and Thorburn is exactly analogous to the equation for an optimal reserve price. Eckbo and Thorburn, examining again the Swedish data, find strong results for the over-bidding theory and no evidence that auction prices are affected by industry-wide distress or business cycle downturns. They also demonstrate a surprising degree of competition in the automatic bankruptcy auctions, and that auction premiums are no lower when the firm is sold back to its own owners. Overall, their evidence—which is the first to exploit directly the cross-sectional variation in auction prices—fails to support either fire-sale arguments or the notion that salebacks are non-competitive transactions.

Auction theory has also been applied to study the question of optimal bankruptcy procedures. Hart et al. (1997) propose an ingenious three-stage auction process for bankrupt companies. The first stage solicits cash and non-cash bids for the firm, while the second and third stages determine prices and ownership of so-called "reorganization rights". Reorganization rights are new securities which consolidate all the various existing claims on the firm's assets. This proposal differs from Aghion, Hart and Moore (1992) in that there is a public auction (the third auction) for the reorganization rights. The purpose here is to reduce any inefficiencies caused by liquidity constraints in determining prices and allocations of the new securities which replace the old claims.

Rhodes-Kropf and Viswanathan (2000) extend the limited work done on non-cash bids in auctions discussed previously. While theory such as Hansen (1985a, 1985b) shows that non-cash bids such as equity can increase sales revenue, non-cash bids are themselves subject to uncertain valuation. Building on these basic insights, Rhodes-Kropf and Viswanathan show that in any separating equilibrium, a security auction (the means-of-payment is a security the value of which depends on the bidder's type) generates higher expected revenue to the seller than a cash auction. The reason for this is that in a security auction, the low types have a greater gain from mimicking the high types, so to separate, the high types have to bid more. However, some securities will not separate the bidders. The authors show that there is no incentive compatible separating equilibrium with stock alone. Debt bids, or a minimum debt requirement, can achieve

separation in some cases; in others, cash payments or large non-pecuniary bankruptcy costs are needed to achieve separation (so that the highest value bidder can be identified). However, relative to cash bids, bids that involve debt or equity distort ex-post effort choices. Bids that involve high debt and low equity rank higher because they distort effort less. Convertibles can work better as they give the seller the option to affect the ex-post capital structure of the target firm. The model thus is capable of explaining why debt and convertibles are often part of reorganization plans, and why companies often end up more highly levered than when they were distressed (Gilson (1997)).

Hansen and Thomas (1998) apply the model of French and McCormick (1984) to argue that uncertainty surrounding a bankrupt firm's assets can cause auction prices to be low. Using the French and McCormick model, with free entry of bidders, the auction price will be N^*C less than true value, where N^* is the equilibrium number of bidders and C is the pre-bid cost of entry (which they model as an information acquisition cost). Theoretically, then, the question is whether a court, by having to only obtain one (good) evaluation of the firm's assets, can hold costs below N^*C. They argue that the greater the uncertainty surrounding a firm's assets, the worse an auction will perform. By way of example, Reece (1978) shows that with high uncertainty, a common-value auction yields a price only 70% of true value.

4.8. Share repurchases

Companies frequently buy back their shares through either fixed-price tender offers or Dutch auction mechanisms. In a Dutch auction repurchase, a company determines a quantity of shares to buy back and asks shareholders to submit bids specifying a price and quantity of shares that they are willing to sell. The bids are ordered according to price (low to high), creating a supply curve. As the Securities and Exchange Commission prohibits price discrimination, a uniform price is set corresponding to the lowest price that enables the firm to buy the pre-determined number of shares.

While there has been little formal modeling of the Dutch auction repurchase process itself (possibly because no real auction-theoretic issues are present) there is considerable empirical study, and their effects relative to fixed-price offers has been studied in a more traditional corporate finance setting. Bagwell (1992) studies 32 Dutch auction repurchases between 1988 and 1991. In one transaction, the highest bid was 14% above the pre-announcement market price, while the lowest bid was only 2% above. Such disparities in bids are documented for the entire sample, showing that the firms did face upward-sloping supply curves for their shares, contrary to naive ideas of a perfect capital market. Bagwell mentions several possible explanations, including differences in private valuations (for example, because of capital gains tax lock-ins), asymmetric information about a common value as in Milgrom and Weber (1982a, 1982b), or differences in opinion (Miller (1977)). While tax considerations could play a large role, it is certainly not a stretch to assume that shareholders will have different information on the value of a company (even though they share the public information embedded in the current price).

Other work has explored signaling aspects of Dutch auction repurchases relative to fixed price tender offers (Persons, 1994) and relative to paying dividends (Hausch and Seward, 1993). Persons (1994) considers a situation in which shareholders demand a premium (perhaps due to capital gains tax frictions) to tender their shares, but this premium varies across shareholders, resulting in an upward sloping supply curve. Repurchases are costly to existing shareholders because the tendering shareholders must be offered a premium. Importantly, the slope of the supply curve is random. In a fixed-price tender offer, the price is fixed, while the quantity of shares tendered adjusts to the random slope of the supply curve; in a Dutch auction, exactly the opposite is the case. If the manager intends to signal the true value by maximizing a weighted average of the intrinsic value and the market value of the shares (as in the dividend signaling model of Miller and Rock, 1985), fixed-price offers are more effective signals of the manager's private information; on the other hand, if the manager needs to buy back a specific number of shares to prevent a takeover threat, a Dutch auction is better as it guarantees that the required number of shares will be tendered.

4.9. Auction aspects of initial public offerings (IPOs)

In the summer of 2004, the internet search firm Google completed the world's largest initial public offering to be conducted via an auction procedure. Google sold 19.6 million shares at an offering price of $85 each, for a total of $1.67 billion raised. The auction method used was a variant of the Wall Street Dutch auction, covered immediately above. Initial public offerings of equity shares would seem to be excellent candidates for an auction procedure: multiple units of the same item for sale, with uncertainty over value and ability of a seller to commit to a sales method.

Interestingly, however, the evidence suggests that formal auctions are not favored as a sales mechanism. Instead, the IPO procedure known as "bookbuilding" attracts most of the market in regions where multiple sales methods can legally exist (Sherman, 2005; Jagannathan and Sherman, 2006; Degeorge, Derrien and Womack, 2004). A fair amount of theoretical work has been done to explore differences in sales mechanisms for IPOs as well as issues within any one sales method. There is also a literature examining relative performance of auctions versus other sales methods, for in some countries we do have different sales methods co-existing.

In applying auction theory to IPOs, the place to start is the literature on uniform price, multiple unit auctions. The main initial contributions here are Wilson (1979), and Back and Zender (1993). A recent contribution is by Kremer and Nyborg (2004a, 2004b). The reason this literature is so important is that it shows how simple auction analysis yields the main underpricing result from IPO studies (that is, that the initial stock market returns immediately after setting the IPO price are overwhelmingly positive).[42] The auction models show in fact that uniform price, multiple unit auctions have a multitude

[42] For a detailed account of various theories of IPO underpricing, see Chapter 7 of Ljungqvist in this volume.

of equilibria with varying degrees of underpricing. The intuition of the underpricing result is quite simple: in a uniform price auction, bidders are asked to essentially submit demand schedules, specifying the number of shares they would be willing to buy at different prices. Wilson (1979) showed that instead of thinking of bidders as selecting a demand schedule to submit, a simple transformation allows us to model a bidder's decision as one of selecting the optimal "stop-out" price after subtracting other bidders' demands from the available supply. This makes each bidder a monopsonist over the residual supply and sets up the essential monopsonistic tension: a higher bid increases the quantity of shares purchased, but raises the price paid on all shares. Optimally, a bidder will submit a low stop-out bid, and as this will be the case for all bidders, a Nash equilibrium holds. Interestingly, the literature on underpricing in IPOs has not picked up on this simple explanation, relying instead on more complicated explanations.

While not relying on the Wilson/Back and Zender insights, Benveniste and Spindt (1989) nonetheless use an auction-based model to explain certain aspects of the IPO process. The basic idea is similar to that of Hansen (2001), as it involves conditions under which bidders reveal truthfully their information through bids that are non-binding "indications of interest". The model asks under what conditions an investor will reveal her information to the investment banker collecting demand information for an IPO. Under-pricing of the IPO guarantees a return to these investors; this is critical for otherwise there could be no incentive to honestly reveal information. Also, those investors who reveal high valuations must receive more of the under-valued shares, or again there would be no payoff from honestly revealing information (and there is a cost to honest revelation as it affects the offering price). Thus, this auction-based model explains two core features of the IPO process, under-pricing and differential allocations of shares.

Biais and Faugeron-Crouzet (2002) present a complex and quite general model of the IPO process that compares auctions to fixed-price offerings. Unfortunately, the authors' conclusion that the book-building approach dominates the auction method is clouded by the assumption that the auction method will induce collusion between the bidders. It is not at all clear why collusion, if profitable, will occur only in one auction method. This paper also shows why it is extremely difficult to use auction theory to convincingly show that one method is more efficient than another: to do this, one must introduce a myriad of assumptions, covering everything from valuations to costs of information collection. The validity of all these assumptions is difficult to evaluate, and the chances that the ranking of the sales methods would change, or become indeterminate, is high if some of the assumptions were changed.

Sherman (2005) compares bookbuilding to auctions under the very reasonable assumption that entry by bidders is an endogenous decision. Her model yields a result similar in spirit to a core result that emerges from comparing the basic auction methods that while the expected price is the same in sealed-bids versus second-price auctions, the variance of prices is greater for the second-price auction. This result comes about because in the first-price auction, bidders put in their bids using their *expectation* of what other bidders' values are, while in the second-price auction, the high-bid is dependent on the *actual* value of the second-highest valuation. Sherman focuses on the uncertainty

in the number of bidders caused by a mixed strategy equilibrium in the game of entry into an IPO auction. If bidders are free to enter the IPO auction, then if there is some cost to entering and some classes of bidders are ex-ante identical, the equilibrium in the entry game has a probability of entry for at least some bidders; the result is uncertainty over the actual number of bidders. Sherman claims that this uncertainty over the actual number of bidders causes the IPO price to vary and in particular to vary in its relation to a "true" underlying value. Sherman observes that this additional uncertainty further worsens the "winners' curse" and considerably complicates the optimal "bid-shaving" calculation that is required when there is winners' curse. She also shows that each investor optimally collects less information in a uniform price rather than a discriminatory auction, because of the free rider (moral hazard) problem in the uniform price auction.[43]

Sherman assumes that in the bookbuilding process, the underwriter can select the number of investors to invite into an information-acquisition process; this makes the bookbuilding process more like the first-price auction in terms of the variance of its outcomes. Jagannathan and Sherman (2006) rely on this model to explain their findings of a worldwide abandonment of IPO auctions in favor of bookbuilding; they also support the theoretical model with evidence on the variance in number of participants for IPO auctions. The issues of number of bidders and information collection would seem to be key in an optimal IPO pricing/allocation mechanism. One wonders, however, if a slight twist on assumptions for the auction models—let the auctioneer control somehow the selection of bidders, à la Hansen (2001) would bring equivalence back to the two mechanisms. Sherman (2005, p. 619) does note that "If the term "auction" is interpreted in a broad sense, it is almost a tautology that an appropriate auction could be designed for IPOs". This exemplifies a general difficulty in building theoretical models of two different institutions to explain their empirical performances: one can capture the sense of institutional differences by making clear assumptions (e.g., the underwriter can select the number of potential investors for bookbuilding but not for auctions) but one is left wondering if the assumptions really do justice to what actually happens in practice.

In anther recent attempt at comparing bookbuilding to auctions, Degeorge, Derrien and Womack (2004) show that bookbuilding seems to dominate empirically (they look at France, where for a time auctions and bookbuilding had roughly equal market shares, but now auctions are virtually extinct) and they offer a justification for issuers' preference for the bookbuilding method that is based not on the price performance of bookbuilding but on the investment bankers' preference for the method. While one might understand why investment bankers prefer a method that creates more demand for their services, the link to issuers' interests is less clear. Degeorge et al. hypothe-

[43] In the uniform price auction, since the auction price is set by the actions of bidders who have already paid the information gathering and processing costs, there is an incentive for uninformed bidders to free ride and jump in with a high bid.

size that bankers agree to provide research coverage for issuers in return for using the bookbuilding method. What is left unstated is that issuers must be unable to buy such research coverage on the open market at prices similar to the costs paid by investment bankers: the authors agree that auctions would yield issuers a better price, so one must wonder why issuers put up with an inefficient procedure simply to get a tied service.

On the empirical side of the auctions/IPO issue, Kandel, Sarig and Wohl (1999) utilize a data set from Israel IPO auctions to document elasticity of demand and under-pricing. The under-pricing of Israeli IPOs is intriguing, for those IPOs had their prices set by an explicit auction mechanism. In the period 1993–1996, Israeli IPOs were conducted much like Dutch auction share repurchases: investors submitted sealed-bids specifying prices and quantities, a demand curve was determined, and a uniform price was set at the highest price for which demand equaled the supply of shares available. Kandel, Sarig and Wohl document some elasticity of demand for the reported bids: the average elasticity at the clearing price, based on the accumulated demand curves, was 37 (relatively elastic). Interestingly, even in these IPO auctions, there was under-pricing: the one-day return between the auction price and the market trading price was 4.5%. Another interesting feature of the Israeli auctions is that after the auction but before the first day of trading, the underwriters announce the market clearing price corresponding to the offered quantity, as well as the oversubscription at the minimum price stipulated in the auction. This essentially means that the investor can estimate the price elasticity of demand based on two points on the demand curve. The authors find that the abnormal return on the first day of trading is positively related to the estimate of the elasticity. The authors argue that this reflects greater homogeneity in the estimates of value on the part of the participants in the auction; this is "good news" either because it implies greater accuracy of information about future cash flows and thus leads to a lower risk-premium demanded by investors, or because it signifies greater "market depth" and hence greater future liquidity.

Kerins, Kutsuna and Smith (2003) examine IPOs in Japan in the period 1995–1997, a time when Japanese firms had to use a discriminatory (bidders pay the amount of their bid) auction to sell the first tranche of newly issued shares. This first tranche of shares would be relatively small, and the sale by auction was restricted to outside investors only, with further limitations on the amount that could be bought by any investor. These restrictions could be interpreted as limiting the informational advantages of any one bidder. Under that interpretation, it is not surprising that the authors find relatively little "underpricing" of the shares for the auction tranche: for all the issues, the auction proceeds were only 1.6% below what proceeds would have been at the final aftermarket price. The second stage of the Japanese process was a more traditional fixed-price offer, and there was considerable underpricing of shares at this stage. While this might suggest that the auction was a better choice of mechanism, one must recognize that costs of a larger auction (to sell the entire issue) could well be larger than costs of just the first tranche.

4.10. The spectrum auctions and the role of debt in auctions

Beginning in 1994, the Federal Communications Commission in the United States auctioned licenses for the use of radio spectrum in designated areas. The licenses were auctioned using a novel auction format involving sequential rounds of sealed-bidding on numerous licenses simultaneously. At the end of each round, complete information on the level of bids for all licenses was revealed. The auction format was designed by economists, and at least in regard to the vast sums of money raised, was a great success. Numerous articles summarize all aspects of the auctions, including their design and performance: see, for example, McAfee and McMillan (1996), Milgrom (2000) and Salant (1997). For the empirical researcher, FCC auctions provide a wealth of information: for example, the FCC Web site (http://www.fcc.gov) lists all the bids in all the auctions. Moreover, many of the participating companies are publicly traded, so that company-specific information is also easily available. We focus here on one analysis which studied the effect of debt on the FCC auctions. Clayton and Ravid (2002) construct an auction model where bidders' debt induces lower bids than would otherwise be the case. In this model, bidders have outstanding debt that is large enough to induce bankruptcy if the auction is not won. Lower bids decrease the probability of winning, of course, but in this case guarantee some residual to the shareholders conditional on winning. In effect, in this model, pre-existing debt holders are "third parties" who have a prior claim of a part of the pie. Thus, pre-existing debt serves to reduce bidders' values and therefore reduces bids.[44] An empirical analysis of the FCC bidding data produces a negative but generally insignificant effect of a bidder's own debt on their bid but a negative and significant effect on a firm's bid of competitors' debt levels.

Che and Gale (1998) were the first to explicitly study the role of debt in auctions.[45] They have a result similar to Clayton and Ravid, although the models rely on different effects. In Che and Gale's framework, a second-price auction yields lower expected revenue than a first-price auction. To see how financial constraints affect revenue comparisons, suppose that due to budget constraints, bidders cannot bid more than a given budget, which is observed only by the bidder. The private valuations and budgetary endowments of each bidder are independently and identically distributed according to some joint distribution function. In this context, since bidders in the second-price auction bid their value, but in the first-price auction they bid *below* their value, bidding is more constrained in the second-price auction because of budget constraints, ceteris paribus. As a consequence, the first-price auction generates higher expected revenue. Che and Gale (1998) allow for financial constraints that are more general than we have considered here: for example, these could take the form of a marginal cost of borrowing that is increasing in the amount of the loan.

[44] On the role of debt holders as "third parties" in the context of bilateral bargaining, see Dasgupta and Sengupta (1993). On the role of "third party" shareholders in the context of bilateral bargaining, see Dasgupta and Tao (1998, 2000).

[45] For a recent contribution on the role of financing in auctions, see Rhodes-Kropf and Viswanathan (2005).

4.11. Advanced econometrics of auction data

There has been considerable progress in the application of econometric techniques to auction data. While the datasets used in these studies do not cover corporate finance directly, the techniques used should be of interest to corporate finance researchers, as they may be applicable to financial datasets and help resolve certain key issues. One broad topic that has been covered in empirical auction studies and that also appears in corporate finance are auctions with one informed bidder and numerous uninformed bidders. In corporate finance, such a situation could reasonably be assumed when current management is allowed to bid for a corporation, either in a takeover or bankruptcy context. Certainly in bankruptcy one concern has been that management, if allowed to bid in an auction, may be able to purchase the corporate assets at less than fair value. Hendricks and Porter (1988, 1992) have studied U.S. government oil lease auctions of so-called "drainage" tracts—tracts that have a neighboring tract currently under lease to one of the bidders. For these drainage tracts, it is reasonable to assume that the owner of the neighboring tract would have better information than other bidders. The authors of several studies have found this assumption, and the related equilibrium bidding theory, to be consistent with the data. The econometrics used relies heavily on the underlying auction theory. For example, equilibrium with one informed bidder imposes restrictions on the distributions of the informed bidder's bid distribution and the uninformed bidders' bid distributions. Note that a test of this type requires that data on all bids be available.

Structural models are also being used successfully to examine auction data. The most exciting approach here is to use equilibrium theory in conjunction with data on all bids to estimate the underlying probability distribution of the valuations of bidders. The essence of the idea here is that an equilibrium bid function maps a valuation to a bid. If data on bids are available, then with suitable econometrics one can recover the distribution of the underlying valuations from the bid data. Li, Perrigne and Vuong (2002) provide a step-by-step guide to structural estimation of the affiliated private value auction model. One aim of this work in the economics literature has been to estimate the optimal selling mechanism for a real auction. For example, if valuations are affiliated, then revenue equivalence no longer holds. Also, the optimal reserve price depends upon the underlying distribution of values, so if that distribution can be estimated, we can also get an estimate of the optimal reserve price. Researchers in empirical corporate finance should be aware of the progress made in structural estimation of auctions, for some of the issues at the heart of finance auctions may be resolved through structural estimation (and in some finance auctions, there should be data on all bids). For example, in the bankruptcy area, questions of reserve prices and informational rents abound, and these are two issues that structural estimation can get at.[46]

[46] In the context of takeover auctions, Betton and Eckbo (2000) pursue an interesting line of empirical research. A takeover contest typically associated with an "event tree" beginning with the initial bid, possibly

5. Conclusion

Upon reflection, the accomplishments of auction theory are really quite amazing. The "black box" of the Walrasian auctioneer has been opened, studied in depth, and its perfection questioned. We can now say a lot about the process of actual price formation in many real markets. While modelers have been able to explore theoretically important topics such as revenue comparisons across auctions, their work has also enabled economists to consult with governments on the design of optimal auctions to sell public assets. And with only a slight time lag, empirical work in auctions is following in the footsteps of theory, with structural estimation methods setting a new standard for creativity and rigor. Similar to the way that theoretical developments made their way into the real world of auction design, empirical work is focusing on real world auctions such as those found on Ebay and other online auctions. There are not too many topics in economics that allow researchers to cover such a broad swath of analytical territory, from the highly theoretical to the highly empirical and practical. In this way, auction theory resembles developments in financial asset pricing, where for instance the development of the option pricing model led to a surge in theoretical and empirical work while at the same time the model was applied in real markets.

The application of auction theory in corporate finance really needs to be seen as the intersection of two fields, that of auction theory and of information-based corporate finance theory. Nobody should have been surprised to see auction theory have a bit of a field day in being applied to topics in corporate finance, and as we think this survey shows, this is clearly what has happened and continues to happen. The question before us, however, must be: what have we learned in the process? That there has been considerable learning cannot be doubted, with the most significant learning being in interpreting the returns to bidders and targets in the market for corporate control, and in understanding the real institutional practices used in financial markets, such as underpricing in the IPO market, non-cash bids in takeover markets, and the role of asymmetries and discrimination against selected bidders. Perhaps the single best measure of auction theory's influence in corporate finance is that most PhD courses in corporate finance will include several papers, if not an entire module, on applications of auctions. As even a superficial study of auctions requires a fair amount of knowledge of game theory, the inclusion of auctions in PhD finance courses reinforces the study of games, itself a critical component of modern finance.

followed by the appearance of rival bidders, until the eventual success or failure of the initial bid. The market reaction to a bid (or indeed, at reaching any node) therefore represents the sum of the product of the probabilities of all subsequent events in the tree emanating from that node, and the associated payoffs. Since the probabilities and market reactions can be estimated, the payoff implications associated with the events (the "market prices") can be estimated. Betton and Eckbo (2000) find generally significant effects for the target, but less significant effects for the bidders.

While auction theory deserves much credit for its inroads into corporate finance, two areas of concern do emerge. First, there are some phenomena in corporate finance for which we still lack sufficient understanding, and where one might have expected auction theory to lead the way. Yes, we have increased our understanding of returns to bidders and targets in the market for corporate control, but why are acquirers' returns so small? Any auction with heterogeneity of valuations or information leads to strategic behavior and expected profits for inframarginal bidders. And why do acquirers seem to do better when acquiring private companies? There is still a huge question as to whether auctions in bankruptcy are better than a court-supervised valuation and division of assets. Why are toeholds so seldom taken, if they lead to a bidding advantage? If auctions really are so good, why are they used so infrequently in the initial public offering market, and why do some sellers of companies bypass an auction in favor of a one-on-one negotiation?

The second unsatisfactory aspect of auctions in corporate finance is simply that no new fundamental insights have emerged. We do understand better how information, values, and strategic behavior combine to yield prices and allocations of assets in real financial markets. There has been no quantum leap forward, just incremental learning at the margin. This should, we suppose, actually be gratifying, for it shows the robustness of our primitive and most cherished assumptions. Unfortunately, at times the models that are developed and that are pushing back the frontier only marginally are incredibly complicated, and one has to wonder if the complexity is worth it. One doubts that quantum leaps in knowledge are going to come from models that need a myriad of questionable assumptions.

Where next for auctions in corporate finance? We would suggest three areas for focus. First, data will be key for further empirical discovery, and this could in turn lead to new theoretical developments. We believe that auctions of private companies and auctions in bankruptcy are two areas that may yield significantly better data in the future and where the returns to clever empirical work would be large. Second, on the theoretical side, it is clear that some of the best work to date has been on what might appear as the second-order institutional practices, such as non-cash bids, toeholds, bidder discrimination, and reserve prices. Much progress has been made in understanding the role of these practices, while at the same time reinforcing the importance and validity of the overall auction-based framework. Third, we would like to see more work done with non-standard informational and valuation assumptions. The general symmetric model is extremely powerful, but does it really capture many of the real settings that we observe? We should expect that heterogeneity of bidders will be manifested in many ways and will turn out to affect the equilibria quite strongly, especially in regard to bidders' profits. Efficiency of the allocation will also become inherently more interesting of a question, and initial work suggests it will be harder to achieve.

We would confidently make the prediction, though, that auctions in corporate finance will be a much-studied topic for years to come. Our very strong recommendation would be for all PhD students to get a thorough grounding in auction theory.

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Chapter 4

BEHAVIORAL CORPORATE FINANCE*

MALCOLM BAKER

Harvard Business School and NBER, Soldiers Field, Boston, MA 02163, USA
e-mail: mbaker@hbs.edu

RICHARD S. RUBACK

Harvard Business School, Soldiers Field, Boston, MA 02163, USA
e-mail: rruback@hbs.edu

JEFFREY WURGLER

Stern School of Business and NBER, 44 West Fourth Street, Suite 9-190, New York, NY 10012-1126, USA
e-mail: jwurgler@stern.nyu.edu

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Abstract

Research in behavioral corporate finance takes two distinct approaches. The first emphasizes that investors are less than fully rational. It views managerial financing and investment decisions as rational responses to securities market mispricing. The second approach emphasizes that managers are less than fully rational. It studies the effect of nonstandard preferences and judgmental biases on managerial decisions. This survey reviews the theory, empirical challenges, and current evidence pertaining to each approach. Overall, the behavioral approaches help to explain a number of important financing and investment patterns. The survey closes with a list of open questions.

Keywords

irrational investors, irrational managers, investment policy, financial policy, market timing, catering

1. Introduction

Corporate finance aims to explain the financial contracts and the real investment behavior that emerge from the interaction of managers and investors. Thus, a complete explanation of financing and investment patterns requires an understanding of the beliefs and preferences of these two sets of agents. The majority of research in corporate finance assumes a broad rationality. Agents are supposed to develop unbiased forecasts about future events and use these to make decisions that best serve their own interests. As a practical matter, this means that managers can take for granted that capital markets are efficient, with prices rationally reflecting public information about fundamental values. Likewise, investors can take for granted that managers will act in their self-interest, rationally responding to incentives shaped by compensation contracts, the market for corporate control, and other governance mechanisms.

This paper surveys research in behavioral corporate finance. This research replaces the traditional rationality assumptions with potentially more realistic behavioral assumptions. The literature is divided into two general approaches, and we organize the survey around them. Roughly speaking, the first approach emphasizes the effect of *investor* behavior that is less than fully rational, and the second considers *managerial* behavior that is less than fully rational. For each line of research, we review the basic theoretical frameworks, the main empirical challenges, and the empirical evidence. Of course, in practice, both channels of irrationality may operate at the same time; our taxonomy is meant to fit the existing literature, but it does suggest some structure for how one might, in the future, go about combining the two approaches.

The "irrational investors approach" assumes that securities market arbitrage is imperfect, and thus that prices can be too high or too low. Rational managers are assumed to perceive mispricings, and to make decisions that may encourage or respond to mispricing. While their decisions may maximize the short-run value of the firm, they may also result in lower long-run values as prices correct. In the simple theoretical framework we outline, managers balance three objectives: fundamental value, catering, and market timing. Maximizing fundamental value has the usual ingredients. Catering refers to any actions intended to boost share prices above fundamental value. Market timing refers specifically to financing decisions intended to capitalize on temporary mispricings, generally via the issuance of overvalued securities and the repurchase of undervalued ones.

Empirical tests of the irrational investors model face a significant challenge: measuring mispricing. We discuss how this issue has been tackled and the ambiguities that remain. Overall, despite some unresolved questions, the evidence suggests that the irrational investors approach has a considerable degree of descriptive power. We review studies on investment behavior, merger activity, the clustering and timing of corporate security offerings, capital structure, corporate name changes, dividend policy, earnings management, and other managerial decisions. We also identify some disparities between the theory and the evidence. For example, while catering to fads has potential to reduce long-run value, the literature has yet to clearly document significant long-term value losses.

The second approach to behavioral corporate finance, the "irrational managers approach", is less developed at this point. It assumes that managers have behavioral biases, but retains the rationality of investors, albeit limiting the governance mechanisms they can employ to constrain managers. Following the emphasis of the current literature, our discussion centers on the biases of optimism and overconfidence. A simple model shows how these biases, in leading managers to believe their firms are undervalued, encourage overinvestment from internal resources, and a preference for internal to external finance, especially internal equity. We note that the predictions of the optimism and overconfidence models typically look very much like those of agency and asymmetric information models.

In this approach, the main obstacles for empirical tests include distinguishing predictions from standard, non-behavioral models, as well as empirically measuring managerial biases. Again, however, creative solutions have been proposed. The effects of optimism and overconfidence have been empirically studied in the context of merger activity, corporate investment-cash flow relationships, entrepreneurial financing and investment decisions, and the structure of financial contracts. Separately, we discuss the potential of a few other behavioral patterns that have received some attention in corporate finance, including bounded rationality and reference-point preferences. As in the case of investor irrationality, the real economic losses associated with managerial irrationality have yet to be clearly quantified, but some evidence suggests that they are very significant.

Taking a step back, it is important to note that the two approaches take very different views about the role and quality of managers, and have very different normative implications as a result. That is, when the primary source of irrationality is on the investor side, long-term value maximization and economic efficiency requires insulating managers from short-term share price pressures. Managers need to be insulated to achieve the flexibility necessary to make decisions that may be unpopular in the marketplace. This may imply benefits from internal capital markets, barriers to takeovers, and so forth. On the other hand, if the main source of irrationality is on the managerial side, efficiency requires reducing discretion and obligating managers to respond to market price signals. The stark contrast between the normative implications of these two approaches to behavioral corporate finance is one reason why the area is fascinating, and why more work in the area is needed.

Overall, our survey suggests that the behavioral approaches can help to explain a range of financing and investment patterns, while at the same time depend on a relatively small set of realistic assumptions. Moreover, there is much room to grow before the field reaches maturity. In an effort to stimulate that growth, we close the survey with a short list of open questions.

2. The irrational investors approach

We start with one extreme, in which rational managers coexist with irrational investors. There are two key building blocks here. First, irrational investors must influence secu-

rities prices. This requires limits on arbitrage. Second, managers must be smart in the sense of being able to distinguish market prices and fundamental value.

The literature on market inefficiency is far too large to survey here. It includes such phenomena as the January effect; the effect of trading hours on price volatility; post-earnings-announcement drift; momentum; delayed reaction to news announcements; positive autocorrelation in earnings announcement effects; Siamese twin securities that have identical cash flows but trade at different prices, negative "stub" values; closed-end fund pricing patterns; bubbles and crashes in growth stocks; related evidence of mispricing in options, bond, and foreign exchange markets; and so on. These patterns, and the associated literature on arbitrage costs and risks, for instance short-sales constraints, that facilitate mispricings, are surveyed by Barberis and Thaler (2003) and Shleifer (2000). In the interest of space, we refer the reader to these excellent sources, and for the discussion of this section we simply take as given that mispricings can and do occur.

But even if capital markets are inefficient, why assume that corporate managers are "smart" in the sense of being able to identify mispricing? One can offer several justifications. First, corporate managers have superior information about their own firm. This is underscored by the evidence that managers earn abnormally high returns on their own trades, as in Muelbroek (1992), Seyhun (1992), or Jenter (2005). Managers can also create an information advantage by managing earnings, a topic to which we will return, or with the help of conflicted analysts, as for example in Bradshaw, Richardson, and Sloan (2003).

Second, corporate managers also have fewer constraints than equally "smart" money managers. Consider two well-known models of limited arbitrage: De Long et al. (1990) is built on short horizons and Miller (1977) on short-sales constraints. CFOs tend to be judged on longer horizon results than are money managers, allowing them to take a view on market valuations in a way that money managers cannot.[1] Also, short-sales constraints prevent money managers from mimicking CFOs. When a firm or a sector becomes overvalued, corporations are the natural candidates to expand the supply of shares. Money managers are not.

Third and finally, managers might just follow intuitive rules of thumb that allow them to identify mispricing even without a real information advantage. In Baker and Stein (2004), one such successful rule of thumb is to issue equity when the market is particularly liquid, in the sense of a small price impact upon the issue announcement. In the presence of short-sales constraints, unusually high liquidity is a symptom of the fact that the market is dominated by irrational investors, and hence is overvalued.

2.1. *Theoretical framework*

We use the assumptions of inefficient markets and smart managers to develop a simple theoretical framework for the irrational investors approach. The framework has roots in

[1] For example, suppose a manager issues equity at $50 per share. Now if those shares subsequently double, the manager might regret not delaying the issue, but he will surely not be fired, having presided over a rise in the stock price. In contrast, imagine a money manager sells (short) the same stock at $50. This might lead to considerable losses, an outflow of funds, and, if the bet is large enough, perhaps the end of a career.

Fischer and Merton (1984), De Long et al. (1989), Morck, Shleifer, and Vishny (1990b), and Blanchard, Rhee, and Summers (1993), but our particular derivation borrows most from Stein (1996).

In the irrational investors approach, the manager balances three conflicting goals. The first is to maximize fundamental value. This means selecting and financing investment projects to increase the rationally risk-adjusted present value of future cash flows. To simplify the analysis, we do not explicitly model taxes, costs of financial distress, agency problems or asymmetric information. Instead, we specify fundamental value as

$$f(K, \cdot) - K,$$

where f is increasing and concave in new investment K. To the extent that any of the usual market imperfections leads the Modigliani–Miller (1958) theorem to fail, financing may enter f alongside investment.

The second goal is to maximize the current share price of the firm's securities. In perfect capital markets, the first two objectives are the same, since the definition of market efficiency is that prices equal fundamental values. But once one relaxes the assumption of investor rationality, this need not be true, and the second objective is distinct. In particular, the second goal is to "cater" to short-term investor demands via particular investment projects or otherwise packaging the firm and its securities in a way that maximizes appeal to investors. Through such catering activities, managers influence the temporary mispricing, which we represent by the function

$$\delta(\cdot),$$

where the arguments of δ depend on the nature of investor sentiment. The arguments might include investing in a particular technology, assuming a conglomerate or single-segment structure, changing the corporate name, managing earnings, initiating a dividend, and so on. In practice, the determinants of mispricing may well vary over time.

The third goal is to exploit the current mispricing for the benefit of existing, long-run investors. This is done by a "market timing" financing policy whereby managers supply securities that are temporarily overvalued and repurchase those that are undervalued. Such a policy transfers value from the new or the outgoing investors to the ongoing, long-run investors; the transfer is realized as prices correct in the long run.[2] For simplicity, we focus here on temporary mispricing in the equity markets, and so δ refers to the difference between the current price and the fundamental value of equity. More generally, each of the firm's securities may be mispriced to some degree. By selling a fraction of the firm e, long run shareholders gain

$$e\delta(\cdot).$$

[2] Of course, we are also using the market inefficiency assumption here in assuming that managerial efforts to capture a mispricing do not completely destroy it in the process, as they would in the rational expectations world of Myers and Majluf (1984). In other words, investors underreact to corporate decisions designed to exploit mispricing. This leads to some testable implications, as we discuss below.

We leave out the budget constraint, lumping together the sale of new and existing shares. Instead of explicitly modeling the flow of funds and any potential financial constraints, we will consider the reduced form impact of e on fundamental value.

It is worth noting that other capital market imperfections can lead to a sort of catering behavior. For example, reputation models in the spirit of Holmstrom (1982) can lead to earnings management, inefficient investment, and excessive swings in corporate strategy even when the capital markets are not fooled in equilibrium.[3] Viewed in this light, the framework here is relaxing the assumptions of rational expectations in Holmstrom, in the case of catering, and Myers and Majluf (1984), in the case of market timing.

Putting the goals of fundamental value, catering, and market timing into one objective function, the irrational investors approach has the manager choosing investment and financing to

$$\max_{K,e} \lambda\big[f(K,\cdot) - K + e\delta(\cdot)\big] + (1-\lambda)\delta(\cdot),$$

where λ, between zero and one, specifies the manager's horizon. When λ equals one, the manager cares only about creating value for existing, long-run shareholders, the last term drops out, and there is no distinct impact of catering. However, even an extreme long-horizon manager cares about short-term mispricing for the purposes of market timing, and thus may cater to short-term mispricing to further this objective. With a shorter horizon, maximizing the stock price becomes an objective in its own right, even without any concomitant equity issues.

We take the managerial horizon as given, exogenously set by personal characteristics, career concerns, and the compensation contract. If the manager plans to sell equity or exercise options in the near term, his portfolio considerations may lower λ. However, the managerial horizon may also be endogenous. For instance, consider a venture capitalist who recognizes a bubble. He might offer a startup manager a contract that loads heavily on options and short-term incentives, since he cares less about valuations that prevail beyond the IPO lock-up period. Career concerns and the market for corporate control can also combine to shorten horizons, since if the manager does not maximize short-run prices, the firm may be acquired and the manager fired.

Differentiating with respect to K and e gives the optimal investment and financial policy of a rational manager operating in inefficient capital markets:

$$f_K(K,\cdot) = 1 - \left(e + \frac{1-\lambda}{\lambda}\right)\delta_K(\cdot),$$

$$-f_e(K,\cdot) = \delta(\cdot) + \left(e + \frac{1-\lambda}{\lambda}\right)\delta_e(\cdot).$$

[3] For examples, see Stein (1989) and Scharfstein and Stein (1990). For a comparison of rational expectations and inefficient markets in this framework, see Aghion and Stein (2006).

In words, the first condition is about investment policy. The marginal value created from investment is weighed against the standard cost of capital, normalized to be one here, net of the impact that this incremental investment has on mispricing, and hence its effect through mispricing on catering and market timing gains. The second condition is about financing. The marginal value lost from shifting the firm's current capital structure toward equity is weighed against the direct market timing gains and the impact that this incremental equity issuance has on mispricing, and hence its effect on catering and market timing gains. This is a lot to swallow at once, so we consider some special cases.

Investment policy. Investment and financing are separable if both δ_K and f_e are equal to zero. Then the investment decision reduces to the familiar perfect markets condition of f_K equal to unity. Real consequences of mispricing for investment thus arise in two ways. In Stein (1996) and Baker, Stein, and Wurgler (2003), f_e is not equal to zero. There *is* an optimal capital structure, or at least an upper bound on debt capacity. The benefits of issuing or repurchasing equity in response to mispricing are balanced against the reduction in fundamental value that arises from too much (or possibly too little) leverage. In Polk and Sapienza (2004) and Gilchrist, Himmelberg, and Huberman (2005), there is no optimal capital structure, but δ_K is not equal to zero: mispricing is itself a function of investment. Polk and Sapienza focus on catering effects and do not consider financing (e equal to zero in this setup), while Gilchrist et al. model the market timing decisions of managers with long horizons (λ equal to one).

Financial policy. The demand curve for a firm's equity slopes down under the natural assumption that δ_e is negative, e.g., issuing shares partly corrects mispricing.[4] When investment and financing are separable, managers act like monopolists. This is easiest to see when managers have long horizons, and they sell down the demand curve until marginal revenue δ is equal to marginal cost $-e\delta_e$. Note that price remains above fundamental value even after the issue: "corporate arbitrage" moves the market toward, but not all the way to, market efficiency.[5] Managers sell less equity when they care about short-run stock price (λ less than one, here). For example, in Ljungqvist, Nanda, and Singh (2006), managers expect to sell their own shares soon after the IPO and so issue less as a result. Managers also sell less equity when there are costs of suboptimal leverage.

Other corporate decisions. Managers do more than simply invest and issue equity, and this framework can be expanded to accommodate other decisions. Consider dividend policy. Increasing or initiating a dividend may simultaneously affect both fundamental value, through taxes, and the degree of mispricing, if investors categorize stocks

[4] Gilchrist, Himmelberg, and Huberman (2005) model this explicitly with heterogeneous investor beliefs and short-sales constraints.

[5] Total market timing gains may be even higher in a dynamic model where managers can sell in small increments down the demand curve.

according to payout policy as they do in Baker and Wurgler (2004a). The tradeoff is

$$-f_d(K,\cdot) = \left(e + \frac{1-\lambda}{\lambda}\right)\delta_d(\cdot),$$

where the left-hand side is the tax cost of dividends, for example, and the right-hand side is the market timing gain, if the firm is simultaneously issuing equity, plus the catering gain, if the manager has short horizons. In principle, a similar tradeoff governs the earnings management decision or corporate name changes; however, in the latter case, the fundamental costs of catering would presumably be small.

2.2. Empirical challenges

The framework outlined above suggests a role for securities mispricing in investment, financing, and other corporate decisions. The main challenge for empirical tests in this area is measuring mispricing, which by its nature is hard to pin down. Researchers have found several ways to operationalize empirical tests, but none of them is perfect.

Ex ante misvaluation. One option is to take an *ex ante* measure of mispricing, for instance a scaled-price ratio in which a market value in the numerator is related to some measure of fundamental value in the denominator. Perhaps the most common choice is the market-to-book ratio: a high market-to-book suggests that the firm may be overvalued. Consistent with this idea, and the presumption that mispricing corrects in the long run, market-to-book is found to be inversely related to future stock returns in the cross-section by Fama and French (1992) and in the time-series by Kothari and Shanken (1997) and Pontiff and Schall (1998). Also, extreme values of market-to-book are connected to extreme investor expectations by Lakonishok, Shleifer, and Vishny (1994), La Porta (1996), and La Porta et al. (1997).

One difficulty that arises with this approach is that the market-to-book ratio or another *ex ante* measure of mispricing may be correlated with an array of firm characteristics. Book value is not a precise estimate of fundamental value, but rather a summary of past accounting performance. Thus, firms with excellent growth prospects tend to have high market-to-book ratios, and those with agency problems might have low ratios—and perhaps these considerations, rather than mispricing, drive investment and financing decisions. Dong et al. (2005) and Ang and Cheng (2006) discount analyst earnings forecasts to construct an arguably less problematic measure of fundamentals than book value.

Another factor that limits this approach is that a precise *ex ante* measure of mispricing would represent a profitable trading rule. There must be limits to arbitrage that prevent rational investors from fully exploiting such rules and trading away the information they contain about mispricing. But on a more positive note, the same intuition suggests that variables like market-to-book are likely to be a more reliable mispricing metric in regions of the data where short-sales constraints and other (measurable) arbitrage costs and risks are most severe. This observation has been exploited as an identification strategy.

Ex post misvaluation. A second option is to use the information in future returns. The idea is that if stock prices routinely decline after a corporate event, one might infer that they were inflated at the time of the event. However, as detailed in Fama (1998) and Mitchell and Stafford (2000), this approach is also subject to several critiques.

The most basic critique is the joint hypothesis problem: a predictable "abnormal" return might mean there was misvaluation *ex ante*, or simply that the definition of "normal" expected return (e.g., CAPM) is wrong. Perhaps the corporate event systematically coincides with changes in risk, and hence the return required in an efficient capital market. Another simple but important critique regards economic significance. Market value-weighting or focusing on NYSE/AMEX firms may reduce abnormal returns or cause them to disappear altogether.

There are also statistical issues. For instance, corporate events are often clustered in time and by industry—IPOs are an example considered in Brav (2000)—and thus abnormal returns may not be independent. Barber and Lyon (1997) and Lyon, Barber, and Tsai (1999) show that inference with buy-and-hold returns (for each event) is challenging. Calendar-time portfolios, which consist of an equal- or value-weighted average of all firms making a given decision, have fewer problems here, but the changing composition of these portfolios adds another complication to standard tests. Loughran and Ritter (2000) also argue that such an approach is a less powerful test of mispricing, since the clustered events have the worst subsequent performance. A final statistical problem is that many studies cover only a short sample period. Schultz (2003) shows that this can lead to a small sample bias if managers engage in "pseudo"-market timing, making decisions in response to past rather than future price changes.

Analyzing aggregate time series resolves some of these problems. Like the calendar time portfolios, time series returns are more independent. There are also established time-series techniques, e.g., Stambaugh (1999), to deal with small-sample biases. Nonetheless, the joint hypothesis problem remains, since rationally required returns may vary over time.

But even when these econometric issues can be solved, interpretational issues may remain. For instance, suppose investors have a tendency to overprice firms that have genuinely good growth opportunities. If so, even investment that is followed by low returns need not be *ex ante* inefficient. Investment may have been responding to omitted measures of investment opportunities, not to the misvaluation itself.

Cross-sectional interactions. Another identification strategy is to exploit the finer cross-sectional predictions of the theory. In this spirit, Baker, Stein, and Wurgler (2003) consider the prediction that if f_e is positive, mispricing should be more relevant for financially constrained firms. More generally, managerial horizons or the fundamental costs of catering to sentiment may vary across firms in a measurable way. Of course, even in this approach, one still has to proxy for mispricing with an *ex ante* or *ex post* method. To the extent that the hypothesized cross-sectional pattern appears strongly in the data, however, objections about the measure of mispricing lose some steam.

2.3. Investment policy

Of paramount importance are the real consequences of market inefficiency. It is one thing to say that investor irrationality has an impact on capital market prices, or even financing policy, which lead to transfers of wealth among investors. It is another to say that mispricing leads to underinvestment, overinvestment, or the general misallocation of capital and deadweight losses for the economy as a whole. In this subsection we review research on how market inefficiency affects real investment, mergers and acquisitions, and diversification.

2.3.1. Real investment

In the rational managers, irrational investors framework, mispricing influences real investment in two ways. First, investment may itself be a characteristic that is subject to mispricing ($\delta_K > 0$ above). Investors may overestimate the value of investment in particular technologies, for example. Second, a financially constrained firm ($f_e > 0$ above) may be forced to pass up fundamentally valuable investment opportunities if it is undervalued.

Most research has looked at the first type of effect. Of course, anecdotal evidence of this effect comes from bubble episodes; it was with the late 1920s bubble fresh in mind that Keynes (1936) argued that short-term investor sentiment is, at least in some eras, a major or dominant determinant of investment. More recent US stock market episodes generally viewed as bubbles include the electronics boom in 1959–1962, growth stocks in 1967–1968, the "nifty fifty" in the early 1970s, gambling stocks in 1977–1978, natural resources, high tech, and biotechnology stocks in the 1980s, and the Internet in the late 1990s; see Malkiel (1990) for an anecdotal review of some of these earlier bubbles, and Ofek and Richardson (2003) on the Internet. See Kindleberger (2000) for an attempt to draw general lessons from bubbles and crashes over several hundred years, and for anecdotal remarks on their sometimes dramatic real consequences.

The first modern empirical studies in this area asked whether investment is sensitive to stock prices over and above direct measures of the marginal product of capital, such as cash flow or profitability. If it is not, they reasoned, then the univariate link between investment and stock valuations likely just reflects the standard, efficient-markets Q channel. This approach did not lead to a clear conclusion, however. For example, Barro (1990) argues for a strong independent effect of stock prices, while Morck, Shleifer, and Vishny (1990b) and Blanchard, Rhee, and Summers (1993) conclude that the incremental effect is weak.

The more recent wave of studies has taken a different tack. Rather than controlling for fundamentals and looking for a residual effect of stock prices, they try to proxy for the mispricing component of stock prices and examine whether it affects investment. In this spirit, Chirinko and Schaller (2001, 2006), Panageas (2004), Polk and Sapienza (2004), and Gilchrist, Himmelberg, and Huberman (2005) all find evidence that investment is sensitive to proxies for mispricing. Of course, the generic concern is that the mispricing

proxies are still just picking up fundamentals. To refute this, Polk and Sapienza, for example, consider the finer prediction that investment should be more sensitive to short-term mispricing when managerial horizons are shorter. They find that investment is indeed more sensitive to mispricing proxies when share turnover is higher, i.e., where the average shareholder's horizon is shorter.

The second type of mispricing-driven investment is tested in Baker, Stein, and Wurgler (2003). Stein (1996) predicts that investment will be most sensitive to mispricing in equity-dependent firms, i.e., firms that have no option but to issue equity to finance their marginal investment, because long-horizon managers of undervalued firms would rather underinvest than issue undervalued shares. Using several proxies for equity dependence, Baker et al. confirm that investment is more sensitive to stock prices in equity-dependent firms.

Overall, the recent studies suggest that some portion of the effect of stock prices on investment is a response to mispricing, but key questions remain. The actual magnitude of the effect of mispricing has not been pinned down, even roughly. The efficiency implications are also unclear. Titman, Wei, and Xie (2004) and Polk and Sapienza (2004) find that high investment is associated with lower future stock returns in the cross section, and Lamont (2000) finds a similar result for planned investment in the time series. However, sentiment and fundamentals seem likely to be correlated, and so, as mentioned previously, even investment followed by low returns may not be *ex ante* inefficient. Finally, even granting an empirical link between overpricing and investment, it is hard to determine the extent to which managers are rationally fanning the flames of overvaluation, as in the catering piece of our simple theoretical framework, or are simply just as overoptimistic as their investors. We return to the effects of managerial optimism in the second part of the survey.

2.3.2. Mergers and acquisitions

Shleifer and Vishny (2003) propose a market timing model of acquisitions. They assume that acquirers are overvalued, and the motive for acquisitions is not to gain synergies, but to preserve some of their temporary overvaluation for long-run shareholders. Specifically, by acquiring less-overvalued targets with overpriced stock (or, less interestingly, undervalued targets with cash), overvalued acquirers can cushion the fall for their shareholders by leaving them with more hard assets per share. Or, if the deal's value proposition caters to a perceived synergy that causes the combined entity to be overvalued, as might have happened in the late 1960s conglomerates wave (see below), then the acquirer can still gain a long-run cushion effect, while offering a larger premium to the target.

The market timing approach to mergers helps to unify a number of stylized facts. The defensive motive for the acquisition, and the idea that acquisitions are further facilitated when catering gains are available, help to explain the time-series link between merger

volume and stock prices, e.g., Golbe and White (1988).[6] The model also predicts that cash acquirers earn positive long-run returns while stock acquirers earn negative long-run returns, consistent with the findings of Loughran and Vijh (1997) and Rau and Vermaelen (1998).

Recent papers have found further evidence for market timing mergers. Dong et al. (2005) and Ang and Cheng (2006) find that market-level mispricing proxies and merger volume are positively correlated, and (within this) that acquirers tend to be more overpriced than targets.[7] They also find evidence that offers for undervalued targets are more likely to be hostile, and that overpriced acquirers pay higher takeover premia. Rhodes-Kropf, Robinson, and Viswanathan (2005) also link valuation levels and merger activity. Bouwman, Fuller, and Nain (2006) find evidence suggestive of a short-term catering effect. In high-valuation periods, investors welcome acquisition announcements, yet the subsequent returns of mergers made in those periods are the worst. Baker, Foley, and Wurgler (2006) find that FDI outflows, which are often simply cross-border acquisitions, increase with the current aggregate market-to-book ratio of the acquirer's stock market and decrease with subsequent returns on that market. All of these patterns are consistent with overvaluation-driven merger activity.

An unresolved question in the Shleifer–Vishny framework is why managers would prefer a stock-for-stock merger to an equity issue if the market timing gains are similar. One explanation is that a merger more effectively hides the underlying market timing motive from investors. Baker, Coval, and Stein (2006) consider another mechanism that can also help explain a generic preference for equity issues via merger.[8] The first ingredient of the story is that the acquiring firm faces a downward sloping demand curve for its shares, as in Shleifer (1986) and Harris and Gurel (1986). The second ingredient is that some investors follow the path of least resistance, passively accepting the acquirer's shares as consideration even when they would not have actively participated in an equity issue. With these two assumptions, the price impact of a stock-financed merger can be much smaller than the price impact of an SEO. Empirically, inertia is a prominent feature in institutional and especially individual holdings data that is associated with smaller merger announcement effects.

[6] See Rhodes-Kropf and Viswanathan (2004) for a somewhat different misvaluation-based explanation of this link, and Jovanovic and Rousseau (2002) for an explanation based on technological change in efficient markets.

[7] A related prediction of the Shleifer–Vishny framework is that an overvalued acquirer creates value for long-term shareholders by acquiring a fairly valued or simply less overvalued target. Savor (2006) tests this proposition by comparing the returns of successful acquirers to those that fail for exogenous reasons, such as a regulatory intervention. Successful acquirers perform poorly, as in Loughran and Vijh (1997), but unsuccessful acquirers perform even worse.

[8] For example, in the case of S&P 100 firms over 1999–2001, Fama and French (2005) find that the amount of equity raised in mergers is roughly 40 times that raised in SEOs.

2.3.3. Diversification and focus

Standard explanations for entering unrelated lines of business include agency problems or synergies, e.g., internal capital markets and tax shields. Likewise, moves toward greater focus are often interpreted as a triumph of governance. While our main task is to survey the existing literature, the topics of diversification and focus have yet to be considered from a perspective where investors are less than fully rational. So, we take a short detour here. We ask whether the evidence at hand is consistent with the view that the late-1960s conglomerate wave, which led to conglomerates so complex they were still being divested or busted up decades later, was in part driven by efforts to cater to a temporary investor appetite for conglomerates.

Investor demand for conglomerates appears to have reached a peak in 1968. Ravenscraft and Scherer (1987, p. 40) find that the average return on 13 leading conglomerates was 385% from July 1965 to June 1968, while the S&P 425 gained only 34%. Diversifying acquisitions were being greeted with a positive announcement effect, while other acquisitions were penalized (Matsusaka, 1993). Klein (2001) finds a "diversification premium" of 36% from 1966–1968 in a sample of 36 conglomerates. Perhaps responding to these valuation incentives, conglomerate mergers accelerated in 1967 and peaked in 1968 (Ravenscraft and Scherer, 1987, pp. 24, 161, 218).

Conglomerate valuations started to fall in mid-1968. Between July 1968 and June 1970, the sample followed by Ravenscraft and Scherer lost 68%, three times more than the S&P 425. Announcement effects also suggest a switch in investor appetites: diversification announcements were greeted with a flat reaction in the mid- to late-1970s and a negative reaction by the 1980s (Morck, Shleifer, and Vishny, 1990a). Klein finds that the diversification premium turned into a discount of 1% in 1969–1971 and 17% by 1972–1974, and a discount seems to have remained through the 1980s (Lang and Stulz, 1994; Berger and Ofek, 1995). Again, possibly in response to this shift in catering incentives, unrelated segments began to be divested, starting a long trend toward focus (Porter, 1987; Kaplan and Weisbach, 1992).[9] Overall, while systematic evidence is lacking, the diversification and subsequent re-focus wave seems to fit the catering model well.

2.4. Financial policy

The simple theoretical framework suggests that long-horizon managers may reduce the overall cost of capital paid by their ongoing investors by issuing overpriced securities and repurchasing underpriced securities. Here, we survey the evidence on the extent to which market timing affects equity issues, repurchases, debt issues, cross-border issues, and capital structure.

[9] In a case study of the diversification and subsequent refocus of General Mills, Donaldson (1990) writes that the company spent some effort "to verify the dominant trends in investor perceptions of corporate efficiency, as seen in the company study of the impact of excessive diversification on the trend of price-earnings multiples in the 1970s" (p. 140).

2.4.1. Equity issues

Several lines of evidence suggest that overvaluation is a motive for equity issuance. Most simply, in the Graham and Harvey (2001) anonymous survey of CFOs of public corporations, two-thirds state that "the amount by which our stock is undervalued or overvalued was an important or very important consideration" in issuing equity (p. 216). Several other questions in the survey also ask about the role of stock prices. Overall, stock prices are viewed as more important than nine out of ten factors considered in the decision to issue common equity, and the most important of five factors in the decision to issue convertible debt.

Empirically, equity issuance is positively associated with plausible *ex ante* indicators of overvaluation. Pagano, Panetta, and Zingales (1998) examine the determinants of Italian private firms' decisions to undertake an IPO between 1982 and 1992, and find that the most important is the market-to-book ratio of seasoned firms in the same industry. Lerner (1994) finds that IPO volume in the biotech sector is highly correlated with biotech stock indexes. Loughran, Ritter, and Rydqvist (1994) find that aggregate IPO volume and stock market valuations are highly correlated in most major stock markets around the world. Similarly, Marsh (1982) examines the choice between (seasoned) equity and long-term debt by UK quoted firms between 1959 and 1974, and finds that recent stock price appreciation tilts firms toward equity issuance. In US data, Jung, Kim, and Stulz (1996) and Hovakimian, Opler, and Titman (2001) also find a strong relationship between stock prices and seasoned equity issuance.

Of course, there are many non-behavioral reasons why equity issuance and market valuations should be positively correlated. More specific evidence for equity market timing comes from the pattern that new issues earn low subsequent returns. In an early test, Stigler (1964) tried to measure the effectiveness of the S.E.C. by comparing the *ex post* returns of new equity issues (lumping together both initial and seasoned) from 1923–1928 with those from 1949–1955. If the S.E.C. improved the pool of issuers, he reasoned, then the returns to issuers in the latter period should be higher. But he found that issuers in both periods performed about equally poorly relative to a market index. Five years out, the average issuer in the pre-S.E.C. era lagged the market by 41%, while the average underperformance in the later period was 30%.

Other sample periods show similar results. Ritter (1991) examines a sample of IPOs, Speiss and Affleck-Graves (1995) examine SEOs, and Loughran and Ritter (1995) examine both. And, Ritter (2003) updates these and several other empirical studies of corporate financing activities. The last paper's sample includes 7,437 IPOs and 7,760 SEOs between 1970 and 1990. Five years out, the average IPO earns lower returns than a size-matched control firm by 30%, and the average SEO underperforms that benchmark by 29%. Gompers and Lerner (2003) fill in the gap between the samples of Stigler (1964) and Loughran and Ritter (1995). Their sample of 3,661 IPOs between 1935 and 1972 shows average five-year buy-and-hold returns that underperform the value-

weighted market index by 21% to 35%.[10] Thus, a rough summary of non-overlapping samples is that, on average, US equity issues underperform the market somewhere in the ballpark of 20–40% over five years.

In a test that speaks closely to the question of opportunistic timing of new investors, Burch, Christie, and Nanda (2004) examine the subsequent performance of seasoned equity issued via rights offers, which are targeted to a firm's ongoing shareholders, and firm commitment offers, which are targeted to new shareholders. In their 1933 to 1949 sample, a period in which rights offers were more common, they find underperformance entirely concentrated in the latter group. This fits exactly with the framework sketched above, which emphasizes the opportunistic timing of *new* investors.

If equity issues cluster when the market as a whole is overvalued, the net gains to equity market timing may be even larger than the underperformance studies suggest. Baker and Wurgler (2000) examine whether equity issuance, relative to total equity and debt issuance, predicts aggregate market returns between 1927 and 1999. They find that when the equity share was in its top historical quartile, the average value-weighted market return over the next year was negative 6%, or 15% below the average market return. Henderson, Jegadeesh, and Weisbach (2006) find a similar relationship in several international markets over the period 1990 to 2001. In 12 out of the 13 markets they examine, average market returns are higher after a below-median equity share year than after an above-median equity share year.[11]

The equity market timing studies continue to be hotly debated. Some authors highlight the joint hypothesis problem, proposing that the reason why IPOs and SEOs deliver low returns is that they are actually less risky. For more on this perspective, see Eckbo, Masulis, and Norli (2000), Eckbo and Norli (2004), and Chapter 6 by Eckbo, Masulis and Norli in this volume. In a recent critique, Schultz (2003) points out that a small-sample bias he calls "pseudo market timing" can lead to exaggerated impressions of underperformance when abnormal performance is calculated in "event time". The empirical relevance of this bias has yet to be pinned down. Schultz (2003, 2004) argues that it may be significant, while Ang, Gu, and Hochberg (2005), Dahlquist and de Jong (2004), and Viswanathan and Wei (2004) argue that it is minor.[12] The key issue concerns

[10] Gompers and Lerner also confirm what Brav and Gompers (1997) found in a later sample: while IPOs have low absolute returns, and low returns relative to market indexes, they often do not do worse than stocks of similar size and book-to-market ratio. One interpretation is that securities with similar characteristics, whether or not they are IPOs, tend to be similarly priced (and mispriced) at a given point in time.

[11] Note that these aggregate predictability results should probably not be interpreted as evidence that "managers can time the aggregate market". A more plausible explanation is that broad waves of investor sentiment lead many firms to be mispriced in the same direction at the same time. Then, the *average* financing decision will contain information about the *average* (i.e., market-level) mispricing, even though individual managers are perceiving and responding only to their *own* firm's mispricing.

[12] Butler, Grullon, and Weston (2005) take Schultz's idea to the time-series and argue that the equity share's predictive power is due to an aggregate version of the pseudo market timing bias. Baker, Taliaferro, and Wurgler (2006) reply that the tests in Butler et al. actually have little relevance to the bias, and that simple simulation techniques show that small-sample bias can account for only one percent of the equity share's actual predictive coefficient.

the variance in the number of security issues over time. Schultz assumes a nonstationary process for this time series. This means that the number of security issues can explode or collapse to zero for prolonged periods of time, and the simulated variance of equity issuance exceeds the actual experience in the U.S.

We leave the resolution to future research, but we stress that the returns studies should not be considered in isolation. Survey evidence was mentioned above. Other relevant results include Teoh, Welch, and Wong (1998a, 1998b), who find that the equity issuers who manage earnings most aggressively have the worst post-issue returns (we return to earnings management below). Jain and Kini (1994), Mikkelson, Partch, and Shah (1997), and Pagano, Panetta, and Zingales (1998) find that profitability deteriorates rapidly following the initial offering, and Loughran and Ritter (1997) document a similar pattern with seasoned issues. Jenter (2005) finds that seasoned equity offerings coincide with insider selling. When viewed as a whole, the evidence indicates that market timing plays a nontrivial role in equity issues.

2.4.2. *Repurchases*

Undervaluation is an important motive for repurchases. Brav et al. (2005) survey 384 CFOs regarding payout policy, and "the most popular response for all the repurchase questions on the entire survey is that firms repurchase when their stock is a good value, relative to its true value: 86.6% of all firms agree" (p. 26). Other work finds positive abnormal returns for firms that conduct repurchases, suggesting that managers are on average successful in timing them. Ikenberry, Lakonishok, and Vermaelen (1995) study 1,239 open market repurchases announced between 1980 and 1990. Over the next four years, the average repurchaser earned 12% more than firms of similar size and book-to-market ratios. Ikenberry, Lakonishok, and Vermaelen (2000) find similar results in a recent sample of Canadian firms.

The evidence shows that managers tend to issue equity before low returns, on average, and repurchase before higher returns. Is there a ballpark estimate of the reduction in the cost of equity, for the average firm, that these patterns imply? Without knowing just how the "rational" cost of equity varies over time, this question is hard to answer. However, suppose that rationally required returns are constant. By following aggregate capital inflows and outflows into corporate equities, and tracking the returns that follow these flows, Dichev (2004) reports that the average "dollar-weighted" return is lower than the average buy-and-hold return by 1.3% per year for the NYSE/Amex, 5.3% for Nasdaq, and 1.5% (on average) for 19 stock markets around the world. Put differently, if NYSE/Amex firms had issued and repurchased randomly across time, then, holding the time series of realized returns fixed, they would have paid 1.3% per year more for the equity capital they employed.

Of course, this reduction in the cost of equity capital is not evenly distributed in the cross section of firms. The difference between Nasdaq and NYSE/Amex gives a hint of this. For the many mature firms that rarely raise external equity, the gains may be

negligible. For other firms that access the capital markets repeatedly through seasoned equity issues and stock-financed mergers, the gains may be much larger.

2.4.3. Debt issues

A few papers have examined debt market timing, i.e., raising debt when its cost is unusually low. Survey evidence lends some initial plausibility to timing in this market as well. In particular, Graham and Harvey (2001) find that interest rates are the most cited factor in debt policy decisions: CFOs issue debt when they feel "rates are particularly low". Expectations about the yield curve also appear to influence the *maturity* of new debt. Short-term debt is preferred "when short-term rates are low compared to long-term rates" and when "waiting for long-term market interest rates to decline". Clearly, CFOs do not believe in the textbook version of the expectations hypothesis, under which the cost of debt is equal across maturities. At the same time, CFOs do not confess to exploiting their private information about credit quality, instead highlighting general debt market conditions.

On the empirical side, Marsh (1982), in his sample of UK firms, finds that the choice between debt and equity does appear to be swayed by the level of interest rates. And Guedes and Opler (1996) examine and largely confirm the survey responses regarding the effect of the yield curve. In a sample of 7,369 US debt issues between 1982 and 1993, they find that maturity is strongly negatively related to the term spread (the difference between long- and short-term bond yields), which was fluctuating considerably during this period.

Is debt market timing successful in any sense? In aggregate data, Baker, Greenwood, and Wurgler (2003) examine the effect of debt market conditions on the maturity of debt issues and, perhaps more interestingly, connect the maturity of new issues to subsequent bond market returns. Specifically, in US Flow of Funds data between 1953 and 2000, the aggregate share of long-term debt issues in total long- and short-term debt issues is negatively related to the term spread, just as Guedes and Opler find with firm-level data. Further, because the term spread is positively related to future excess bond returns—i.e., the difference in the returns of long-term and short-term bonds, or the realized relative cost of long- and short-term debt—so is the long-term share in debt issues. Perhaps simply by using a naïve rule of thumb, "issue short-term debt when short-term rates are low compared to long-term rates", managers may have timed their debt maturity decisions so as to reduce their overall cost of debt. Of course, such a conclusion is subject to the usual risk-adjustment caveats.

Unfortunately, the data on individual debt issues and their subsequent returns does not approach the level of detail of the IPO and SEO data. But one intriguing pattern that has been uncovered is that debt issues are followed by low *equity* returns. Speiss and Affleck-Graves (1999) examine 392 straight debt issues and 400 convertible issues between 1975 and 1989. The shares of straight debt issuers underperform a size- and book-to-market benchmark by an insignificant 14% over five years (the median underperformance is significant), while convertible issuers underperform by a significant

37%. There is also a suggestion that the riskiest firms may be timing their idiosyncratic credit quality, despite the survey answers on this point: the shares of unrated issuers have a median five-year underperformance of 54%. If the equity did so poorly, the debt issues presumably also did poorly. In a much broader panel, Richardson and Sloan (2003) also find that net debt issuance is followed by low stock returns.

There are several potential explanations for this pattern. Certainly, equity overvaluation would be expected to lower the cost of debt directly—credit risk models routinely include stock market capitalization as an input—so the relationship with subsequent stock returns may reflect debt market timing *per se*. Or, managerial and investor sentiment is correlated; managers may tend to be most optimistic precisely when capital is cheap, and thus raise and invest as much as they can from any source. This story combines investor and managerial irrationality and so does not fit neatly within our taxonomy, but seems like a promising approach for future work. A third possibility, outlined in Baker, Stein, and Wurgler (2003), is that equity overvaluation relaxes a binding leverage constraint, creating debt capacity that subsequently gets used up. But debt is always correctly priced in this setting, so debt market timing *per se* is not possible.

2.4.4. Cross-border issues

The evidence in Froot and Dabora (1999) suggests that relative mispricings across international securities markets are possible, even between particularly liquid markets such as the US and the UK. This raises the possibility of international market timing. Along these lines, Graham and Harvey (2001) find that among US CFOs who have considered raising debt abroad, 44% implicitly dismissed covered interest parity in replying that lower foreign interest rates were an important or very important consideration in their decision.[13]

In practice, most international stock and bond issues are made on the US and UK markets. Henderson, Jegadeesh, and Weisbach (2006) find that when total foreign issues in the US or the UK are high, relative to respective GDP, subsequent returns on those markets tend to be low, particularly in comparison to the returns on issuers' own markets. In a similar vein, and consistent with the survey evidence mentioned above, foreign firms tend to issue more debt in the US and the UK when rates there are low relative to domestic rates.

2.4.5. Capital structure

As an accounting identity, every firm's capital structure is the cumulative outcome of a long series of incremental financing decisions, each driven by the need to fund some investment project, consummate a merger, or achieve some other purpose. To the extent that market timing is a determinant of any of these incremental financing decisions,

[13] Almost all equity raised by US corporations is placed in domestic markets, so Graham and Harvey do not ask about the determinants of international stock issues.

then, it may help to explain the cross-section of capital structure. In particular, if market timing-motivated financing decisions are not quickly rebalanced away, low-leverage firms will tend to be those that raised external finance when their stock prices were high, and hence those that tended to choose equity to finance past investments and mergers, and vice-versa for high leverage firms.[14]

This market timing theory of capital structure is developed and tested in Baker and Wurgler (2002). In an effort to capture the historical coincidence of market valuations and the demand for external finance in a single variable, they construct an "external finance weighted-average" of a firm's past market-to-book ratios. For example, a high value would mean that the firm raised the bulk of its external finance, equity *or* debt, when its market-to-book was high. If market timing has a persistent impact on capital structure, Baker and Wurgler argue, this variable will have a negative cross-sectional relationship to the debt-to-assets ratio, even in regressions that control for the current market-to-book ratio. In a broad Compustat sample from 1968 to 1999, a strong negative relationship is apparent.

This evidence has inspired debate. On one hand, Hovakimian (2006) argues that equity issues do not have persistent effects on capital structure, and that the explanatory power of the weighted average market-to-book arises because it contains information about growth opportunities, a likely determinant of target leverage, that is not captured in current market-to-book. Leary and Roberts (2005), Kayhan and Titman (2004), Flannery and Rangan (2006) also argue that firms rebalance toward a target. Alti (2005) looks specifically at the time series variation in IPO leverage, finding that an initial and statistically significant response to hot issues markets is short-lived.

On the other hand, Huang and Ritter (2005) show that the tendency to fund a financing deficit with equity decreases with proxies for the cost of equity capital. And, Welch (2004) and Huang and Ritter (2005), like Fama and French (2002), argue that firms rebalance their capital structures much more slowly, so that shocks to capital structure are long lived. Moreover, Chen and Zhao (2004b) point out that mean reversion in leverage is not definitive evidence for a tradeoff theory. Because leverage is a ratio, shocks tend to cause mean reversion mechanically. In an analysis of the choice between equity and debt issues, which avoids this problem, Chen and Zhao (2004a) find that deviation-from-target proxies have little explanatory power, while market-to-book and past stock returns are very important.

2.5. Other corporate decisions

In this subsection, we consider what the irrational investors approach has to say about dividend policy, firm name changes, and earnings management.[15] We also discuss recent work that looks at executive compensation from this perspective.

[14] Similarly, one could articulate a simple theory of debt maturity structure as reflecting the historical coincidence of debt issuance and debt market conditions like the term spread.

[15] We put dividend policy in this section and repurchases in the financing section, because, unlike a repurchase, pro-rata dividends do not change the ownership structure of the firm, and there is no market timing

2.5.1. Dividends

The catering idea has been applied to dividend policy. Long (1978) provides some early motivation for this application. He finds that shareholders of Citizens Utilities put different prices on its cash dividend share class than its stock dividend share class, even though the value of the shares' payouts are equal by charter. In addition, this relative price fluctuates. The unique experiment suggests that investors may view cash dividends *per se* as a salient characteristic, and in turn raises the possibility of a catering motive for paying them.

Baker and Wurgler (2004a) outline and test a catering theory of dividends in aggregate US data between 1963 and 2000. They find that firms initiate dividends when the shares of existing payers are trading at a premium to those of nonpayers, and dividends are omitted when payers are at a discount. To measure the relative price of payers and nonpayers, they use an *ex ante* measure of mispricing they call the "dividend premium". This is just the difference between the average market-to-book ratios of payers and nonpayers. They also use *ex post* returns, and find that when the rate of dividend initiation increases, the future stock returns of payers (as a portfolio) are lower than those of nonpayers. This is consistent with the idea that firms initiate dividends when existing payers are relatively overpriced. Li and Lie (2005) find similar results for dividend changes.

Time-varying catering incentives also appear to shed light on the "disappearance" of dividends. Fama and French (2001) document that the percentage of Compustat firms that pay dividends declines from 67% in 1978 to 21% in 1999, and that only a part of this is due to the compositional shift towards small, unprofitable, growth firms which are generally less likely to pay dividends. Baker and Wurgler (2004b) observe that the dividend premium switched sign from positive to negative in 1978 and has remained negative through 1999, suggesting that dividends may have been disappearing in part because of the consistently lower valuations put on payers over this period. An analysis of earlier 1963–1977 data also lends support to this idea. Dividends "appeared", "disappeared", and then "reappeared" in this period, and each shift roughly lines up with a flip in the sign of the dividend premium. In UK data, Ferris, Sen, and Yui (2006) find that dividends have been disappearing during the late 1990s, and that a dividend premium variable formed using UK stocks lines up with this pattern.

The evidence suggests that the dividend supply responds to catering incentives, but why does investor demand for payers vary over time? One possibility is that "dividend clienteles" vary over time, for example with tax code changes. However, in US data, the dividend premium is unrelated to the tax disadvantage of dividend income, as is the rate of dividend initiation. Shefrin and Statman (1984) develop explanations for why investors prefer dividends based on self-control problems, prospect theory, mental accounting, and regret aversion. Perhaps these elements vary over time. Baker and Wurgler (2004a) argue that the dividend premium reflects sentiment for "risky" nonpaying

benefit or cost. For this reason, it fits more naturally with the category of corporate decisions that might influence the level of mispricing, but do not otherwise transfer value among investors.

growth firms versus "safe" dividend payers, since it falls in growth stock bubbles and rises in crashes. Fuller and Goldstein (2003) show more explicitly that payers outperform in market downturns. Perhaps investors seek the perceived safety of cash dividends in these gloomy periods, and bid up the shares of payers.

There are clear limitations to a catering theory of dividends, however. For one, it is a descriptive theory of whether firms pay dividends at all, not how much—in US data, at least, the dividend premium does not explain aggregate fluctuations in the level of dividends. DeAngelo, DeAngelo, and Skinner (2004) report that the aggregate dollar value of dividends has increased in real terms, as dividends have become concentrated in a smaller faction of traded firms. Also, it works better for explaining initiations than omissions, and it has little to say about the strong persistence in dividend policy. Catering is probably best viewed as one building block in an overall descriptive theory of dividend policy.

2.5.2. *Firm names*

Name changes provide some of the simplest and most colorful examples of catering. In frictionless and efficient markets, firm names should be about as irrelevant as dividends. But there is a low fundamental cost of changing names, and perhaps through a name change a firm can create a salient association with an overpriced category of stocks.

Evidence of a catering motive for corporate names is most prominent in bubbles. In the 1959–1962 era which Malkiel (1990) refers to as the "tronics boom", firms "often included some garbled version of the word 'electronics' in their title even if the companies had nothing to do with the electronics industry" (p. 54). Systematic evidence has been assembled for the Internet bubble. Cooper, Dimitrov, and Rau (2001) find that 147 (generally small) firms changed to "dotcom" names between June 1998 and July 1999, as Internet valuations were rapidly rising. Catering to Internet sentiment did seem to deliver a short-term price boost: the authors report an average announcement effect of 74% for their main sample, and an even larger effect for the subset that had little true involvement with the Internet. Interestingly, Cooper et al. (2005) find that names were also used to *dissociate* companies from the Internet sector, as prices started crashing. Between August 2000 and September 2001, firms that dropped their dotcom name saw a positive announcement effect of around 70%. The effect was almost as large for firms that dropped the dotcom name but kept an Internet business focus, and for the "double dippers" which dropped the name they had newly adopted just a few years earlier.

The names of mutual funds also seem to be sensitive to investor sentiment. Cooper, Gulen, and Rau (2005) find that fund names shift away from styles that experience low returns and toward those with high returns. The authors find that name changes do not predict fund performance, yet inflows increase dramatically, even for "cosmetic" name changers whose underlying investment style remains constant. Presumably, then, the name change decision is driven in part by the desire to attract fund inflows, which increase the fund's size and the fees its managers earn. Indeed, Cooper et al. find that the inflow effect is increased when money is spent to advertise the "new" styles. While

we group this study with other name changes, it actually involves an investment policy decision, in the sense that the goal of the name change is to increase the fundamental value of the franchise.

2.5.3. Earnings management

The quarterly net income figure that managers report to shareholders does not equal actual economic cash flows, but instead includes various non-cash accruals, some of which are fairly discretionary. According to the survey by Graham, Harvey, and Rajgopal (2005), CFOs believe that investors care more about earnings per share than cash flows.[16]

As the irrational investors theory predicts, managers with "short horizons" are especially likely to manage earnings. Bergstresser and Philippon (2006) find that accruals management increases as the CEO's compensation, via stock and options holdings, becomes more sensitive to current share prices. Sloan (1996) finds that firms with high accruals earn low subsequent returns, which suggests that earnings management may be successful in boosting share price, or at least in maintaining overvaluation. Consistent with the view that managers use earnings management to fool investors and issue overvalued equity, Teoh, Welch, and Wong (1998a, 1998b) find that initial and seasoned equity issuer underperformance is greatest for firms that most aggressively manage pre-issue earnings.

An interesting and largely unexplored question is whether earnings management has serious consequences for investment. Graham, Harvey, and Rajgopal (2005) present CFOs with hypothetical scenarios and find that 41% of them would be willing to pass up a positive-NPV project just to meet the analyst consensus EPS estimate. Direct evidence of this type of value loss is difficult to document, but Jensen (2005) presents a range of anecdotes, and highly suggestive empirical studies include Teoh et al. (1998a, 1998b), Erickson and Wang (1999), Bergstresser, Desai, and Rauh (2006), and Pshisva and Suarez (2004). The last three papers report that earnings management activity increases prior to stock acquisitions.

2.5.4. Executive compensation

In the theoretical framework at the beginning of this section, we assumed that managers may have the incentive to cater to short-term mispricing. One question is why shareholders do not set up executive compensation contracts to force managers to take the long view.[17] Bolton, Scheinkman, and Xiong (2005) suggest that short horizons may be an equilibrium outcome. They study the optimal incentive compensation contract for the

[16] There is a large literature in financial accounting on corporate earnings management. Here, we offer a brief and incomplete review, focusing on the link between earnings management and corporate financing decisions.

[17] A separate but related question is how managers compensate lower level employees within the firm. Bergman and Jenter (2006) argue that rational managers may minimize costs by paying optimistic employees

dynamic speculative market of Scheinkman and Xiong (2003), in which two groups of overconfident investors trade shares back and forth as their relative optimism fluctuates. The share price in this market contains a speculative option component, reflecting the possibility that nonholders might suddenly become willing to buy at a high price. Bolton et al. find that the optimal contract may induce the CEO to take costly actions that exacerbate differences of opinion, thus increasing the value of the option component of stock prices, at the expense of long-run value.

3. The irrational managers approach

The second approach to behavioral corporate finance takes the opposite extreme, in which irrational managers operate in efficient capital markets. To be more precise, by irrational managerial behavior we mean behavior that departs from rational expectations and expected utility maximization of the manager. We are not interested in rational moral hazard behavior, such as empire building, stealing, and plain slacking off. Instead, we are concerned with situations where the manager believes that he is actually close to maximizing firm value—and, in the process, some compensation scheme—but is in fact deviating from this ideal.[18]

As in the irrational investors approach, an extra building block is required. In order for less-than-fully-rational managers to have an impact, corporate governance must be limited in its ability to constrain them into making rational decisions. In general, an assumption of limited governance seems like a reasonable one to maintain. Takeover battles and proxy fights are notoriously blunt tools. Boards may be more a part of the problem than the solution if they have their own biases or are pawns of management. And unlike in a traditional agency problem, which arises when there is a conflict of interest between managers and outside investors, standard incentive contracts have little effect: an irrational manager may well think that he is maximizing value. Finally, in the US, a significant element of managerial discretion is codified in the business judgment rule. See Adams, Almeida, and Ferreira (2005) and Bertrand and Schoar (2003) for direct evidence that managers have discretion, and Shleifer and Vishny (1997) for a broader review of corporate governance institutions.

The psychology and economics literatures relevant to managerial behavior are vast. For us, the main themes are that individuals do not always form beliefs logically, nor do these beliefs convert to decisions in a consistent and rational manner—see Gilovich, Griffin, and Kahneman (2002) and Kahneman and Tversky (2000) for collected works. Thus far, most research in corporate finance has focused on the positive illusions of optimism and overconfidence. Illustrating the pattern of optimism, Weinstein (1980) finds

in overvalued equity, in the form of options grants. Benartzi (2001) offers a foundation for this sort of optimism, showing that employees have a tendency to extrapolate past returns, and as a consequence hold too much company stock. See also Core and Guay (2001) and Oyer and Schaeffer (2005).

[18] Our focus is on corporate finance decisions. Camerer and Malmendier (2005) discuss the impact of less than fully rational behavior in other parts of organizations.

that subjects tend to believe themselves to be more likely than average to experience positive future life events (e.g., owning own home, living past 80) and less likely to experience negative events (being fired, getting cancer). Illustrating overconfidence in one's own skills, Svenson (1981) finds that 82% of a sample of students placed themselves in the top 30% in terms of driving safety.

There are good reasons to focus on these particular biases in a managerial setting. First, they are strong and robust, having been documented in many samples, in particular samples of managers (Larwood and Whittaker, 1977; March and Shapira, 1987; Ben-David, 2004). Second, they are often fairly easy to integrate into existing models, in that optimism can be modeled as an overestimate of a mean and overconfidence as an underestimate of a variance. Third, overconfidence leads naturally to more risk-taking. Even if there is no overconfidence on average in the population of *potential* managers, those that are overconfident are more likely to perform extremely well (and extremely badly), placing them disproportionately in the ranks of upper (and former) management. And fourth, even if managers start out without bias, an attribution bias—the tendency to take greater responsibility for success than failure (e.g., Langer and Roth, 1975)—may lead successful managers to *become* overconfident, as in Gervais and Odean (2001).

After reviewing the theory and evidence on optimism and overconfidence, we turn briefly to potential applications of bounded rationality and reference-point preferences. Given the state of the literature, our treatment there is necessarily more speculative. Further, we do not discuss at all the impact of several other judgmental biases, such as representativeness, availability, anchoring, and narrow framing—not because we believe them to be unimportant, but because no systematic studies of their impacts on corporate finance decisions have yet been conducted.

3.1. Theoretical framework

The idea of managerial optimism and overconfidence in finance dates at least to Roll (1986). The derivation below is in the spirit of Heaton (2002) and Malmendier and Tate (2005), as modified to match our earlier notation as much as possible. We start by assuming the manager is optimistic about the value of the firm's assets and investment opportunities. He then balances two conflicting goals. The first is to maximize *perceived* fundamental value. To capture this, we augment fundamental value with an optimism parameter γ,

$$(1+\gamma)f(K,\cdot)-K,$$

where f is increasing and concave in new investment K. Note that here, the manager is optimistic about both the assets in place (f can include a constant term) and new opportunities. Once again, if traditional market imperfections cause the Modigliani and Miller (1958) theorem to fail, financing may enter f alongside investment.

The manager's second concern is to minimize the *perceived* cost of capital. We assume here that the manager acts on behalf of existing investors, because of his own stake

in the firm and fiduciary duty. This leads to a similar setup to the market timing objective in Section 2.1, except that an optimistic manager believes there is never a good time to issue equity. In particular, since the capital market is efficient and values the firm at its true fundamental value of $f - K$, the manager believes that the firm is undervalued by γf, and thus in selling a fraction of the firm e he perceives that existing, long-run shareholders will lose

$$e\gamma f(K, \cdot).$$

Putting the two concerns together, the optimistic manager chooses new investment and financing to solve

$$\max_{K,e}(1+\gamma)f(K, \cdot) - K - e\gamma f(K, \cdot).$$

We do not explicitly include a budget constraint. Instead, again to keep the notation simple, we consider its reduced-form impact on f.

Differentiating with respect to K and e gives the optimal investment and financial policy of an optimistic manager operating in efficient capital markets:

$$f_K(K, \cdot) = \frac{1}{1+(1-e)\gamma}, \quad \text{and}$$
$$(1+\gamma)f_e(K, \cdot) = \gamma\big(f(K, \cdot) + ef_e(K, \cdot)\big).$$

Put into words, the first condition is about investment policy. Instead of setting the marginal value created from investment equal to the true cost of capital, normalized to be one here, managers overinvest, to the point where the marginal value creation is less than one. The more optimistic (γ) is the manager and the less equity (e) he is forced to raise in financing investment, the greater the problem. The second is about financing. The marginal value lost from shifting the firm's current capital structure away from equity is weighed against the perceived market timing losses. As in the analysis of irrational investors, we consider some special cases.

Investment policy. If there is no optimal capital structure, so that f_e is equal to zero, the manager will not issue equity, setting e to zero, and there is no interaction among financing, internal funds, and investment. In this case, the optimistic manager will clearly overinvest: f_K is less than unity. In Heaton (2002) and Malmendier and Tate (2005), there is an optimal capital structure, or more precisely an upper bound on debt. If the manager needs equity to invest (f_e greater than zero, here), the degree of overinvestment falls.

Needing equity is akin to having little cash or cash flow available for investment. Thus in this setup, investment can be strongly related to current cash flow and profits, controlling for investment opportunities. This leads to a behavioral foundation for the Jensen (1986) agency costs of free cash flow. But instead of receiving private benefits of control, managers are simply overconfident and overinvest from current resources as a result. Leverage reduces the degree of overinvestment by increasing f_e, thereby increasing equity issues e and reducing K.

In a more complex specification, these conclusions may change. One might have the manager optimistic only about assets in place, in which case there is no overinvestment, and there will typically be underinvestment as a firm approaches its debt capacity. Also, it is worth emphasizing that we are examining optimism in isolation here. Layering on other imperfections, such as risk aversion, may mean that optimism moves investment from an inefficiently *low* level toward the first best, as in Gervais, Heaton, and Odean (2003) and Goel and Thakor (2002). In a related vein, Hackbarth (2004) argues that managerial optimism and overconfidence can reduce the underinvestment associated with debt overhang, as in Myers (1977).

Financial policy. An optimistic manager never sells equity unless he has to. If there is an upper bound on leverage (f_e greater than zero, here), optimism predicts a 'pecking order' of financing decisions: the manager relies on internal capital and debt and uses outside equity only as a last resort. Again, other imperfections may mitigate the aversion to equity. If the manager is risk averse with an undiversified position in the firm's equity, for example, he may wish to issue equity even though it is below what he thinks it to be worth.

Other corporate decisions. It is not as easy to incorporate other decisions into this framework. Consider dividend policy. If the manager is more optimistic about future cash flow and assets in place than outside investors, he might view a dividend payment as more sustainable. On the other hand, if he views future investment opportunities, and hence funding requirements, as greater, he might be reluctant to initiate or increase dividends and retain internal funds instead. This analysis requires a more dynamic model of investment and cash flow and a decomposition of firm value into assets in place and growth opportunities.

3.2. Empirical challenges

If the main obstacle to testing the irrational investors approach is finding a proxy for misvaluation, the challenge here is to identify optimism, overconfidence, or the behavioral bias of interest. Without an empirical measure, the irrational managers approach is difficult to distinguish from traditional agency theory, in particular. That is, in Stein (2003), an empire-building manager will

$$\max_{K,e}(1+\gamma)f(K) - K - c(e),$$

where γ reflects the preference for or the private benefits that come with presiding over a larger firm, as in Jensen and Meckling (1976) or Grossman and Hart (1988), rather than optimism. Rational investors recognize the agency problem up front, so c reflects the cost of raising outside equity, and management and existing shareholders bear the agency costs.

This reduced form is almost identical to the objective function of an optimistic manager. Both can generate overinvestment, underinvestment, cash flow-investment sensitivities, pecking order financing, and so forth. Moreover, Stein points out that the agency

model is itself hard to distinguish from models of costly external finance built on asymmetric information. Thus, to test the behavioral theories, one must separate the γ related to overconfidence and optimism from the γ that arises from agency or asymmetric information problems.

3.3. Investment policy

Despite the obvious difficulty of obtaining direct, manager-level measures of optimism and overconfidence, evidence is accumulating that these biases do affect business investment.

3.3.1. Real investment

We begin with startup investments. The evidence indicates that entrepreneurial startups are generally made under a halo of overconfidence and optimism. Cooper, Woo, and Dunkelberg (1988) find that 68% of entrepreneurs think that their startup is more likely to succeed than comparable enterprises, while only 5% believe that their odds are worse, and a third of entrepreneurs view their success as essentially guaranteed. The survey responses of French entrepreneurs tabulated in Landier and Thesmar (2005) also seem consistent with an initial underestimation of the task of starting a firm: at startup, 56% expect "development" in the near future, and 6% expect "difficulties".

The actual performance of startup investments is more sobering. Landier and Thesmar find that when surveyed three years into their endeavor, only 38% of French entrepreneurs expect further "development" while 17% anticipate "difficulty". Leaving profitability aside entirely, only half of all startups survive more than three years (Scarpetta et al., 2002). Moskowitz and Vissing-Jorgensen (2002) argue more generally that the return on private equity in the US between 1952 and 1999 is lower than seems justified given the undiversified nature of entrepreneurial investment. As a whole, the evidence on startup investments seems consistent with the overconfidence that Camerer and Lovallo's (1999) experimental subjects display when making entry decisions.

Optimism also appears to influence investment in more mature firms. Merrow, Phillips, and Myers (1981) compare forecast and actual construction costs for pioneer process plants in the energy industry. There is a strong optimism bias in project cost forecasts, with actual costs typically more than double the initial estimates. Statman and Tyebjee (1985) survey several other studies of this sort, involving military hardware, drugs, chemicals, and other development projects, and conclude that optimistic biases in cost and sales forecasts are fairly widespread.

Malmendier and Tate (2005) provide cross-sectional tests of the effects of optimism in a broader sample. They form a clever manager-level proxy for optimism: the propensity for a manager to voluntarily hold in-the-money stock options in his own firm. The intuition is that since the CEO's human capital is already so exposed to firm-specific risk, voluntarily holding in-the-money options can be seen as a strong vote of opti-

mism.[19] With this optimism proxy in hand for a large sample of US firms between 1980 and 1994, Malmendier and Tate find that the sensitivity of investment to cash flow is higher for the more optimistic CEOs. This sensitivity is especially high for optimistic CEOs in equity-dependent firms, that is, in situations where perceived financial constraints are most binding. Their results support the predictions of the basic optimism model.

While the empirical evidence that optimism affects investment may not seem extensive, keep in mind that optimism, as discussed earlier, shares many predictions with more established theories, and thus is a candidate to explain various earlier results. For example, the fact that managers invest rather than pay out cash windfalls (Blanchard, Lopez-de-Silanes, and Shleifer, 1994) looks like a moral hazard problem, but is also consistent with optimism. Likewise, some investment patterns that look like adverse-selection-driven costly external finance may actually reflect a mistaken managerial belief that external finance is costlier. A possible example is the higher investment-cash flow sensitivities among younger and entrepreneurial firms (Schaller, 1993), which as noted above appear to be run by especial optimists.

3.3.2. Mergers and acquisitions

Roll (1986) pioneered the optimism and overconfidence approach to corporate finance with his "hubris" theory of acquisitions. He suggests that successful acquirers may be optimistic and overconfident in their own valuation of deal synergies, and fail to properly account for the winner's curse. Roll interprets the evidence on merger announcement effects, surveyed by Jensen and Ruback (1983) and more recently by Andrade, Mitchell, and Stafford (2001) and Moeller, Schlingemann, and Stulz (2005), as well as the lack of evidence of fundamental value creation through mergers, as consistent with this theory.

More recently, Malmendier and Tate (2006) develop this argument and use their proxy for CEO optimism, outlined above, to test it. They find a number of patterns consistent with the optimism and overconfidence theory. First, optimistic CEOs complete more mergers, especially diversifying mergers, which are perhaps of more dubious value. Second, optimism has its biggest effect among the least equity dependent firms, i.e., when managers do not have to weigh the merger against an equity issue that they, as optimists, would perceive as undervalued. Third, investors are more skeptical about bid announcements when they are made by optimistic CEOs. This last result is consistent with the theme of irrational managers operating in efficient markets.[20]

[19] Malmendier and Tate find that the propensity to voluntarily retain in-the-money options is not significantly related to future abnormal stock returns, supporting their assumption that such behavior indeed reflects optimism rather than genuine inside information.

[20] For additional, anecdotal evidence on the role of hubris in takeovers, see Hietala, Kaplan, and Robinson (2003) and Shefrin (2000, Chapter 16).

3.4. Financial policy

Direct empirical tests of how optimism and overconfidence affects financing patterns is not extensive. Existing work addresses capital structure and financial contracting.

3.4.1. Capital structure

The basic optimism model predicts a pecking order financing policy, as pointed out by Heaton (2002). Thus, much of the existing evidence of pecking-order policies, from Donaldson (1961) to Fama and French (2002), is at face value equally consistent with pervasive managerial optimism. And the notion of pervasive managerial optimism does not seem farfetched. In Graham's (1999) survey, almost two-thirds of CFOs state their stock is undervalued while only three percent state it is overvalued. Such responses are all the more striking given the fact that the survey was taken shortly *before* the Internet crash.

To distinguish optimism from other explanations of pecking order behavior (for example, adverse selection as in Myers and Majluf, 1984), a natural test would use cross-sectional variation in measured optimism to see whether such behavior is more prevalent in firms run by optimists. To our knowledge, exactly this test has yet to be conducted, but certain results in Malmendier and Tate (2005, 2006) have a closely related flavor. First, and as noted above, firms run by optimists (as identified by the Malmendier and Tate options-based proxies for optimism) display a higher sensitivity of investment to internal cash flow. Second, managers classified as optimistic show a differentially higher propensity to make acquisitions when they are not dependent on external equity.

3.4.2. Financial contracting

Landier and Thesmar (2005) examine financial contracting between rational investors and optimistic entrepreneurs.[21] They highlight two aspects of contracting with optimists. First, because optimists tend to inefficiently persist in their initial business plan, the optimal contract transfers control when changes are necessary. (Kaplan and Stromberg, 2003, find that contingent transfers of control are common features of venture capital contracts.) Second, because optimists believe good states to be more likely, they are willing to trade some control and ownership rights in bad states for greater claims in good ones; in this sense, the optimal contract "pays the entrepreneur with dreams". Ultimately, optimists may self-select into short-term debt, as it transfers payments and control to the investor in states that seem unlikely to occur, while realistic entrepreneurs prefer less risky long-term debt.

Landier and Thesmar find some empirical evidence of this separation in a data set of French entrepreneurs. Among other results, they find that the use of short-term debt

[21] Manove and Padilla (1999) also consider how banks separate optimists and realists. They focus on the overall efficiency of the credit market.

is positively related to an *ex post* measure of optimistic expectations, the difference between realized growth and initial growth expectations. They also find that the use of short-term debt is positively related to psychologically-motivated instruments for expectations, such as regional sunlight exposure and rates of mental depression.

3.5. Other behavioral patterns

In the remainder of the survey, we briefly explore patterns other than optimism and overconfidence, in particular bounded rationality and reference-point preferences.

3.5.1. Bounded rationality

Perhaps the simplest deviation from the benchmark of full rationality is bounded rationality, introduced by Simon (1955). Bounded rationality assumes that some type of cognitive or information-gathering cost prevents agents from making fully optimal decisions. Boundedly-rational managers cope with complexity by using rules of thumb that ensure an acceptable level of performance and, hopefully, avoid severe bias. Conlisk (1996) reviews the bounded rationality literature.

Rules of thumb are hardly uncommon in financial management. For example, the net present value criterion is the optimal capital budgeting rule (in efficient markets), yet in practice managers employ various simpler rules. Surveying practice in the 1970s, Gitman and Forrester (1977) find that less than 10% of 103 large firms use NPV as their primary technique, while over 50% use the IRR rule, which avoids a cost of capital calculation. The Graham and Harvey (2001) survey of CFOs also finds that the IRR rule is more widely used than NPV, and over 50% of CFOs use the payback period rule, an even less sophisticated rule that requires neither a cost of capital input nor forecasts of cash flows beyond a cutoff date. Graham and Harvey also find that among managers who do use a discounting procedure, it is common to apply a firm-wide discount rate rather than a project-specific rate, again in stark contrast to normative principles.[22]

Other instances of rule-based management include the use of simple targets for capital structures and payouts. Graham and Harvey (2001) find that 10% of the CFOs in their sample use a "very strict" target debt–equity ratio and 34% use a "somewhat tight" target or range. Such leverage targets are typically defined in terms of book value, and Welch (2004) confirms that market leverage is, to a large extent, allowed to float with stock prices. Likewise, the Lintner (1956) field interviews revealed a set of common rules of thumb in payout policy that led him to an empirically accurate specification for dividends.

[22] A good question is whether the use of such rules is better understood as an agency problem than as bounded rationality. That is, executives might use simple rules to shorten the workday and save time for golf. However, Graham and Harvey find that high-ownership managers are if anything *less* likely to use NPV and *more* likely to use the payback period rule.

3.5.2. *Reference-point preferences*

Psychological experiments and intuition suggest that people value *changes* in economic states, such as wealth or performance, not just levels. This is reflected in the value function in Kahneman and Tversky's (1979) prospect theory, which is defined in terms of gains and losses relative to a reference point.

In corporate finance, the most developed application of reference-point preferences has been to IPO underpricing, the pattern that the initial offering price is, on average, below the market price that prevails after a day of trading. (For more on this, see the chapter by Ljungqvist in this volume.) There are, of course, many non-behavioral explanations for this pattern. Loughran and Ritter (2002) develop an explanation that combines reference-point preferences and mental accounting (Thaler, 1980, 1985). They assume that issuing managers mentally account for two quantities in judging an offering's success: the (perceived) gain from the gap between the first day closing price and a natural reference point, the midpoint of the file price range; and the (real) loss from the dilutive effect of the underpricing. If the gain is judged to outweigh the loss, where each is evaluated with the prospect theory value function, the executives are net satisfied. Intuitively, they may be too overwhelmed by the "windfall" gain versus the reference point to complain much about underpricing.[23]

This setup is designed, in part, to explain the pattern that underpricing is greater when the offer price is above the initial file price range. Loughran and Ritter (2002) find that in issues where the offer price is below the minimum of the file price range, first-day returns are a relatively small 4%, on average, while those priced above the maximum have average first-day returns of 32%. This is consistent with issuers acquiescing in severe underpricing only when they are simultaneously getting good news in the form of upward revisions from the filing range.[24] Ljungqvist and Wilhelm (2005) test some of the behavioral underpinnings of the Loughran and Ritter view. Using data on the ownership stakes of executives in IPO firms, they crudely proxy for the proposed notion of issuer satisfaction by taking the dollar amount of executives' perceived "gain" from revisions from the midpoint of the file price range and subtracting the dollar amount of dilution due to underpricing. They find that executive teams that are more "satisfied" with their IPOs by this criterion are more likely to use the same underwriter for seasoned offerings, and to pay higher fees for those transactions.

A different application of reference-point thinking is the widely asserted, but less well documented, managerial propensity to "throw good money after bad". Such behavior is most relevant for us to the extent that it reflects something more than rational

[23] Loughran and Ritter assume that the underwriter prefers underpricing, perhaps because it generates profitable rent-seeking activities among investors, e.g., trading with the underwriter's brokerage arm, or because it reduces marketing costs.

[24] See Benveniste and Spindt (1989) for an alternative explanation for this asymmetry based on information gathering in the book-building process; and Edelen and Kadlec (2005) for an alternative explanation, based on sample truncation bias related to the withdrawl of IPOs whose prospects deteriorate during the waiting period.

career concerns, e.g., a situation where the manager tries to distort the updating process to maintain high compensation. Shefrin (2001) offers several anecdotes concerning major corporate investments that have the flavor of good money after bad, and Statman and Sepe (1989) find that the market reaction to the termination of historically unprofitable investment projects is positive, suggesting that investors recognize that executives have a tendency to continue poor projects. Related evidence comes from the Guedj and Scharfstein (2004) study of drug development decisions. Those authors find that single-product early stage firms appear highly reluctant to abandon their only viable drug candidates, even when the results of clinical trials are less than promising. Some combination of agency, managerial optimism, and a gambling-to-get-back-to-even attitude seems like a plausible explanation for these results.

4. Conclusion

The behavioral corporate finance literature has matured to the point where one can now sketch out a handful of canonical theoretical frameworks and use them to organize the accumulated evidence of dozens of empirical studies. This survey suggests that the behavioral approaches to corporate finance offer a useful complement to the other paradigms in the field. They deliver intuitive and sometimes quite compelling explanations for important financing and investing patterns, including some that are difficult to reconcile with existing theory.

In its current state of flux, the field offers a number of exciting research questions. We close by highlighting just a few. In no particular order, we wonder:

- Are behavioral factors at the root of why managers do not more aggressively pursue the tax benefits of debt, as in Graham (2000)? Hackbarth (2004) develops a theoretical argument along these lines.
- While the existing literature has generally considered the two approaches separately, the irrational manager and irrational investor stories can certainly coexist. Would a model featuring a correlation between investor and managerial sentiment, for example, lead to new insights?
- What are the determinants of managerial "horizons", and how can they be measured and appropriately governed? Polk and Sapienza (2004) and Gaspar, Massa, and Matos (2005) use share turnover by investors to proxy for shareholder horizons.
- To what extent should the venture capital industry be viewed as an institution that identifies and caters to emerging pockets of investor sentiment?
- What determines investor sentiment, and how is it managed through corporate investor relations? Potential avenues to consider are interactions with past stock market returns, technological change and the valuation of new industries, media coverage, financial analysts and financial reporting, or investment banking. Brennan and Tamarowski (2000) offer an overview of investor relations.
- Do equity and debt market timing reduce the overall cost of capital by a large amount, or just a little? Dichev (2004) offers an approach here.

- To what extent can features of financial contracts be understood as a response to assorted behavioral biases? Williamson took first steps here. Regarding consumer contracts, Della Vigna and Malmendier (2004) suggest that credit cards and health club contracts, among others, are shaped by naïve expectations and time inconsistent preferences.
- What is the impact of investor inertia and limited attention on corporate finance? Recent papers by Baker, Coval, and Stein (2006) and Della Vigna and Pollet (2006) consider stock swaps and the timing of corporate disclosure. Hirshleifer and Welch (2002) develop implications for organizations.
- How should one approach the proper regulation of inefficient markets and financial reporting?
- What are the limits of corporate arbitrage, including detecting and generating mispricing, maintaining reputation, and avoiding fraud?
- Can a catering approach help to explain the diversification and subsequent re-focus wave that has taken place in the US since the late-1960s? We speculated in Section 2.3.2, but are aware of no systematic studies.
- How significant is the economy-wide misallocation of capital caused by collected behavioral distortions, and in particular how do these distortions interact with traditional capital market imperfections? For example, if there is underinvestment due to agency or asymmetric information, bubbles may bring investment closer to the efficient level.
- What are the behavioral underpinnings of Lintner's (1956) dividend model?
- If bounded rationality or investor pressures lead managers to rely on specific performance metrics, will third parties exploit this? The marketing of takeovers and financing vehicles as EPS-improving transactions by investment banks is a potential example. More generally, what profit opportunities are created by behavioral biases of investors and managers?
- To what extent are corporate "hedging" policies actually directional bets? The evidence in Brown, Crabb, and Haushalter (2005) and Faulkender (2005) suggests that in many companies, interest rate risk management and the use of derivatives has little to do with textbook hedging.
- In the Introduction, we pointed out that the normative implication of the irrational investors approach is to insulate managers from short-term market pressures, while the implication of the irrational managers approach is to obligate them to follow market prices. What, in the end, is the right balance?

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PART 2

BANKING, PUBLIC OFFERINGS, AND PRIVATE SOURCES OF CAPITAL

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Chapter 5

BANKS IN CAPITAL MARKETS*

STEVEN DRUCKER

Columbia Business School, Uris Hall, 3022 Broadway, New York, NY 10027, USA
e-mail: sd2281@columbia.edu

MANJU PURI

Fuqua School of Business, 1 Towerview Drive, Duke University and NBER, Durham, NC 27708, USA
e-mail: mpuri@duke.edu

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* The focus of this survey is by its very nature limited in its scope and, inevitably, we have left out many important papers. We apologize to those who feel that their research has been ignored or misrepresented.

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Abstract

Banks are an important source of funding in economies all around the world, making it vital to understand how banks directly and indirectly affect funding through capital markets. Few issues have perhaps been as controversial as the appropriate scope of bank activities and whether banks should participate directly in capital market activities, providing both lending and other services, such as underwriting. We review the arguments and theoretical models that consider the consequences of commercial banks engaging in investment banking activities, and we examine the empirical evidence on the potential for conflicts of interest, which focuses on the pricing and long run performance of debt and equity underwritten securities, both in the United States and internationally. A related topic is whether investment banks and commercial banks can co-exist as underwriters. We summarize the theoretical and empirical literature, focusing on the effect that bank lending has had on underwriter fees and the ability of banks to win underwriting mandates, as well as how investment banks have adapted to commercial bank entry into investment banking. We also consider the indirect role of commercial banks in capital markets, providing a summary of banks' ability to signal the quality of borrowers through their decisions to originate and sell loans. Finally we examine related topics, such as the effects of banks holding equity and engaging in venture capital activities, and we suggest research directions.

Keywords

commercial banks, investment banks, underwriters, certification, conflicts of interest, Glass–Steagall

1. Introduction

Banks are an important source of funding in economies around the world. Through syndicated loans arranged by commercial banks, industrial firms borrowed 1.4 trillion dollars in 2003 and 13.2 trillion dollars between 1993 and 2003.[1] The public capital markets have also proved to be a very important funding source. Between 1993 and 2003, industrial firms issued 10.2 trillion dollars of public debt and 2.3 trillion dollars of common stock.[2] Nearly 40 percent of equity issuance and 20 percent of debt issuance occurred in the United States. These facts raise an important question—how do banks directly and indirectly affect funding through capital markets?

Few regulatory issues have been as controversial as the appropriate scope of bank activities. Should banks participate directly in capital markets, providing not just lending services but also other services for the firm, such as public security underwriting? Both academics and regulators have debated this issue for decades. In the United States, commercial banks were permitted to underwrite public securities prior to 1933. However, the stock market crash of 1929 raised concerns over the potential for conflicts of interest and the fear that commingling of investment and commercial banking increased the riskiness of the financial system. In response, Congress passed the Glass–Steagall Act, which effectively prohibited banks from underwriting securities and set the basis for the following sixty year separation of commercial and investment banking. While there has been much rhetoric on potential conflicts of interest when banks combine lending with underwriting, the academic literature on this subject burgeoned only recently.

We begin by reviewing some of the arguments and theoretical models that analyze the implications of banks combining lending with underwriting. Much of the focus of these studies is on the potential for conflicts of interest that can occur when banks use their private information from lending relationships in underwriting their borrowers' public securities. These conflicts of interest are weighed against potential benefits, such as the bank being able to credibly certify the quality of its borrowers to outside investors and generate cost savings from informational economies of scope. This survey deals with these issues and its scope is defined by our perception of this literature.

The theoretical analyses provide a framework for empirical tests of conflicts of interest. These papers analyze the pricing and long run performance of commercial bank-underwritten securities. The first papers use data on public security offerings from before the enactment of the 1933 Glass–Steagall Act while more recent research uses data from the 1980s and beyond, after the relaxation and eventual repeal of the Glass–Steagall Act. Additional studies test whether banks can use organizational means to reduce the potential for conflicts of interest, and other papers examine the effects of a financial intermediary holding equity claims in firms. We also summarize the international evidence on the interaction between commercial banks and capital markets.

[1] Estimates are from Loan Pricing Corporation, which gathers its loan data from SEC filings, large loan syndicators, and a staff of reporters.

[2] Global issuance. Estimates from Thomson Financial.

There are considerable differences in regulatory environments and quality of the financial markets across countries, so additional insight into the causes and consequences of potential conflicts of interest can be ascertained from these studies. As the literature has grown, researchers have become increasingly sophisticated in using many different empirical methodologies to test for the presence of conflicts of interest. We highlight these methods throughout this survey.

Can investment banks, which generally do not provide lending services, co-exist with commercial banks? Some theoretical models suggest that this is a realistic possibility. For example, issuers may choose commercial banks when economies of scope are large and choose investment banks when the costs from conflicts of interest are sizable. Other models point out the possibility that investment banks and commercial banks can co-exist by charging different underwriter fees that reflect their relative benefits and costs. Another possibility, not generally addressed in the theoretical literature, is that investment banks will compete with commercial banks by expanding their lending activities. We survey the empirical literature on this topic by highlighting a number of papers that examine the effects of commercial bank re-entry into underwriting on the costs of intermediation, the impact of lending relationships on underwriting fees, and whether lending influences the likelihood of winning underwriting mandates.

In addition to the direct interaction between commercial banks and the capital markets, there is an indirect role of commercial banks on capital markets. Through screening and monitoring, banks gather private information about their borrowers. Even if banks do not directly participate in underwriting, banks' lending decisions can still signal the quality of firms to investors. Generally, researchers have examined this possibility by quantifying the firm's stock price reaction to loan initiations, renewals, and sales. Other studies examine if lending relationships provide positive information to outsiders by documenting the effects of bank loans from non-underwriting banks on the pricing of public security offerings. We provide a detailed summary of banks' ability to convey quality to outsiders through signaling.

Finally, we explore a number of areas where more research is needed. One such topic concerns the ability of banks to hold equity in firms, which is currently limited in the United States but is allowed in other countries, such as Germany and Japan. There is some evidence from the United States on the effects of banks and other financial intermediaries holding equity through venture capital subsidiaries. However, the consequences of banks holding equity remain unclear and highlight the need for additional research so that we can more fully understand the interaction between banks and capital markets.

2. Commercial banks as underwriters: Theoretical literature

When a commercial bank underwrites a firm's public securities, a number of benefits may arise. First, the private information that a bank gathers in the lending process may be valuable in public security underwriting. Insider banks know more about a firm's

prospects than outsiders due to their screening and monitoring of loans. Compared with investment banks, which do not generally acquire private information through lending activities, commercial banks have lower costs of information production. This advantage can allow commercial banks to gather more information about their clients and be better certifiers of firm value than investment banks. Second, banks may achieve informational economies of scope by jointly delivering lending and underwriting services and re-using the same client specific information for several purposes (see e.g. Benston, 1990; Saunders and Walter, 1994). As a result, informational economies of scope can lower transaction costs and reduce the costs of intermediation.

However, the potential benefits of commercial banks as underwriters of public securities can be limited by costs that can occur due to conflicts of interest from banks' incentives to misuse their private information. A bank may privately know that a firm has poor prospects but attempt to protect its own interests by certifying that the firm is of high quality and underwriting public securities, with the hope that investors will subscribe to the issue. The firm then can use the proceeds to pay down its bank loans at the expense of outside investors. This activity benefits the bank in two ways—in addition to earning a fee on the security underwriting, the bank reduces its overall portfolio exposure to default risk. A commercial bank that lends and underwrites may face other conflicts of interest that it may attempt to exploit. For example, banks may issue loans to third-party investors on the condition that these funds are used to support the price of a new issuance of public securities. In this case, the supporting of the security price through bank loans could send incorrect signals to investors and other new issuers regarding the true performance of the underwriter, making the bank appear to be a better underwriter than in truth. As another example, the bank may attempt to "tie" the provision or pricing of credit to the firm's use of the bank's investment banking services. By threatening to reduce the availability of credit or increase the cost of borrowing, the client may then face costs from higher-priced or lower-quality services, with the bank reaping the rewards.[3] Of course, conflicts of interest may be mitigated by the bank's concern for harming ongoing client relationships and its own reputation. It is likely that short-term gains from exploiting these conflicts are offset in the long run by these concerns, which can affect the ability of the bank to generate future business and profits.

Theoretical papers by Kanatas and Qi (1998, 2003), Puri (1999), and Rajan (2002) contrast the benefits that can arise from certification and informational economies of scope with the costs from conflicts of interest. These papers provide formal analyses of allowing banks to extend their business beyond traditional lending activities, and these studies produce some implications for the pricing of public securities, the firm's choice of underwriter, and the costs of financial intermediation.[4]

[3] See Walter (2004) for a thorough analysis of potential conflicts of interest in financial services firms.

[4] In a slightly different vein, Boot and Thakor (1997a, 1997b) examine the impact of the choice between universal and functionally separate banking, and argue that a financial system in its infancy will be bank dominated.

Rajan (2002) and Kanatas and Qi (1998, 2003) examine the implications of some costs and benefits of universal banking. Rajan (2002) examines if, with unrestricted competition, commercial banks with expanded powers will naturally evolve as efficient institutions. He shows that unrestricted competition does not necessarily lead to efficient institutions if the markets in which institutions compete are not naturally competitive. The intuition is that in producing one service (say lending), the integrated producer obtains the possibility of an ex-post rent in producing the second service (say underwriting). This rent can arise because the private information that the bank attains through lending may allow the bank to "capture" the firm.[5] So long as the ex-post rent is greater than the inefficiency that the integrated producer brings to underwriting, the bank can secure the customer's underwriting business. In this setting, universal banks can deter the emergence of other specialized organizational forms. Rajan (2002) argues that this is one plausible scenario for financial institutions not to evolve in the socially optimal way. Of course, whether these conditions apply is an empirical question. Rajan (2002) points out that if underwriting markets are competitive, then commercial banks will be forced to internalize the costs of the structure that they choose. In such a case, regulators can rely on commercial banks to make the right decision about whether to enter into the security underwriting.

Kanatas and Qi (1998) focus on the trade-offs between informational economies of scope and conflicts of interest. The authors assume the existence of the incentive conflict where the bank underwrites low quality firms' securities in order to pay down its bank loans. This incentive conflict limits the ability of the bank to credibly certify the quality of firms that use its underwriting services. Therefore, outside investors pool high-quality security issues with low-quality issues, which increases the financing costs of high-quality firms. High-quality firms can avoid being pooled with low-quality issuers by either using an independent underwriter or borrowing from a lending-only bank. However, by doing so, the firm forgoes any benefits that could arise due to informational economies of scope from using the same bank for both lending and underwriting services. Therefore, universal banks underwrite securities for firms when the benefits of scope economies outweigh the costs from conflicts of interest. In a related study, Kanatas and Qi (2003) develop a model in which economies of scope are a double-edged sword for the universal bank. On the positive side, informational economies of scope provide a cost advantage to universal banks (which is shared with clients) that enables universal banks to lock-in their clients' future business. However, on the negative side, the fact that relationships are more durable reduces the incentive for the universal bank to place effort into underwriting the clients' securities. In this model, firms trade-off the benefit of lower costs of dealing with a universal bank with the greater likelihood

[5] The firm can be captured for two reasons. First, the bank has lower costs of information production in security underwriting, which deters competition from other underwriters. Second, the bank's information creates a lemons problem for the firm in that other underwriters will be skeptical of the quality of firms that do not use their universal bank as underwriter.

of successful capital market financing from choosing an investment bank. Two key implications of the model are that universal banks will likely be selected as the underwriter when economies of scope are large, and underwriting allows banks to form and maintain strong relationships in multiple product lines, with firms that use universal banks for underwriting more likely to use the same universal bank for bank lending services.

Puri (1999) models the trade-off between commercial banks' potential to be better certifiers of firm value and the conflict of interest that can arise from the bank misrepresenting the value of a firm's securities in order to use the proceeds to repay bank loans. The formal model is a repeated game where investors are rational and update their beliefs about banks given the last period action, which allows reputation concerns to be captured. Commercial banks know if the firm is good or bad due to previous loan monitoring activities. Commercial banks can underwrite bad firms in order to pay down pre-existing claims, but if investors observe this action, then this observation will reduce the reputation of the bank and its future profits. Investment banks, which do not know the quality of the firm, can incur an investigative cost to determine the true quality of the firm. If they choose not to investigate and subsequently underwrite a low quality firm, the investment bank will suffer through reputation loss. The trade-offs that each underwriter faces determine equilibrium strategies and the prices that the market assigns to underwritten securities. A key result is that commercial banks are likely to obtain better prices for underwritten securities than investment banks when the costs of information production are high, as might be seen in junior and informational sensitive securities.[6] These results help provide theoretical underpinnings for many of the results in the empirical literature. This paper also examines if it is possible for commercial banks and investment banks to coexist in equilibrium and derives sufficient conditions for coexistence in which the level of rent extraction and the relative underwriting fees adjust so that firms are indifferent between going to commercial banks and investment banks. In Section 4, we survey the empirical evidence on competition between commercial banks and investment banks, including the literature on underwriting fees.

3. Empirical evidence on conflicts of interest

Like the theoretical literature, the empirical studies also examine the benefits and costs of universal banking. Much of the focus of the empirical literature is on the effect of bank's lending, and the private information contained therein, on commercial banks' ability to certify firm value in the presence of potential conflicts of interest. In this section, we provide an overview of this literature. The literature examines these issues over multiple periods of time in the United States. In Section 3.1, we provide a summary

[6] Of course, there are other scenarios where an investment bank can achieve higher prices than a commercial bank, such as when the costs of investigation for the investment bank are sufficiently small, or when both types of underwriters are perceived to have low reputations.

of the evidence from before the enactment of the 1933 Glass–Steagall Act, which prohibited commercial banks from underwriting public securities for nearly sixty years. Section 3.2 provides a review of studies that use data from the late 1980s and beyond, after the relaxation and repeal of the Glass–Steagall Act. In Section 3.3, we explore another strand of the literature that examines if commercial banks can use organizational means to mitigate the potential for conflicts of interest. Also, there are papers that explore the consequences of a financial intermediary holding equity claims in firms. We summarize these studies in Section 3.4. Throughout, we highlight the many different methodologies that have been used to test for the presence of conflicts of interest.

There are two primary ways that researchers examine whether banks are net certifiers of firm value or if commercial banks are subject to conflicts of interest. The first method is to examine the ex ante pricing of public securities. The foundation of these studies is that rational investors should anticipate whether commercial banks or investment banks have a higher net certification effect, and price the securities accordingly. If investors perceive that conflicts of interest are large, then commercial bank-underwritten securities will be priced lower than similar investment bank-underwritten securities, while if conflicts of interest are small, then commercial bank issues will achieve higher prices. The second method is to examine the ex post performance of underwritten securities. If commercial bank-underwritten securities perform worse than *ex ante similar* securities that are underwritten by investment banks, then this would be consistent with commercial banks underwriting securities that they privately know to be of lower quality, which is indicative of conflicts of interest. In general, there is little support for banks' exploiting conflicts of interest. In fact, many studies find commercial banks to be net certifiers of firm value.

3.1. Before the 1933 Glass–Steagall Act

Prior to 1933, commercial banks were permitted to underwrite public securities. However, after the stock market crash of 1929, concerns over the potential for conflicts of interest and the fear that the commingling of investment and commercial banking increases the riskiness of the financial system prompted Congress to enact the Glass–Steagall Act of 1933, which prohibited commercial banks from engaging in public security underwriting. Popular support for the Act came from investigations by the Pecora Committee (U.S. Senate Committee on Banking and Currency, 1933–1934), which examined alleged abuses at the security affiliates of commercial banks, in particular, National City Company and Chase Securities Corporation.[7] However, many scholars have argued that evidence of these concerns was anecdotal and little verification was provided that any abuses were systematic in nature (see e.g. Carosso, 1985; Benston,

[7] See Kelly (1985) for details on the legal history of the Glass–Steagall Act.

1990).[8] Below, we highlight the formal empirical analyses that explore if the committee's concerns were justified.

Puri (1996) examines the ex ante pricing of industrial bonds and preferred stock during the period January 1927 through September 1929. She regresses the yield of the securities on a dummy variable that indicates if the issue is commercial bank-underwritten, and she includes control variables for bond characteristics and issuer characteristics that could also affect the yield.[9] She finds that, relative to investment bank issues, commercial bank-underwritten issues have a significantly lower yield, which is consistent with commercial banks having a net certification effect. Of course, there are other explanations (other than net certification) that could account for this yield difference. Hence the author conducts a number of tests to determine if yield differences are higher in junior and more information sensitive securities as suggested in Puri (1999). She finds that having a commercial bank underwriter has a significantly larger effect on yield in samples where private information is likely to be more important. For example, the strongest effects are in the preferred stock sample, which is junior and more sensitive to information than bonds. There are also stronger effects for new issues than seasoned issues and non investment-grade issues than investment-grade securities. Further, there is little effect of underwriter type on foreign government bond issues, which are not information intensive.

The baseline tests in Puri (1996) use OLS regressions of yield on control variables and a bank underwriting dummy, and use the coefficient on the dummy to infer whether a bank underwriting lowers yields. This is a standard approach prevalent in empirical banking and corporate finance research. Puri (1996) also conducts additional tests to examine whether the lower yield of bank underwritings can be attributed to the private information held by banks. Her approach is to estimate private information as a residual and use its correlation with the next-stage dependent variable as a basis for testing whether private information matters. In the specific implementation of this approach in Puri (1996), a probit model is used to determine the probability of being bank underwritten. The estimates are used to compute the inverse Mills ratio, which is a proxy for private information because it is the expectation of the residuals not explained by public information. The coefficient for the inverse Mills ratio is negative, consistent with a net certification effect for commercial bank underwritten offerings. Interestingly, Puri's technique parallels a similar approach used subsequently in the insurance literature, where Chiappori and Salanie (2000) test whether customers buying more comprehensive automobile insurance coverage have private information that they have higher accident probabilities. Like Puri (1996), Chiappori and Salanie (2000) also

[8] In recent times, regulators have raised questions on the firm-level and competitive effects of the relaxation and repeal of the Glass–Steagall Act (see e.g. Mester, 1996; Berger, Demsetz, and Strahan, 1999; Santomero and Eckles, 2000).

[9] The yield is defined as the premium of the ex ante yield of the security over the ex ante yield of a government bond of nearest maturity issued in the same month.

estimate private information as a residual and use its correlation with the second stage dependent variable as a basis for testing whether private information matters.

Clearly, many different approaches can be used to assess the benefits of bank underwriting, and a number of these techniques are utilized in studies of the post-1990 period and in examinations of underwriter fees, which we will discuss later. For example, an alternate approach is to use endogenous switching models (see e.g. Fang, 2005; Song, 2004 for applications and Maddala (1983) for details on the model). These models generalize the two-stage approach used in Puri (1996) by allowing commercial banks and investment banks to have separate yield equations. This relaxes the assumption that the variables that affect yield have the same effect for investment bank and commercial bank issues. Estimating the model involves two steps. First, the researcher runs a probit model to determine the probability that the issuer chooses a commercial bank or investment bank underwriter. In the second step, the researcher estimates two yield equations separately for investment bank and commercial bank issues, including independent variables that affect yield as well as the inverse Mills ratio. Interestingly, when we apply endogenous switching methodology to industrial bonds in the pre-1933 data, similar effects are found.

The evidence that investors paid more for bank underwritten-securities pre-Glass–Steagall suggests that commercial banks are net certifiers of firm value. However, this raises an important question of interpretation. Namely, did investors pay more for bank-underwritten securities because they rationally believed them to be of better quality, or were investors naïve and banks took advantage of them so that investors paid higher prices for worse securities? This question can be addressed by examining the ex post performance of bank underwritten securities. Ang and Richardson (1994), Kroszner and Rajan (1994), and Puri (1994) examine the ex post performance of securities using data from the pre-Glass–Steagall period. As noted, if commercial bank-underwritten securities perform worse than ex ante similar securities that are underwritten by investment banks, then this would be consistent with commercial banks underwriting securities that they privately know to be of lower quality. All three studies find no evidence to support the existence of conflicts of interest.

Ang and Richardson (1994) examine the long-run performance of bonds, using a comprehensive sample of 647 bond issuances over the years 1926 through 1930. The authors compare the default rate of commercial bank and investment bank-underwritten bonds based on the default status of the bonds at two points in time (1934 and 1939) and find that the default rates are similar for investment bank- and commercial bank-underwritten securities. While this analysis is limited because the authors do not control for differences in the characteristics of issuers across the two types of underwriter, the results suggest that conflicts of interest did not override the certification ability of commercial banks.

Kroszner and Rajan (1994), using data from the first quarters of the years 1921 through 1929, examine the relative performance of industrial bonds that are underwritten by commercial banks with those that are investment bank-underwritten. The main measure of bond performance is the default rate because reliable price data is scarce

for this time period. To compare default performance between ex ante similar bonds, the authors use two methods: (i) matched-security tests, where bonds originated by commercial bank affiliates are matched to similar investment bank-underwritten bonds based on observable characteristics; and, (ii) logit analysis. For the matched-security tests, the authors create a sample of ex ante similar commercial bank and investment bank-underwritten securities, using the credit rating as the primary measure of bond quality. In total, Kroszner and Rajan (1994) find 121 industrial bond matches, where the bonds have the same initial credit rating, are issued within six months of each other, have similar maturity and size, and have the same conversion provision.[10] Using this sample, the authors find that at the end of each year after 1924, there are fewer cumulative defaults among commercial bank-underwritten issues, and by the end of the sample period in 1940, 32 percent of investment bank-underwritten bonds defaulted relative to 23 percent of bonds that were underwritten by commercial banks. By dollar volume, approximately 28 percent of investment bank-underwritten issues default by 1940, compared with only 11 percent of commercial bank-underwritten issues. Further, not only do investment bank-underwritten issues default more frequently, but they also default earlier in their lives. All of these findings suggest that commercial bank-underwritten issues performed better than similar, investment bank-underwritten issues, which is inconsistent with commercial banks succumbing to conflicts of interest.

In addition, Kroszner and Rajan (1994) perform a log-rank test using the sample of matched securities. This test takes into account both the number of defaults and the timing of defaults by comparing the mortality rates of the two groups of bonds. Consistent with their initial findings, the main result of this test is that the survival rate of commercial bank-underwritten bonds is significantly higher than investment bank-underwritten bonds. Importantly, these differences are strong in the non investment-grade sample, but insignificant in the investment-grade sample. Since incentive conflicts created by information asymmetries between underwriters and investors are larger in low quality issues, this result supports the view that conflicts of interest were not large during the pre-Glass–Steagall period.

Kroszner and Rajan (1994) confirm the lower default probability of commercial bank-underwritten issues using logit analysis in which they estimate whether the type of underwriter affects the probability of default, after controlling for security and firm characteristics. The logit analysis complements the matched-security tests by allowing the authors to use data on all of the investment bank-underwritten issues (instead of just the smaller sample that is matched to commercial bank-underwritten issues) and providing means to control for other factors that may be correlated with default. According to the estimates from logit models, underwriting by a commercial bank reduces the probability of default by 11 percent, with large and significant reductions in default probabilities seen among the lowest quality issues. In economic terms, an 11 percent

[10] If there are multiple matches, the authors use other criteria, such as collateralization status, to select the best match.

difference in the probability of default is approximately the same as the difference in default probability between investment-grade bonds and unrated bonds.

Puri (1994) also examines the long run default performance of bank-underwritten issues. The author uses both the cumulative mortality rate and probit models to examine the default performance of bonds. The cumulative mortality rate allows for an accurate comparison of default probability by measuring default rates on bonds that have been outstanding for equal periods of time, adjusted for calls, maturities, and previous defaults.[11] Using a sample of industrial bond issues during the period January 1927 through September 1929, Puri (1994) finds that the cumulative mortality rate is significantly higher for non-bank underwritten issues than bank underwritten issues for 3, 5, and 7 years from the issue date.[12] These results are particularly strong in the non-investment grade sample for all time periods. The results support the view that banks were not exploiting conflicts of interest. While the mortality rate analysis is better than an unconditional comparison of default rates, the probit model allows the researcher to control for other important factors that might influence the probability of default. Consistent with the mortality analysis, the results of the probit model strongly indicate that commercial bank underwritings of industrial bonds and preferred stock defaulted less often, and foreign government bonds defaulted with similar probability. Interestingly, Puri (1994) finds that there was a selection bias in the Senate hearings that lead to the Glass–Steagall Act. The two banks that bore the brunt of the investigation underwrote securities that had a significantly higher default rates than that of other banks and were not representative of bank underwriters in general.

Together, the ex ante pricing results and the long run performance studies paint a convincing picture. Commercial bank-underwritten securities received higher prices. Investors rationally paid higher prices because in the long run these securities performed better than ex ante similar offerings. This suggests that conflicts of interest were not dominant in bank-underwritings during the pre Glass–Steagall period.

3.2. The late 1980s and beyond

During the late 1980s and throughout the 1990s, commercial banks were gradually allowed to re-enter underwriting markets. In 1987, the Federal Reserve permitted individual bank holding companies to establish Section 20 subsidiaries that could to a limited extent engage in "bank ineligible" activities.[13] However, the subsidiaries had to be separately capitalized and separated from the lending parent by information, finance,

[11] See Altman (1989) for a formal definition and discussion.

[12] The sample period for this study provides for a more uniform regulatory and economic environment, as it starts after the passage of the McFadden Act, which legally allowed national banks to underwrite debt securities, and ends before the stock market crash of October 1929.

[13] Section 20 of the Glass–Steagall Act prevented commercial banks from affiliating with a company "engaged principally" in the "issue, flotation, underwriting, public sale, or distribution at wholesale or retail or through syndicate participation of stocks, bonds, debentures, notes or other securities".

and resource firewalls. In 1989, Section 20 affiliates were permitted to underwrite corporate debt, and in 1990, the Federal Reserve granted equity underwriting powers. The Federal Reserve set an initial revenue cap on bank ineligible activities at 5 percent of the gross revenue of the Section 20 subsidiary, and the cap was raised to 10 percent in 1989 and then to 25 percent in December 1996.[14] In 1997, the Federal Reserve removed the majority of firewalls between Section 20 subsidiaries and their bank holding company parents, and on November 12, 1999, the Gramm–Leach–Bliley Act (Financial Modernization Act) effectively repealed the Glass–Steagall Act.

There are a number of papers that use more recent data to examine the pricing of securities underwritten by commercial banks. As in the pre Glass–Steagall period, most of the evidence points to a net certification effect for commercial banks. Gande et al. (1997) examine the pricing of debt securities from January 1, 1993 to March 31, 1995, a period when commercial banks' underwriting affiliates were constrained by regulation that limited their ability to generate revenues and faced significant firewalls that could reduce information flow between the underwriting affiliate and the parent commercial bank. The authors are able to measure the amount of lending exposure between the issuer and the underwriter, which, as per the theory, should be important in determining security prices. The authors find that commercial banks primarily underwrite small issues, which is consistent with a positive role of banks in bringing smaller issuers to the market. Importantly, after controlling for bond characteristics, issuer characteristics, and underwriter attributes, the authors find that underwritings where the bank has existing lending exposure have significantly lower yields for lower credit rated (Caa-Ba3) issues, but no difference on the less informationally sensitive, higher rated issues.[15] Again, these results are consistent with bank underwriting being valuable for lower credit rated issues due to a net certification effect. Further, if conflicts of interest are present, they are likely to be highest when the purpose of the debt issuance is to refinance existing bank debt because in these issues, the bank may misrepresent the quality of the firm so that the issuer can raise more money to pay down its existing bank loans. Among this sample of issues, the effect of lending exposure on yields is economically and statistically insignificant, indicating a lack of conflicts of interest. As an additional robustness check, the authors create a proxy for private information by estimating the residuals in a probit model where the dependent variable is one if lending bank is the underwriter and independent variables are observable factors that affect underwriter choice. These residuals are found to be correlated with reduced yields for lower credit rated issues, after controlling for publicly available bond characteristics, consistent with a net certification effect.

[14] Note that the other revenue of the Section 20 subsidiary comes from "eligible" activities, such as swaps origination and government bond underwriting.

[15] For lower credit rated issues, a one-unit increase in LN(Amount of lending exposure) reduces yields by 27 basis points for lower-credit rated issues. An alternative measure, PROP(STAKE), which is the lending exposure over the amount of the debt issue size, produces similar results.

A follow-up paper by Roten and Mullineaux (2002) uses similar methods as Gande et al. (1997), but examines a later time period: January 1, 1995 to December 31, 1998. During this period, many of the restrictions on commercial bank underwriting were relaxed. Roten and Mullineaux (2002) find the benefits of bank underwriting in this later period show up in reduced underwriting fees rather than in net yields. There is more work on the underwriting fee differentials between commercial and investment banks that we will discuss in more detail in Section 4.1.

Thus far, we have focused on the effect of commercial bank underwriting on public debt issues. A few recent papers examine equity issues. In equity markets, an indirect cost of initial public offerings (IPOs) is underpricing, where the price of the security at offering is, on average, below the price prevailing in the market shortly after the IPO.[16] It is well documented that IPOs are underpriced, and many theoretical papers indicate that IPO underpricing arises from asymmetric information problems regarding the issuing firm's value (see e.g. Rock, 1986; Benveniste and Spindt, 1989; Benveniste and Wilhelm, 1990; Allen and Faulhaber, 1989; Grinblatt and Hwang, 1989; Welch, 1989, 1992). The benefits of bank lending relationships are likely to be especially important when a firm goes public due to the substantial uncertainty about a firm's value. However, the consequences of conflicts of interest can be more severe in IPOs due to equity being junior to debt and the pronounced asymmetric problems with private firms.

Schenone (2004) examines the effect of having a banking relationship with the underwriter of the IPO on the firm's IPO underpricing. If conflicts of interest are high, then investors may perceive stocks underwritten by relationship banks to be riskier than other IPOs. Using a sample of 306 IPOs from 1998 through 2000, the author finds that IPOs underwritten by a firm's relationship bank are less underpriced than IPOs where the firm does not have lending relationships with any potential underwriter. In addition, there is no significant difference in underpricing relative to firms that could have, but do not, use their relationship bank as underwriter. These results indicate that IPOs with relationship banks are, at a minimum, not perceived to be riskier than other IPOs, supporting that conflicts of interest do not override the certification ability of the bank.

Benzoni and Schenone (2004) examine the long run performance of equity issues that are underwritten by the firms' relationship banks relative to those issues that are underwritten by other commercial bank and investment bank underwriters. The focus on ex post performance is similar to Ang and Richardson (1994), Kroszner and Rajan (1994), and Puri (1994). The main differences are that Benzoni and Schenone (2004) use modern data from 1998 through 2000 and examine equity issues as opposed to debt issues. The authors examine the impact of lending relationships on the firm's long run equity performance in two ways. First, for each of the 306 IPO firms, the authors construct 2-year buy-and-hold returns for the firm's stock as well as the buy-and-hold returns for two benchmark portfolios, one of which is specific to each firm and is comprised of

[16] Underpricing is defined as the differences between the first closing pricing and the offer price, divided by the offer price. See Ritter (1998) for a survey of empirical evidence.

the returns on six portfolios of stock ranked by size and book-to-market, and the other is the CRSP value-weighted market portfolio. Using feasible generalized least squares to account for cross-sectional correlation in the stock returns of firms, the authors estimate the impact of having an existing lending relationship with the underwriter on the long-run returns of the IPO firm relative to the benchmark portfolios, controlling for firm characteristics, IPO characteristics, and other factors. The authors find that IPOs underwritten by relationship banks perform no better or worse than issues underwritten by outside commercial or investment banks. This result is inconsistent with relationship banks misrepresenting the quality of the firm's that they underwrite. Second, for each IPO underwritten by the firm's relationship bank, the authors find a similar matched IPO from the sample of non-relationship bank IPOs based on the dates of the IPOs and the book-to-market ratios of the firms. Benzoni and Schenone (2004) form a portfolio of long positions in the relationship bank IPO firms and short positions in the matched sample of non-relationship bank IPO firms. The authors regress the weekly portfolio returns on Fama and French's (1993) market, size, and book-to-market returns and examine if there are abnormal returns associated with this portfolio. The authors do not find significant abnormal returns, indicating that relationship bank-underwritten firms perform similarly to the matched sample, which is again inconsistent with relationship banks misrepresenting the quality of the firm's that they underwrite.

As in the pre Glass–Steagall period, the evidence from the late 1980s and beyond suggests that conflicts of interest are not dominant in bank underwritings. The ex ante pricing results indicate that when the firm and underwriting commercial bank have a lending relationship, the public security prices are no worse and sometimes better than similar issues underwritten by investment banks or non-relationship commercial banks. These results are robust to different methodologies, time periods, and types of security. Further, the long run performance of relationship bank-underwritten IPOs are no worse than similar IPOs that are underwritten by non-relationship banks, which is inconsistent with the existence of conflicts of interest.

3.3. Mitigating conflicts of interest: Organizational structure and syndicates

The aforementioned papers examine the trade-offs between certification and conflicts of interest by analyzing the ex-ante yield of debt, the underpricing of equity securities, and the ex post performance of securities. The evidence suggests that bank certification at least cancels out and may outweigh potential conflicts of interest. While these studies take as given, and attempt to quantify, the relative magnitude of these offsetting effects, a number of papers examine if there are ways for commercial banks to take action to reduce the potential for conflicts of interest. In other words, can commercial banks credibly commit to certifying firm value in order to mitigate any perception that they will exploit conflicts of interest?

Puri (1996) and Kroszner and Rajan (1997) examine if the organizational structure of the financial institution can mitigate potential conflicts of interest. During the pre-Glass–Steagall period, commercial banks organized their investment banks as either internal

securities departments within the bank or as separately incorporated affiliates with their own boards of directors. By forming independent entities, banks may be able to credibly commit to not exploit potential conflicts of interest that could be pronounced due to the likelihood of increased information flows in an internal structure. Puri (1996) finds that affiliate underwritings do not have significantly lower yields than similar investment bank issues, while in-house underwritings have significantly lower yields when compared with investment bank issues. Her results do not support the view that independent entities were beneficial. However, these results contrast with Kroszner and Rajan (1997). Using a sample of 422 industrial bonds from 1925 through 1929, the authors compare the initial yields on issues underwritten by internal departments with issues that are underwritten by separate affiliates. The results of their multivariate regression suggest that independent affiliate-underwritten issues have yields that are significantly lower than internal department-underwritten bonds, by 12 to 23 basis points. These results are consistent with the independent structure allowing for credible commitment. There are some differences in the samples and approaches of these two studies. Clearly, more research is needed to sort out this question.

Narayanan, Rangan, and Rangan (2004) and Song (2004) explore another way for commercial banks to credibly commit to certify firm value and avoid conflicts of interest. These authors examine the role of syndicate structure in underwriting. Narayanan, Rangan, and Rangan (2004) focus on the possibility that a relationship bank may co-manage an issuance with a reputable, non-lending underwriter in order to commit against opportunistic behavior. Using 1,640 seasoned equity issuances from the years 1994 through 1997, Narayanan, Rangan, and Rangan (2004) find that the proportion of syndicate co-manger roles to lead manager roles for relationship banks is about three times higher than for non-relationship banks. Also, relationship banks are significantly more likely than non-lending banks to co-manage an issue with an independent, high reputation lead manager. Further, an examination of the pricing of these issues reveals that issues where a relationship bank is a co-manager exhibit similar levels of underpricing as issues where only investment banks are underwriters. Taken together, these results are consistent with the view that relationship banks use the syndicate structure to credibly commit against exploiting potential conflicts of interest. Importantly, similar to the results in Roten and Mullineaux (2002) for debt issuances, Narayanan, Rangan, and Rangan (2004) show that while issuers do not receive better pricing on their equity issuance, the issuer benefits from reduced underwriting fees. We discuss this further in Section 4.1.

Another interpretation of the underpricing results in Narayanan, Rangan, and Rangan (2004) is that relationship banks do not improve the certification ability of the syndicate. Otherwise, we would observe lower underpricing on issues where relationship banks are co-managers. However, to really examine if co-managing allows relationship banks to improve their net certification of issues relative to lead managing, one would have to contrast underpricing between issues that are co-managed by relationship banks with similar issues that are lead managed by relationship banks. This comparison is not provided in Narayanan, Rangan, and Rangan (2004) due to a lack of commercial bank

lead managed issues during the time period. However, Song (2004) is able to make a related comparison in the bond underwriting market. Using a sample of 2,345 corporate bond issues from 1991 to 1996, Song (2004) examines the clienteles and bond pricing associated with three different syndicate structures: (i) commercial bank-lead syndicates; (ii) syndicates with only investment banks; and, (iii) hybrid syndicates where an investment bank leads the issue and commercial banks are co-managers. Song uses an endogenous switching model with six equations: three selection equations, which capture the likelihood of choosing a given syndicate structure over the other options, and three yield equations, one for each of the three syndicates.[17] The results of her model indicate that commercial banks are more likely to co-manage an issue rather than serve as lead manager when the purpose of the issue is to refinance bank debt and the issuer has more loans from the commercial bank underwriters. Since these issues are more likely to be prone to conflicts of interest, the results are consistent with the view that acting as a co-manager allows commercial banks to mitigate perceptions that they will exploit conflicts of interest. However, bond yields are similar when commercial banks are lead managers as opposed to co-managers. This suggests that co-managing does not improve the certification ability of commercial banks.

3.4. Conflicts of interest from equity holdings: Evidence from venture capital

Much of the focus so far has been on the trade-off between the private information from lending allowing banks to be better certifiers of firm value with the potential for conflicts of interest from misusing the information. In this section, we again explore this trade-off, but examine some of the different effects that can occur when underwriters are equity holders in the firm. The evidence from venture capital can provide insight into the potential consequences of allowing banks to hold equity in firms.

Some authors maintain that allowing banks to hold equity claims helps increase a financial intermediary's credibility in certifying the firm's value (see e.g. Leland and Pyle, 1977), which provides a formal analysis of how equity holdings in the firm can provide a signal of firm value). However, as Puri's (1999) model points out, the horizon for which equity is held is critical to this certification. If the bank can retire its financial claim through the proceeds of the equity issuance, then holding equity can hurt the credibility of the bank more than holding debt. There is some empirical evidence on the impact of equity holdings on the certification ability of the underwriter, derived from comparing IPOs where the underwriter has gained an equity stake through venture capital investments and other IPOs where the underwriter does not have an equity claim. Both papers that we survey do not find evidence of conflicts of interest.

[17] In another application of this method, Fang (2005) studies the relation between investment bank reputation and the prices of underwritten bonds and uses separate pricing equations for high and low reputation underwriters. Fang (2005) finds that more reputable underwriters obtain lower yields and charge higher fees.

Using a sample of 885 venture-backed IPOs from December 1972 to December 1992, Gompers and Lerner (1999) compare long run performance, liquidation probability, and underpricing based on if an underwriter in the IPO holds a venture stake. To examine long-run performance, Gompers and Lerner (1999) calculate the 5-year buy-and-hold excess return, which is the firm's buy-and-hold return minus the 5-year buy-and-hold return of the portfolio of firms with the same size and book-to-market ratio. This comparison reveals that issues where the investment bank held an equity stake perform just as well, and by some measures significantly better than, non-affiliated offerings. These results are inconsistent with the existence of conflicts of interest. Further, the authors explore if excess returns are influenced by the percentage of venture investors' equity sold at the time of the IPO. If venture investors are attempting to take advantage of outsider investors, then higher fractions of equity sold should result in lower excess returns. They find no evidence to support this hypothesis, and in fact, find the opposite to be true. In addition, Gompers and Lerner (1999) examine the probability that a firm is liquidated within 5 years of the IPO and find no significant relationship between liquidation probability and using an underwriter that has a venture claim in the firm. Again, these results suggest that conflicts of interest are not a concern. Further supporting this view, when examining underpricing, the authors do not find a significant difference between IPOs that are underwritten by affiliated underwriters and independent underwriters.

Li and Masulis (2004) also examine the impact of venture capital investments by IPO underwriters on the net certification ability of the underwriter. However, as opposed to Gompers and Lerner (1999) who treat all existing venture relationships as equally important, Li and Masulis (2004) examine if the size of the equity ownership by the underwriter affects IPO underpricing and the probability of being delisted in the future. This approach is similar to that in Gande et al. (1997). Using a sample of 1,480 venture-backed IPOs from 1993 to 2000, the authors find that IPO underpricing decreases as the share of the underwriter's equity ownership increases, even after controlling for other factors that can influence underpricing. The underpricing results are consistent with certification effects overriding any conflicts of interest. In support, the authors find that among issues that are more uncertain, which is proxied for by the firm's stock volatility during the year following IPO, venture investments reduce underpricing more than for less risky issues. This suggests that the prior information from the venture investment allows the underwriter to reduce informational asymmetries. Similar to Gompers and Lerner's (1999) evaluation of liquidation, Li and Masulis (2004) find no significant relationship between underwriter shareholdings and the likelihood of subsequent stock delisting, which is consistent with conflicts of interest not being pronounced.

The evidence in these two studies highlight that conflicts of interest are not a concern when an underwriter holds an equity stake in the firm. Further, the analysis in Li and Masulis (2004) suggests there are benefits from the underwriter holding an equity stake, with affiliated underwriters being net certifiers of firm value and allowing for firms to reduce their direct costs of going public.

4. Empirical evidence on competition between commercial and investment banks

The empirical evidence in Section 3 on conflicts of interest raises an important point: If commercial banks are net certifiers of firm value and conflicts of interest can be mitigated, then commercial banks may be superior underwriters compared to investment banks. If so, can both types of underwriter co-exist? How can competition between them affect the services they offer to firms?

By combining lending with underwriting, banks may achieve informational economies of scope by jointly delivering lending and underwriting services and re-using the same client specific information for several purposes (see e.g. Benston, 1990; Saunders and Walter, 1994). As emphasized in Kanatas and Qi (2003), informational economies of scope can lower transaction costs and can theoretically reduce underwriting fees if banks pass along costs savings to firms. Puri (1999) derives sufficient conditions for commercial banks and investment banks to coexist. One implication of this analysis drawn out in the paper is that, under some circumstances, commercial banks may charge higher underwriting fees than investment banks. We survey the literature on underwriting fees in Section 4.1. The analyses in Kanatas and Qi (1998, 2003) emphasize that large scope economies from combining lending and underwriting will be important in determining if an issuer selects its commercial bank lender as public security underwriter. Rajan (2002) points out that the bank's information advantage from lending may allow it to secure the underwriting mandates of its borrowers. In Section 4.2, we summarize the studies that examine the effect of bank lending on underwriter selection. In Section 4.3, we provide some additional evidence on how investment banks are adapting to competition from commercial banks.

4.1. Underwriting fees

We begin by providing evidence that commercial bank entry after the relaxation of the Glass–Steagall Act caused lower overall underwriting fees, consistent with a pro-competitive effect on corporate securities underwriting markets. Gande, Puri, and Saunders (1999), using a sample of 2,992 debt issues from 1985 through 1996, document that following bank entry into debt underwriting in 1989, the gross spread, or underwriting fee, declined significantly.[18] Further, this decline is more pronounced in samples where commercial banks gained a larger market share (non-investment-grade and smaller issues). This result stands in contrast to equity markets where commercial banks had not yet gained much market share, and where similar declines in gross spreads are not observed in this time period.

Gande, Puri, and Saunders (1999) also find that among the sample of 1,180 debt issues between 1989 and 1996, commercial banks and investment banks charge similar

[18] The authors capture the impact of bank competition on gross spreads in two ways. First, they use a dummy variable that is one after 1989, when banks were first allowed to underwrite corporate debt. Second, they use the logarithm of commercial banks market share in debt underwriting.

fees. A number of studies build on this comparison of fees by focusing directly on the impact of lending relationships on gross spreads. In public debt markets, two studies find that prior lending relationships reduce the gross spread. Using a regression framework that controls for bond and issuer characteristics, Roten and Mullineaux (2002) find that prior lending relationships lower debt underwriting fees by 10 basis points during the 1995 to 1998 period. Yasuda (2005) gathers a sample of 1,535 bond issues from 1993 to 1997 and uses a more advanced methodology to examine the impact of lending relationships on fees. The author points out that studies that examine the effect of lending relationships on fees use the equilibrium pricing outcomes that are observed. Yasuda (2005) argues that the gross spread that is observed is likely to be lower on average than the unconditional distribution of the gross spread. Therefore, the author imputes the implied gross spread for each of the other underwriters that the firm could have selected to underwrite the issue. Using the Expectation-Maximization Algorithm that accounts for this downward bias in observed gross spread, Yasuda (2005) estimates a joint model of the gross spread and the firm's selection of underwriter. The gross spread is modeled as a function of bond and issuer characteristics, as well as if the potential underwriter was an arranger on any of the firm's prior loans before 1993. The choice of underwriter is a function of the implied gross spread, bond and issuer characteristics, and existing lending relationships. Yasuda (2005) also finds that lending relationships significantly decrease the gross spread by approximately nine basis points.

As in debt underwriting, the evidence suggests that lending reduces the gross spreads of equity offerings. Three papers use the framework developed by Altinkilic and Hansen (2000), who find that gross spreads for seasoned equity offerings are U-shaped with respect to the size of the offering. Theoretically, U-shaped curves can arise because scale economies cause gross spreads to decline initially, but as issue size increases, higher placement costs can override the benefits of scale economies, causing gross spreads to increase. Narayanan, Rangan, and Rangan (2004), using seasoned equity offerings from 1994 to 1997, include a variable that captures if a commercial bank in the underwriting syndicate has a lending relationship with the issuing firm. They find that the existence of a lending relationship reduces gross spreads by 46 basis points, which is significant at the one percent level. This result is consistent with informational economies of scope from combining lending and underwriting. Drucker and Puri (2005) study "concurrent lending" and underwriting, which occurs when the underwriter of a seasoned equity offering provides a loan to the issuer between six months before and six months after the issuance. As part of their study, the authors examine the impact of concurrent lending and prior lending on seasoned equity offering gross spreads. The authors argue that informational economies of scope are likely to be large when issuers receive a loan concurrently because the information from the lending transaction is directly re-usable in the equity offering. The authors extend the Altinkilic and Hansen (2000) model to include variables that control for firm characteristics and prior underwriting relationships as well as variables that indicate if the lead underwriter provided concurrent loans or had a prior lending relationship with the issuer. For a sample of 2,301 seasoned equity offerings from 1996 through 2001, concurrent lending without a prior lending rela-

tionship significantly reduces gross spreads by 18 basis points and concurrent lending where a prior lending relationship exists results in gross spreads that are 36 basis points lower. Prior lending relationships without a concurrent loan also cause gross spreads to be reduced significantly, by 36 basis points. These discounts are consistent with the existence of informational economies of scope. Further, the discounts for concurrent and prior lending relationships are significant in the sample of non-investment-grade issuers, where economies of scope from combining lending and underwriting are likely to be larger. Bharath et al. (2004) use a sample of 283 initial public offerings and estimate U-shaped models that separately include three different measures of lending relationship strength. These measures capture if the firm and underwriter have a prior lending relationship, the proportion of the firm's loans over the five years prior to the IPO where the underwriter had a lead role, and the dollar-based percentage of the firm's loans where the underwriter had a lead role. In all three cases, gross spreads are significantly lower by 19 to 26 basis points.

4.2. Underwriter selection

In general, the evidence points to better pricing and lower underwriting fees from using a relationship bank as underwriter. Presumably, the benefits of using a relationship lender as security underwriter will influence the firm's choice of underwriter. Is there evidence that lending relationships allow underwriters to increase their likelihood of winning underwriting mandates? Four recent papers examine the effect of lending on a firm's choice of underwriter, and all find that lending increases the likelihood of winning underwriting business.

Drucker and Puri (2005) examine if lending around the time of a securities offering (concurrent lending) and prior lending impact the choice of seasoned equity underwriter. The authors use McFadden's (1973) choice model to examine the choice of underwriter. The authors allow the choice of underwriter to depend upon concurrent and prior lending, firm characteristics, and attributes that are specific to the relationships between each firm and potential underwriter, such as the analyst coverage and the quality of the coverage that potential underwriters provide for the firm, the reputation of potential underwriters, and any existing underwriting relationships. The results of this model reveal that both concurrent lending and prior lending increase the likelihood of the bank being selected as the lead underwriter. Further, the authors examine if concurrent lending increases the likelihood that underwriters are selected for future equity underwriting business. Using a nested logit model in which the issuer first chooses if it will re-issue in the equity market and then chooses if it will keep the same underwriter or switch to a new underwriter, the authors find that concurrent lending increases the likelihood that investment banks keep future underwriting business, which is consistent with lending fostering an ongoing relationship between underwriters and firms.

In a related paper, Bharath et al. (2004) examines the impact of prior lending on capturing debt and equity underwriting business. The authors use a logit model, allowing each issuer to choose among the top-20 investment banks and any commercial bank that

could underwrite its securities. They allow the choice of underwriter to depend upon the size of the issue, existing lending and underwriting relationships, and the reputation of the underwriters in both the underwriting and lending market. Bharath et al. (2004) find that prior lending relationships significantly increase the likelihood of winning debt underwriting mandates and being selected as lead manager on IPOs.

Ljungqvist, Marston, and Wilhelm (2006) also provide evidence related to the influence of bank lending relationships on underwriter selection. Using a sample of 16,625 debt and equity deals over the period December 1993 to December 2002, the authors estimate a probit model, providing each firm with the potential to choose any of the 16 most active underwriters. In their model, the choice of underwriter depends upon bank-firm underwriting and lending relationships, as well as bank reputation and analyst characteristics and behavior. Ljungqvist, Marston, and Wilhelm (2006) find that the probability of winning both equity and debt underwriting business is increasing in the bank's share of the issuer's prior loans.

Yasuda (2005) provides an examination of the impact of existing lending relationships on the choice of debt underwriter during the period 1993 to 1997. As previously explained, Yasuda (2005) estimates a joint model of the gross spread and the firm's selection of underwriter, allowing the firm to choose between sixteen underwriters. The joint framework allows the author to include in the underwriter selection equation the estimated fee that each underwriter would have charged the issuer to underwrite the offering. Therefore, Yasuda (2005) can examine if the lending relationship influences underwriter selection above and beyond any effect that charging lower gross spreads has on underwriter selection. The author finds that prior lending relationships significantly increase the likelihood that the lending bank wins the bond underwriting business over and above the effect of the gross spread discount. Further, lending relationships have a stronger impact on underwriter selection among junk rated issuers and new issuers, where a bank's private information is likely to be most valuable. These results are consistent with Kanatas and Qi's (1998, 2003) theoretical models, which indicate that lenders will select their bank as underwriter when there are likely to be large informational economies of scope. The estimates of Yasuda's (2005) model indicate that firms are willing to pay a higher underwriter fee to banks with which they have a prior relationship. One of the major benefits of this framework is that the author can explicitly calculate how much more an issuer is willing to pay. For the sample mean issue size of $180 million, an issuer is willing to pay $2.23 million more to use a relationship commercial bank and $2.62 million to have a relationship investment bank as underwriter. Junk rated issuers and first time issuers, where the value of a bank's private information is likely to be largest, are willing to pay even more. These results are consistent with a certification effect for relationship banks.

4.3. Can investment banks survive?

Overall, the empirical evidence shows that using relationship banks as underwriters improves the pricing of issues and lowers fees, and both prior lending relationships and

lending around the time of a security issuance increase the probability that an underwriter will be selected as underwriter. Further, as Yasuda (2005) points out, lending relationships increase the likelihood of selection above and beyond any cost reductions. Given these facts, is it possible for investment banks to remain viable underwriters?

One possibility is that investment banks can remain viable competitors by expanding their lending activities. Some evidence of investment bank lending and its effects on financing costs and the choice of underwriter is provided in Drucker and Puri (2005). They document that investment banks are now making loans and are competing aggressively with commercial banks by providing loans around the time of seasoned equity offerings.[19] While the authors show that, in concurrent deals, investment banks cannot compete with commercial banks on the yield spreads that they can charge for the loan, concurrent lending and prior lending allow investment banks to provide lower gross spreads on the equity offering, with investment bank lending significantly reducing gross spreads by between 26 and 44 basis points. These results are consistent with lending by investment banks creating sufficient economies of scope to allow investment banks to be viable competitors with commercial banks. This inference is bolstered by an examination of issuers' selection of their underwriter. As with commercial banks, when investment banks have prior lending relationships or provide concurrent loans, their likelihood of being selected as equity underwriter increases. Further, investment banks are able to leverage concurrent deals into extended relationships by capturing future underwriting business.

The evidence in Yasuda (2005) also hints that investment banks may use lending to compete with commercial banks. Her model shows that for the mean debt issue, issuers that have a lending relationship with an investment bank underwriter are willing to pay more to use the relationship investment bank as underwriter. Further, investment bank lending increases the likelihood of winning the underwriting mandate. These results suggest that firms value lending relationships with investment banks, and as a result, lending may allow investment banks to remain competitive.

5. International evidence

Thus far, we have examined the impact of commercial banks as underwriters in the United States. However, there is some international evidence on differences between the ex ante pricing and ex post performance of commercial bank and investment bank-underwritten issues, additional analyses on the extent to which commercial banking relationships affect the choice of underwriter, and evidence on other potential conflicts of interest. Below, we survey the literature related to commercial bank underwriting in Japan, Canada, and Israel.

[19] In fact, of the 201 issues where the underwriter provides a loan concurrently with the seasoned equity offering, investment banks are the underwriter in 110 cases.

5.1. Japan

Japan and the United States have similar regulatory histories regarding the ability of commercial banks to underwrite securities. In Japan, commercial banks were allowed to underwrite securities until 1948. However, much like the Glass–Steagall Act in the United States, Article 65 of the Securities and Exchange Act of 1948 effectively prohibited commercial banks from running securities businesses. The Financial System Reform Act of 1992, which came into effect in 1993, allowed commercial banks to again underwrite securities through subsidiaries, and in a short period of time, commercial banks gained significant market share in corporate bond underwriting.[20] Despite the similarities in their regulatory histories, as opposed to banks in the United States, Japanese commercial banks have historically operated in a main bank system where banking relationships are strong and long-term.[21] Therefore, the trade-offs between conflicts of interest and certification should be pronounced in Japan, and there is likely to be a strong impact of existing banking relationships on competition for underwriting mandates.

Konishi (2002) examines the pricing and long-term default performance of industrial bonds underwritten by commercial banks as compared with investment banks during the pre-war period in Japan (January 1919–December 1927). Using the same framework to examine ex-ante pricing as in Puri (1996), the author finds no difference in the yields of commercial bank-underwritten and investment bank-underwritten bonds, consistent with conflicts of interest not dominating the certification effect. To examine long-term default performance, Konishi (2002) follows Puri (1994) and calculates cumulative mortality rates as well as uses a probit model to estimate if the probability of default is influenced by bank underwriting, after controlling for other important factors. The results of the mortality analysis indicate that commercial bank-underwritten issues default significantly less often than investment bank issues at time horizons from three to seven years after issuance. Further, the probit analysis of default probability also shows that commercial bank issues are significantly less likely to default. Together, these results suggest that conflicts of interest were not a problem when banks underwrote public securities in pre-war Japan, which is consistent with the evidence from the pre-Glass–Steagall period in the United States.

There are three papers that study the pricing of industrial bonds in Japan after the Financial Systems Reform Act, comparing commercial bank and investment bank issues. In each of these papers, the authors identify if the underwriter has an outstanding loan to the issuer and also if the underwriter owns shares in the firm. As in Gande et al. (1997), Roten and Mullineaux (2002), and Schenone (2004), the identification of these prior relationships allows for a richer testing ground. These papers are by Hamao and Hoshi (2002), Takaoka and McKenzie (2006) and Liu and Kang (2004). In examining

[20] See Hoshi and Kashyap (1999) for more details on financial deregulation in Japan and its consequences.
[21] See Hoshi (1996) for a discussion of main bank relationships and universal banking in Japan.

yields, Hamao and Hoshi (2002) find weak evidence for conflicts of interest, Takaoka and McKenzie (2006) find weak evidence of certification, and Liu and Kang (2004) find no evidence of conflicts of interest in terms of differential effects between commercial banks and investment banks. Takaoka and McKenzie (2006) additionally examine if bank entry post-1993 lowered commissions and yields, and they find some supporting evidence. Each of these papers has slightly different samples and methodology. Clearly more research is needed here to answer this question.

Yasuda (2006) also examines the Japanese bond market after the Financial Systems Reform Act but focuses on the effect of bank relationships on competition in the underwriting market. Using a framework similar to Yasuda (2005), the author estimates a joint model of the gross spread and the firm's selection of underwriter, allowing the firm to choose between fifteen underwriters. The estimates indicate that having a prior lending relationship significantly increases the probability of being selected as bond underwriter, and stronger lending relationships increase the likelihood of selection by more than weaker relationships. This is consistent with the evidence from the United States. In addition, issuers are willing to pay a higher fee (+0.513%) for underwriting services from banks with which they have pre-existing lending relationships, all else equal. This suggests that banking relationships provide additional value to the firm. Interestingly, the results in Yasuda (2005) indicate that issuers in the United States are willing to pay 1.238% more to use a relationship commercial bank as underwriter, which provides some indication that there could be more benefits in the United States from issuers using a relationship bank as underwriter.

5.2. Canada

In Canada, universal banking began after deregulation occurred in 1987. Within thirteen months after the June 1987 change in law permitting bank entry, all six of Canada's chartered banks had an underwriting division. The commercial banks gained significant market share during the following years. Ursel and Ljucovic (1998) examine the relationship between commercial bank underwriting (as modeled by a dummy variable that indicates if the underwriter is bank-owned) and underpricing using a data set of 111 Canadian IPOs between July 1987 and December 1994. The authors are limited by data constraints that prevent them from tracking existing lending relationships between banks and firms, which would enable stronger conclusions. Using a parsimonious specification, the authors find that commercial bank-underwritten issues have lower underpricing, but after controlling for other important factors, such as reputation, Ursel and Ljucovic (1998) no longer find a significant difference.

Hebb and Fraser (2002) examine the relationship between commercial bank underwriting and bond yields using 356 non-convertible bond issues from 1987 to 1997. The authors find that commercial bank underwritten issues have a yield that is lower by 20 basis points, consistent with commercial banks being net certifiers. For the issues where the authors are able to identify the issuer's primary lender they find that the existence of a lending relationship does not affect bond yield spreads. The Canadian data from both

the equity and debt markets suggest that conflicts of interest are limited by commercial banks certification ability.

5.3. Israel

In Israel, banks are highly universal in nature, managing investment funds and controlling underwriting affiliates. The close links between the investment fund and the bank allow for researchers to examine this potential source of conflicts of interest. Ber, Yafeh, and Yosha (2001) perform such an analysis, examining if conflicts of interest are present when banks underwrite Israeli IPOs. In this study, the authors gather data on 128 IPOs of manufacturing firms from 1991 to 1994. For each of the issues, the authors identify if the firm has a prior lending relationship with the underwriter and if the bank's investment fund purchases the firm's stock at the time of the offering and in the aftermarket. Ber, Yafeh, and Yosha (2001) examine the effect of these relationships on the accounting and stock performance for one year following the issue as well as the underpricing of the issue. In terms of accounting profitability, the authors find that firms that are underwritten by bank lenders significantly outperform other issuers. Further, they find that these better performing firms were similar ex ante to other IPO firms based on publicly available information, indicating that banks underwrite superior firms. This is inconsistent with the existence of conflicts of interest. However, when the authors examine the long run stock performance, their results indicate that the stocks of firms with a bank underwriter-lender exhibit significantly negative excess returns during the first year that are significantly different than the excess of returns of firms that do not have a bank lender-underwriter.[22] Also, an examination of first day returns reveals that issues involving a bank lender-underwriter are significantly overpriced. How can the strong accounting performance and poor stock performance be reconciled? The authors find that much of the poor stock performance comes from issues where the bank's fund management division made significant purchases. Ber, Yafeh, and Yosha (2001) conclude that the results indicate a conflict of interest, as banks overpriced these IPOs, favoring the IPO client firms at the expense of investors in the bank's investment fund.

6. The indirect role of commercial banks on capital markets

Throughout this article, we have documented that the empirical literature has generally found commercial banks to be certifiers of firm value when they combine lending and underwriting activities. However, even if banks cannot directly participate in capital markets through underwriting, banks' actions and lending decisions might still affect outside stakeholders in firms. Can banks, which have private information about

[22] The authors use a market model approach and compare the excess returns for each firm for the first year after IPO.

a firm's prospects, signal the quality of firms to outside investors through their lending decisions? Fama (1985) and Diamond (1991) provide theoretical analyses of these questions. Fama (1985) claims that banks are "special" with respect to other financial intermediaries in their ability to gather and process private information and their ability to certify firm value to outsiders. His argument relies on two important observations. First, bank borrowers are usually depositors at the bank, which creates an information advantage for banks relative to other financial intermediaries because they have access to private information provided by the ongoing history of bank deposits. The deposit record makes it cheaper for banks to monitor and screen potential borrowers. Second, bank loans are generally low priority claims, so the granting and renewal of bank loans provides positive signals to higher priority lenders, allowing these higher priority lenders to avoid monitoring the firm.[23] Therefore, bank loans reduce the need for outsiders to generate duplicate information, allowing bank loans to reduce overall information costs. Since outsiders use the bank loans as positive signals of firm value, according to this analysis, bank loans are important conveyers of private information to the capital markets.

Building on insights in Fama (1985), Diamond (1991) develops a model in which banks have a comparative advantage relative to capital markets in funding younger, smaller and less well-known firms due to their ability to screen and monitor borrowers. Through ongoing lending relationships in which the bank monitors the firm, young firms can develop a credit record to obtain a sound reputation. The acquisition of reputation allows the firm to access the public debt markets later in the "life-cycle." In this model, the banks' superior access to private information from screening and monitoring activities allows the bank to convey information about borrower quality and signal creditworthiness to the capital markets.

The analyses in Fama (1985) and Diamond (1991) highlight banks' role as information producers. One implication of these studies is that if the private information gathered in the lending process provides banks with a comparative advantage over other intermediaries and allows firms to build a reputation, then the granting and renewal of bank loans will provide a positive signal to outside investors of the bank's private information, particularly when borrowers are young and informationally-opaque. Conversely, the selling of loans may be a negative signal. In Section 6.1, we survey the empirical studies that test this claim by examining the borrowing firm's stock price response to bank loan announcements, renewals, and sales. Another implication of the analyses in Fama (1985) and Diamond (1991) is that by conveying private information to the market through lending decisions, bank loans reduce the need for outsiders to

[23] In contrast to Fama's (1985) theory, Carey (1995) shows that in a sample of 18,000 syndicated loans made between 1986 and 1993, 99% of the loans are senior. Welch (1997) aroves that bank loans are senior to reduce deadweight costs from Organized banks contesting priority in financial distress. Stih, Fama's (1985) suggestion that banks are compactively advantaged over capital market participants in screening and monitoring borrowers is well supported in the literature (see e.g. Diamond, 1984; Ramakrishnan and Thakor, 1984; Boyd and Prescott, 1986). See Mayer and Vives (1993) for a comprehensive survey.

generate duplicate information and reduce information asymmetries between firms and capital markets. Therefore, even if the bank cannot underwrite the firm's public securities, the existence of a bank loan may result in higher security prices. In Section 6.2, we summarize the empirical evidence on the effects of bank loans from non-underwriting banks on the pricing of public security offerings.

6.1. Market reaction to loan announcements, renewals, and sales

If the announcement of bank loans conveys positive private information to investors, then the borrowing firm should realize an abnormal return around the event date. James (1987) provides the first in-depth analysis of the impact of bank loan announcements on a firm's equity returns, as he compares the abnormal returns associated with bank loan announcements with the returns generated by announcements of other financings.[24] James (1987) selects 300 companies at random from the Center for Research on Security Prices (CRSP) daily return files and searches the *Wall Street Journal Index* for announcements of public straight debt offerings, private placements of debt, and bank borrowing agreements over the period 1974–1983. The bank loan agreements consist of new credit agreements and the expansion of existing agreements. In total, James (1987) finds 207 financing announcements, which are comprised of 80 bank loan agreements, 37 private placements (which are primarily arranged by insurance companies), and 90 public straight debt offerings.[25] He uses a market model to obtain estimates of abnormal stock returns around the announcement of the financing events. Using two-day announcement period abnormal returns, James (1987) finds that bank loan agreements produce an abnormal return of $+1.93\%$, which is significant at the one percent level. In contrast, the author finds that announcements of public debt offerings produce a statistically insignificant abnormal return of -0.11%, and private placements produce an average abnormal return of -0.91%, which is significant at the ten percent level. The positive reaction to bank loan agreements and the negative reaction to the other financings, which are not arranged by commercial banks, suggest that there is some benefit to the intermediation process provided by commercial banks and bank loans. However, since the abnormal returns may be driven by differences in the characteristics of the issues rather than the special nature of bank lending, James (1987) further refines his tests by grouping the types of announcements based on the purpose of the financing, the maturity of the issuances, the debt rating of the issuer, and the size of the borrower. His analysis indicates that differences in the abnormal performance are not driven by these characteristics, strengthening the view that bank loan agreements signal the bank's positive private information about a firm's prospects to the capital markets.

[24] Mikkelson and Partch (1986) first discovered that bank credit line announcements cause abnormal returns, but this analysis was a small aspect of their study.

[25] In James (1987) and future studies that examine announcement effects, the authors take great care to remove any announcements that are potentially "contaminated" by other news information, such as dividend declarations, earnings announcements, or other financings.

Building on James (1987), Lummer and McConnell (1989) make an important distinction between new bank credit agreements and revisions to already existing credit agreements. If the announcement effects are significant for new bank credit agreements, then this suggests that banks can transmit private information to the capital markets at the outset of a loan agreement due to the initial screening of the client. However, if announcement effects are pronounced among loan renewals and revisions, then this suggests that banks are able to convey private information from their ongoing monitoring activities to capital markets. To construct their sample, Lummer and McConnell (1989) search the *Wall Street Journal Index* for announcements of credit agreements involving commercial banks and U.S. corporations covered by CRSP for the period 1976 to 1986, and they find 728 announcements that meet their criteria. Of the 728 announcements, 371 are new credit agreements and 357 concern existing agreements. Using the same methodology employed by James (1987), the authors employ an event-time study of stock returns over the two-day period encompassing the announcement day in the *Wall Street Journal* and the previous day. Consistent with James (1987), the authors find an announcement-period excess return of $+0.61\%$, which is significant at the one percent level. Importantly, the authors find that the positive abnormal return is driven by revised credit agreements, which produce a highly significant positive abnormal return of $+1.24\%$. In contrast, the sample of new credit agreements produces a statistically insignificant announcement-period excess return of -0.01%. Further, favorable revisions produce positive abnormal returns while negative revisions and cancellations that are initiated by the lender produce strongly negative announcement-period excess returns. Importantly, the results hold up when the authors use multivariate regression models that control for other characteristics of loan initiations and renewals that could be driving the results, such as the sizes, maturity, secured status, and structure of the contract. Overall, these results support the view that the private information that banks transmit to the capital markets arises from the monitoring activities of the bank that take place over the course of an ongoing relationship rather than from the screening of the borrower during a loan initiation.

An empirical study by Slovin, Johnson, and Glascock (1992) examines if announcement effects differ by the size of the firm. Based on insights in Diamond's (1991) model, the authors claim that since there is more public information available for larger firms rather than smaller firms, banks do not have to provide as intense screening and monitoring services for larger borrowers. Therefore, if announcement day abnormal returns reflect a bank's private information that is gathered through screening and monitoring, then bank loan announcement effects should decrease in firm size. To test the hypothesis, Slovin, Johnson, and Glascock (1992) classify the sample firms into small and large based on the median market value of equity of all listed CRSP firms in the year of a given announcement. A search of the *Wall Street Journal Index* over 1980 to 1986 produces 273 favorable loan announcements, of which 156 are for small firms and 117 are for large firms. The results indicate a statistically insignificant reaction to large firm loan announcements ($+0.48\%$, z-statistic $= 1.58$), but a large positive abnormal return for small firm loan announcements ($+1.92\%$, $z = 5.35$). Furthermore, for small firms, both

initiations and renewals produce positive abnormal returns, while for large firms, neither initiations nor renewals have significant announcement period excess returns. These results, which are robust to a multivariate specification, support the view that banks gather more private information when screening and monitoring small firms rather than large firms.

Best and Zhang (1993) also examine the information content of bank loan agreements. The authors claim that if there are reliably accurate public signals of firm value, then bank loan announcements should convey little additional information to the market. Alternatively, in cases where public signals are noisy, then the information content of bank loans should be pronounced. To examine this possibility, the authors split their sample according to whether financial analysts' percentage earnings prediction errors during the year prior to the announcement are high or low. The results, which are based on 491 usable loan announcements over the period 1977 to 1989, indicate that announcement day excess returns are significant for the high prediction error sample (+0.6031%, $z = 2.99$) but not for the low prediction error sample (+0.0444%, $z = 0.28$). These findings indicate that bank's private information is valuable when public information is unclear. The authors also examine if there is evidence consistent with the view that banks expend more effort to monitor a firm when public signals indicate that a firm's prospects have changed. To do so, Best and Zhang (1993) test if abnormal returns differ if the most recent earnings forecast revisions are positive, unchanged, or negative. The authors find that for firms that receive positive earnings forecast revisions, loan announcement abnormal returns are insignificant, but for firms who receive negative earnings forecast revisions and have noisy forecasts of earnings, loan announcements produce significant abnormal returns. All of the results withstand a multivariate specification that allows the authors to control for other factors that could influence abnormal returns. One interpretation of the results is that banks do little further monitoring and screening when public signals are reliable and positive, but when public signals are noisy and firms prospects change for the worse, banks expend additional effort on monitoring.

In another study, Billett, Flannery, and Garfinkel (1995) examine if the lender's identity affects the announcement day abnormal returns. The key motivation for this breakdown is that loan announcements from higher-quality lenders, who could have better monitoring abilities, may be more informative to outsiders than loan announcements from lower-quality lenders. To examine if lender identity matters, the authors examine if a bank's credit rating causes differences in the announcement day abnormal returns. Billett, Flannery, and Garfinkel (1995) search Dow Jones News Retrieval Service for the time period 1980 to 1989 and find 626 usable loan announcements. Using the same basic methodology as in previous studies, the authors find that loan announcements where the lender is a high-quality lender (rated AAA) produce a significantly positive abnormal return of +0.320%, while loans from low-quality lenders (rated BAA or below) are negative (−0.233%) and statistically insignificant.[26] Further, mean abnormal returns for

[26] One difference between Billett, Flannery, and Garfinkel (1995) and the previous papers is that this study uses one-day event windows because the authors are able to identify if the announcement occurred during the

loans from AAA lenders significantly exceed the excess returns from lenders rated BAA or lower. While the univariate results indicate that the announcement effects are concentrated among loans from high-quality lenders, as in previous studies, the authors refine their test through regressions that control for other characteristics that could be driving the result (such as differences in borrower characteristics). Even after controlling for these other factors, higher quality lenders continue to be associated with significantly higher abnormal announcement returns.

Overall, these studies find that the announcement day abnormal returns are significantly positive for loan announcements, stronger for loan renewals and changes rather than initiations, larger for smaller firms rather than larger firms, stronger when public information about the firm is noisy rather than clear, and larger for higher quality lenders. It is important to note that the positive abnormal returns around loan announcements contrasts with the strongly negative announcement effects of equity, the moderately negative abnormal returns around convertible debt issuance, and the insignificant abnormal returns surrounding straight public debt announcements (see Asquith and Mullins (1986), Mikkelson and Partch (1986), and Masulis and Korwar (1986) for equity issuances; Eckbo (1986) and Mikkelson and Partch (1986) for debt issuances). These latter results are consistent with a firm's public security issuance decision revealing its private information on its prospects (Myers and Majluf, 1984) and strengthen the view that bank loan announcements convey positive private information to the capital markets.[27]

To further examine the information content of loans, Dahiya, Puri, and Saunders (2003) take a different approach and study the announcement of a *sale* of a borrower's loans by its lending bank. The termination of a banking relationship through a loan sale may convey a negative signal to the market about a firm's prospects. To test this hypothesis, the authors employ the event-study methodology, using a sample of loan sale announcements by the originating bank for sub-par loans. The data is collected by cross-matching loan sale information in two market newsletters (*Gold Sheets* and *Bank Letter*) with CRSP.[28] Using 3-day, 5-day, and 7-day event windows, the authors find a highly significant negative abnormal return of between -1.61% and -8.11%. These results are consistent with a negative information effect arising from loan sales. The authors also perform two additional tests to examine if loan sales are valid signals of a bank's negative private information about the firm. First, the authors find that firms that have their loans sold are more likely to file for bankruptcy than other comparable firms

trading day. The data used in previous studies does not allow for the authors to distinguish announcements that occur during or after the trading day, which forces the use of two-day event windows.

[27] See however, some contrary evidence in Billett, Flannery, and Garfinkel (2003) who find in the long run, bank loan announcements appear no different from seasoned equity or public debt issuance. Thus the positive abnormal return is subsequently followed by a negative return.

[28] Dahiya, Puri, and Saunders (2003) focus on the sales of seasoned sub-par loans, where the information effects of bank sales are likely to be highest and where they have a more representative sample of loan sales.

and firms that are performing poorly.[29] Second, the authors find that firms that have their loans sold are not the worst performers in their respective industries during the year before their loan was sold, indicating that ex-ante, publicly available information alone may not have allowed outsiders to identify the true weakness of these firms. These results support the view that loan sales by the original lender provide negative private information to outside investors.

6.2. Non underwriter-bank loans and public security pricing

In addition to conveying private information to the market through announcements and sales, the analysis in Fama (1985) and Diamond (1991) indicates that bank loans reduce the need for outsiders to generate duplicate information. This may allow bank lending to reduce overall information costs. Further, bank loans can help resolve information asymmetries between management and outside investors that could induce managers to refrain from issuing equity and foregoing positive net present value investments (Myers and Majluf, 1984). One way to test if bank loans reduce information-related costs is to empirically examine the impact of existing loans on the pricing of a firm's public security issuance. If bank loans reduce information costs, then the existence of bank loans should result in higher security pricing.

James and Weir (1990) investigate how an established relationship with a bank affects IPO underpricing. The authors develop a theoretical model that predicts that due to the information benefits of having an existing lending relationship, firms with an established lending relationship will experience less severe underpricing when they go public. To test the model, the authors collect a sample of 549 IPOs for non-financial firms that occurred between 1980 and 1983 and identify 417 firms with existing bank borrowing relationships. After controlling for factors that have been identified to affect underpricing (i.e. the reputation of the underwriter, the age of the firm, the offering size, and the shares offered by insiders), having bank loans outstanding or a bank-credit agreement significantly reduces underpricing by 8.5 percent. This result suggests that bank loans reduce the information costs associated with issuing public securities.[30]

In addition to having a positive effect on equity issuances, existing lending relationships may also reduce the costs of public debt financings. Datta, Iskandar-Datta, and Patel (1999) examine this possibility. The authors argue that if banks have superior monitoring ability, then the presence of a bank lending relationship should lower information costs associated with raising public debt, which will be reflected through a lower

[29] For this test, the authors are able to expand their sample to 53 firms that have a sub-par loan sold. They were forced to use the smaller sample of 15 loan sales in the event-study due to missing information on the precise date of sale.

[30] However, the authors do not find a statistically significant difference between the effect of bank loans and long term debt on IPO underpricing, which does not support the hypothesis that bank loans play a special role in reducing information costs for IPOs.

at-issue yield spread (higher price) of a firm's first public debt issuance. The authors focus on first debt issuances because firms issuing seasoned debt are already monitored by public debtholders, which can make it difficult to distinguish if the private banking relationship drives any results. Further, first public debt offers are undertaken by younger and smaller firms, where asymmetric information is likely to be high. Datta, Iskandar-Datta, and Patel (1999) collect a sample of 98 initial public offerings of straight debt that occurred between 1971 and 1994 and determine that 64 firms have bank debt at the time of public issuance. In their main specification, after controlling for firm and bond characteristics, as well as differences in risk, the authors find that the existence of a bank lending relationship during the year prior to the public debt issuance reduces the at-issue yield spread of the first public bond offering by 84 basis points.[31]

The findings in these two papers support the view that the existence of a bank relationship reduces the information costs of accessing the public equity and debt markets. The results are consistent with bank lending agreements being valuable because the existence of a banking relationship increases a firm's public security prices. These findings complement the evidence on the market's reaction to loan announcements, renewals, and sales in that they emphasize the importance of the information content of bank loans.

7. Extensions

Thus far, we have confined ourselves to the interaction of banks and capital markets. There are, of course, many interesting and important areas in banking and financial intermediation that are not directly related to the main focus of this survey but where additional research is needed.[32] Some of these areas are mentioned here.

7.1. Banks as equity holders

An area where banks might expand their activities but traditionally have not been allowed to, at least in the U.S., is in holding equity stakes. As opposed to Japan and Germany, where banks are allowed to hold equity, banks in the U.S. are allowed to hold equity only though restructuring bad loans (see e.g. James, 1995), or through some provisions in venture capital (see e.g. Hellmann, Lindsey, and Puri (2006)).[33] As previously noted, there are efficiencies from underwriters holding equity in firms; venture

[31] The results in Datta, Iskandar-Datta, and Patel (1999) are somewhat mixed. In another specification, they find a significantly *positive* relationship between a banking relationship and the at-issue yield spread when they only control for firm characteristics and if the bond has a call provision. The negative relationship arises once the authors control for subordination and covenants.

[32] For an excellent survey of many of the other areas in financial intermediation not covered here, see Gorton and Winton (2002).

[33] The advantages and disadvantages of allowing banks to hold equity have been analyzed in a number of models (see e.g. Berlin, John, and Saunders, 1996; Stiglitz, 1985; Winton, 2003). Empirical work on bank

capitalists as equity holders reduce IPO underpricing when they underwrite and, further, gross spreads on IPOs decrease in the underwriters' shareholdings of the firm (Li and Masulis, 2004).

Why and when do banks choose to invest in equity, and what are the implications for the firm? There is surprisingly little research on this issue. Hellmann, Lindsey, and Puri (2006) explore this topic by focusing on the impact of bank venture capital relationships on the bank's core lending division. Venture relationships may allow the bank to foster an ongoing lending relationship. Also, the private information from the venture relationship may reduce the bank's cost of lending due to informational economies of scope, allowing firms to benefit from lower loan yield spreads. To examine these issues, the authors collect detailed information on all venture capital investments for the period 1980 through 2000 and gather lending data for the 10,583 venture backed customers. To examine if venture relationships increase the likelihood that the bank investor will forge a lending relationship with the firm, the authors estimate a conditional logit model in which each firm can choose among banks. The results reveal that the venture relationship does indeed increase the likelihood of being selected as lender, even after controlling for the bank's share of the lending market and the firm's public status. These results are confirmed through another test at the aggregate level in which the authors find that banks are more likely, on average, to lend to companies with whom they have a prior venture relationship.

To examine loan pricing, Hellmann, Lindsey, and Puri (2006) match loans where the lender has a prior venture relationship with the firm ("relationship loans") with similar loans where no venture relationship exists ("non-relationship loans") and compare the yield spreads of the matched loans. Since it is difficult to match loans directly based on multiple relevant characteristics, the authors use propensity score matching, which reduces the multiple-dimension matching problem to a single-dimension, called the propensity score.[34] These methods take into account the fact that the characteristics of relationship loans may differ significantly from non-relationship loans and ensure that such observed characteristics are not driving the results. Using various estimators, the authors find that relationship loans have significantly lower yield spreads, by 18 to 26 basis points. In sum, the results suggest that as venture capitalists, banks tend to be strategic investors in equity and use venture capital relationships to foster a lending relationship that results in efficiencies that benefit both banks and firms. The results

control rights through board seats and equity holding is found in Germany by Gorton and Schmid (2000), who find that banks use their equity holding and board seats to improve firm performance. For Japan, Kaplan and Minton (1994) find banks are more likely to get board seats following poor firm performance, and Weinstein and Yafeh (1998) and Morck, Nakamura, and Shivdasani (2000) find that Japanese firms with a main bank have lower growth and profitability than others.

[34] To employ the methodology, the authors first run a probit model, where the dependent variable is one if the loan is a relationship loan and zero otherwise, and the independent variables are the matching dimensions, which include loan and borrower characteristics. Each loan is assigned a propensity score, which is the predicted probability from the probit model. See Heckman, Ichimura, and Todd (1997, 1998) for more details. This method of matching loans is also used in Drucker and Puri (2005).

highlight the impact of organizational form on the incentives and behavior of investors. This is an area worthy of more study.

7.2. Beyond screening and monitoring

The central idea behind much of the banking literature is that banks have access to private information about the firm. The bank's ability to generate information has implications on the firm's financing decision. Can banks play other roles for firms that go beyond screening and monitoring? In studies of venture capitalists, there is some evidence that venture capitalists do not simply screen and monitor but also help provide costly effort in the form of support activities for the firm. When financing the firm, venture capitalists expect to help the founder professionalize the company (Kaplan and Stromberg, 2001, 2004). Also, firms financed by venture capitalists are more likely to professionalize early and are more likely to get their product to market (Hellmann and Puri, 2000, 2002). Lerner (1995), Baker and Gompers (2003), and Hochberg (2004) find that venture capitalists play an important role in determining the composition of the board of directors. Lindsey (2004) finds some evidence that venture capitalists facilitate strategic alliances of firms within their portfolio. Of course, one could argue that the main difference between banks and venture capitalists is that banks typically provide only debt financing while venture capitalists have equity-based contracts. However, in many countries around the world, banks are not prohibited from taking equity stakes. Yet, other than some evidence on banks' role on boards of directors (see e.g. Kroszner and Strahan, 2001), we have little evidence that banks play a support role for their borrowers. Is there limited evidence because banks do not provide these services or simply because this possibility has not been explored by researchers? Again, this is an area where more research is warranted.

7.3. Loan sales

The loan sales market is rapidly growing, and loans sales are a major source of funding for banks and a way for banks to manage risk.[35] While a number of studies have formed and tested theories of the loan sales market, a consensus has not been reached on the functioning of this very important market. We summarize the literature on the two prevailing information-based theories of loan sales – the "monitoring technology hypothesis", and the "comparative advantage hypothesis".[36] We also provide some recent evidence on the effects of loan sales on corporate borrowers.

[35] See Gorton and Haubrich (1990) for early evidence on loan sales and Yago and McCarthy (2004) and Thomas and Wang (2004) for more recent developments in the loan sales market. See Gorton and Haubrich (1990) for empirical evidence on loan sales market size and trends.

[36] Berger and Udell (1993) provide details on nine competing theories. Non-information based theories include the "diversification hypothesis", which claims that loan sales provide a way for banks with limited opportunities to diversify their loan portfolio (Demsetz, 2000; Haubrich and Thomson, 1996; Pavel and Phillis, 1987), the "regulatory tax hypothesis", which suggests that regulatory taxes on on-balance sheet

Berger and Udell (1993) develop the "monitoring technology hypothesis", which attempts to explain loan sales as a reaction to improvements in monitoring and information technology.[37] As information technology improves, banks can sell loans to direct lenders because these loan buyers increase their ability to monitor loans. For high quality borrowers, the monitoring cost advantage of banks falls below the signaling costs of intermediation, which enables the sale of loans. An important implication of the theory is that banks keep risky, essentially illiquid loans for which their monitoring advantage is important. Berger and Udell (1993) find empirical support.

Drucker and Puri (2006) also find evidence consistent with the monitoring technology hypothesis. Using a sample of loans that are originated between 1999 and 2004, the authors identify individual loans that are traded in the secondary market. They find that banks sell the loans of more informationally transparent borrowers—larger firms who have long-term debt credit ratings. The monitoring cost advantage of banks is presumably smaller for these types of loans. Interestingly, sold loans have additional, tighter financial covenants as compared with loans to similar firms which are not traded in the secondary market. This is consistent with loan buyers directly monitoring borrowers through covenants.

The "comparative advantage hypothesis" argues that loan sales arise out of exogenous differences in the comparative advantages of financial intermediaries. Researchers have explored a number of different comparative advantages that could motivate loan sales.[38] Hess and Smith (1994) claim that banks may have a comparative advantage in originating and servicing loans but not in funding or interest risk management. Pavel and Phillis (1987) provide empirical support, showing that banks with origination and servicing advantages have a higher probability of selling loans and also sell more loans. Carlstrom and Samolyk (1995) assume that banks have an advantage in finding and screening profitable local projects and loan sales arise because, otherwise, financially constrained banks would have to pass up positive investments when there were many good opportunities in the local market. Some empirical studies have supported this theory, as a typical bank with a binding capital constraint is more likely to sell a higher

activities result in banks using off-balance sheet activities, such as loan sales (Pennacchi, 1988; Pavel and Phillis, 1987), the "collateralization hypothesis", in which loan sales provide a mechanism to shift risk from risk-averse to risk-neutral investors (Benveniste and Berger, 1986, 1987) or to help avoid debt overhang for banks (James, 1988), and the "moral hazard hypothesis", which suggests that banks use loan sales to book income immediately and increase leverage to take advantage of deposit insurance (Benveniste and Berger, 1986; James, 1988).

[37] This theory is an extension of Bhattacharya and Thakor (1993), who find that intermediary monitoring dominates direct monitoring when the benefits from scale economies in monitoring exceed the costs of signaling the value of assets to investors.

[38] In addition to the information-based comparative advantages that are discussed here, Pennacchi (1988) discusses another comparative advantage that is based on funding differences between banks. Loan sales provide a means by which the inexpensive funds that are raised by some banks can be used to finance the loans at other, higher cost banks. The empirical evidence on this non-information-based view is mixed (see e.g. Berger and Udell, 1993; Haubrich and Thomson, 1996).

proportion of loans than an unconstrained bank (Haubrich and Thomson, 1996; Pavel and Phillis, 1987), unconstrained banks are more likely to buy loans (Demsetz, 2000), and strong local origination opportunities are positively related to loan selling (Demsetz, 1994, 2000).

Recent papers have explored the effect of loan sales on corporate borrowers. It may be costly for borrowers to have their loans sold, particularly if they need to renegotiate their loans in the future, as they will have to deal with additional lenders that may not take a long-term view of the company's prospects. Further, there is a concern that loan sales harm lending relationships. Guner (2006) examines if borrowers receive an offsetting benefit through lower loan interest rates. Guner (2006) identifies banks that were active loan sellers during the 1987 through 1993 period and shows that borrowers of these banks indeed received lower loan interest rates. Importantly, the interest rate reductions are concentrated among borrowers that are more likely to have their loans sold based on ex ante characteristics. Drucker and Puri (2006), using data that covers the time period 1999 through 2004, show that borrowers whose loans are sold receive additional bank loans, both in the year of the loan sale and in the future. These results are consistent with loan selling increasing borrowers' access to bank loans. Contrary to concerns that lending relationships are harmed by loan selling, Drucker and Puri (2006) show that borrowers whose loans are sold are more likely to retain their lending relationships. One explanation is that loan sales let banks manage their lending risks up front, which permits banks to extend loans to their relationship borrowers in the future.

7.4. Bank organizational form

There is a growing amount of work on the nature of information collected by banks from their clients, and on how the organizational form of the bank may be more conducive to collecting some kinds of information as opposed to others. A key empirical finding is that large banks tend to lend to large companies and small banks tend to lend to small companies (see Berger, Kashyap, and Scalise, 1995; Berger et al., 1998; Berger and Udell, 1996; Nakamura, 1994; Peek and Rosengren, 1996; Strahan and Weston, 1996, 1998; Sapienza, 2002). Stein (2002) argues that the key difference between small and large business lending is that small business lending relies on "soft" information, which is information that cannot be directly verified by anyone other than the agent who produces the information. Small banks are better at processing soft information while large banks are better at processing verifiable "hard" information, such as financial statements, public credit ratings, and formalized records.

Since research shows that relationships are important for small companies (see e.g. Petersen and Rajan, 1994), it is vital to understand the effects on small firms of the growth in the size of banks and the increased reliance on hard information. There are a few empirical papers that examine the role of hard and soft information in the credit decisions of banks. Liberti (2002) examines a hierarchical structure change in a corporate commercial lending division of a foreign bank in Argentina. He finds that managers with more independence base their pricing decision more heavily on soft information

than managers with more limited decision authority. Berger and Udell (1996) show that large banks do not reduce credit to small firms whose credit worthiness can be judged by examining hard information, such as their financial ratios. Another study by Cole, Goldberg, and White (1999) uses the National Survey of Small Business Finances to examine the decision by banks to accept or reject credit applications by small firms. They find that larger banks make credit allocations based on standard hard information criteria, such as figures that can be obtained in financial statements. Mian (2004) finds evidence consistent with foreign banks with larger distance between their head offices and local branches avoiding informationally difficult credit, where soft information is likely to be more important. Also, Berger et al. (2005) use a sample of small business loans and find that firms with financial records borrow from banks that are larger, on average.

7.5. Bank-based vs. market-based economies

Many economies are largely bank-dependent and capital markets are not well developed. Are banks and stock markets substitutes? This remains an important question. There has been some theoretical work on this subject. Allen (1993) and Allen and Gale (1999) argue that banks and stock markets fundamentally differ in the way that they process information, in that banks are inherently more conservative. Thus, stock market based economies are more likely to embrace new technologies. In contrast, Dow and Gorton (1997) argue that banks and stock markets are alternative institutions for the savings/investment process. There is now growing empirical research on bank based and stock market based systems.[39] The bulk of evidence seems to suggest that both financial intermediaries and markets matter for growth. However, the results are far from conclusive and more research is needed.

8. Concluding remarks

There has been a large amount of research on the implications of allowing banks to expand their activities beyond traditional lending into underwriting. There is convincing evidence that, at least in the United States, commercial banks do not suffer from conflicts of interest and can be net certifiers of firm value when underwriting public securities. This is seen through the ex ante pricing and ex post performance of commercial bank-underwritten securities. The results are robust across different time periods, different securities, and the use of different empirical methodology. The international evidence on conflicts of interest from commercial bank underwriting is mixed. However, the discrepancies may be partially explained by the varying regulatory environments and quality of the financial markets in these countries. Future research will benefit from empirical tests that explicitly account for these differences.

[39] See Levine (2004) for an excellent review.

Many empirical studies document that, in both debt and equity offerings, borrowers receive lower underwriting fees when they use their lending bank as underwriter. Both prior lending and concurrent lending increases the likelihood that the bank will win underwriting mandates. These results seem to imply that commercial banks will crowd out specialized investment banks. However, recent evidence suggests that investment banks are competing with commercial banks by developing lending units. Investment bank lending raises serious issues for regulators, yet there is limited evidence on the consequences of investment bank lending. More research is needed in this area.

Banks also play an indirect role in capital markets. Empirical studies of stock market reaction to loan initiations, renewals, and sales confirm that banks can signal the quality of firms to outside investors through their lending decisions. Additional evidence suggests that the existence of a bank lending relationship reduces the costs of information acquisition for capital market participants.

Overall, there are positive effects from the interaction between commercial banks' lending activities and the capital markets. However, banks in the U.S. are allowed to hold equity only though restructuring bad loans or through venture capital investments. Should commercial banks in the U.S. be allowed to expand their ability to hold equity holdings of firms? In general, we observe that there is some evidence of efficiencies from financial intermediaries being able to hold equity stakes. For example, when commercial banks hold equity in firms through venture capital subsidiaries, they foster an ongoing lending relationship that results in efficiencies that benefit firms through lower loan pricing. Would there be positive effects from the interaction between commercial banks' equity holdings and capital markets? When banks hold equity in firms do they provide value added services similar to those provided by venture capitalists, such as professionalization or support in the human resources area? What can we learn from examining the effects of commercial bank equity holding in other countries, such as Germany and Japan? These issues are yet unresolved and promise to be at the forefront of continued regulatory debate on the scope of bank activities.

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Chapter 6

SECURITY OFFERINGS*

B. ESPEN ECKBO

Tuck School of Business, Dartmouth College, Hanover, NH 03755, USA
e-mail: b.espen.eckbo@dartmouth.edu

RONALD W. MASULIS

Owen Graduate School of Management, Vanderbilt University, 401 21st Avenue South, Nashville, TN 37203, USA
e-mail: ronald.masulis@owen.vanderbilt.edu

ØYVIND NORLI

Norwegian School of Management BI, Nydalsveien 37, N-0442 Oslo, Norway
e-mail: oyvind.norli@bi.no

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Abstract

This essay surveys the extant literature and adds to the empirical evidence on issuance activity, flotation costs, and valuation effects of security offerings. We focus primarily on public offerings of equity for cash, although we also review and present new evidence on debt offerings and private placements. The essay has four major parts: (1) We review aggregate issue activity in exchange listed securities from 1980 through 2004. Following the IPO, only about one-half of the publicly traded firms undertake a public security offering of *any* type, and only about one-quarter undertake a SEO. Thus, SEOs are relatively rare, which is consistent with adverse selection costs being an important consideration when raising cash externally. (2) We review the evidence on direct issue costs across security types and flotation methods, including the more recent SEO underpricing phenomenon. A large number of studies provide evidence on the determinants of underwriter compensation, and confirm the importance of variables capturing information asymmetries and underwriter competition. (3) We survey and interpret the valuation effects of security issue announcements. In the period since the Eckbo and Masulis (1995) survey, many studies examining announcement-period stock returns have focused on the effects of flotation method choice and foreign offerings. The well-known negative average announcement effect observed for U.S. SEOs appears to be a somewhat U.S.-specific phenomenon. (4) We review and extend evidence on the performance of issuing firms in the five year post-issue period. The literature proposes either a risk based-explanation or a behavioral explanation for the phenomenon of low average realized returns following IPOs and SEOs. Standard factor model regressions fail to reject the null that the low average returns are commensurate with issuers' risk exposures. Recent theoretical developments suggest that lower risk levels following equity issues may be linked to issuers' investment activity, a promising direction for future research.

Keywords

security offering, IPO, SEO, debt offer, flotation method, underwriting, rights offer, private placement, shelf registration, adverse selection, announcement returns, long run performance

1. Introduction

Security offerings are a very visible and important activity in the life of a firm. Their visibility arises in part because of the typically large amount of new capital raised relative to an issuer's existing capital base or asset size. The motives for security offerings are quite varied. The most common reason given for these actions is to raise capital for capital expenditures and new investment projects. Other reasons explored in the literature include the need to refinance or replace existing or maturing securities, to modify a firms capital structure, to exploit private information about securities intrinsic value, to exploit periods when financing costs are historically low, to finance mergers and acquisitions, to facilitate asset restructuring such as spin-offs and carve-outs, to shift wealth and risk bearing among classes of securities, to improve the liquidity of existing securities, to create more diffuse voting rights and ownership, to strengthen takeover defenses and to facilitate blockholder sales, privatizations, demutualizations and reorganizations.

This survey focuses exclusively on security offerings *for cash*, and then primarily to the *public*—although we also track private placements to some extent. Non-cash offerings, such as securities issued as employee compensation, and the many variants of security swaps, are covered elsewhere in this Handbook. For example, stocks issued as part of employee compensation plans are covered extensively in Aggarwal (2007, Chapter 17). Equity-for-equity swaps associated with mergers and takeovers are evidenced in Betton, Eckbo, and Thorburn (2007, Chapter 15). Security swaps associated with financial restructurings of non-distressed firms are covered in Eckbo and Thorburn (2007, Chapter 16), and senior-for-junior security swaps by firms in financial distress are examined in Hotchkiss et al. (2007, Chapter 14).

The decision to issue securities draws on all of the core areas in financial economics: asset pricing theory, capital structure theory, managerial investment incentives, financial institutions, contracting, and corporate governance. Moreover, there is a wealth of available data, particularly with the emergence in the 1990s of the comprehensive, machine-readable, transactions-oriented data base provided by the Security Data Corporation (SDC), with data back to 1980. Yet, there is surprisingly little consensus on key determinants of the security issuance decision and its economic effects on the firm.

The very existence of elaborate schemes for marketing security offerings to the public—including book building and road shows by underwriters—speaks to the importance of information asymmetries in the market for public issues. Moreover, judging from the recent regulatory focus on investor protection (e.g., the Sarbanes–Oxley Act of 2002), public security offerings for cash are relatively vulnerable to potential conflicts of interests. As such, these security issues are also the prime empirical laboratory for exploring models of capital structure choice—including the "pecking order" of (Myers, 1984)—as well as selling-mechanism designs that presume the public is substantially less informed than the issuer about the true value of the security issued.[1] While the survey provides information on the number of initial public offerings (IPOs) and private

[1] Time series evidence on the pecking order theory is surveyed in Frank and Goyal (2007, Chapter 12).

placements, the main focus is on issuances by exchange-listed firms—both seasoned equity offerings (SEOs) and debt issues.

We have four main objectives: (1) To survey the level of aggregate security issue activity and some of the characteristics of issuing firms; (2) to review direct issue costs across security types and selling mechanisms; (3) to survey and interpret the valuation effect of security issue announcements; and (4) to review and extend evidence on the performance of issuing firms in the five year post-issue period.

Mapping out the SDC data base, we start by providing an overview of aggregate issue activity in the U.S. over the period 1980–2003. We separate industrial firms from public utilities, and financial issuers from non-financial companies. We track primarily the largest security classes, such as common stock (IPOs, SEOs, and private placements) and debt (both straight and convertible), but provide some information on unit offerings, dual offerings, and foreign offerings (ADR and GDR) as well. We review potential determinants of the wave-like pattern of aggregate security offerings. At the firm level, we review evidence that links the security offering frequency through time. This includes the time period between the IPO and the first follow-on SEO, between two successive SEOs, and between debt and equity issues. Overall, this evidence confirms and generalize the early finding of Mikkelson and Partch (1986) that equity issues for cash are rare—both on an absolute level and relative to public debt issues.

Our second objective is to survey the nature and magnitude of direct issue costs, including the more recent phenomenon of SEO underpricing.[2] At the most basic level of economic analysis, firms minimize direct costs of raising capital. Yet, surprisingly few papers try to estimate the direct issue cost function. Following the adverse selection model of Myers and Majluf (1984), the literature has been preoccupied with the potential for wealth transfer caused by security offerings. We confirm the conclusion of Eckbo and Masulis (1995) that the adverse selection framework is the leading theoretical explanation for the announcement-induced abnormal stock returns for seasoned public offerings of debt and equity. However, the current evidence does not rule out the influence of direct transaction costs on a firm's issue decision, but is less supportive of wealth transfer concerns.

Understanding issue costs and the issue decision requires a thorough understanding of alternative selling mechanisms. We review how different selling mechanisms are designed to deal with different forms of information asymmetry, and the associated total issue costs. The literature here is sparse, leaving the link between contracting theory and optimal selling mechanisms design a fertile area for future research. One area in which this has immediate practical importance is in the choice between auctions and firm-commitment underwriting (fixed price) offerings, as witnessed in the recent Google IPO. Establishing the efficiency of the auction mechanism is also essential to the literal interpretation of an offering-price discount (underpricing) as "money left on the table" for shareholders of the issuing firm (Loughran and Ritter, 2002).

[2] We touch only briefly on IPO underpricing, which is the topic of Ljungqvist (2007, Chapter 7).

A third major objective of the survey is to both review and provide additional evidence on short- and long-term performance of issuing firms. In the period after the review of Eckbo and Masulis (1995), studies reporting short-term, announcement-period abnormal stock returns have focused in particular on the effect of the flotation method choice and of foreign offerings. Interestingly, the well-known negative announcement effect of the average SEO in the U.S. appears to be somewhat of a U.S.-specific phenomenon. While Eckbo and Masulis (1995) did not cover long-run performance studies, in this survey we provide our own large-scale analysis in addition to surveying the evidence in existing studies.

As in Loughran and Ritter (1995) and Eckbo and Norli (2004), we find that *total* returns are relatively low following security offerings, and in particular following IPOs. The low post-issue total return is most noticeable after IPO clusters ("hot" IPO periods). These clusters raise issues concerning selection bias and what Shultz (2003) terms "pseudo-timing" evidence. Overall, consistent with the conclusions of Eckbo, Masulis, and Norli (2000), Brav, Geczy, and Gompers (2000) and Eckbo and Norli (2005), but contrary to the inference Ritter (2003) draws from his survey, we conclude that the preponderance of the evidence fails to reject the hypothesis of zero *abnormal* returns in the post-issue period. This conclusion is robust to alternative definitions of expected returns, and it holds whether the issue is an IPO, a SEO, a private placement, or a (straight or convertible) debt offering.

The survey is organized as follows. Section 2 provides an overview of major regulatory rules and restrictions guiding security issues in the U.S. The section covers both regulations by the Securities and Exchange Commission (SEC), and self-regulatory authority rules issued by stock exchanges and the National Association of Security Dealers (NASD). Section 2 also summarizes the overall issue activity in the SDC population of U.S. issuers, 1980–2004. Section 3 reviews direct issue costs across major flotation methods, with a major emphasis on underwriting costs and understanding the underwriting process. Section 4 examines the flotation method choice and summarizes the evidence on the valuation effects of security offering announcements (both U.S. and internationally). Section 5 examines various theories for post-issue stock price performance, and presents the results of an original long-term return analysis performed on our SDC sample. Section 6 provide concluding remarks.

2. The security offering process

Equity offerings come in many colors and flavors, from IPOs to SEOs, public offers to private placements, classes of stock with differing cash flow and voting rights, from domestic issues to global issues and from warrants to employee/management stock options to convertible debt. They are also sold using many different mechanisms, from a firm commitment underwriting contract to a rights offering to a discriminatory or non-discriminatory auction, to more exotic methods such as privatizations, carve-outs,

employee stock ownership plans (ESOPs), equity bonus plans, mutual-to-stock conversions, forced conversions of convertible securities (including conversions of venture capital held securities at the IPO), equity financed acquisitions, dividend reinvestment plans and funding pension plans with your own stock.

Legal systems, tax codes, securities regulations and the treatment of investors of a country are likely to have a significant bearing on the level of security offering activity as well as the choice of flotation methods. Over the last 25 years, there have been major changes in securities regulations in the U.S. and other major capital markets. We review some of these major changes and the trends in the evolution of security regulation in the next section.

2.1. U.S. securities regulations

The U.S. regulatory environment is anchored on two major laws. The first major law is the Securities Act of 1933, which requires issuers of securities to sell the entire issue at a single offer price to all investors, to meet filing rules and extensive disclosure requirements prior to the offering date. Under the regulations implementing this law, prospective issuers must file an S-1 statement with SEC prior to the offering. Within approximately 30 days, the SEC will send the issuer a letter of comment asking for additional disclosures and request amendments to the registration statement. The issuer sends a response and after several exchanges of letters, the SEC will typically declare the registration effective. Once the filing statement is approved, the issuer can proceed with the offering. The second major act is the Securities Exchange Act of 1934 which mandates that issuers of publicly held securities make periodic disclosures through public filings of annual 10-K, quarterly 10-Q and occasional 8-K statements, when material changes occur.

There are several exemptions from the registration requirements under the Securities Act for small issues, private placements, mergers and reorganizations. While privately placed securities are exempt from registration requirements, these securities can not be resold for a year without being publicly registered with the SEC.

In recent years U.S. securities regulations have moved toward more rapid disclosure of material changes in company conditions, less delay in securities issuance and an easing of restrictions on private placements and foreign security issuance in the U.S. and the use of U.S. accounting standards under "generally accepted accounting standards" (GAAP). However, these changes appear to be more than offset for foreign issuers and small U.S. issuers by the passage of the Sarbanes–Oxley Act of 2002 which requires major changes in Board of Directors committee structure, auditor independence and certification of company financial disclosures.

As of March 1982, the SEC adopted Rule 415 Shelf Registration, which enabled public companies to sell securities more rapidly. Under the Rule, issuers register securities that can be sold from time to time over a two year period, with offer terms at each sale set in light of current market conditions and other factors. The Rule permits an issuer to avoid the delays involved in filing a new registration statement at each sale date. This

flotation method was only available to larger, financially sound issuers meeting the following requirements: common stock (with or without voting rights) having a market value of at least $75 million, no defaults on any debt, preferred stock or rental payments for 3 years, all SEC disclosure requirements have been met for the last 3 years and the firm's debt is investment grade.

Under U.S. securities regulations, a foreign issuer has a choice of issuing either publicly or privately held equity or debt in the U.S. Typically, a foreign issuer of equity in the U.S. employs an American Depository Receipt (ADR) or Global Depository Receipt (GDR) mechanism which eliminates the domestic investors need to undertake foreign exchange transactions to acquire and dispose of these securities and convert cash dividend payments to dollars. An ADR is a financial instrument backed by a depository bank owning the underlying foreign shares, to which the ADR has a fractional claim, but which pays cash distributions and trades in dollars and settles trades in the U.S. market. Arbitrage keeps the prices of the underlying shares and the ADR in close alignment after adjusting for foreign exchange movements. GDRs are similar financial instruments which pay cash distributions and trade in a specific foreign currency and settle trades on a particular foreign stock exchange.

In April 1990 the SEC approved Rule 144A, which allows immediate sale and resale of private placements to "qualified institutional buyers" (QIBs) without having to register these securities or hold them for a year, as previously required.[3] This rule was particularly aimed at reducing regulatory costs and improving the liquidity of privately placed securities issued by privately held companies and foreign issuers. It gives privately held U.S. firms the ability to either privately place securities with accredited and sophisticated investors pursuant to Section 4.2 of the 1933 Securities Act or Rule 506 of Regulation D or to sell them to QIBs as a Rule 144A issue. The approval of Rule 144A also has the effect of allowing international firms to gain access to U.S. institutional investors without having to meet the strict disclosure and GAAP accounting requirements of U.S. public companies.

Under U.S. regulation, there are several ways a foreign company can tap the U.S. capital market. A firm can first make a small Rule 144A private placement and trade over-the-counter, which is called a Level I program. If it chooses to list on a U.S. exchange, it moves to a Level II program. Alternatively, it may undertake a Level III public offer of stock in the U.S. with listing on a U.S. stock exchange. An issuer can simply undertake a large 144A private placement or a firm can begin by seeking Level I or II market listing in the U.S., followed by a public offering. One key benefit of a 144A private placement is that a foreign issuer can raise capital in the U.S. sooner, since the issuer does not have to meet U.S. accounting and disclosure standards to tap this market. However, the stock's issue price is likely to be significantly discounted for its lower liquidity in the private placement market. In addition, issuers often need to obtain

[3] QIB typically refers to an institution (e.g., insurance companies, investment companies and pension funds) that own or invest $100 million in securities of non-affiliated companies.

home market regulatory approval before initiating any foreign trading in its securities. There can also be home country restrictions on foreign sales of domestic securities and purchases of foreign securities by domestic investors.

Under Regulation T of the Securities and Exchange Act of 1934, the Federal Reserve Board of Governors establishes rules to limit the portion of a security's market value that can be loaned to the investor by a broker. These margin requirements are established for the purpose of reducing selling pressure on investors who financed their security purchases with loans. Thus, in market downturns, investors borrowing on margin are required to put up additional collateral when their securities fall in value. This can force many liquidity impaired investors to sell securities to raise collateral or if they fail to meet the call for added collateral, the broker can sell their securities and close out their margin loans. Either event can create a cascading pattern of sell orders, which has been alleged to destabilize the stock market.

The SEC regulates the financial condition of brokerage firms and the short selling of securities by investors and underwriters. In the normal case of investor short selling, brokerage houses and institutional investors lend securities to short sellers, who immediately sell these securities in the stock market, knowing that at a future date they will be obligated to purchase these same securities in the stock market to close out their short positions with their lenders.

SEC regulations concerning public offerings of securities underwent sweeping changes as of December 1, 2005. One major innovation is the creation of a new category of issuers called "well known seasoned issuers" (WKSI) with special filing exemptions. WKSIs are publicly listed firms (involuntary filers) that are eligible to issue shelf offerings, which are current and timely in their reporting obligations over the past year. They must also meet one of two conditions; (1) have outstanding a minimum of $700 million of common equity market capitalization world-wide that is held by non-affiliates, or (2) if they are only registering non-convertible securities other than common equity, that during the past three years they have issued non-convertible securities other than common equity in registered primary offerings with an aggregate value of $1 billion.[4]

Under the new rules, a WKSI can have oral or written communication with investors before during and after the offering process. WKSIs are also given automatic shelf registration status. They are permitted to register unspecified amounts of different specified types of securities on Form S-3 or F-3 (only non-convertible securities excluding common equity if only condition (2) above is met) without allocating between primary and secondary offerings. These registration statements are automatically effective on filing without SEC review. Issuers can also add further classes of securities and eligible majority owned subsidiary securities after the registration statement is effective, provided they make a post-effective amendment to the offering's registration statement.

[4] Majority owned subsidiaries of these firms also may be considered to be "well-known seasoned issuers" if the securities issued are non-convertible securities other than common equity, are fully and unconditionally guaranteed by the parent and are of investment grade.

A second major change in SEC regulations is increased disclosure requirements in registration statements and 10-K statements concerning risk factors. Third, Rule 415 will no longer limit the amount of securities registered on a shelf registration statement to an amount intended to be offered and sold within two years of the effective date of the registration statement. In practice the SEC has allowed shelf registration statements to remain effective for many years. Under the new rules, the shelf registration can only be used for three years. The new rules allow seasoned issuers to conduct primary offerings immediately after the effectiveness of a shelf registration statement. Shelf issuers may also conduct "at-the-market" equity offerings (sales at varying prices rather than a conventional fixed price offer) without existing volume limitations and without needing to identify the potential underwriters.

WKSIs are permitted to omit the plan of distribution, the names of any selling security holders, the description of securities to be offered, and the allocation between primary and secondary shares. This information can be incorporated in prospectus supplements and post-effective date amendments to the shelf registration statement.

Foreign private issues are able to take advantage of the relaxation of the gun-jumping rules (communications occurring prior to the effective date of the registration statement) and the revised shelf registration rules to the same extent as domestic issuers. Moreover, automatic shelf registration will make it much easier for foreign private issuers that are WKSIs to conduct rights offerings in the U.S.

Other changes in SEC regulations include giving issuers a safe harbor from being in violation of security regulations for written communications of regularly released factual information made before or during an offering and commonly released forward-looking information (e.g., earnings forecasts) made before or during an offering, allowing issuers a wider range of oral and written communications while the offering is in registration, allowing electronic delivery of filing materials to shareholders, and allowing analysts reports of new issues under a wide range of situations, even for analysts affiliated with an underwriter.

Parallel to U.S. securities regulation, there are similar national regulatory authorities around the globe. The International Organization of Securities Commissions (IOSC) is a global organization of national security regulators created to foster cooperation in promoting high standards of regulation in order to maintain efficient and sound capital markets; to establish standards and effective surveillance of international securities transactions and to promote effective enforcement of these standards. Among its recent achievements, the IOSC in 1998 adopted a comprehensive set of objectives and principles of securities regulation, which today are recognized by the world financial community as international benchmarks for all markets. In 2002 the IOSC endorsed a memorandum of understanding among securities regulators around the world, designed to facilitate the enforcement of security regulation and the exchange of information. Looking internationally, there has been an increase in disclosure regulation and increased regulation and enforcement of insider trading activity.

In addition to securities regulation, several other recent laws and rules of self regulatory organizations also have impacted the security offering process. In 1999, the

Glass–Steagall Act which prohibited commercial banks and their subsidiaries from affiliating with securities firms or underwriting corporate securities was effectively repealed by the Gramm–Leach–Bliley Financial Modernization Act. The passage of this law had a direct effect on the securities market by increasing competition for corporate underwriting assignments by allowing entry by commercial banks who could have prior lending relationships with issuers (see also Drucker and Puri, 2007, Chapter 5, this volume).

Self-Regulatory Authorities (NYSE, NASD) impose various listing requirements on firms trading securities on their exchanges. In addition, the NASD has responsibility for regulating many of the activities of broker-dealers and underwriters. In recent years, both the NYSE and the Nasdaq have imposed new corporate governance requirements on firms listing in their markets. The NYSE also prohibits listed firms from inducing dual shares with unequal voting rights since 1994.[5]

The passage of the Sarbanes–Oxley Act of 2002 has enhanced shareholder voting rights by encouraging more independent boards and requiring outside directors take on major governance roles within the board of directors. This Act has increased the credibility of firm disclosure requirements by requiring greater auditor independence and the CEO and CFO to personally certify the company's annual financial statements.

2.2. Alternative flotation methods

Table 1 summarizes the major flotation method choices observed for IPOs, SEOs and debt offerings. The table starts with "firm commitment" underwriting, which is the primary choice of publicly traded U.S. firms. Here, an underwriter syndicate guarantees the proceeds of the issue (net of fees) and organizes the sale of the shares. Given the prominence of this flotation method, we discuss key aspects of the underwriting process before commenting on the other flotation methods listed in Table 1.

2.2.1. The firm commitment underwriting process

The time line in a firm commitment offering is roughly as follows: The issuer contacts an investment bank to form a syndicate guaranteeing the offering. The lead underwriter performs due diligence (examining the financial status of the issuer), registers the issue with the SEC, and presents a preliminary prospectus ("red herring") to key investors and clients in a "road show". The preliminary prospectus specifies only a possible price range for the offering as the firm is not permitted to sell shares prior to SEC registration. When the SEC approves the issue, the firm meets with the underwriter syndicate and sets the final offer price ("pricing meeting") and the offer typically starts the following day. The underwriter guarantee requires a firm offer price, so the guarantee period starts

[5] Exceptions are firms with dual class shares prior to listing such as Ford Motor Co., Berkshire Hathaway, which was grandfathered when these requirements were first implemented.

Table 1
Flotation methods

Firm commitment. An underwriter contractually commits to purchase an entire security issue at a fixed price discount from the public offering price. All shares are sold to the public at the same price and the underwriter generally has the power to allocate the issue if there is excess demand. This process may involve book building or a fixed price placing

Rights. Short lived in-the-money warrants to buy a fixed number of new shares at fixed price, which are distributed to existing shareholders on a pro rata basis. These rights can often be resold to other investors. On the warrant expiration date, unexercised warrants are sometimes redistributed to shareholders who do exercise their rights

Standby rights. These contracts represent rights offers combined with a standby underwriting contract. The underwriter guarantees to exercise all unexercised warrants delivered to them at the warrant expiration date. Underwriter will often short-sell the stock and buy rights in the secondary market ("layoff") during the offering period to the lessen uncertainty about the number of unexercised warrants they will need to exercise and to receive higher compensation. Compensation is in form of a fixed pre-commitment fee and a variable take-up fee that is proportional to the number of rights exercised by the underwriter

Private placement. An issuer privately negotiates a sale of stock to qualified investors. There are registered private placements and restricted private placements. Resale of the stock is generally restricted to other qualified investors for one year, unless the issue has an effective registration statement covering the resale of these securities. Restricted private placements are unregistered offers (no prospectus is required) that fall under Regulation D or Regulation S. Regulation S private placements are sold outside the U.S., while Regulation D allows private placements within the U.S. Regulation D prohibits an issuer from soliciting the general public under Rules 505 and 506. Under Regulation D, issuers of private placements are exempt from SEC disclosure requirements such as having a prospectus. Issuers must target mostly accredited investors (wealthy or sophisticated investors). Issuers may distribute an offering memorandum, but cannot advertise or solicit investors. If unaccredited investors participate in the offer, then the offering size is limited to $5 million under Rule 505, though the number of accredited investors also involved is unlimited. Under Rule 506, the offer size is unlimited, but the number of accredited investors is limited to at most 35

PIPE (Private investments in public equity). Private investment in public equity. A public company sells equity through a privately negotiated sale. These offering may or may not include some form of issuer price guarantee against a subsequent share price drop, but they generally include a large discount from the security's market price

Shelf issue. Financially strong public companies can register to sell up to a certain number of shares over the next two years using a list of possible underwriters. The registration allows the sale of one or more equity issues or alternatively the sale of one or more debt issues, the choice of debt or equity must be made at the filing date

Universal shelf issue. Similar to shelf issues except that the issuer can choose to sell either debt or equity

Direct public offering. Issuer sells equity directly to investors without the use of bank as a financial intermediary. If the sale involves interstate distribution of the securities, then a brief filing statement with the SEC is required. A short form registration of an offering under $5 million in a 12 month period is allowed under Regulation A. Under Regulation D, Rule 504 provides for offerings up to $1 million in a 12 month period by filing a Form D (Form D registration or small corporate offering registration (SCOR).

(*Continued on next page*)

Table 1
(*Continued*)

Best effort. Investment banks do not underwrite these security issues, instead they only guarantee to do their best to sell/market the issue. If less than a fixed percentage of an issue is sold, the entire issue is usually cancelled

DRIPS. Dividend reinvestment plans allow shareholders to buy more shares in lieu of receiving cash dividends. The shares may be sold at a small discount.

Sealed bid auction. This is a traditional method of selling IPOs. Typically a fixed number of shares are sold on a specific date, where the rules of the auction are publicly announced considerably in advance of the auction date. Sealed bids can generally be submitted over a specified period of time for a specific number of shares. The auction can be fixed price so that all accepted bids are paid the same purchase price (Dutch auction), or it can be a discriminatory auction where each accepted bid pays the bid price (Boston auction). In a nondiscriminatory auction, investors bid for parts of an issue at their bid price. Bids are ordered and a stop out price is determined where demand equals shares offered. All shares are sold at that price to those investors bidding at the stop-out price or higher. In a discriminatory auction, all offers at or above the stop-out price are accepted, but each investor pays the price they bid. Prior to the auction rules are announced concerning the bidding process, determination of the bidder purchase price and share allocation process. There are also often minimum bid price requirements. Other more complicated rules are also possible and are typically used in privatizations

with the pricing meeting and expires at the end of the offer period. Since the typical (successful) offering is fully sold out over a couple of days, the effective firm commitment guarantee period is also typically short.

The following summarizes key aspects and terminology associated with the firm commitment underwriting process.

Board of directors approval. Approval is necessary before an offering can occur and it is also necessary to get prior shareholder authorization of any shares that will be issued, though most companies typically have shareholders authorize large numbers of shares far in advance of their possible use.

Choice of lead underwriters. Competing underwriters make presentations to the issuer, though many publicly listed issuers have long standing investment banking and commercial banking relationships with one or more potential underwriters.

Advisory role of underwriters. Lead underwriters advise the issuer on the security's price, the timing of the offering, the size of the offering, desirable and undesirable offering characteristics, road show mechanics and meeting various regulatory requirements.

Syndicate formation. Lead (and co-lead) underwriters often line up other banks to help underwrite and distribute shares. Syndicate members sign legal contracts to underwrite or distribute a certain number of shares in return for underwriting and distribution fees. Lead underwriters tend to take the largest portion of the underwriting risk. In most underwriting contracts, all banks share in any loses associated with unsold shares that are later resold in the secondary market.

Syndicate roles and compensation. Lead underwriters form and coordinate syndicates and receive the management fees. Some banks share underwriting risk and underwriting fees while other banks may help distribute shares and receive distribution fees. Lee et al. (1996) discuss the typical breakdown of underwriting syndicate compensation for IPOs.

Due diligence investigation. Underwriters must investigate the issuer and certify that the issue price is fair.

Prospectus. An issuer must produce a document describing the security offering and its financial condition with the help of its underwriter. The due diligence investigation helps assemble the information needed to meet SEC filing requirements.

Registration process. An issue must be registered in advance with the SEC. This must include a preliminary prospectus or red herring and later a final prospectus. In the U.S. and many other countries this will include an initial price range for the proposed offering.

Effective date. Security registration statements that must be filed prior to a security offering are said to be effective after they are reviewed by the SEC staff and any concerns are resolved. The date of SEC approval is termed the effective date of the security offering's registration statement, after which selling of the issue can occur.

A seasoned issuer. A reporting company that is eligible to use SEC Form S-3 or F-3 to register primary offerings of securities.

A well-known seasoned issuer. Publicly listed firms (involuntary filers) eligible to issue shelf offerings, which are current and timely in their reporting obligations over the past year. They must also (1) have outstanding a minimum of $700 million of common equity market capitalization world-wide that is held by non-affiliates or (2) if they are only registering non-convertible securities other than common equity, they have issued non-convertible securities other than common equity in registered primary offerings for cash $1 billion aggregate amount of during the past three years.

Exchange listing process. An issuer may seek a preliminary assessment of whether subsequent to a successful offering its stock is likely to meet an exchange's listing requirements. Plans to list on an exchange will be reported in the registration document.

Quiet period. U.S. regulation which prohibits firms going public and their underwriters from disclosing sales and earnings forecasts not in the prospectus starting before the firm announces its IPO and ending 40 calendar days after the offer.[6] This also precludes stock analysts affiliated with an underwriter from covering the stock of an IPO for the same period.

[6] Prior to July 2002, the quiet period only lasted until 25 calendar days after the IPO.

Road show. To market a security offering, senior management and the lead underwriters travel to major cities to meet with potential investors to discuss the planned offering. An exemption to the "quiet period" regulations allows managers and underwriters to make limited oral disclosures during road show presentations, where attendance is restricted to institutional investors. However, in practice most managers and underwriters try to avoid releasing new information. Thus, this process may be more an information gathering and marketing effort by an underwriter than an information session that offers investors new information about the issuer.

Book building process. Underwriters solicit tentative offers from a select group of institutional investors and other potential investors to buy shares. Bids can be in several forms: strike bids to buy a specific number of shares at almost any market clearing price, limit bids where an investor submits a bid for a specific number of shares at a specific offer price and step-bids where an investor submits a number of limit bids for specific numbers of shares at different offer prices. The underwriter can use its allocation ability to reward investors for revealing information on demand in the book building process. Generally, investors can submit bids until the book closes and can revise or cancel their bids. This process may cause the issuer to revise the price range, which will necessitate filing an amendment with the SEC. At the end of this process the underwriters will have reasonably good estimate of institutional investor demand for the issue. Of course small retail investors may have a very different demand for the issue.[7]

Signing underwriting contract and setting the offer price. The Underwriter accepts security issue price risk when it signs the Underwriting Agreement to purchase the entire security issue at an agreed upon fixed price, usually within 24 hours of the start of the public offering. It is at this point that the final prospectus is printed. On the morning of the chosen offer date, the underwriter files a "price amendment" with the SEC on behalf of the issuer specifying the security's offer price. As Smith (1977) notes, this is similar to the underwriter selling a put option on the security issue to the issuer for a fee. Underwriters reject some potential issuers and vice versa when they disagree on the level of risk and the appropriate fee or when the underwriters are unable to meet all the potential demand for their services. Underwriters can also back out of tentative commitments to underwrite issues up until the day before the public offering date.

Allocation of offering and overselling of offering. The syndicate generally oversells the issue since the orders are not legally binding and can be withdrawn, though withdrawals are likely to trigger future loss of allocations in offerings. The lead underwriter generally determines who is allowed to buy shares in a hot offer and how much of their order is filled. These investors tend to be good (large) customers of the underwriter.

[7] For further analysis of the book building process in IPOs, see the studies by Benveniste and Spindt (1989), Benveniste and Wilhelm (1990), Cornelli and Goldreich (2001), Cornelli and Goldreich (2003) and Sherman and Titman (2002).

Some issues are also allocated to friends and family of the issuer's management and to CEOs of companies the underwriter is cultivating for future business.[8]

Public offer date activities. Underwriters confirm investor orders, allocate hot issues, and may buy shares in the secondary market to meet some of their commitments as a result of overselling the issue when the after-market price isn't rising relative to the offering price.

Analyst coverage commitment. Lead underwriters, co-managers and other syndicate members often commit to produce analyst coverage for the stock for a period after the offering. This is likely to enhance investor interest in the stock and improve the stock's liquidity. A survey of issuer managers finds that underwriter selection is strongly influenced by whether an underwriter has reputable industry analysts.[9]

Market making commitment. Lead underwriters generally commit to be active market makers in the stock for a period of time after the offering. Existing evidence shows that this market making is very important in the early seasoning of an issue, but typically declines in importance over the first year following listing. This market making activity is typically profitable for the lead underwriter.[10]

Price support. Lead underwriters often place limit orders to buy shares immediately after an offering without being subject to price manipulation restrictions. If an underwriter oversells an offering, which afterwards drops in price, then the underwriter can buy additional shares in the secondary market at a price at or below the offering price, rather than exercise its over-allotment option to buy additional securities from the issuer. This has the effect of supporting the secondary market price and avoids adding more shares into the secondary market. If the secondary market price rises relative to the offering price, then no price support activity is necessary. Instead, the underwriter can meet its commitments to customers of oversold issues by exercising its over-allotment options to buy shares at the offer price net of the underwriter discount.[11]

Lock-up agreements. Insiders and other large holders such as venture capitalists commit not to sell their shares for a period of time after the offering. The typical lock-up period is 180 days for IPOs. If the secondary market reception for the issue is very strong, the agreements may be terminated early.[12]

Insider trading regulation. U.S. SEC Rule 10b-5 prohibits a person in possession of material non-public information from using it to buy or sell company securities or to tip

[8] See Cornelli and Goldreich (2001, 2003) and Jenkinson and Jones (2004) for evidence on the book building and share allocation process and Loughran and Ritter (2002) for evidence of spinning.

[9] See Krigman, Shaw, and Womack (2001) and Brau and Fawcett (2006).

[10] For an analysis of post-IPO market making by underwriters see (Ellis, Michaely, and O'Hara, 2004).

[11] Price support or stabilization activity for IPOs is studied by Aggarwal (2000), Boehmer and Fishe (2003) and Cotter, Chen, and Kao (2004) and Lewellen (2006).

[12] The lock-up process and its expiration effects are studied by Brav and Gompers (2003), Field and Hanka (2001), Field, Cao, and Hanka (2004) and Brau, Lambson, and McQueen (2005).

others who do so. There is also a filing requirement after the sale or purchase by insiders of the firm's securities.

2.2.2. Other major flotation methods

Table 1 gives a summary of the various flotation methods available for security offerings. A more detailed description of these flotation methods follows.

In a "rights offer" current shareholders are given the right to purchase a (pro rata) portion of a new equity issue at a fixed price. A rights offer in the U.S. typically expires after a period of typically one month. The rights offer price is initially set at a discount from the current market price, but if the market price falls, the rights offer can end up being at a premium, which is likely to result in offer undersubscription or offer failure. Thus, a rights offer is like a short-lived in-the-money warrant distributed to current shareholders in the same manner as a stock dividend. It is also similar to a stock dividend in that the sale of new shares at a discount has the effect of diluting the current share price. Rights may or may not be transferable and unsubscribed rights may be reallocated among subscribing shareholders. In these non-underwritten offers, the issuer bears a risk of offering failure, but this risk can be reduced by increasing the size of the offering price discount.

In a "standby rights offer" the firm making the rights offer hires an underwriter to "stand by" and guarantee to take up whatever portion of the rights offer shareholders leave unsubscribed. The standby underwriter as a consequence bears price risk, and carries out a due diligence investigation and may pursue a book building process described above for firm commitment offerings. For these services, the underwriter charges a fixed "standby" fee. In addition, the underwriter typically charges a "takeup" fee on each share taken up under the guarantee. If there is a secondary market in the rights, it is common for the underwriter to be the primary purchaser of these rights.

In a private placement, the firm places the entire issue with a single investor or consortium of investors, bypassing current shareholders. As listed in Table 1 and discussed above, such issues are subject to a number of regulations primarily designed to protect investors.

A "shelf" offering refers to an issue that has been pre-registered with the SEC. With the introduction of SEC Rule 415 in 1983, financially strong companies are allowed to sell up to a certain number of shares over the next two years using a list of possible underwriters. Thus, shelf registration increases the flexibility and speed of issue over a two-year period.

Auctions present another mechanism for selling equity. This method is only rarely used in the U.S. (it was used recently by Google), but has been an important method in certain international markets including France. The auction design is flexible, but the most common is a sealed bid auction where all accepted bids pay the same price. There are often minimum bid (reserve) price requirements (see Dasgupta and Hansen (2007) and Jagannathan and Sherman (2006) for details on IPO auction procedures).

Table 2
Flotation methods used to sell various types of securities

Security type	Flotation method
IPOs	Firm commitments, Auctions, Direct offerings, Private placements, Best efforts, Privatization methods, Mutual to stock conversions
SEOs	Firm commitments, Shelf issues, Universal shelf issues, Private placements, Direct offerings, Rights, Standbys, Auctions, Best efforts, Equity financed acquisitions, PIPES, DRIPS, ESOPs, Equity based bonus plans, Equity for debt exchange offers and swaps, Privatization methods
Convertible offers	Firm commitments, Private placements, Auctions, Direct offerings, Shelf issues, Universal shelf issues, Convertible debt for equity exchange offers and swaps, Convertible debt financed acquisitions
Debt offers	Firm commitments, Private placements, Auctions, Shelf issues, Universal shelf issues, Debt for equity exchange offers and swaps, Debt financed acquisitions
Private debt	Direct offerings, Private placements, Venture capital
Private equity	Direct offerings, Private placements, Venture capital

A detailed economic analysis of the flotation method choice is given in Section 4, below. As indicated there, the importance of the various flotation methods listed in Table 1 varies across countries, with issuers in larger capital markets exhibiting different preferences than those in smaller capital markets. In the U.S. nearly all IPOs are sold through a book building mechanism. Internationally, a firm commitment contract with book building is the dominant IPO issuance method in most large capital markets, while auction methods are dominant in smaller capital markets with more concentrated share ownership. For evidence that IPO flotation methods vary across countries, see the survey of international IPOs by Loughran, Ritter, and Rydqvist (1994), and Ritter (2003).

Table 2 describes the flotation methods used to sell various types of securities. As the table highlights, seasoned equity issues and debt issues use a wider array of offering methods. Debt offerings tend to rely on the same flotation methods as seasoned equity issues. In the U.S., the primary SEO flotation methods are: firm commitment underwritten offers (either syndicated or not, U.S. or global), shelf registered offers (either equity or universal), standby underwritten rights offers, rights offers, best efforts, direct issues and private placements. Outside the U.S., the primary flotation methods used are rights and standby offers, however, auctions, bought deals, installment sales and other methods are also important. Some capital markets have their own particular flotation methods including the U.K., France and Singapore. Privatization methods tend to be very idiosyncratic across countries as is highlighted in a survey by Megginson and Netter (2001).

IPO flotation methods vary across capital markets of differing size as discussed in Loughran, Ritter, and Rydqvist (1994), and Ritter (2003). In the U.S. nearly all IPOs

are sold through a book building mechanism. Internationally, the firm commitment book building method is dominant in most large capital markets, while auction methods are dominant in smaller capital markets with more concentrated share ownership, though there is some question as to whether auctions are successful more because book building is unavailable due to regulation or minimum offer size. Jagannathan and Sherman (2006) examine why IPO auctions are unsuccessful in the U.S. market.

2.3. Aggregate issuance activity, U.S. 1980–2003

2.3.1. Offering frequencies and cash proceeds

In order to understand the patterns in security issuance activity by U.S. firms, we start with the grand population of 91,455 issues from the SDC over the period 1980–2003. We then eliminate 8,173 issues for which we are unable to match the issuing firm's name and Cusip number in Thomson Financial's SDC database with a corresponding exchange-listed firm name on the University of Chicago CRSP daily stock master file for the issue year. This leaves a total of 83,282 issues for analysis. We then restrict our focus to the following seven major security classes:

(1) Public offerings of straight debt ($N = 37{,}398$, of which 18,662 are shelf offerings),
(2) Private placements of straight debt ($N = 17{,}948$, of which 5,983 are reg-144A offerings),
(3) SEOs ($N = 11{,}151$, of which 1,645 are shelf offerings),
(4) Equity IPOs ($N = 9{,}987$, of which 1,063 are "unit" offerings–with warrants),
(5) Private placements of equity ($N = 2{,}145$, of which 83 are SEC regulation 144A offerings),
(6) Convertible debt offerings ($N = 1{,}545$), and
(7) ADRs (American depository receipt stock offerings, $N = 453$).

After excluding 2,655 "other" security issues, we are left with a sample of 80,627 security offerings.

Table 3 shows the annual frequency of offerings across the seven major security offering categories. A number of regularities emerge from this table:

- For both IPOs and SEOs, the number of issues exceed 600 in years 1983, 1993, 1996 and 1997 (particularly "hot" issue markets).
- The total number of straight debt offerings outnumber the total number of SEOs by approximately three to one (37,298 vs. 11,151).
- Firms use the shelf registration procedure for approximately half of the debt issues (18,662 of 37,398), while fifteen percent of the SEOs are shelf issues (1,645 of 11,151).
- Straight debt is issued through private placements in one-third of the offerings (17,948 of 55,346 straight debt offerings), while one in six equity issues are sold in private placements (2,145 of 13,296 seasoned equity issues).
- In approximately ten percent of the IPOs, the stock is sold with stock warrants, which is termed a unit offering.

Table 3
Annual distribution of the population of 80,627 security issues in the U.S., 1980–2003

Year	Equity IPOs			Seasoned equity offerings			Public straight debt offerings		
	All	Regular	Unit	All	Regular	Shelf	All	Regular	Shelf
1980	127	108	19	382	382	0	314	314	0
1981	303	267	36	416	416	0	254	254	0
1982	117	98	19	444	417	27	375	226	149
1983	659	574	85	813	672	141	324	135	189
1984	332	261	71	251	242	9	376	164	212
1985	339	287	52	400	391	9	554	251	303
1986	675	584	91	507	500	7	860	322	538
1987	529	447	82	314	311	3	626	232	394
1988	276	234	42	140	139	1	529	197	332
1989	237	183	54	230	229	1	555	202	353
1990	205	175	30	188	184	4	468	146	322
1991	398	349	49	508	498	10	1327	627	700
1993	805	729	76	736	706	30	1789	953	836
1994	631	539	92	474	438	36	1597	676	921
1995	572	508	64	619	535	84	2253	945	1308
1996	857	785	72	767	674	93	2626	1084	1542
1997	606	570	36	736	518	218	3440	1493	1947
1998	380	371	9	562	360	202	3704	1634	2070
1999	531	523	8	438	354	84	3488	2051	1437
2000	382	378	4	397	304	93	3172	1953	1219
2001	126	119	7	427	244	183	2873	1680	1193
2002	169	166	3	422	255	167	2596	1410	1186
2003	128	128	0	502	267	235	2160	1197	963
All	9987	8924	1063	11151	9506	1645	37398	18736	18662

Year	PP straight debt			PP common stock			Conv. debt	ADR
	All	Regular	Reg-144a	All	Regular	Reg-144a		
1980	2	2	0	0	0	0	93	2
1981	365	365	0	29	29	0	88	1
1982	429	429	0	34	34	0	66	3
1983	462	462	0	51	51	0	113	10
1984	408	408	0	37	37	0	66	9
1985	553	553	0	69	69	0	138	2
1986	735	735	0	67	67	0	203	6
1987	864	864	0	53	53	0	146	16
1988	1160	1159	1	80	80	0	35	8
1989	971	971	0	99	99	0	61	8
1990	907	892	15	69	66	3	33	2
1991	987	870	117	90	77	13	49	12
1992	956	764	192	89	84	5	63	19
1993	1234	806	428	96	88	8	89	39

(*Continued on next page*)

Table 3
(*Continued*)

Year	PP straight debt			PP common stock			Conv. debt	ADR
	All	Regular	Reg-144a	All	Regular	Reg-144a		
1994	906	639	267	93	75	18	33	49
1995	623	413	210	64	60	4	30	34
1996	623	294	329	50	49	1	44	69
1997	865	290	575	58	58	0	43	56
1998	1006	309	697	49	40	9	23	19
1999	812	252	560	66	64	2	27	23
2000	543	126	417	89	87	2	31	19
2001	833	142	691	265	258	7	43	13
2002	705	103	602	256	249	7	11	15
2003	999	117	882	292	288	4	17	19
All	17948	11965	5983	2145	2062	83	1545	453

The SDC source contains a total of 91,455 issues over the 24-year sample period. Of these, 8,173 are excluded as the issuing firm could not be identified on the University of Chicago CRSP file using the SDC name and Cusip number and the CRSP Permno. Moreover, another 2,659 offerings are excluded as they do not belong to any of the issue categories shown below. "PP" denotes private placement; "Unit" offerings are equity offerings with warrants; "Shelf" offerings are pre-registered under SEC Rule 415; "ADR" denotes American depository receipt; and "Reg-144a" denotes private placement to a qualifying investor under SEC regulation 144a.

- Convertible debt issues represent only three percent of all debt issues (1,545 of 56,891) and has remained relatively stable in annual terms since 1990.
- ADRs represent 4% of all SEOs and have remained relatively stable in annual terms since 1991.

Table 4 provides the annual distribution of offering proceeds (in $billion) from the offerings in Table 3. Over the 24-year period, the proceeds from all offerings are in excess of $12 trillion. Dividing through by the total number of issues reveals the following interesting regularities concerning average issue sizes:

- The average IPO is 21% smaller than the average SEO: $68 vs. $86 million.
- The typical public debt issue is about three times the average SEO: $230 vs. $86 million.
- Private placement issues are roughly half the size of public issues: $46 vs. $86 million for SEOs, and $122 vs. $230 million for public debt issues.
- For SEOs, shelf offerings are on average twice as large as traditional registered offerings: $149 vs. $75 million.
- For public offerings of straight debt, shelf issues are on average slightly smaller than traditional registered offerings, $211 vs. $250 million.
- Convertible debt issues are of the same average size as the privately placed straight debt issues: $119 vs. $122 million.

Table 4
Annual distribution the total of $12,820 billion issue proceeds from the population of 80,627 U.S. security issues, 1980–2003 (all numbers in $billion)

Year	Equity IPOs			Seasoned equity offerings			Public straight debt offerings		
	All	Regular	Unit	All	Regular	Shelf	All	Regular	Shelf
1980	1.23	1.15	0.08	11.57	11.57	0.00	32.26	32.26	0.00
1981	2.96	2.76	0.19	12.17	12.17	0.00	26.69	26.69	0.00
1982	1.33	1.27	0.06	15.33	13.48	1.84	32.47	18.59	13.87
1983	12.37	12.02	0.35	25.80	19.06	6.73	30.69	11.36	19.33
1984	3.83	3.53	0.30	6.14	5.63	0.50	46.12	20.05	26.08
1985	8.44	8.10	0.34	16.40	15.58	0.83	66.56	25.89	40.67
1986	21.57	21.21	0.36	21.04	20.52	0.52	130.61	45.60	85.00
1987	23.88	23.44	0.45	17.34	17.23	0.10	97.65	37.04	60.61
1988	23.75	23.44	0.31	6.13	6.08	0.04	88.26	36.24	52.02
1989	13.39	13.16	0.23	9.35	9.28	0.07	94.56	36.01	58.55
1990	10.11	9.92	0.19	9.04	8.93	0.11	79.40	21.36	58.04
1991	25.71	25.37	0.34	33.38	32.09	1.28	164.12	62.90	101.22
1992	40.30	39.68	0.62	34.29	33.41	0.88	235.56	99.52	136.04
1993	56.45	55.89	0.56	49.75	45.80	3.94	316.84	147.13	169.71
1994	33.32	32.65	0.67	31.83	27.76	4.08	243.10	130.09	113.02
1995	30.14	29.36	0.77	52.23	44.47	7.76	350.95	189.06	161.90
1996	49.50	48.74	0.75	66.36	56.44	9.92	410.91	228.62	182.28
1997	41.04	40.61	0.43	75.05	48.97	26.08	542.47	297.81	244.66
1998	42.60	42.50	0.10	62.06	41.89	20.16	799.35	431.16	368.19
1999	59.37	59.29	0.07	86.95	67.79	19.16	845.74	491.40	354.34
2000	54.43	54.40	0.03	99.19	70.20	28.99	835.86	444.07	391.79
2001	38.39	38.07	0.32	78.05	39.00	39.06	1075.83	594.64	481.19
2002	42.08	41.96	0.12	68.59	32.76	35.83	974.32	560.79	413.54
2003	40.87	40.87	0.00	70.99	35.51	35.48	1107.35	701.98	405.37
All	677.05	669.40	7.65	959.00	715.64	243.36	8,627.70	4,690.26	3,937.43

Year	PP straight debt			PP common stock			Conv. debt	ADR
	All	Regular	Reg-144a	All	Regular	Reg-144a		
1980	0.08	0.08	0.00	0.00	0.00	0.00	4.23	0.09
1981	10.89	10.89	0.00	0.16	0.16	0.00	4.57	0.06
1982	15.63	15.63	0.00	0.27	0.27	0.00	3.18	0.19
1983	21.24	21.24	0.00	0.34	0.34	0.00	6.11	0.62
1984	25.31	25.31	0.00	0.60	0.60	0.00	4.09	0.61
1985	43.63	43.63	0.00	1.31	1.31	0.00	7.10	0.03
1986	65.52	65.52	0.00	1.78	1.78	0.00	9.71	0.37
1987	65.67	65.67	0.00	2.12	2.12	0.00	9.68	4.40
1988	102.10	101.61	0.48	2.84	2.84	0.00	3.14	1.10
1989	99.64	99.64	0.00	7.27	7.27	0.00	5.42	0.91
1990	66.54	64.51	2.03	3.83	3.79	0.03	4.76	0.14
1991	56.46	48.64	7.83	4.03	2.62	1.41	7.83	3.13
1992	52.82	35.98	16.84	3.86	3.48	0.39	6.71	4.23

(*Continued on next page*)

Table 4
(*Continued*)

Year	PP straight debt			PP common stock			Conv. debt	ADR
	All	Regular	Reg-144a	All	Regular	Reg-144a		
1993	81.97	41.58	40.39	3.28	1.86	1.42	9.41	7.26
1994	56.82	29.67	27.15	2.62	0.88	1.75	4.42	8.63
1995	50.67	23.10	27.57	2.20	1.80	0.39	6.31	5.18
1996	65.01	19.10	45.91	4.99	4.95	0.04	6.69	10.48
1997	134.73	18.36	116.37	5.55	5.55	0.00	8.97	9.85
1998	189.95	30.07	159.88	5.89	5.46	0.43	14.22	8.09
2000	170.50	11.46	159.04	9.70	9.48	0.22	15.58	7.92
2001	277.67	15.16	262.51	13.74	10.94	2.79	18.54	4.20
2002	135.79	10.88	124.91	7.52	6.73	0.78	7.74	4.85
2003	206.00	15.54	190.46	7.12	6.54	0.58	9.67	5.46
All	2,181.79	841.98	1,339.81	98.36	84.66	13.70	183.60	92.08

"PP" denotes private placement; "Unit" offerings are equity offerings with warrants; "Shelf" offerings are pre-registered under SEC Rule 415; "ADR" denotes American depository receipt; and "Reg-144a" denotes private placement to a qualifying investor under SEC regulation 144a.

- ADRs have a relatively larger average size of $203 million, compared to SEO average proceeds of $86 million.

Figure 1 and Figure 2 show the distribution of total issue proceeds across three categories of issuers: industrial firms, banks and financial institutions, and public utilities.[13] Industrial firms are by far the dominant issuers of SEOs throughout the entire 24-year period (Figure 1). Banks and financial institutions are a distant second, with utilities are a very distant third. Both industrial firms and banks/financial institutions have substantially greater total issue proceeds in the second half of the sample period.

On the debt side, banks and other financial institutions greatly dominate the amount raised from public offerings of straight debt (part (a) of Figure 2). Here industrial firms and utilities are a distant second and third. For private placements of debt, however, industrial issuers dominate, with banks and financial institutions a close second. As with equity issues, the proceeds from both public and private debt issues are substantially greater in the second half of the sample period.

2.3.2. Time from IPO to follow-on offerings

The need for new capital is undoubtedly a key motivation to go public for many private companies. The immediate need for capital is covered by the proceeds from the IPO—but, equally important, a public company subsequently has better access to the capital markets. This section reviews evidence on how rapidly new public companies in fact do come back to the market with a follow-on offering.

[13] Notice the different scales across the vertical axis of the three figures.

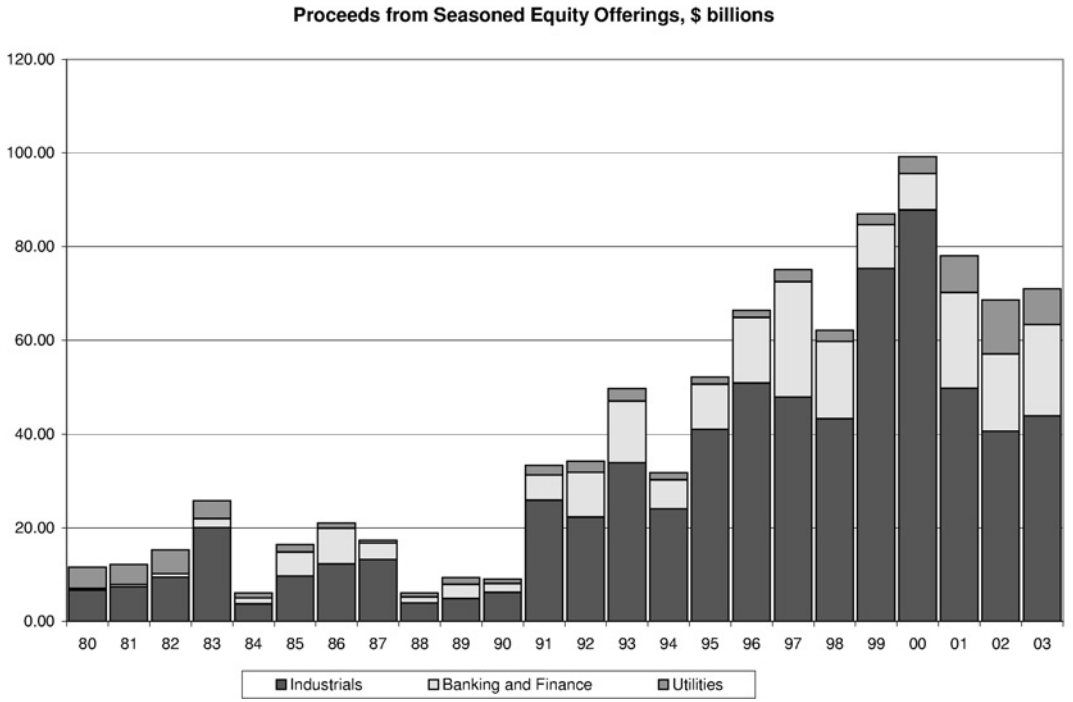
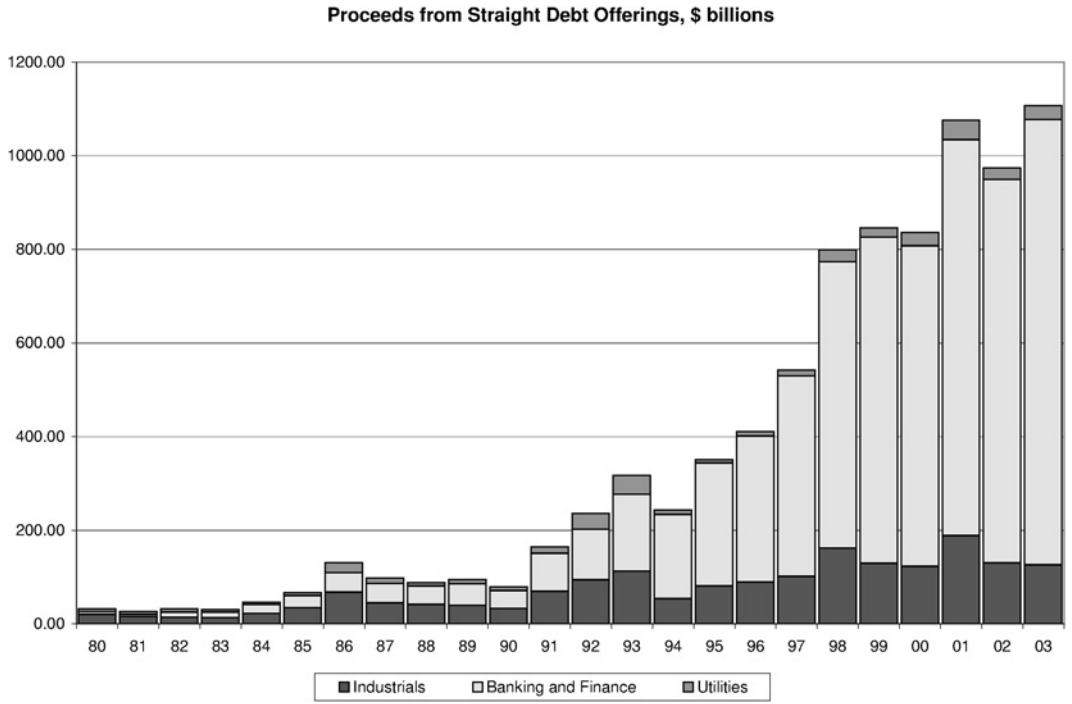
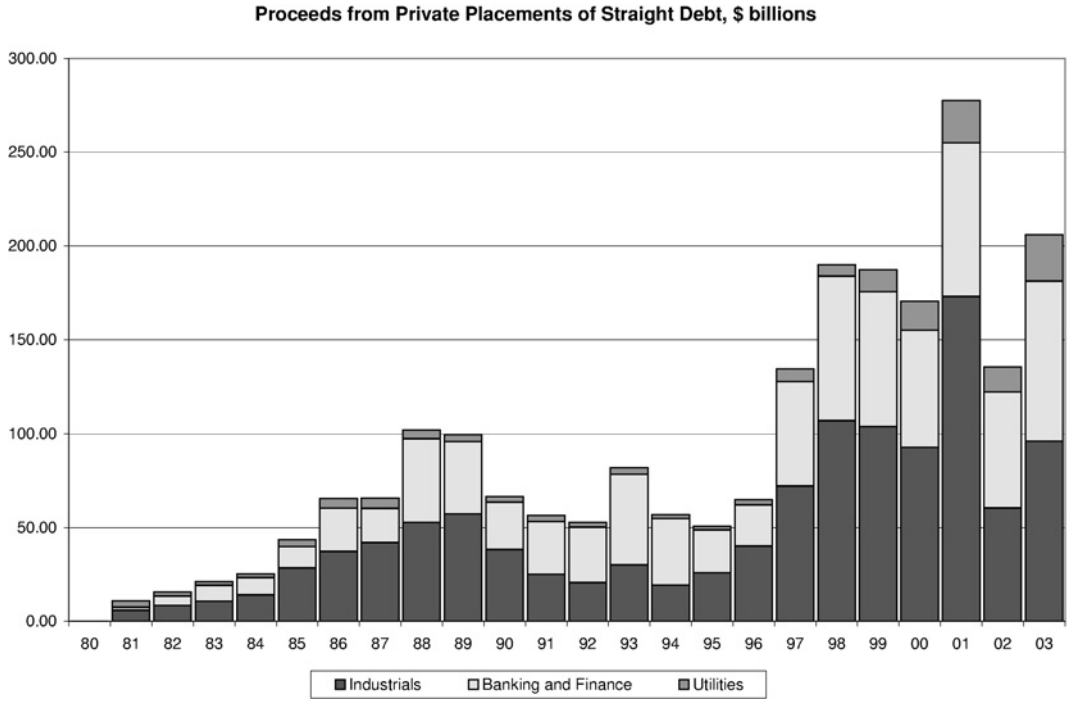


Fig. 1. Annual distribution of total issue proceeds in 11,151 SEOs by U.S. issuers, classified by whether the issuer is an Industrial Company, a Bank or Financial Institution, or a Public Utility, 1980–2003.



(a)

Fig. 2. Annual distribution of total issue proceeds in 37,398 public and 17,948 private issues of straight debt by U.S. companies, classified by whether the issuer is an Industrial Company, a Bank or Financial Institution, or a Public Utility, 1980–2003.



(b)

Fig. 2. (*Continued*)

Table 5
Time between an IPO and follow-on offerings, conditional on observing at least one follow-on offering, classified by security type, 1980–2000

	N	Mean	Std. Dev.	Min	Max
A. First post-IPO issue regardless of security type					
Seasoned equity offerings	1724	2.31	2.50	0.18	15.26
Private placement of equity	119	2.81	2.30	0.00	11.60
Preferred equity	61	2.64	2.61	0.07	10.98
Convertible debt	129	1.95	1.98	0.21	12.21
Private placement of debt	353	2.52	2.62	0.01	13.86
Straight debt	124	2.27	2.41	0.00	12.47
Overall	2531	2.35	2.51	0.00	16.44
B. First post-IPO issue conditional on security type					
Seasoned equity offerings	2665	3.30	3.26	0.13	19.70
Private placement of equity	214	3.80	3.11	0.00	18.70
Preferred equity	142	4.22	3.33	0.07	13.40
Convertible debt	315	3.62	3.15	0.21	15.58
Private placement of debt	1230	4.49	3.60	0.01	18.26
Straight debt	514	5.28	4.05	0.00	18.02

Source: Eckbo and Norli (2006). The table reports the number of calendar days between a firm's IPO date and the date of subsequent security offerings. The restriction that there must be at least one follow-on offering before 12/2000 (regardless of security type) restricts the sample from 6,092 to 2,531 IPOs. Panel A lists the time between the IPO and the first follow-on issue regardless of the type of security issued. Panel B shows the time between the IPO date and the date of the follow-on issue given that the security is of the type listed in the panel. N is the number of security offerings after the IPO. For example, Panel B shows that there are a total of $N = 2{,}665$ (or 28%) SEOs following the 6,092 IPOs over the sample period.

Table 5, which appears in Eckbo and Norli (2006), shows descriptive statistics for follow-on security offerings made by 6,092 firms that went public during the period 1980–2000. A total of 3,579 firms (approximately 59%) do *no* follow-on offering during the sample period. Since firms going public in the last part of the sample period would have little time to do a follow-on offering, this number overstates the true fraction of non-follow-on firms. However, restricting the sample to the 3,750 IPOs that were completed in the period 1980–1993, which insures a minimum seven-year post-IPO period, a total of 1,977 firms (53%) did no follow-on offering during the interval 1980–2000. Overall, it appears that only one of two firms undertaking an IPO comes back to raise capital externally through a public security offering.[14]

[14] Firms that delist in the first few years after their IPO are even less likely to have any follow-on offerings. See Fama and French (2004) for information on survival frequencies in the population of listed firms. Eckbo and Norli (2005) show that delistings of IPO firms due to either acquisitions or bankruptcies in the first five years after the IPO is indistinguishable from the delisting frequency of seasoned firms matched on size and book-to-market ratio.

Panel A of Table 5 reports the average number of years between the IPO offer date and the first post-IPO security offering. In the sample of 6,092 IPOs, there are 1,724 firms that follow the IPO with a SEO as the first post-IPO security offering. The average number of years between the IPO and the SEO is 2.31 years. Panel A also shows that the SEO is the most common type of security offering to be made after the IPO. The second most common "first post-IPO offering" is a private placement of debt: 353 firms follow the IPO with this type of security.

The time from the IPO to the first security offering varies little across security types. The average time between the IPO and the follow-on security offering ranges from 1.95 years for convertible debt to 2.81 years for private placement of equity. Excluding convertible debt, the remaining five securities are offered on average between 2.27 and 2.81 years after the IPO. As suggested by Eckbo and Norli (2006), it appears that it takes on average 2.35 years to burn through the IPO proceeds, after which time companies may be selecting the security offering that minimizes issue costs.

Panel B of Table 5 reports the average number of years between the IPO and the first offering of security type j—regardless of whether or not security offering j is the first to follow the IPO. Again, conditional on observing an IPO during the sample period, the most frequent security offering in our sample is SEOs. However, it is clear that if one does not condition on observing an IPO, the most common security offered is debt. As expected, the average number of years from the IPO to a specific security offering is longer than in Panel A of Table 5. The reason is that in Panel A each offering is required to be the first offering after the IPO. Panel B shows that following an equity IPO a convertible debt offering typically occurs sooner than a straight debt offering.

The finding that only one in two firms undertake a follow-on offerings is interesting. Although private firms almost certainly go public partly to get access to public security markets, external security issues (for cash) may be costly relative to internal financing. As discussed in Myers and Majluf (1984) and in Section 4 below, information asymmetries between the issuer and investors purchasing the issue may give rise to issue costs. These issue costs are found to be roughly proportional to the ex ante risk that an issue is overpriced, which leads Myers and Majluf (1984) to propose a financing pecking order. Internal equity (retained earnings) tops the pecking order, followed by debt securities and, finally, by external equity issues.

As surveyed by Frank and Goyal (2007), one prediction of the pecking order model is that debt ratios should be driven by the need for external funds. For example, the debt ratio should increase when firms experience a "financing deficit" (when retained earnings are insufficient to cover investment outlays). Shyam-Sunder and Myers (1999) find evidence consistent with this prediction. However, Frank and Goyal (2003) and Fama and French (2005) reach a different conclusion. Using a different sample than Shyam-Sunder and Myers (1999), Frank and Goyal (2003) find instead that net equity issues track financing deficits more closely than do net debt issues. Fama and French (2005) construct a measure of equity issues that includes any transaction that increases the split-adjusted number of shares outstanding. In addition to public equity offers for cash, such transactions include stock issues to employees, stock financed mergers, and

rights offerings and direct purchase plans. Fama and French (2005) document that under their measure of equity issues, equity offerings are commonplace. For the three ten-year periods between 1973–2002 the authors find that 54%, 62%, and 72% of sample firms make net equity issues *every year*. They interpret this finding as a violation of the pecking order theory.

However, it is not clear that the evidence in Fama and French (2005), or studies of the Shyam-Sunder and Myers (1999) type of financing deficit, have the requisite power to reject the (basic) pecking order theory. Recall that this theory requires asymmetric information between the issuer and the investor purchasing the issue. A large proportion of the equity issues identified by Fama and French (2005) are stock swaps in mergers and acquisitions as well as stocks issued as part of employee compensation plans. It is difficult to imagine that stocks issued to CEOs give rise to adverse selection costs. Moreover, the ample opportunities for information exchange during merger negotiations also reduce adverse selection costs driven by information asymmetries. Also, given the *two-sided* information asymmetry associated with a stock exchange merger (the true value of the target shares is unknown to the bidder and vice versa), there is theoretical support for the proposition that the bidder prefers equity over cash or debt as the form of payment (see Eckbo, Giammarino, and Heinkel (1990) and the survey by Betton, Eckbo, and Thorburn (2007)). In sum, absent the requisite one-sided information asymmetry depicted in the original paper of Myers and Majluf (1984), evidence on the frequency of equity issues per se may have little power to test the pecking order. Of course, an equity issue for cash *does* satisfy this particular information asymmetry requirement since the value of cash is known to both sides of the transaction. As shown by Eckbo and Norli (2006) (Table 5 above), external equity issues for cash are indeed rare. This is consistent with the presence of external financing costs emanating from asymmetric information—as emphasized under the pecking order theory.

3. Flotation costs

To the extent that corporations choose among alternative financing methods so as to maximize the expected net proceeds of security offerings, flotation costs can have a large bearing on the choices an issuer makes. Broadly speaking, expected flotation costs includes components such as the expected issue announcement effect, expected underpricing, underwriter spread, expected out of pocket expenses, the probability of offer cancellation multiplied by the expected cost of cancellation,[15] and any short term incremental costs or benefits (if any) of moving away or towards a firm's target leverage ratio.

There is some disagreement on whether a security announcement is an expected flotation cost. Some researchers argue that a security offering announcement effect simply

[15] The expected cost of offer cancellation includes the loss of out of pocket expenses, management time and the expected opportunity costs of forgoing profitable investment projects if the offering isn't resurrected later.

conveys negative information about the issuing firm that managers alway knew, which would become public at some future date anyway, so why should it represent an issue cost? In contrast, other researchers view this announcement effect as capitalizing the direct and indirect effects of raising new equity capital, including empire building. At this point, we don't have resolution on this question. However, what we do know is that the typical negative announcement effect represents an expected permanent drop in the issue price. Furthermore, we view the early revelation of negative information about the issuer as an expected issue cost as well, as would any shareholder selling in the secondary market thereafter and as would any blockholder selling shares in a secondary offering. Evidence about security offering announcement effects is discussed extensively in Section 4, below.

While expected flotation costs tend not to change much over short time periods, market conditions and the firm's financial condition as well as the quality of publicly available information about the firm are all likely to vary substantially over longer periods of time (several years). For example, there are distinct differences in the level of underpricing needed to float a security issue and sizable differences in the likelihood of offer cancellation, both of which depend on current market conditions. Furthermore, our sample period has witnessed significant changes in securities regulations (such as shelf registration) and the competitive structure of the underwriting market—with the entry of commercial banks, investment banking industry consolidation and the increased internationalization of the security offering process—which can alter the level of underwriter competition and the pricing of their services.

Expected flotation costs also vary across firms at any point in time, depending of the characteristics of the issuers and the security offering. Thus, knowing these characteristics allows us to better forecast the expected flotation costs an issuer will bear from making a particular security offering. In the discussion to follow, we examine the existing evidence on the determinants of several of the flotation cost components.

3.1. Total flotation costs

Flotation costs are made up of direct costs and indirect cost of selling a security through a public offering, where the direct costs include underwriter compensation, registration and listing fees, legal, accounting and printing expenses, etc. Underwriter compensation is made up of several components, the most important being the underwriter's gross spread or the difference between the public offering price and the underwriter purchase price. The other components of underwriter compensation include: an over-allotment option (typically this is a one month warrant to purchase an additional 15 percent of shares at the same price as the offering itself), plus long term warrants exercisable at the offer price, and extra reimbursements of underwriter expenses by the issuer.

Security sales also involve indirect flotation costs. The most important indirect cost is the typical underpricing costs associated with selling a security at a discount relative to both its prior trading day's closing price and its closing market price immediately following the public offering. Since an underwriter can allocate the issue, it is possible

for an underwriter to capture much of the value associated with security offer underpricing. The effect of a security issue announcement on its offering price and the expected cost of a security issue delay or withdrawal are also potentially important indirect costs, which are discussed below. Finally, management time and energy devoted to the offering process is yet another significant, but hard to quantify indirect cost.

To summarize, expected flotation costs can be separated into direct and indirect cost components. Direct flotation costs are composed of:

- Fees to underwriters (including warrants and over-allotment options).
- Other out of pocket expenses, which include fees to accountants, law firms, listing fees, registration fees, printing, advertising as well as *road show* expenses and the cost of management time.

Indirect flotation costs include

- Issue underpricing, which can potentially be captured by underwriters through their power to allocate the issue to preferred customers and affiliates.
- Stock price reactions to initial offering announcements, which on average are negative, and any follow up announcements concerning changes in offer size and other characteristics.
- Costs of offering delays/cancellations.

Most of the extant literature focuses on the size and determinants of underwriting discounts (or fees) and security offering underpricing of equity offerings.

Early research on SEO flotation costs was conducted by the SEC staff in a series of studies and later by Smith (1977), who examined mean underwriter fees and other expenses. These two direct flotation cost components were examined across issue size categories and three major flotation methods. Flotation costs as a percent of gross proceeds were observed to fall with a rise in issue size. In addition, these costs were found to vary with flotation method for comparable size offers; more specifically, underwriter fees and other expenses were largest for firm commitments and cheapest for rights offers. Smith raised the question of why most U.S. firms appear to choose the highest cost flotation method and explored a number of possible added costs and benefits associated with each of these flotation methods. He was unable to explain away the puzzle. The question of whether there is a comparative advantage for alternative flotation methods was first raised by Hansen and Pinkerton (1982). A complication in undertaking this analysis is that the flotation method is an endogenous issuer decision, which could produce selection biases across the samples. These issues were more extensively studied by Eckbo and Masulis (1992) who re-examine the question of whether issuing firms fail to choose the flotation method that maximizes the net proceeds from their security sales. They uncover evidence consistent with the hypothesis that firms' choices do maximize net proceeds (further details on this issue are given in Section 4 below).

The issuer type and the flotation method choice generally affect both direct and indirect flotation costs of a particular security offering. As summarized in Table 6, in their sample of 1,249 SEOs over the period 1963–1981, Eckbo and Masulis (1992) report that the average direct cost of uninsured rights as a percent of total issue

Table 6
Total direct issue costs for U.S. issuers of seasoned equity, classified by issuer type and flotation method

	Firm commitments		Standby rights		Uninsured rights	
Flotation costs	Ind	Utl	Ind	Utl	Ind	Utl
Number of observations	351	639	42	89	26	23
Underwriter compensation ($ millions)	47 (1.03)	1.78 (1.32)	1.20 (0.47)	0.56 (0.34)	–	–
Other expenses ($ millions)	0.16 (0.15)	0.14 (0.12)	0.36 (0.19)	0.38 (0.29)	0.11 (0.09)	0.45 (0.19)
Total costs ($ millions)	1.72 (1.28)	1.92 (1.45)	1.59 (0.68)	0.94 (0.72)	0.11 (0.09)	0.45 (0.19)
Total costs/ gross proceeds (%)	6.09 (5.53)	4.23 (3.82)	4.03 (3.32)	2.44 (2.07)	1.82 (0.94)	0.51 (0.22)
Total costs/ market value common (%)	1.05 (0.68)	0.49 (0.41)	0.93 (0.57)	0.22 (0.18)	0.80 (0.30)	0.05 (0.02)

Source: Eckbo and Masulis (1992). The sample size is 1,249 SEOs and the sample period 1963–1981. "Ind" denotes industrial issues and "Utl" denotes public utility. Data sources in the original study are the SEC Registered Offerings Statistics data tape and issue prospectuses. The cost of the offer price discount in firm commitment offers is not included, nor is the value of any "Green Shoe" options. In the standby rights category, the underwriter's compensation is computed using the actual takeup fee based on subscription information.

proceeds is 1.82% for industrial issuer and 0.51% utility issuers. Despite a subscription rate that typically exceeds 70% (Hansen and Pinkerton, 1982; Eckbo and Masulis, 1992; Singh, 1997), the cost of standbys average as much as 4.03% of gross proceeds for industrials and 2.44% for utilities. Firm commitment offerings are the most expensive with average direct costs of 6.09% and 4.23% for industrial and utility issuers, respectively. Smith (1977), Hansen (1988) and Singh (1997) also presents costs of standby rights offerings consistent with those in Table 6. Furthermore, the low-cost status of uninsured rights holds internationally as well (e.g., Bøhren, Eckbo, and Michalsen, 1997; Slovin, Sushka, and Lai, 2000; Gajewski and Ginglinger, 2002).

Eckbo and Masulis (1992) also report that the average underpricing of SEOs in their firm commitment sample is very close to zero over their sample period (typically, the issue was offered at the previous closing price). As discussed below, this has since changed: it is now common to underprice a firm commitment SEO. Since current shareholders in a rights offer capture the value of underpricing through the value of the right, the development of underpricing in firm commitment SEOs further exacerbatesthe direct-cost disadvantage of this flotation method. It is clear that rights have lowest

direct costs, while commitments is a firm's most expensive method, with standby rights in between.

Keep in mind that when comparing the costs of alternative flotation methods, one must control for firms' self-selection of the issue method. For example, as Hansen and Pinkerton (1982) point out, it is possible that observed flotation costs of uninsured rights are particularly low because this method is selected when a large blockholder is willing to guarantee subscription (which is typically the case). It is also possible that firms tend to select uninsured rights more generally when shareholder concentration is high, and when stock return variance is low. The point is that these and other characteristics can reduce direct flotation costs regardless of the chosen flotation method. To control for this effect, Eckbo and Masulis (1992) pool all flotation methods and use indicator variables for standbys and firm commitment issues in their cross-sectional regressions with direct issue costs as dependent variable. Conditional on various firm- and issue-specific factors, they conclude that the choice of an underwritten offer (standby or firm commitment) increases the flotation costs over and above uninsured rights, and that the choice of a firm commitment offer increases these costs further.

Lee et al. (1996) study direct flotation costs (underwriting spreads and other direct expenses as a percentage of offer gross proceeds) of IPOs, SEOs and issues of convertible and straight corporate debt over the 1990–1994 sample period. They find that the total direct issue costs are 11 percent for IPOs, 7.1 percent for SEOs, 3.8 percent for convertible debt and 2.2 percent for straight debt. They also document the frequency of issues with global tranches and over-allotment options. While debt offering flotation costs are low, it is important to keep in mind that debt issues, have a finite life of generally less than 10 years duration, especially taking into account sinking funds and callability. Thus, for a firm to have long term access to this debt capital, it is necessary to periodically refinance these debt issues, which involves repeated rounds of future flotation costs.

Public offering of debt can at times precede an IPO of stock, a phenomenon studied by Datta, Iskandar-Datta, and Patel (1997) and Cai, Ramchand, and Warga (2004). Firms issuing public debt are required to meet the SEC mandated financial disclosure requirements of public companies. Cai, Ramchand, and Warga (2004) report that subsequent IPOs by these firms are associated with significantly lower underpricing and lower price revisions from the midpoint of the filing range to the offer price. However, the lower underpricing is restricted to subsequent IPOs that have rated public debt, which tend to be financially stronger issuers. Also, public debt issues can be simultaneously offered with public equity issues, which is a financing decision studied by Hovakimian, Hovakimian, and Tehranian (2004).

3.2. Underwriter compensation

Underwriter compensation is made up of three parts: management fees paid to the syndicate's lead underwriter or book runner, underwriting fees paid to the underwriters,

and selling concessions to the syndicate members selling the shares to institutional and retail customers. In this literature, spreads are almost always measured as a percentage of offering size or gross proceeds. Most studies focus on either underwriter gross spread or underpricing costs, while very few studies estimate both the direct and indirect flotation costs of security offerings. Most studies also limit themselves to studying one security class, with SEOs being the most intensively examined offering type.

Moreover, most existing research on flotation costs focuses on the experiences of U.S. companies, primarily issuing common stock listed on major U.S. stock exchanges. Over the last 20 years, nearly all security offerings sold in the U.S. have relied on a firm commitment underwriting contract and a large majority of existing studies restrict their investigations to this sample. Most of these studies also limit their analysis to unregulated industrial firms. Since many of these studies also require the availability of machine readable accounting data, typically extracted from Compustat, the samples are further reduced by excluding many smaller firms not covered in this financial accounting database.

Kim, Palia, and Saunders (2005a) report underwriting spreads of industrial issues for SEOs, IPOs and straight corporate debt issues over the 1970–2000 period. They find that for the last three decades (i.e., 1970s, 1980s and 1990s) average underwriting spreads have fallen from 5.6 percent to 4.7 percent for SEOs, and from 7.7 percent to 6.7 percent for IPOs, with increased clustering of SEO spreads at 5 percent and IPO spreads at 7 percent. Similarly, average underwriting spreads have dropped in half from 1.6 percent to 0.8 percent for debt issues.

A consistent result found in the security offering literature is that underwriting spread rises with a security's total risk measured by return standard deviation over a pre-offering (SEOs) or post-offering (IPOs) estimation period. First, underwriting spreads are substantially larger for IPOs than SEOs, larger for SEOs than convertibles debt offers and smallest for straight debt offers. The average total risk (stock return standard deviation) of these classes of securities can likewise be ranked from highest to lowest. The rankings of total risk across security classes mirror those for security underwriter spreads: Total risk is on average highest for IPOs, followed by SEOs, then convertible debt and finally is smallest for straight debt. Within each of these security classes, there is also evidence that underwriter spreads are directly related to a security's return standard deviation.

The second major characteristic of security offerings found to reduce spreads is the offering size and this has been interpreted as an underwriting economy of scale effect due to the presence of large fixed costs, which exhibits increasing returns to scale. However, Altinkilic and Hansen (2000) takes issue with this interpretation. They point out that the observed fees do not fall steeply enough if they consist mostly of fixed costs. Thus, they argue that most of the fee is a variable cost, rather than a fixed cost. Offering size is also often measured as a percent of equity capitalization where it is interpreted as capturing an adverse selection effect.

A third very common characteristic used as a control variable is a measure of firm size, usually measured by firm book value of assets, market value of assets, equity market value (measured by book market value or debt plus equity market value), or firm annual sales. Firm size is generally interpreted as capturing asset diversification and the quality of publicly available information about the firm. These three characteristics are frequently used as control variables in this stream of literature examining underwriter spreads.

Two well cited studies of IPO underwriting spreads Chen and Ritter (2000) and Hansen (2001) document that these spreads strongly cluster at 7 percent, especially in the 1990s. However, in selecting their sample, Chen and Ritter exclude very large and very small issues where other levels of underwriting fees would most likely be observed. They interpret this as evidence that the market for underwriting services is oligopolistic. Hansen (2001) re-examines IPO underpricing without excluding relatively large and small issues and finds much greater variability in underwriting spreads. He also presents other evidence supporting the existence of a competitive underwriting market. More recently, Mullineaux and Roten (2005) compare IPO underwriting spreads by commercial banks and investment banks and find that commercial bank underwriters tend to be more concentrated at 7% than investment bank underwriters. Kim, Palia, and Saunders (2005b) examine trends in IPO and SEO underwriter spreads over the 1970–2004 period. They find evidence of a fall in IPO spreads over the 1990–2004 period, but no evidence of a change in SEO spreads, which is weak support for an increase in competition in the underwriting market.

In most studies of underwriter spreads, researchers take a particular focus, usually investigating an economic determinant of spreads that is not well documented in the literature, while controlling for other offering characteristics previously shown to affect spreads. For example, Kim, Palia, and Saunders (2005a) jointly study IPO underwriter spreads and underpricing, with particular focus on the interrelationship of underwriter spreads and underpricing. They argue that underpricing can be viewed as an additional form of compensation, which underwriters can capture through their power to allocate offers to favored customers. They find that IPO underwriter spread is positively related to IPO underpricing, a missing financial statement indicator and the inverse of the log of offer size and negatively related to the underwriter having a star analyst and issuer return volatility.

Turning to SEOs, Smith (1977) reports on direct flotation cost components classified by flotation method and offer size and scaled by gross proceeds. He calculates the mean values of both underwriter fees and other expenses across three major flotation methods; namely firm commitments, rights offers and standby offers. Smith finds that underwriter spreads average 5 percent of the offer price for firm commitments and that they range from over 10 percent for small issues to under 4 percent for very large issues.

Eckbo and Masulis (1992) study SEO underwriter spreads and flotation methods for industrials and utility issuers listed on NYSE and AMEX for nearly a 20 year period. They report underwriter fees and other flotation costs by flotation method and confirm

Smith (1977)'s findings that rights and standby offerings are less costly. Estimating determinants of direct flotation costs separately for industrial and utility issuers, they find for industrial issuers that flotation costs are negatively related to gross proceeds and average shareholding value and positively related to gross proceeds squared, return standard deviation, and percent change in shares. They emphasize the importance to flotation method choice of expected shareholder take-up in both rights and standby offers. Their evidence is consistent with the Myers and Majluf (1984) interpretation of the market's negative average announcement price reaction to an SEO as an upward revision in the market's expectation that the security is overvalued. They also find evidence that firms choose the flotation method that maximizes the net proceeds of their security offerings.

Altinkilic and Hansen (2000) study the determinants of underwriter spreads in industrial SEOs. They calculate mean underwriter spreads across offer size ranges and find that average spreads vary from 4.4 percent to 6.3 percent. They estimate the determinants of underwriter spreads as a function of the log of offer size, percent change in shares, return standard deviation and value of all underwritten industrial SEOs in the prior 3 months. They find that spread is significantly negatively related to log of offer size and positively related to percent change in shares, return standard deviation, the value of underwritten industrial SEOs in prior 3 months and the inverse of offer size when it is substituted for the log of offer size. Alternatively, Altinkilic and Hansen replace the log of offer size by the inverse of offer size and use it to estimate the slope of marginal spread. They find that the slope rises with offer size. This supports a rising variable cost of underwriting as offer size expands. Their perspective is that underwriter spreads are U shaped and that larger, less risky issuers have spreads that reach their minimum value at high offer sizes. Hansen (2001) examines whether this U shape spread phenomenon is present in IPO spreads prior to the rise of the 7% contract. He shows that IPO spreads are also consistent with rising variable costs, and are U-shaped. Corroborating evidence from German IPOs and SEOs is reported by Buhner and Kaserer (2002) and Kaserer and Kraft (2003) that marginal spreads are not decreasing in offer size. The Kaserer and Kraft analysis uses an principal components analysis within a generalized weighted least squares framework.

Kim, Palia, and Saunders (2005a) jointly study underwriter spreads and underpricing in SEOs as well as IPOs. They find that underwriter spreads are positively correlated with underpricing costs in SEOs and IPOs. They also investigate whether underwriter spreads are affected by market conditions, underwriter competition and issue characteristics using three stage least squares. They find SEO underwriter spread is positively related to underpricing, issuer leverage, missing financial statements, the inverse of the log of offer size and negatively related to market share of the top 25 underwriters, a top 25 underwriter indicator, indicator for bank entry into the underwriting market, and issuer profitability.

Butler, Grullon, and Weston (2005b) study the importance of SEO liquidity as a determinant of SEO underwriting spreads over the 1993–2000 period. They examine a broad range of liquidity measures including: quoted spread, effective spread, relative

effective spread, quoted depth, trading volume, turnover, trade size, and a liquidity index of the above measures. They report that all the liquidity measures they examine are significant, with bid–ask spreads being positively related and the depth and activity levels being negatively related to underwriter spreads. They control for a broad range of other SEO characteristics and find that underwriting spreads are also negatively related to offer size, equity capitalization, share price, a multiple book manager indicator and positively related to return volatility, and Amex and Nasdaq indicators. In contrast, Altinkilic (2006) examines the role of underwriter market making immediately following SEOs to determine whether market making activities are partially paid by the underwriting spread. She argues that paying for market making in the underwriting spread takes pressure off the bid–ask spread, thus improving secondary market liquidity after the offer. Using abnormal share trading volume in the four weeks following the SEO as a proxy for market making costs, She finds that compensation for market making can explain 20% of the lead underwriter's total compensation, after controlling for other known determinants and that this underwriting fee component rises as the cost of market making rises.

More recently, Lee and Masulis (2006) examines the effect on SEO underwriting fees of financial accounting information quality, using a recent measure of accruals quality developed in the accounting literature by Dechow and Dichev (2002). They report that as the quality of issuer's financial accounting deteriorates, both SEO underwriting spreads, the negative announcement return, and frequency of offer withdrawals rise. They also find that a large number of other control variables are significant including log of net offer proceeds, secondary scale percentage, underwriter rank, log of total assets, stock return standard deviation and indicators for credit rated bonds and shelf offerings.

In another recent study, Drucker and Puri (1989) explore the effects of concurrent and prior lending and prior equity underwriting on the gross spreads of SEO. They find that a concurrent lending relationship, a prior lending relationship, or both, all reduce gross spreads. However, the effect of a concurrent lending relationship is stronger than a past relationship and a combined relationship is greater than a simple concurrent relationship. They also find that a past equity underwriting relationship reduces gross spreads, where they allow for a U-shaped spread following Altinkilic and Hansen (2000). This last result is consistent with several earlier studies of SEO underwriter competition that will be discussed later.

Table 7 summarizes the existing studies of underwriting spreads. The extant evidence shows that SEO underwriter spreads (1) exhibit a scale economy effect with diminishing marginal returns and (2) are negatively related to a firm's size and the offer's size relative to the issuer's equity capitalization. Finally, there is recent evidence that these underwriting spreads are negatively related to a security's liquidity and positively related to the quality of accounting information and existing and prior banking relationships. The evidence summarized in Table 7 is that SEO underwriting spreads are positively related to a firm commitment underwriting contract, percentage change in shares, inverse of offer size, log of offer size squared, underpricing, a missing financial statement indicator, bid–ask spread, prior SEO activity (prior 3 months), Amex and Nasdaq indicators.

Table 7
Evidence on underwriter spreads in IPOs and SEOs

Study	Sample period	Explanatory variable	Sign
A. IPO studies			
Megginson and Weiss (1991)	1983–1987	Venture backing	−
		Log(offer size)	−
		Underwriter market share	−
		Firm age	−
Hansen (2001)	1980–1999	Relative offer size	+
		Stock return standard deviation	+
		Log(offer size)	−
		Secondary offering proportion	−
Kim, Palia, and Saunders (2005a)	1970–2000	Underpricing estimate	+
		Missing financial statement (2 years)	+
		Inverse log(issue size)	+
		Stock return standard deviation	+
		Lead underwriter's market share	−
		Underwriter with All-Star analyst	−
B. SEO studies			
Smith (1977)	1971–1975	Firm commitment indicator	+
		Offer size classes	−
Hansen and Torregrosa (1992)	1978–1986	Stock return residual st. error	+
		Offer size	+
		Log(offer size)	−
		Log(equity market value)	−
		Log(% manager shareholdings)	−
		Syndicate manager portion of offer	−
Bhagat, Marr, and Thompson (1985)	1982–1983	Stock return residual variance	+
		Log(offer size)	−
		Stock beta	−
		Utility firms	−
		Shelf registrations	−
Eckbo and Masulis (1992)	1963–1981	Increased shares outstanding (%)	+
		Stock return standard deviation	+
		Log(offer size) squared	+
		Log(offer size)	−
		Ave shareholdings value	−
Denis (1993)	1982–1985	Log(offer size) ∗ shelf offer	+
		Shelf issuer ∗ log(offer size)	+
		Stock return variance (adjusted)	+
		Log(offer size)	−
		Shelf offer	−
		Shelf issuer	−
Altinkilic and Hansen (2000)	1990–1997	Increase in shares outstanding (%)	+
		Stock return variance	+

(*Continued on next page*)

Table 7
(*Continued*)

Study	Sample period	Explanatory variable	Sign
		Recent SEO activity (prior 3 months)	+
		Inverse of offer size (offer size)	+
Kim, Palia, and Saunders (2005a)	1970–2000	Underpricing estimate	+
		Missed financial statement	+
		Lead underwriter not in top 25	+
		Issuer leverage	+
		Stock return standard deviation	+
		Over-allotment option used	+
		Inverse log(offer size)	+
		Market cap ∗ Inverse log(offer size)	−
		Herfindahl index in I-banking	−
		Lead underwriters market share	−
		Commercial bank market entry	−
		Issuer profitability	−
Butler, Grullon, and Weston (2005a)	1993–2000	Bid–ask spread (%)	+
		Log(stock return standard deviation)	+
		Amex indicator	+
		Nasdax indicator	+
		Quoted depth	−
		Trading volume	−
		Issuer share turnover	−
		Log(offer size)	−
		Log(equity capitalization)	−
		Log(share offer price)	−
		Multiple syndicate book managers	−
Lee and Masulis (2006)	1991–2002	Poor accrual quality	+
		Stock return standard deviation	+
		Relative offer size	+
		Shelf offering	−
		Log(offer size)	−
		Underwriter market share	−
		Log(total assets)	−
Drucker and Puri (1989)	1996–2001	Inverse of offer size	+
		Stock return standard deviation	+
		Concurrent lending	−
		Concurrent and prior lending	−
		Prior lending	−
		Prior equity underwriter	−
		SEO market activity	−

At the same time, SEO underwriting spreads are negatively related to offer size, issuer profitability, market depth, equity capitalization, share price, average shareholding value, market share of top 25 underwriter, commercial bank entry in the underwriting market, and multiple book managers.

3.3. Underpricing of SEOs

Underpricing is typically the most important indirect flotation costs in a security offering. There are several ways to measure underpricing of security issues. The offer price can be compared to the closing price, bid, ask or midpoint on the prior trading day or the first trade day following SEO completion. The offer price relative to the closing price on the offer date is generally termed the underpricing level. Researchers have also examined the offer price relative to the prior day's high and low prices.

We will focus most of our attention on recent empirical developments in IPO and SEO underpricing. Ljungqvist (2007) provides an excellent review of the theory and evidence on IPO underpricing elsewhere in this book. He concludes that much of the underpricing effect can be explained by information frictions including the Benveniste and Spindt (1989) theory that underwriters reward investors for information on issue demand through underpricing, as well as underwriter certification and various agency theory models which explore the conflict between IPO investors and issuer/management.

In a recent IPO study, Li and Masulis (2006) explore the effects of pre-IPO equity investments by major financial institutions including commercial banks, investment banks, venture capitalists and insurance companies, controlling for whether these financial institutions are also lenders to the firm or underwriters in its IPO. They examine these venture investment effects on IPO underpricing, offer price revisions from the filing range, post-IPO long run performance. Li and Masulis also employ a large number of other control variables used in earlier studies. They find evidence consistent with financial institution certification through venture investment, that is associated with lower IPO underpricing and offer price revisions and better long run performance. They also find that there are incremental certification effects as additional classes of financial institutions invest in these issuers. These results are robust to controlling for several forms of endogeneity. They also report that the coverage of pre-IPO loans is more completely reported in offering prospectuses than in the Dealscan loan database.

In another recent IPO study, Edelen and Kadlec (2005) develop a model of underpricing based on the probability of offer withdrawal and the importance of a successful offering. In essence, when the firm's stock price is rising before the offer day, managers are more willing to increase IPO underpricing to enhance the likelihood of a successful offering. Their model can explain why there is partial adjustment to public information released between the filing date and the offering date and it takes into account public information spillovers from the issuers industry. They report that their model can explain a large portion of the cross sectional dispersion in IPO underpricing and can explain hot issues markets. In their analysis, they use Heckman (1979)'s two step procedure where in the first step they estimate the probability of offer withdrawal and then in the second step they estimate the determinants of underpricing. They find that the estimated probability of an offer withdrawal has a significant negative effect on IPO underpricing. Their model also predicts an inverse relation between withdrawal frequency and industry stock returns between the filing and withdrawal dates. They argue that the asymmetric partial adjustment effect to industry information spillover effects found in

earlier studies is due to a truncation regression bias and that once the withdrawal probability is taken into account this information spillover effect becomes symmetric.

Turning to SEO underpricing, Eckbo and Masulis (1992) examine mean and median underpricing by flotation methods for utility and industrial issues of NYSE and AMEX listed firms over the 1963–1981 period. They find that offer prices for firm commitments of industrial and utility issuers were on average underpriced by less than a half percent (i.e., 0.44 percent). Altinkilic and Hansen (2003) and Corwin (2003) investigate SEO underpricing of NYSE and Nasdaq listed stocks in more recent periods. Looking at mean underpricing by year, they find that it increases substantially in the 1990s relative to the 1980s. For example, Corwin (2003) reports that in the 1980s, it averaged 1.30 percent, while in the 1990s it averaged 2.92 percent. He observes that the rise in average underpricing of SEOs could be due in part to the large increase in the proportion of Nasdaq issuers, which in the 1990s were very young and with their asset values comprised mainly of risky intellectual property and growth options. However, a full explanation for SEO underpricing as well as its recent rise is still lacking.

Safieddine and Wilhelm (1996) analyzes the relationship of SEO underpricing to short selling. They examine offer date returns for industrials and utilities issuers with and without option trading and relate it to short interests in their stocks. They examine this activity before and after the enactment of Rule 10b-21, which prohibited using shares purchased at the offering price to close out short positions opened after the offering registration statement is filled. In this study, offering day returns are measured relative to the high and low prices on the day prior to the offer and the offer day. They report that underpricing is significantly negatively related to underwriter rank and a utility indicator and significantly positively related to abnormal short interest pre-Rule 10b-21 and an option trading indicator in the Rule 10b-21 period. They conclude that SEO offer dates exhibit abnormally high levels of short interest and option open interests and that SEO price discounts are positively related to these higher levels of short interest and option open interest. They also conclude that Rule 10b-21 appears to have curbed short selling activities and reduced underpricing, though Rule 10b-21 was implemented only three years earlier.

Kim and Shin (2004) re-examines the effects of short selling on underpricing using a longer and more recent sample period. They find that offer discounts are negatively related to underwriter rank and positively related to the Rule 10b-21 indicator, underwriter spread, and return volatility. Kim and Shin conclude that the SEC Rule was a partial cause for the temporal increased underpricing of NYSE listed stocks between the 1980s and 1990s, which runs counter to the conclusions of Safieddine and Wilhelm (1996). One serious concern with their study is that both underwriter rank and underwriter spreads are endogenously determined. Whether or not these results will hold up to taking this endogeneity in account is an open question.

Corwin (2003) reexamine the effect of Rule 10b-21 on underpricing using a model that excludes both underwriter rank and spread as regressors and draws a similar conclusion to Kim and Shin (2004). In his study, SEO underpricing is investigated for NYSE and Nasdaq listed stocks, with special emphasis on the differing market microstruc-

ture characteristics in the two marketplaces. He reports that underpricing is positively related to return standard deviation, average IPO underpricing in the month of SEO, relative offer size interacted with quartile indicators for the lowest stock prices and the highest stock return volatility and bid–ask spreads, and indicators for a negative 5 day pre-offer CAR, a tick size less than 0.25, and the Rule 10b-21 period. He also finds underpricing is negatively related to the closing price on day -1 and its interaction with offer price tick size less than 0.25, an NYSE indicator and the interaction of the negative 5 day pre-offer CAR indicator with the Rule 10b-21 period indicator. The negative NYSE indicator is consistent with the findings of Altinkilic and Hansen (2003) of greater underpricing for Nasdaq issues.

When Corwin estimates this model with Nasdaq quote data and adds several market microstructure variables, he finds similar findings, except that Nasdaq underpricing is also positively related to underwriter spread. He concludes that these changes can be explained by a variety of hypotheses related to asymmetric information (return standard deviation), temporary price pressure combined with inelastic demand relative offer size), short selling and manipulative trading (negative pre-offer CAR and Rule 10b-21 indicator), the informativeness of closing prices on the two exchanges (NYSE indicator), differences in underwriter pricing practices on these two exchanges (pre-offer price) and changes in the economics of the underwriting business (average IPO underpricing).

Kim, Palia, and Saunders (2005a) empirically examine the relationship between IPO and SEO underpricing and underwriter spreads. They find that underpricing is positively related to estimated underwriter spread. They also find that underpricing is positively related to the inverse log of issue size (consistent with Altinkilic and Hansen, 2003), the period with commercial bank underwriting and a prior 15 day momentum measure. They find SEO underpricing is negatively related to the market share of the top 25 underwriters, an indicator of a non top 25 lead underwriter and issuer equity market capitalization interacted with the inverse log of issue size. Their empirical analysis is based on a three-stage least squares model of underpricing and underwriter spread.

Evidence in several studies raises questions about the accuracy of the two benchmark prices used to measure underpricing, i.e., the offering day closing price and previous day's closing price. First, Altinkilic and Hansen (2006) report abnormal negative returns over the week prior to the SEO and abnormally high returns over the week following the SEO. Third, we know that underwriters can short sell shares of SEOs prior to the offering date and hedge them against their over-allotment options. Second, following an offering, stabilization activities can bias closing prices, cushioning price drops below the offer price for up to a month thereafter, though a couple of weeks or less is more common. Cotter, Chen, and Kao (2004) report price stabilization for SEOs is negatively related to offer price, trading volume, return variance and positively related to the interval between the filing and offer date. In addition, by looking at only completed SEOs, there can be some added selection bias where less favorably received offers are cancelled or delayed.

Of course accurate determination of the timing of an offering is critical to measure its price reactions, and Brown and Warner (1985) estimate the attenuation effect on measured market price reactions from inaccurate announcement dates. Another problem is that Lease, Masulis, and Page (1991) found a substantial proportion of SEOs are sold after the close of trading, rather than before the open, which is the more common occurrence. They used the Dow Jones time stamps to determine the actual time of day when the SEO is sold. Safieddine and Wilhelm (1996) use abnormal trading volume to determine the time of day when the SEO is sold and argue that this is more accurate approach. They also report a significant number of offers occurring after the market close.

A number of studies have investigated whether SEO underpricing is evidence of price pressure or a downward sloping demand curve. These studies include: Kadlec, Loderer, and Sheehan (1994), Corwin (2003), Meidan (2004) and Altinkilic and Hansen (2006). They report mixed results as to whether there is a downward sloping demand curve effect, short lived price pressure effect or adverse information effect similar to the observed effect of block trades. Kadlec, Loderer and Sheehan reports that in the months immediately surrounding an SEO there is evidence of a temporary stock price decline. Corwin (2003) finds SEO underpricing is positively related to relative offer size and interprets this as support for a price pressure effect. Meidan (2004) reports significant negative returns immediately before an SEO and significant positive returns immediately afterwards, which supports a price pressure effect. Altinkilic and Hansen (2003) report an unusually large negative mean return of -2.6 percent over the week prior to an SEO, followed by a small positive return in the week following the SEO, which is inconsistent with simple price pressure effect.

Table 8 provides a detailed summary of the empirical evidence from prior empirical studies on the determinants of underpricing of IPOs and SEOs. In light of the large number of explanatory variables studied, Table 9 provides a summary of these for easy reference. For the most part, the studies in this area report qualitatively consistent results for their effects on underpricing. Underpricing is found to be significantly related to (1) firm characteristics such firm size, financial condition, industry and share ownership structure, (2) security characteristics such as exchange listing, listed stock options, security volatility and market microstructure properties, and (3) offering characteristics such as offer size, offer price, underwriting syndicate, capital market conditions, other flotation costs and the likelihood of offer withdrawal.

Interestingly, venture capital backing, underwriter rank, and lead underwriter not in the top 25 are all often found to be significant, but with differing signs across the studies. This could reflect the endogeneity associated with the later two variables and underpricing. The varying sign of venture capital backing on underpricing is consistent with Habib and Ljungqvist (2001) who argue that the incentive to avoid underpricing an IPO will vary with the relative size of the primary and secondary shares that are offered. Thus, from this perspective it is important to model not only an indicator for venture backing, but also the size of venture shareholdings and whether these shares are being sold.

Table 8
Evidence on underpricing in IPOs and SEOs

Study	Sample period	Explanatory variable	Sign
A. IPO studies			
Megginson and Weiss (1991)	1983–1987	Venture capital backing	−
		Underwriter rank (market share)	−
		Firm age	−
Booth and Chua (1996)	1977–1988	Log(offer price)	+
		Underwriter rank ∗ firm commitment	−
		Log(offer price) ∗ best effort	−
		Prior IPO activity (past 3 month)	−
		Prior IPO activity ∗ best efforts	−
		Industry IPOs (12 month) ∗ best effort	−
Beatty and Welch (1996)	1992–1994	Underwriter compensation (%)	+
		Log(1 + listed risks)	+
		Underwriter rank (market share)	+
		Inverse of offer price	−
		Auditor market share (residual)	−
		Lawyer compensation (residual)	−
Carter, Dark, and Singh (1998)	1979–1991	Secondary offering (%)	+
		Stock return standard deviation	+
		Log(offer size)	−
		Log(1 + firm age)	−
		Underwriter rank (Carter–Manaster)	−
Gompers and Lerner (1999)	1972–1992	Log(equity capitalization)	+
		Filing midpoint − offer price (%)	+
		Log(book to market)	−
		Underwriter rank	−
		Underwriter and venture investor	−
Lowry and Shu (2002)	1988–1995	Lawsuit likelihood estimate	+
		Market capitalization	+
		Technology firm	+
		Offer price − filing midpoint (%)	+
		Cum. market return (prior 15 days)	+
		Underwriter rank	−
		Venture backed	−
		NYSE/Amex listed	−
Lowry and Schwert (2002)	1985–1997	Technology firm	+
		Filing midpoint − offer price	+
		Filing midpoint − offer price > 0	+
		Underwriter rank	−
		Log(real total assets)	−
		National market system listed	−
		Amex listed	−
Hansen (2001)	1980–1999	Underwriter rank	+
		Stock return standard deviation	+
		Secondary offering proportion	+

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Table 8
(*Continued*)

Study	Sample period	Explanatory variable	Sign
		Log(offer size)	−
		Leverage (Debt/Assets)	−
		EBIT/Offer Proceeds	−
Habib and Ljungqvist (2001)	1991–1995	Underwriter spread estimate	+
		Filing midpoint − offer price	+
		Firm age	−
		Log(sales)	−
		Leverage	−
		Increase in shares outstanding	−
		Secondary shares (%)	−
		Other expenses	−
Ljungqvist and Wilhelm (2003)	1996–2000	Targeted direct share programs	+
		Proceeds for operating expenses	+
		Estimated price revision	+
		Estimated + price revision	+
		High tech industry	+
		Internet firm	+
		1999–2000 period	+
		Venture capital shareholdings	−
		Investment bank shareholdings	−
		Corporate shareholdings	−
		CEO shareholdings × Internet firm	−
		Ownership concentration	−
		Insider share sales	−
		Venture capital share sales	−
		Log(1 + firm age)	−
		Secondary offer (%)	−
		Increase in shares outstanding (%)	−
Edelen and Kadlec (2005)	1985–2000	Venture backing	+
		Underwriter rank	+
		Industry stk retns (filing to offer)	+
		IPO underpricing (prior 30 days)[a]	+
		Ave IPO offer price revision (30 day)[a]	+
		IPO offer price-filing midpoint[a]	+
		Log(offer size at filing)	−
		IPO offer price revision $< 0^a$	−
		Estimated probability of withdrawal	−
Kim, Palia, and Saunders (2005a)	1970–2000	Underwriter spread estimate	+
		Underwriter rank (market share)	+
		Lead underwriter not in top 25	+
		Commercial banks enter market	+
		Herfindahl index in I-banking	+
		Cumulative mkt. ret. (prior 15 days)	+
		Issuer profitability	−

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Table 8
(*Continued*)

Study	Sample period	Explanatory variable	Sign
		Issuer leverage	−
		Over-allotment option	−
Li and Masulis (2006)	1993–2000	Prior market return	+
		Underwriter reputation	+
		Venture capitalist share sale	+
		Internet issuer	+
		Global offering	+
		Prior market return	+
		New shares issued (%)	−
		Bank shareholdings	−
		Insurance co. shareholdings	−
		Issuer bank loans	−
		Venture capitalist shareholdings	−
		CEO shareholdings	−
		Fin'l institution shareholdings	−
		Log(total assets)	−
		IPO registration period	−
		Big 6 auditor	−
B. SEO studies			
Bhagat, Marr, and Thompson (1985)	1982–1983	Stock return residual variance	+
		Market return variance	+
		Stock beta	−
		Utility firms	−
Safieddine and Wilhelm (1996)	1980–1988	Abnormal short interest	+
		Lead underwriter rank	−
		Utility issuers	−
	1989–1991	Stock with listed options	+
	(Rule 10b-21)	Lead underwriter rank	−
		Utility issuers	−
Corwin (2003)	1980–1998	Stk ret stnd deviation (prior 30 days)	+
		Increase in shares outstanding (%)	+
		Lowest market cap quartile	+
		Highest standard deviation quartile	+
		Lowest stock price quartile	+
		Prior CAR < 0 (week prior to offer)	+
		Offer price tick size $< 1/4$	+
		Rule 10b-21 in force	+
		IPO underpricing in same month	+
		Close − Bid on day -1 (%) $*$ Nasdaq	+
		Log(stock price on day -1)	−
		Log(stock price) $*$ Tick size $< 1/4$	−
		Prior CAR $< 0 *$ Rule 10b-21	−
		NYSE listed	−
Altinkilic and Hansen (2003)	1990–1997	Nasdaq listing	+
		Relative offer size	+

(*Continued on next page*)

Table 8
(*Continued*)

Study	Sample period	Explanatory variable	Sign
		Inverse of stock price	+
		Stock return standard deviation	+
		Offer size	−
		Cumulative market return (from filing)	−
		Cumulative abnormal stock return	−
		Underwriter rank	−
Kim and Shin (2004)	1983–1998	Stk ret standard deviation (prior year)	+
		Rule 10b-21 in force	+
		Underwriter spread	+
		Underwriter rank	−
Mola and Loughran (2004)	1986–1999	Nasdaq listing	+
		Technology firm	+
		Underwriter spread	+
		Underwriter has top tier analyst	+
		Offer price is an integer	+
		Utility industry	−
		Log(closing price on day −1)	−
		Prior SEO	−
		Underwriter rank	−
Kim, Palia, and Saunders (2005a)	1970–2000	Underwriter spread estimate	+
		Commercial bank undrwrtrs allowed	+
		Cumulative mkt. ret. (prior 15 days)	+
		Inverse log(issue size)	+
		Market cap ∗ Inverse log(issue size)	−
		Underwriter rank (market share)	−
		Lead underwriter not in top 25	−

3.4. Dependence between underpricing and underwriter spreads

Mola and Loughran (2004) finds a significantly positive relationship for SEOs between underpricing and underwriter spreads. However, they do not fully control for the potential joint determination of these two costs. Kim, Palia, and Saunders (2005a) examines the relationship between underpricing and underwriter spreads. They find that in both SEOs and IPOs there is a positive relation between underwriter spreads and underpricing, though in the case of IPOs the relationship is driven by low quality issuers. They argue that these two flotation cost components can both be viewed as forms of underwriter compensation, which can be one explanation for their positive correlation. This evidence is consistent with Smith (1986), Hansen (1986) and Chen and Ritter (2000) who argue that underwriters and issuers jointly determining the direct and indirect costs of issuance.[16]

[16] Yeoman (2001) develops a model of net proceeds maximization where underwriter spreads and underpricing are interrelated. However, the predicted relationship is negative in his model.

Table 9
Summary of determinants of underpricing in IPOs and SEOs

Variables with significantly positive effects	Variables with significantly negative effects
A. Issuer characteristics	
Firm size	Log of prior stock price
Technology issuer	Log of total sales
Internet issuer	Log of book to market
Prior cumulative stock return	Issuer profitability
Stock return's (or residual) standard dev. or variance	Percentage of tangible assets
Nasdaq listing	Firm age or Log(1 + firm age)
Stock with listed options	NYSE/Amex listed; Stock beta; Leverage; Prior SEO indicator; Utility issuer
B. Offer characteristics	
Log of offer price	Log of offer size
Offer price is an integer	Log of offer price ∗ best effort
Offer price tick size less than 0.25	Inverse of offer price
Offer price revision from midpoint of filing range	Underwriter rank (market share)
Proceeds used for operating expenses	Underwriter rank ∗ firm commitment
Targeted direct share purchase programs	Lead underwriter not in the top 25
Log(1 + listed risks in SEC filing)	Qualified independent underwriter employed
Abnormal short interest in stock	Over-allotment option used
Estimated likelihood of a lawsuit	Auditor market share
Underwriter rank	Big 6 auditor
Underwriter with top tier analyst	Legal compensation
Herfindahl index for investment banking	Prior week cumulative stock return ∗ Rule 10b-21
Lead underwriter not in top 25	Log of prior stock price ∗ indicator of offer price tick size less than 0.25; Filing to offer date interval; Estimated probability of offer withdrawal

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To analyze the potential interdependence of spread and underpricing, Kim, Palia, and Saunders (2005a) employ three stage least squares to estimate the jointly determined underwriter spread and underpricing, which they note gives consistent estimates. They find three instruments that are significantly related to spreads, but not to underpricing (existence of a star analyst, issuers lacking two years of financial statements at the IPO date, standard deviation of daily stock returns for one year), and one instrument related to underpricing, but unrelated to spreads (market run-up over the prior 15 trading days). They point out that this interdependence raises some serious questions about the reliability of many earlier studies, which focus exclusively on underpricing or underwriter spreads, and generally do not control for the potential interdependence of these two flotation cost components. While the study makes a strong case for interdependence of underpricing and spreads, it is less convincing in its claims about the appropriate instruments needed to identify their three equation system.

Table 9
(*Continued*)

Variables with significantly positive effects	Variables with significantly negative effects
C. Market conditions	
Prior cumulative market return	Prior IPO activity
1999–2000 "Bubble" period	Prior IPO activity ∗ best effort
Average IPO underpricing in the prior month	Prior industry IPOs ∗ best efforts
Commercial banks allowed to underwrite securities	Industry stock returns (filing to offer date)
Rule 10b-21 in force	Negative industry stock returns (filing to offer date)
Global offering	Out of pocket expenses
Estimated or actual underwriter spread	Percentage secondary offer
Percent increase in shares outstanding and its interactions with: (1) lowest market capitalization quartile, (2) lowest stock price quartile, (3) highest stock return standard deviation quartile	Average offer price revisions in prior 30 days
D. Share ownership	
Venture capital backing	CEO shareholdings ∗ Internet firm
Venture capitalist selling shares	Issuer share ownership concentration; Investment bank shareholdings; Investment bank non-underwriter shareholdings; Commercial bank shareholdings; Commercial bank underwriter shareholdings; Venture capital backing; Venture capital shareholdings; Corporate shareholdings; Insurance company shareholder; Insider share sales; CEO share sale; Venture capital share sales; Commercial bank lender

Another serious methodological issue is the extent to which various explanatory variables found to be correlated with underpricing and underwriter spreads are themselves endogenously determined. In this category, underwriter ranking has been most extensively studied and Ljungqvist and Wilhelm (2003) and Habib and Ljungqvist (2001) conclude that it is endogenously determined. Habib and Ljungqvist also find evidence that the some of underwriting fees and out of pocket expenses, which they call promotion costs are significantly related to underpricing and endogenously determined as well. Habib and Ljungqvist also test whether number of shares sold is endogenously determined and conclude that is not.

Another explanatory variable that is often used in explaining underpricing is the price revision from the filing range midpoint, measured by the offer price minus the midpoint, divided by the midpoint. Since underpricing is also a non-linear function of offer price, there is a danger that this strong empirical association is being driven mechanically by the common component in the two measures.

3.5. Offering delays and withdrawals

Another component of expected flotation costs is the costs of bearing most of the out of pocket expenses associated with preparing a security offering without realizing the benefits of actually raising capital due to an offering cancellation. In addition, this capital short fall can have adverse implications for a firm's ability to pursue the positive net present value projects that it has available to it and may have a negative effect on the timing, size and pricing of a subsequent security offering. Interestingly, several early studies by Mikkelson and Partch (1986) and Officer and Smith (1986) reported that announcements of SEO withdrawals are greeted by a positive market reaction. Examining both SEO and convertible debt withdrawals, Jensen and Pugh (1995) report similar positive stock reactions. Altinkilic and Hansen (2006) report that SEO withdrawals are preceded on average by a precipitous stock price drop of 17 percent. To the extent that offer cancellation has negative implications for the firm's financial condition and the size of flotation costs and its ability to pursue investment projects, this positive price reaction suggests that the market was skeptical about the profitability of the firm's planned investment projects or else was concerned that the reason for the stock offer was that the stock was seriously overvalued, following the logic of Myers and Majluf (1984).

Edelen and Kadlec (2005) explore the implications of the risk of offer cancellation on the pricing of the offering. They observe that as offer price discount rises the risk of offer cancellation falls. This can explain why issuers are willing to go forward with offerings that they know are underpriced and why positive information released between the filing and offering dates is only partially incorporated into the final offer price as documented by Hanley (1993). Taking into account that some firms will have greater need for funds than others, and that new public information about the stock's value will vary across offerings, they are also able to develop a model to predict which offers will be more underpriced. In estimating the probability of offer withdrawal using a probit model, they find that it is significantly *positively* related to industry returns between the filing and offering date, prior IPO initial returns (30 days), log of the offer size, and withdrawals of earlier IPOs and significantly negatively related to prior IPO offer price revisions between the filing and offering dates (prior 30 days), and underwriter rank.

3.6. Underwriter competition

There is conflicting evidence on whether the market for underwriter services is highly competitive or oligopolistic. Chen and Ritter (2000) argue that the high frequency of 7 percent underwriter spreads in IPOs is evidence that this market is far from perfectly competitive. Hansen (2001) reports a number of pieces of evidence about the IPO process that supports the contention that this market is highly competitive, such as an IPO with 7 percent underwriter spread does not contain abnormal profits relative to other IPOs, that there is no evidence of monopoly profits in underpricing or unusual charges in subsequent SEOs, and that the 7 percent contract has persisted despite the

Department of Justice investigation of collusion allegations following the release of the Chen and Ritter (2000) findings. Hansen (2001) also reports that measures of concentration in the IPO market are well below the level considered by the Department of Justice to be anticompetitive. He notes that underwriters compete in many dimensions in addition to underwriter spreads, so that convergence to a common spread like 7 percent is not strong evidence of anticompetitive behavior.

Dunbar (2000) studies market share changes of book managers of IPOs and finds that they are negatively related to IPO first day returns and underwriter compensation (fees) and positively with analyst reputation.[17] This suggests that underwriters are competing implicitly, if not explicitly, on the level of IPO underpricing and underwriter spreads, contrary to the popular notion that banks do not cut fees to attract business. Corwin (2003) finds that seasoned offers were underpriced by an average of 2.2 percent during the 1980s and 1990s, with the discount increasing substantially over time, and that underpricing is significantly related to underwriter pricing conventions such as price rounding and pricing relative to the bid quote. Mola and Loughran (2004) also documents the increased usage of price rounding in setting SEO offer prices. These results appear to suggest a weakening in underwriter competition.

Adding to this debate, Burch, Nanda, and Warther (2005) examine underwriting fees of repeat security issuers to determine the relation between loyalty to a bank underwriter and the fees charged. They find that loyalty is associated with lower fees for common stock offers, but higher fees for debt offers. For both offer types, firms that graduate to higher ranked banks face lower fees. They also show that firms, which tend to switch banks to improve analyst coverage, pay higher fees in common stock offers, but do not pay higher fees in debt offers.

In contrast to this evidence, Ellis, Michaely, and O'Hara (2004) report that while many firms "graduate" to better underwriters, most firms move laterally or are downgraded in terms of lead underwriter ranking. They show that firms that graduate to a higher ranked underwriter must pay a premium for the privilege (i.e., above the fee charged by the same underwriter to an existing client for a similar deal), and, similarly, firms that use a lower ranked underwriter for their equity offering must also pay a premium.

Krigman, Shaw, and Womack (2001) studies underwriter selection in IPOs and finds that the quality of the analyst team is a key factor in underwriter selection. They also find that better performing IPO firms often switch to higher ranked underwriters for their SEOs. In addition, they conducted a field-based survey of chief financial officers (CFOs) and chief executive officers (CEOs) of IPO firms, who later switched underwriters, as to which factors were most important to their underwriter selections. Their survey reveals that the most important factors for issuers' senior management in selecting a lead underwriter are underwriters' and analysts' reputations, with issue pricing

[17] Interestingly, Dunbar (2000) also finds that banks lose market share if they are associated with overpriced IPOs, consistent with Booth and Smith (1986)'s certification theory.

and market making ability being moderately important and underwriting fees being the least important attribute. This ranking suggests that competition over underwriting fees is unlikely to have much explanatory power empirically. Mola and Loughran (2004) estimates the determinants of SEO underwriter market share and finds that a highly regarded analyst team increases the underwriter market share by 1.5 percent, adjusting for other factors (see their Table 5).

Ellis, Michaely, and O'Hara (2000) report that lead underwriters are initially the most active market maker in IPO stocks. Ellis, Michaely, and O'Hara (2004) find that the economic significance of lead underwriter market making declines as IPO stocks become seasoned over the following year. Corwin and Schultz (2005) show that number of market makers and analysts that are covering a stock rise with syndicate size. This suggests that the quality of underwriter market making and analyst coverage are likely to be less important to larger issuers, who benefit from greater investor interest. Consistent with this, Altinkilic (2006) reports that the market making component in SEO underwriting spreads is lower for larger firms.

Ljungqvist et al. (2004) document that analysts' recommendations relative to the consensus are positively associated with investment banking relationships and brokerage pressure, but negatively associated with the presence of institutional investors in the firm being followed. The latter result is especially strong when there are more institutions holding larger blocks in the firm, and for firms whose institutional holdings are concentrated in the hands of the largest institutional investors. They conclude that presence of institutional investors (who are primary customers of the analysts' services) provides an incentive mechanism for the analysts not to succumb to pressure to provide favorable opinions on their employers' investment banking clients and to boost brokerage business. Ljungqvist, Marston, and Wilhelm (2006) find optimistic analyst reports don't help underwriters win SEO assignments. Instead, they find that analysts' reputation, lending relationships and bond underwriting increase the bank's chances of winning underwriting assignments.

Ellis, Michaely, and O'Hara (2004) report that underwriters with continuing issuer relationships tend to charge lower fees, have optimistic analyst forecasts and are active in writing analyst reports. Banks competing for new SEO assignments often take actions in advance of an underwriting assignment: add analyst coverage, make optimistic analyst forecasts, do not compete on fees and do not become more active in market making services. Banks gaining new SEO assignments move quickly to: add analyst coverage, issue optimistic forecasts and increase their market making presence. Banks facing a weakened or terminated issuer relationship tend to reduce their analyst coverage, eliminate the positive bias in analyst forecasts, but do not reduce their market making services. They conclude that investment banks compete for follow-on equity offering underwriting business along multiple-dimensions (such as fees, underpricing discount, analyst coverage, market making, debt relationship, and overall reputation), and that underwriters who deliver on all these dimensions are retained by firms, and can be viewed as providing superior overall service to the issuer.

Fernando, Gatchev, and Spindt (2005) develops and empirically tests a model of firm-underwriter selection, where high (low) quality underwriters tend to sign contracts with high (low) quality issuers. In their empirical tests, they find that issuers and underwriters will associate with different partners for subsequent offerings if changes in issuer quality and/or underwriter reputation are large enough, suggesting that the association of issuers and underwriters is transactional rather than relationship-based. However, Kim, Palia, and Saunders (2005a) report evidence that the frequency of low (high) quality issuers using high (low) quality underwriters is as frequent as high (low) quality issuers employing high (low) quality issuers, which appears to be strong evidence against the Fernando, Gatchev and Spindt model.

Gande, Puri, and Saunders (1999) was the first study to examine the competitive effects of commercial bank entry into the corporate debt underwriting market. They find that underwriter spreads and ex-ante yields have declined significantly following commercial bank entry in the market, consistent with commercial bank underwriters with prior lending relationships with issuers having an information advantage over investment banks. They show that the reduction in underwriter spreads and ex-ante yields is strongest among lower rated and smaller debt issues, where commercial banks have underwritten a relatively greater proportion of these issues (as compared to investment banks). They also show that bank entry has tended to decrease market concentration, suggesting that commercial bank entry generally has had a pro-competitive effect. However, whether this is a short-term rather than a long-term effect is yet to be determined. Narayanan, Rangan, and Rangan (2004) study commercial bank entry into the equity underwriting market and report that commercial banks are increasing their roles as lead managers in equity underwriters, though they usually participate as a co-lead manager with an experienced investment bank.

Using a sample of SEOs from 1996–2001, Drucker and Puri (1989) finds that when a financial intermediary concurrently lends to an issuer and underwrites the firm's SEO, the issuer benefits through lower financing costs, receiving lower underwriter fees and lower loan yield spreads. This is particularly true for non-investment grade issuers, for whom the informational economies of scope are likely to be large. They show that concurrent lending also helps underwriters build relationships, increasing the probability of receiving future business. Specifically, they show that issuers with prior lending relationships receive lower underwriter spreads, while an underwriter with a prior lending relationship with an issuer is more likely to receive its subsequent underwriting assignments.

Wu and Kwok (2003) study global IPOs and the effects of competition by examining the pricing of global initial public offerings made by U.S. companies as compared to purely domestic offerings. They find that global participation significantly reduces underpricing (on average by four percentage points), and that underpricing is negatively related to the proportion of shares allocated to foreign investors. They conclude that U.S. companies time their global offerings when foreign demand for U.S. shares is high. Cornett, Davidson, and Rangan (1996) investigated the effects of Rule 415 on the

level of competition in the investment banking industry and find that it has weaken the competitive position of the smaller underwriters.

3.7. Rights and standby offerings

Since the 1950s, rights and standby offerings are used with less frequency in the U.S. However, they are still commonly employed by some regulated financial firms. Utilities, REITS, closed-end funds and conversions of mutual thrifts or insurance companies to stock charter are examples of right issuers discussed in the literature, e.g., Singh (1997), Khorana, Wahal, and Zenner (2002), Higgins, Howton, and Howton (2003), Howe and Shilling (1988), Masulis (1987). More recently, there has been a resurgence of the used of rights offers beyond utilities and financial firms by financial distressed industrial firms as reported by Heron and Lie (2004) and Ursel (2006).

3.8. Shelf registered offerings

In 1983 the SEC gave final approval to Rule 415, a new regulation that allowed security issuance under an expedited registration process. This option was only available to larger publicly listed firms. Bhagat, Marr, and Thompson (1985) studied direct and indirect flotation costs (underwriting fees and other expenses and underpricing) for a small sample of syndicated firm commitment and shelf issues found that shelf offerings have lower flotation costs than traditional book building method.

Sherman (1999) develops a model of underwriter certification and the effect of shelf registrations. She concludes that shelf registrations increase underwriter competition and reduce the quality of their due diligence investigations. Blackwell, Marr, and Spivey (1990) examine whether shelf issues reduce underwriters due diligence investigations and results in higher underpricing. They report that underwriter spreads vary with issuer quality and that weaker issuers have to pay a premium relative to firms using a firm commitment offering. Denis (1991) reported that most industrial security issuers used shelf offerings primarily for debt securities, which have much lower due diligence concerns. Denis (1993) finds that firms that use shelf registrations some of the time, also have lower non-shelf SEOs flotation costs. Thus, the inference about the cost saving associated with using shelf registration was thrown into question. However, Dennis also notes the low frequency of shelf registered SEOs is consistent with there not being a cost advantage.

More recently, shelf registration was expanded in 1992 to universal shelf issues, which allows the offering to be either debt or equity. This change is likely to intensify underwriter competition. Since the rule change, universal shelf registrations have dominated equity shelf registrations. Moreover, a greater portion of universal shelf issues result in equity offerings. Autore, Kumar, and Shome (2004) revisited the issue of flotation costs and the impact of shelf registration. They report that shelf issues of SEOs have overtaken non-shelf issues as the dominant flotation method beginning in 2001 for NYSE, Amex and Nasdaq listed firms. They report that 85 percent of shelf registrations result in no subsequent offer. They find that shelf issues have lower costs and

greater timing flexibility. These results hold up after adjusting for the self-selection bias highlighted in the early Denis (1991) study. They also separately study universal shelf issues that result in an SEO. They note that shelf issues create valuable options that become more valuable under more volatile market conditions. Bethel and Krigman (2004) re-examine the question of reduced due diligence in shelf issues. They report that high asymmetric information issuers experience high discounts from using the shelf registration mechanism, which explains why this mechanism isn't more widely employed.

3.9. Over-allotment options, warrants and other direct expenses

Over-allotment options. A second component of underwriter compensation is an over-allotment option, which is a warrant to buy an additional 10–15 percent of the offering at the same price as the SEO/IPO. The typical over-allotment option has a maximum life of 30 days. Underwriters can use these options to lower their risk exposure in a firm-commitment underwriting contract. This underwriter hedging activity in the IPO market is the focus of a study by Aggarwal (2000). She finds that underwriters exercise over-allotment options to cover short positions created by underwriters over-selling securities in public offerings when the after-market stock price rises relative to the offering price. She also finds that underwriters buy shares in the after-market to cover short positions when the stock price falls to the offering price or lower.

Over-allotment options can alternatively be viewed as valuable short term warrants held by underwriters that allow them to purchase up to an additional 15 percent of an undervalued offering at the underwriter's discount from the public offer price. Little research is available on the value of these options, with the exception of an early study by Hansen, Fuller and Janjigian (1987), who examine over-allotment options in SEOs of industrial firms. They estimated the value of the typical over-allotment option to be 1 percent of the offer's gross proceeds. They also report that about half their offer sample had over-allotment options. Using a logit model, they find that over-allotment options are more frequent in offers with smaller dollar size, larger relative size, greater stock and market return variances and more retail oriented (strong broker system) underwriters. In the IPO market, Lee et al. (1996) report that virtually all U.S. issues include over-allotment options and nearly all are for 15 percent of the original issue size and are issued at-the-money. Further, about 60 percent of the options are either partially or fully exercised, with the vast majority fully exercised.

Warrants as additional underwriter compensation. Several studies by Ng and Smith (1996) and Dunbar (1995) investigate the use and importance of warrants as an additional element of underwriter compensation in SEOs. Controlling for the selectivity imbedded in the choice of using warrants as added underwriter compensation with a logit model, they find that warrant use reduces the overall flotation costs of SEOs. Since warrants are less valuable when the underlying stock is overvalued, the credibility of smaller and less well known underwriters is increased when they accept warrants as compensation. This can reassure investors who could otherwise question the credibility of less reputable underwriters, thus lowering the average SEO underpricing necessary to sell these issues.

Other direct flotation expenses. The analysis of the other expenses such as registration and listing fees, legal and accounting and printing expenses is fairly limited. Smith (1977) finds for firm commitment SEOs that other direct expenses average about 1.15 percent of the offer price. He also examines the determinants of these other direct expenses and finds them to be functions of flotation method and offer size, measured by gross proceeds. His evidence documented a strong economy of scale effect in direct total flotation costs, with the smallest offerings having total direct costs ranging from 14 to 15 percent and the largest offerings having a total cost of less than 4 percent. Altinkilic and Hansen (2000) argue that a large fraction of these fees (85 percent) are a variable cost. There is little added information on other expenses.

Eckbo and Masulis (1992) estimate the determinants of direct flotation costs (sum of underwriting fees and other expenses). They find that on average direct flotation costs average over 6 percent for industrial issues and 4.25 percent for utility issues. They also report that they have a non-linear relationship to size (−), percentage change in outstanding shares (+ for industrials), log of holdings per shareholder (−), prior stock return standard deviation (+) and an indicator of underwritten firm commitments and standby offers (+).

Habib and Ljungqvist (2001) analyze the relationship of out-of-pocket expenses plus underwriting fees (which they term "promotion costs") and underpricing. They develop a model that assumes that the issuer makes decisions to minimize the wealth loss of going public, which includes the cost of underpricing and the promotion costs. They predict that promotion costs increase with the portion of the IPO that represents insider selling (size of secondary offer), the relative offer size and uncertainty. In testing their model they take account the endogeneity of underpricing, promotion costs and underwriter rank. They find that promotion costs are positively related to the estimated relative offer size, estimated proportion of insider sales and several risk proxies, namely underwriting fees and the log of sales while they are negatively related to gross proceeds and firm age. These results support the predictions of their model.

Other flotation costs of rights. Rights offerings are generally used only in SEOs. As noted earlier, a rights offer involves issuing short lived in-the-money warrants to existing shareholders on a pro-rata basis. This issue method differs substantially from a firm commitment method and has several potentially large indirect issue costs, which are borne by the issuer and its shareholders.[18]

(1) *Capital gains taxes*. In a rights offer, shareholders who do not wish to purchase shares of the issue must sell their rights (or subscribe and sell the shares) in order to avoid losing the value of their subscription rights or warrants. These sales are subject to capital gains taxes, which are increasing in the subscription price discount, discouraging large discounts.

[18] This discussion is partially drawn from Eckbo and Masulis (1995).

(2) *Stock liquidity and transaction costs of reselling rights*. The resale of rights by current shareholders takes place on organized exchanges, entailing dealer spreads and brokerage fees. Since shareholders avoid these costs when the firm employs an underwriter to sell its new shares, a rights offer carries an added transaction cost disadvantage for shareholders uninterested in exercising their warrants. Kothare (1997) argues that rights issuers have typically high ownership concentration, and a rights offering tends to increase concentration. The result is a higher adverse selection effect associated with buying the stock (or the rights), which Kothari finds raises the stock's bid–ask spread and this reduced liquidity is likely to lower the stock's market price.

(3) *Arbitrage activity and the risk of rights offer failure*. Investors can use rights as warrants to hedge their short sale positions in a firm's stock. This encourages increased short selling of the stock, but as additional short positions are opened, the stock price will tend to be depressed as resulting sell orders rise (at least within the bid–ask spread). Thus, between the announcement of rights offer terms and offer expiration, this short-selling activity tends to keep the stock price down, reducing the attractiveness of exercising rights for most stockholders. This creates additional uncertainty for issuers as to the ultimate rights offer subscription level.

(4) *Anti-dilution clauses and wealth transfers to convertible security holders*. If a firm has convertible securities or warrants outstanding with anti-dilution clauses in place, then issuing rights at discounts can trigger automatic reductions in conversion rates of these securities as discussed in Kaplan (1965) and Myhal (1990). These anti-dilution clauses are likely to result in improved positions for the convertible security holders, shifting wealth away from the common stock holders who are the residual claimants. As a result, there is an added incentive for firms with convertible securities outstanding to avoid issuing rights at deep discounts.

3.10. Market microstructure effects

Seasoned public offers of common stock have important impacts on the secondary market in which the common stock trades.[19] The typical firm commitment offer involves a large increase in shares outstanding along with a large increase in the number of stockholders and a reduction in management and blockholder percentage ownership. As a result, one would anticipate that there would be major increases in trading volume, changes in bid–ask spread and depth, increased insider trading at the end of the lock-up period, and possibly major changes in price volatility after the public offering. One would also expect similar effects on secondary market trading of corporate bonds following subsequent bond offerings of similar seniority and duration bonds.

Theories of bid–ask spread determination are based on adverse selection and inventory cost considerations. These theories predict that if trading volume rises and price

[19] Parts of this section are drawn from Eckbo and Masulis (1995).

volatility falls, then bid–ask spreads will also fall since the expected costs of market making decline. The SEO announcement per se can also lower the asymmetric information about the firm's stock price borne by market makers, which would cause bid–ask spreads to drop further.

Amihud and Mendelson (1986) develop a valuation model of security pricing that assumes that investors have a positive preference for liquidity measured by percentage bid–ask spread. They derive a model of security pricing where the expected return is a positive and concave function of bid–ask spread. Amihud and Mendelson (1988) extend the implications of the model and present evidence that liquidity is an important determinant of security value. They argue that managers seeking to maximize current stockholder wealth should take market liquidity into account when making corporate financing decisions. Thus, in deciding whether to make an SEO and in choosing the flotation method, liquidity implications need to be taken into account. A further implication is that the negative adverse selection effect of the offer announcement can be partially offset by the positive liquidity effect.

Lease, Masulis, and Page (1991) explore the market microstructure effects of firm commitment SEOs for NYSE and AMEX listed firms. They document that share trading volume rises substantially and that price volatility falls subsequent after the SEO. Not surprisingly, both dollar bid–ask spreads and percentage spreads fall significantly after the seasoned public offering, consistent with inventory cost and adverse selection cost models of bid–ask spread determination. They also report that trading volume and price volatility fall between the announcement and the offer dates, while bid–ask spreads drop, but not to the level observed subsequent to the public offer. This is suggestive of a modest increase in liquidity following the SEO announcement and a significant improvement after the SEO. Not withstanding the improvement in stock liquidity, Altinkilic and Hansen (2006) report that on average issuer stocks experience an abnormal negative return of 2.6 percent over the week prior to the SEO. They also find that this effect cannot be explained alone by a short term price reversal effect in the immediate post-SEO period and suggest that this is due to a negative information effect related to the underwriting process.

Tripathy and Rao (1992) examine the market microstructure effects of SEOs for NASDAQ listed firms. They split their sample into large and small capitalization stocks and that larger stocks have increases in bid–ask spread over a 60 day period prior to an SEO announcement, which is followed by decreases in spread over the next 43 days. In contrast, small stocks experience increases in spread from 80 days prior to the announcement through 20 days after the announcement. Focusing on the public offering date, they find that the bid–ask spreads of large stocks decrease over the 20 days prior to the offering and decrease even more over the 20 days following the offer. Spreads of small stocks increase over the 20 days prior to the offering, but then decrease beginning just before the offering through 20 days after.

Masulis and Shivakumar (2002) separately investigates the speed of price reactions measured in 15 minute intervals to SEO announcements by NYSE/Amex and Nasdaq listed stocks. They report that Nasdaq listed stocks react more quickly to these an-

nouncements (by about an hour) and attribute it the differences in the organizational structure of the NYSE/Amex and Nasdaq market places. They find evidence consistent with NYSE/Amex limit order books and market opening mechanisms slowing price reactions to news. They also report a large number of trading halts (21%) on the NYSE around daytime SEO announcements, while there are very few on Nasdaq.

Stock offers can also cause temporary biases in daily stock returns by disrupting normal buy-sell order flow in the secondary market. Lease, Masulis, and Page (1991) document that around the public offer dates of SEOs stock returns are biased downward due to the loss of purchase orders to the temporary primary market in the stock. One result is that stock transaction prices tend to occur at the lower ask quote, rather than at the midpoint of the bid and ask, which generates an apparent fall in the stock price. There is also evidence that market makers may lower their quotes in this period due to a positive imbalance in their inventory position resulting from the predominance of sell orders at this time. Lease, Masulis and Page find that using the closing bid–ask average rather than the closing transaction prices eliminates the statistical significance of the drop and reduces by more than half the average negative offer date return.

Several more recent studies explore the impacts of market microstructure on securities issuance. Presumably, as lead underwriter they have better knowledge of potential buyers and sellers, which should give them a competitive advantage in market making immediately after the IPOs, especially for larger orders. Ellis, Michaely, and O'Hara (2000, 2004) report that the typical lead underwriter is highly active as a market maker immediately following the IPO, but that this role diminishes over the following year. Corwin, Harris, and Lipson (2004) examine IPOs listed on the NYSE and report that initial buy-side liquidity is higher for IPOs with high quality underwriters, large syndicates, low insider sales and high pre-market demand (offer is priced at or above the maximum filing range price), while sell-side liquidity is higher for IPOs that represent a large fraction of outstanding shares and have low pre-market demand (offer is priced at or below the minimum filing range price). Limit order trading is very weak on the first day of trading, though there is an unusual number of limit buy orders submitted at the offer price for cold IPOs, which are likely to be underwriter stabilization bids. They also report that pre-opening order flow is a good predictor of first day prices and are reflected in the opening price set by the specialist. Field, Cao, and Hanka (2004) study the effects of lock-up expirations on IPO stocks and find that substantial increases in insider trading by officers and directors in almost 25 percent of cases do not adversely affect stock liquidity. They find only a 3 percent increase in effective bid–ask spreads that lasts only about one week, while depth and trading activity substantially improve.

Mola and Loughran (2004) studies the effects of market microstructure factors on SEO underpricing, along with the effects of underwriter competition. They find that the offer price discount is positively related to relative offer price, a tech indicator, gross spread and a top tier analyst indicator and negatively related to a utility indicator, log of share price, a high underwriter reputation indicator and an integer offer price indicator. Mola and Loughran conclude that changing issuer composition toward smaller, riskier Nasdaq listed issuers and increasing underwriter market power measured in terms of

underwriter market share, underwriter reputation and analyst quality can explain this phenomenon. As discussed earlier in the SEO underpricing section, Corwin (2003) also explores many of these issues. In addition, Butler, Grullon, and Weston (2005b) find that the underwriter spreads are negatively related to a wide range of stock liquidity measures, while Altinkilic (2006) reports that spreads are directly related to market making effort.

3.11. Miscellaneous offerings

3.11.1. Global offerings

Global issues are often sold through an ADR or GDR mechanism to minimize foreign exchange issues for foreign investors. Under these mechanisms, a depository bank holds the original stock and issues new shares that are denominated in local currency and pays cash dividends in the local currency. Global offerings by U.S. firms generally use the GDR mechanism. The supply of ADRs or GDRs can be expanded or contracted by the depository bank purchasing more shares of stock or selling back some of its shareholdings with the creation or redemption of a like number of claims to these shares through the issuance or redemption of ADRs/GDRs. Foreign issuers selling shares in the U.S. must register their securities under Rule 144A as is discussed in greater detail below.

The implication of cross listing of its stock on firm value is studied by Doidge, Karolyi, and Stulz (2004). They argue that cross-listing in the United States helps controlling shareholders of foreign firms commit to limit their expropriation of minority shareholders, since U.S. security laws are stricter than most other jurisdictions. They also argue that cross-listing increases the ability of these firms to raise equity capital at more attractive terms, allowing the firms to take advantage of their growth opportunities. They show supporting evidence in that foreign companies with shares cross-listed in the U.S. had market to book ratios (at the end of 1997) that were 16.5 percent higher than that of non-cross listed firms from the same country, and that growth opportunities are more highly valued for firms that cross-list from countries with weaker investor rights (also, see LaPorta, Lopez-de-Silanes, and Shleifer, 1999).[20]

Ljungqvist, Jenkinson, and Wilhelm (2003) examine the tradeoff between investor demand estimation methods (book building versus fixed-price) and the costs associated with hiring an underwriter for initial public offerings (IPOs). Book building conditions the final issue price on market demand conditions, whereas in case of a fixed-price method, shares are priced first and then later put up for subscription. Using a dataset containing 2,143 IPOs by issuers from 65 countries outside the United States during January 1992–July 1999, they show that book building, when used in combination with U.S. banks (as underwriters) and U.S. investors, can reduce underpricing significantly relative to fixed-price offerings or book building efforts by other banks. They attribute

[20] For a more recent survey of the literature on cross-listings, see Karolyi (2006).

this result to the fact that because of their longer book building experience, U.S. banks are more likely to have access to key institutional investors and may be in a better position to reward investors dynamically for their information revelation. Interestingly, they show that for most issuers, the gains associated with lower underpricing outweighed the additional costs associated with hiring U.S. banks, such as the 7 percent gross spread that is typically paid when U.S. banks are involved (see Chen and Ritter, 2000, and Hansen, 2001).

Wu and Kwok (2003) study the underpricing, underwriting fees and direct expenses of global IPOs. They report that global offers significantly reduce underpricing by 4 percentage points relative to purely domestic IPOs. The result can not be explained by potential selection bias in the offering decision. Underpricing is found to be a decreasing function of the relative size of the global tranche. They also find that global offers are more likely as the prior performance of the U.S. stock market rises. They also find no evidence of differences in underwriting spreads or other expenses.

Bruner, Chaplinsky, and Ramchand (2004) examine the direct and indirect costs of raising equity capital for a sample of 293 first-time foreign IPOs in the United States (i.e., these companies did not have their stock traded in a domestic market or other foreign market prior to the IPO) and compare the costs to those of U.S. IPOs. They conclude that in general foreign IPOs experienced approximately the same capital raising costs as the U.S. IPOs, with the exception of foreign firms with strong investor demand and upward revisions to offer prices that incurred a smaller underpricing than that of U.S. IPOs.

Chaplinsky and Ramchand (2004) analyze the choice between issuing public and private (under Rule 144A) debt by foreign firms. They conclude that SEC Rule 144A, which permitted firms to raise capital (in terms of both debt and equity) from qualified institutional buyers without requiring registration of these securities or compliance with U.S. GAAP, has resulted in the Rule 144A debt market replacing the public debt market in terms of number and volume of foreign debt issuers, especially for high-yield and non-rated issues.

3.11.2. Convertible securities and warrants issuance

Convertible debt and equity securities can be viewed as a method of issuing stock in the future, contingent on the issuer's financial conditional improving. As such, these securities are very similar to issuing warrants plus straight debt or preferred stock. These securities are often issued by privately held firms, which are raising capital from venture capitalists. These convertible securities are generally convertible preferred stock with an automatic conversion into common stock if the firm goes public. Unlike public issues of convertible securities, these privately placed equity issues generally carry powerful governance rights and may also have the feature that on conversion to common stock, the liquidation rights of the preferred issue may not have to be relinquished.

Public offerings of convertible securities are frequently convertible debt or straight debt with detachable warrants. These convertible securities are generally issued out-of-

the-money with American exercise rights over most or all of the security's life. Many of these securities are also callable, which is a method that allows the issuer to force the in-the-money convertible securities and warrants to convert their securities to common stock. Also, typical convertible securities held by venture capitalists automatically convert to common stock at the time of an IPO. Lastly, many convertible securities are not protected against cash dividends, which can again create incentives on the part of the option holder to exercise their conversion rights early, so as to avoid the stock price fall associated with the ex-dividend effect. Mayers (1998) argues that firms with significant real options can benefit from issuing convertible securities that don't have to be exercised until after the real options are exercised. This is similar to staged financing in the private equity market. Mayers finds that prior to calls of convertible bonds, firms exhibit increases in capital expenditures and new long term debt financing, consistent with the exercise of important real options.

There have been a variety of studies of convertible debt, convertible preferred stock and warrant issue including: Brennan and Schwartz (1982), Stein (1992), Nyberg (1995), Kang and Lee (1996), Mayers (1998), Lewis, Rogalski, and Seward (1998), Byoun and Moore (2003), Korkeamaki and Moore (2004), and Brick, Palmon, and Patro (2004). Most of these studies have focused on offering methods, offering frequencies and announcement effects. A few of these studies have also examined components of flotation costs.

3.11.3. Private placements of equity and convertibles

Wruck (1989) was first to study private placements of equity by publicly listed firms. She documented that these negotiated sales of equity by large NYSE listed firms had a positive mean announcement effect of 4.5 percent on the issuer's stock price unlike the average negative announcement effects of public offerings of stock. She analyzes the changes in shareholder ownership and concentration and documents that a private placement on average increases the voting power of the dominant blockholder and reduces the voting power of management. She finds that the change in stock value is strongly correlated with the change in ownership concentration. Sales that afterwards give the blockholder under 5 percent or more than 25 percent ownership have positive effects, while intermediate blocks result in negative effects. Moreover, sales that result in a change in control or an increase in management shareholdings have a negative effect. She argues that increasing shareholder concentration often increases shareholder wealth by improving firm efficiency and alignment of interests with outside shareholders, but at times can adversely effect outside shareholder wealth, when it is likely that substantial firm resources are diverted to private benefit.

In a follow up study, Herzel and Smith (1993) examine private placements by primarily smaller Nasdaq listed firms. They document that private placements are sold on average at substantial discount of 20 percent relative to public offerings. They argue that this underpricing is to compensate private placement investors for their investigation costs prior to investing, while the positive announcement effect reflects the positive

information effect associated with a sophisticated institutional investors agreeing to purchase shares, rather than improved monitoring of management by blockholders. Hertzel and Smith also report that institutional investment declines in private placement firms.

Wu (2004) examines the identity of private placement investors. She reports that private placement firms have higher asymmetric information than firms that rely on public offerings based on issuer age, lack of venture capital backing, fewer institutional investors and wider bid–ask spreads and coverage by fewer analysts. Also, she finds that private placement investors who engage in more intensive monitoring (i.e., venture capitalists and pensions funds) are not increasing their holdings in these firms after the private placements. This result is inconsistent with increase monitoring of management after the private placement. Finally, discounts on private placements sold to managers are higher than those when managers are not involved. These discounts are also higher when managers' initial holdings are lower. These last two results are consistent with management self-dealing. Wu also reports that private placement investors are typically passive, which is consistent with the evidence of Barclay, Holderness, and Sheehan (2005).

Gomes and Phillips (2005) examine a comprehensive sample of 13,000 private and public security issues of debt, convertibles and common stock by publicly listed firms. They find that in the recent 2000–2003 period private issues exceed public issues. Gomes and Phillips report that publicly listed firms with higher levels of asymmetric information (measured by analysts' earnings forecast errors or dispersion in earnings forecasts) are more likely to issue debt in the public market, while they are more likely to issue riskier equity and convertible securities in the private capital market. They also find that smaller public firms with higher risk, lower profitability and good investment opportunities are more likely to issue equity and convertible securities privately, while public equity issues are more likely for firms experiencing a stock price rise in the prior year relative to a benchmark portfolio.

More recently, a new type of private placements of equity by public companies (PIPES) has become popular, especially with small and medium size companies. The PIPE market originated with the SEC adoption of Regulation S in 1990, which permitted U.S. issuers to sell unregistered shares to foreign investors at any price in off shore markets without first registering them with the SEC or publicly disclosing them. In 1996, the SEC modified its rules to require issuers to report the sale of Reg S shares and required investors to hold these shares for a year. To gain greater liquidity, issuers typically registered the PIPE shares with the SEC via a shelf registration within 30 days of closing of the deal. The securities typically become effective 90 days after registration.

There are two major types of PIPEs. There are traditional PIPEs that are fixed number of shares or a convertible with a fixed strike price, which can be sold at a discount through private negotiations and there is a more recent innovation called structured PIPEs. Structured PIPEs represent convertible securities having variable strike prices that decline if the underlying stock prices decline beyond a specified interval. A structured PIPE allows investors to convert into a larger number of shares if the stock price

declines, thereby giving investors significant downside protection.[21] Not surprisingly, Brophy, Sialm, and Ouimet (2005) report that younger firms with weak performance in industries with high growth rates and risk levels (i.e., greater adverse selection) are the primary issuers. The typical investors in PIPEs are hedge funds.

3.11.4. Unit offerings in IPOs and SEOs

Unit offers involve the issue of a combination of common stock and warrants by an issuer. One potential advantages of selling units rather than shares is that when an issuer is very risky the market is apt to overestimate its leverage and its return volatility, which causes its warrants to be overvalued, while the stock is apt to be undervalued. The result of selling a unit is that these two effects are combined and become partially offsetting, which means firms sell the unit offers at closer to its true market value. This is similar to Brennan and Schwartz (1982) argument for why firms issue convertible securities. Warrants also give investors more time before committing to buy equity, which acts as a credible signal that the issuer holds no negative proprietary information about the firm's value. Taking into account the callability of many warrant and convertible issues and the cost of financial distress Stein (1992) argues that this can be a backdoor means of selling more equity, when the market over-estimates the adverse selection risk associated with the issuer. He finds that firms with intermediate levels of risk should issue convertibles. Unit offers of SEOs have been studied by Schultz (1993), Chemmanur and Fulghieri (1997) and Byoun (2004).

3.12. Conflicts of interest in the security offering process

Recently there has been a stream of new research exploring potential conflicts of interest by decision makers in the security offering process. These conflicts are sometimes between managers and securityholders, and in other cases between underwriters and either security investors or security issuers. A key question is whether these potential conflicts are large enough to alter the security underwriting process to a measurable degree and if so, do any underwriter customers suffer any serious financial consequences. A second important question is whether there are significant economic benefits from combining underwriting and other financial services.

One major concern is that at least some managers make security issuance, pricing, and underwriting decisions to benefit themselves, rather than their shareholders. Managers can accomplish this by issuing underpriced securities to friends and family, or capturing side payments from underwriters, for instance through underwriter allocations of other firms' underpriced IPOs, often called spinning or receiving new stock options exercisable at the IPO offer price, which represent valuable in-the-money options. Studies that explore this line of research include Jung, Kim, and Stulz (1996) who

[21] A similar security is studied by Hillion and Vermalen (2004). They investigate floating rate convertible debt, which adjusts the conversion ratio for stock price drops.

tests whether firms undertaking SEOs when facing poor growth opportunities, measured by market to book ratios, are experiencing agency conflicts between managers and shareholders. Consistent with this hypothesis, they find that some firms with poor growth opportunities do undertake SEOs and that these firms have more negative announcement effects. Ljungqvist and Wilhelm (2003) finds that managers participating in friends and family programs and not making secondary offerings are more apt to have underpriced IPOs. Datta, Iskandar-Datta, and Raman (2005) presents indirect evidence that on average SEO announcement effects are positively related to managers' equity based compensation, so greater equity based compensation is associated with less negative announcement effects. Kim and Purnanandam (2006) reports a similar finding.

Turning to the management compensation effects of IPOs, Lowry and Murphy (2006) examines whether IPOs are underpriced more because managers obtain more valuable stock options with lower strike prices (set at the offer price) when new stock option plans are established at the IPO date. They find no evidence of a positive relation between underpricing and IPO option grants, which does not support a serious conflict of interest effect.

A second avenue of concern is that underwriters may have conflicts of interest with their customers due to joint production of underwriting and other financial services including brokerage, market making, security analysis, venture capitalist investing, lending and asset management, to name a few. Many researchers have investigated whether the joint production of these services creates serious conflicts of interest or whether there are significant economies of scale or scope realized from sharing financial information produced in the course of performing one or more of these services. Since financial service providers need timely information about customers' financial strength, joint production of information or sharing of this information can be particularly cost efficient.

Of all of these related services, the area that has elicited the most research interest is security analysis by underwriting firms. Underwriters seek to reduce the time and expense of selling a security offer and to lower their risk of offer failure, and the question is whether these incentives dominate the analyst's reputation concerns near security offering dates, causing sell-side analysts to hype these issues through overly optomistic earnings forecasts and investment recommendations. Michaely and Womack (1999) report evidence of such a bias. However, more recent evidence does not support this finding. Kadan et al. (2005) report that after the 2002 NYSE and NASD rules regulating sell side analyst's investment banking relationships, there is no evidence that analysts issue optimistic earnings forecasts. However, these same analysts remain reluctant to recommend selling stocks that their investment banking arms are underwriting. Other studies that find affiliated analysts do not make more optimistic earnings forecasts includes: Kolasinski and Kothari (2004), O'Brien, McNichols, and Lin (2005), Barber et al. (2005), Agrawal and Chen (2004) and Ljungqvist, Marston, and Wilhelm (2006).

There is a stream of literature including Puri (1994, 1996, 1999), Gande et al. (1997), Schenone (2004), Chaplinsky and Erwin (2005), Drucker and Puri (1989) and Li and

Masulis (2006) examining situations where lenders are also debt or equity underwriters. The basic concern is that underwriters who are also lenders have incentives to underwrite weak security issues to strengthen the financial condition of borrowers. These studies generally find no evidence supporting a significant conflict of interest effect.

Another potential underwriter conflict of interest with IPO investors occurs when IPO underwriters are also venture investors since venture investors realize substantial financial benefits when their portfolio firms complete IPOs. Several recent studies by Li and Masulis (2005, 2006) examine whether underwriters alter their underwriting and pricing decisions when they have venture investments in these issuers. However, they find no evidence to support underwriters weakening their underwriting standards to improve the returns on their venture investments.

4. The flotation method choice

In this section, we examine the firm's choice of issue method. We start with the so-called rights offer paradox first observed by Smith (1977). The paradox highlights the fact that a focus on *direct* issue costs alone fails to adequately explain the near disappearance of the rights offer method for large, publicly traded corporations in the U.S. We then examine how observed flotation method choices may minimize issue costs under asymmetric information and survey the empirical evidence on announcement effects of security offerings as a function of the flotation method.

4.1. The paradoxical decline in the use of rights

With symmetric information between corporate insiders and outside investors, standard economic theory predicts a preference for the relatively inexpensive uninsured rights offer method for floating seasoned equity. Nevertheless, Table 10 shows that as of the mid-1970s, publicly listed companies in the U.S. have virtually abandoned the rights issue method in favor of firm commitment underwritten offerings.[22] Furthermore, this phenomenon is not restricted to U.S. offerings. Ursel and Trepanier (2001) show a strong trend towards declining use of rights and increasing use of public offerings in Canada 1970–1985. The trend away from rights is also evident in Japan: Table 11 shows a dramatic decline in rights offerings after the mid-1990s. Slovin, Sushka, and Lai (2000) report that uninsured rights represents a small fraction of total SEOs by British firms listed on the London Stock Exchange. In Hong Kong, rights are also now in a minority (Wu, Wang, and Yao, 2005). Bøhren, Eckbo, and Michalsen (1997) present evidence that issuers on the Oslo Stock Exchange have moved from uninsured rights

[22] A corporation's charter originally stipulates that shareholders have the first right of refusal (preemptive right) to purchase new equity issues. Thus, abandoning the rights method requires a shareholder vote in favor of eliminating the preemptive right. Such charter amendments became popular among U.S. publicly traded firms in the early 1970s, preceding the move towards firm commitment offerings. See also Bhagat (1983).

Table 10
SEOs by NYSE- and AMEX-listed firms, classified by flotation method (FC = firm commitments, Stand = standby rights), 1935–1955 and 1963–1981[a]

	Total issues				Industrial issues				Utility issues			
	Total	FC	Stand	Right	Total	FC	Stand	Right	Total	FC	Stand	Right
1935	6	1	3	2	5	–	3	2	1	1	–	–
1936	37	11	17	9	37	11	17	9	–	–	–	–
1937	40	15	18	7	39	15	17	7	1	–	1	–
1938	5	2	–	3	4	1	–	3	1	1	–	–
1939	13	6	3	4	8	5	3	–	2	1	–	1
1940	18	9	4	5	13	7	4	2	3	2	–	1
1941	9	1	3	5	9	5	3	1	6	2	–	4
1942	1	1	–	–	1	1	–	–	–	–	–	–
1943	14	8	5	1	13	7	5	1	1	1	–	–
1944	23	13	9	1	22	12	9	1	1	1	–	–
1945	52	23	18	11	45	20	15	10	7	3	3	1
1946	110	73	24	13	96	65	21	10	14	8	3	3
1947	53	27	12	14	29	19	5	5	24	8	7	9
1948	61	20	20	21	28	11	9	8	33	9	11	13
1949	79	27	30	22	14	7	5	2	65	20	25	20
1950	84	35	31	18	30	16	9	5	54	19	22	13
1951	131	61	49	21	63	40	16	7	68	21	33	14
1952	131	66	43	22	71	41	20	10	60	25	23	12
1953	120	55	47	18	43	28	11	4	77	27	36	14
1954	101	51	33	17	51	36	11	4	50	15	22	13
1955	113	44	56	13	56	29	25	2	57	15	31	11
1935–1955	1,201	549	425	227	677	376	208	93	525	179	217	129
1963	12	2	6	4	5	1	3	1	7	1	3	3
1964	17	8	6	3	8	4	3	1	9	4	3	2
1965	20	5	9	6	11	5	4	2	9	0	5	4
1966	27	12	12	3	17	7	8	2	10	5	4	1
1967	26	12	9	5	17	9	4	4	9	3	5	1
1968	44	26	9	9	31	20	4	7	13	6	5	2
1969	42	24	15	3	22	13	7	2	20	11	8	1
1970	49	36	10	3	22	18	2	2	27	18	8	1
1971	84	65	15	4	44	40	2	2	40	25	13	2
1972	81	68	11	2	29	27	1	1	52	41	10	1
1973	58	50	6	2	12	10	1	1	46	40	5	1
1974	53	47	4	3	6	5	0	1	47	42	3	2
1975	89	79	8	1	20	19	1	0	69	60	8	1
1976	93	88	3	1	30	29	1	0	63	59	3	1
1977	65	62	3	0	2	2	0	0	63	60	3	0
1978	90	86	3	1	25	23	2	0	65	63	1	1
1979	85	81	2	2	21	20	0	1	64	61	2	1

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Table 10
(*Continued*)

	Total issues				Industrial issues				Utility issues			
	Total	FC	Stand	Right	Total	FC	Stand	Right	Total	FC	Stand	Right
1980	162	157	2	3	87	86	0	1	75	71	2	2
1981	152	149	1	2	64	63	0	1	88	86	1	1
1963–1981	1,249	1,057	134	57	473	401	43	29	776	656	92	28
1982–2003	8,708	8,375	333[b]	–	8,241	7,912	329[b]	–	467	463	4[b]	

[a]The information is from Stevenson (1957) (1935–1955), Eckbo and Masulis (1992) (1963–1981), and SDC (1982–2003). Stevenson (1957) lists common stock issues with proceeds over $1 million appearing in Sullivan and Cromwell Issuer Summaries 1933–1950 and in The Commercial and Financial Chronicle 1950–1955. Eckbo and Masulis (1992) base their sample on the Wall Street Journal Index, the Investment Dealer's Digest, and Moody's Industrials and Utilities Manuals. Their sample excludes simultaneous offers of debt/preferred stock/warrants, combination primary/secondary stock offerings, cancelled or postponed offers, and non-U.S. issues. The SDC sample shown for the period 1982–2003 includes issues on exchanges other than NYSE and AMEX.
[b]The SDC does not provide sufficient information to separate uninsured rights offerings from rights with standby underwriting. Thus, all rights are reported under the standby category in this table.

to standbys over the past two decades. A similar time trend is evident in the study of French SEOs by Gajewski and Ginglinger (2002).[23] Overall, as concluded by Eckbo and Masulis (1995) and Armitage (1998) as well, there appears to be an international trend away from rights. This trend coincides with substantial growth in listed firms' total equity size.

As discussed in Section 3 above, the uninsured rights method has by far the lowest direct costs. Thus, it appears that issuers in the U.S. and increasingly elsewhere are selecting the most expensive equity flotation method. Therein lies the rights offer paradox. Resolution of the paradox requires identifying indirect costs of rights that are of sufficient economic magnitude to make the total (direct and indirect) costs of firm commitment offerings the lowest for nearly all large, publicly traded industrial issuers in the U.S. We identified some of these indirect costs in Section 3. Eckbo and Masulis (1992) argue that a potentially large indirect cost emanates from adverse selection in the rights issue market. We discuss why information asymmetries may drive issuers away from the rights method next.

[23] Cronqvist and Nilsson (2005) report that uninsured rights are more frequent than uninsured rights over their sample period but do not show the time trend.

Table 11
Equity security issues by firms listed on the Tokyo Stock Exchange, 1956–2003[a]

Year	Rights offerings		Public offerings		Preferred stocks		Private placements		Exercise of warrants		Total	
	No. of issues	Amount raised (¥ bils.)	No. of issues	Amount raised (¥ bils.)	No. of issues	Amount raised (¥ bils.)	No. of issues	Amount raised (¥ bils.)	No. of issues	Amount raised (¥ bils.)	No. of issues	Amount raised (¥ bils.)
1956	294	157	36	4	–	–	11	2	–	–	341	164
1957	292	199	40	5	–	–	10	1	–	–	342	205
1958	147	160	30	5	–	–	3	0	–	–	180	165
1959	158	153	60	10	–	–	3	0	–	–	211	183
1960	275	331	100	35	–	–	4	1	–	–	379	387
1961	465	632	224	80	1	0.4	6	1	–	–	695	712
1962	554	587	171	20	–	–	9	3	–	–	734	609
1963	508	410	157	38	–	–	8	7	–	–	673	453
1964	434	623	85	4	–	–	14	3	–	–	533	631
1965	95	115	19	1	–	–	8	3	–	–	122	117
1966	173	202	34	1	–	–	24	8	–	–	231	212
1967	190	194	68	5	–	–	13	4	–	–	261	202
1968	201	303	80	10	–	–	12	2	–	–	293	315
1969	300	447	145	55	–	–	14	5	–	–	469	506
1970	316	538	203	138	–	–	18	5	–	–	537	681
1971	220	409	147	84	–	–	24	44	–	–	391	637
1972	180	284	275	665	–	–	43	92	–	–	498	1,041
1973	177	344	256	565	–	–	45	30	–	–	478	939
1974	214	244	193	277	–	–	31	23	–	–	438	544
1975	166	771	103	222	–	–	16	8	–	–	285	1,001

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Table 11
(*Continued*)

Year	Rights offerings		Public offerings		Preferred stocks		Private placements		Exercise of warrants		Total	
	No. of issues	Amount raised (¥ bils.)	No. of issues	Amount raised (¥ bils.)	No. of issues	Amount raised (¥ bils.)	No. of issues	Amount raised (¥ bils.)	No. of issues	Amount raised (¥ bils.)	No. of issues	Amount raised (¥ bils.)
1976	102	180	181	500	1	12	11	9	–	–	294	689
1977	120	291	238	604	–	–	48	29	–	–	406	923
1978	86	267	195	565	–	–	62	84	–	–	313	897
1979	64	262	229	629	–	–	42	63	–	–	325	953
1980	34	90	218	881	–	–	28	81	–	–	280	1,052
1981	67	494	249	1,396	–	–	20	37	–	–	336	1,928
1982	45	224	209	1,103	1	30	14	21	4	2	272	1,349
1983	18	135	72	472	–	–	23	165	18	30	131	802
1984	23	91	128	821	1	6	18	68	39	66	208	1,043
1985	40	183	103	506	–	–	18	33	70	137	231	859
1986	27	69	76	400	–	–	18	30	118	373	235	673
1987	26	436	99	1,394	–	–	22	109	241	1,074	388	3,013
1988	40	787	157	2,582	–	–	23	104	316	1,309	536	4,782
1989	32	726	227	5,830	–	–	22	102	436	2,190	718	8,849
1990	39	825	121	1,975	–	–	21	315	397	678	578	3,792
1991	40	218	27	126	–	–	19	104	309	360	395	808
1992	20	111	3	4	–	–	22	102	127	203	172	420
1993	9	48	4	7	–	–	14	150	184	617	211	823
1994	2	10	17	137	1	100	8	239	180	451	208	936
1995	12	96	8	33	1	50	19	160	118	299	158	638

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Table 11
(*Continued*)

Year	Rights offerings		Public offerings		Preferred stocks		Private placements		Exercise of warrants		Total	
	No. of issues	Amount raised (¥ bils.)	No. of issues	Amount raised (¥ bils.)	No. of issues	Amount raised (¥ bils.)	No. of issues	Amount raised (¥ bils.)	No. of issues	Amount raised (¥ bils.)	No. of issues	Amount raised (¥ bils.)
1996	9	337	36	305	5	539	20	219	187	674	257	2,074
1997	9	73	26	128	2	224	19	370	88	368	144	1,162
1998	1	0.3	12	284	5	471	35	696	35	88	88	1,540
1999	–	–	35	371	27	7,012	86	2,445	74	262	222	10,090
2000	2	8	36	573	5	137	56	972	94	111	193	1,798
2001	3	32	18	1,201	6	228	71	567	92	38	190	2,067
2002	–	–	21	156	40	1,029	79	502	82	276	222	1,963
2003	3	2	40	573	75	2,537	103	234	126	40	347	3,385
2004	4	4	80	754	55	1,411	142	624	241	104	522	2,900

Source: The Tokyo Stock Exchange Fact Book, 2005.
[a]The table includes foreign issues.

4.2. Adverse selection and current shareholder takeup

Myers and Majluf (1984) provide the first analytical approach to the equity issue decision under asymmetric information. It is useful to recap the setting of their primary model:

- The firm's objective is to maximize the full-information (long-run) value of current shareholders' claim on the firm.
- The firm knows the true value a of its assets in place while outside investors know only the probability distribution over a.
- The firm needs to sell equity to raise a cash amount of I dollars in order to finance a short-lived investment project with a commonly known net present value of b.
- The equity issue is sold using a simple flotation method: a direct offering to the public with no mechanism (such as an underwriter) for communication between the issuer and outside investors, and with no participation in the issue by current shareholders.

A key insight of Myers and Majluf (1984) is that the cost of selling undervalued stock may exceed b, causing the undervalued firm to forego the investment project rather than issue and invest.[24] The cost of this underinvestment drives a demand for more expensive flotation methods designed to reduce the information asymmetry between the issuer and outside investors. The cost may also induce the firm to turn to its own shareholders for additional equity capital. In sum, the Myers and Majluf (1984) setting provide a useful starting point for thinking about how undervalued firms may use alternative flotation methods to reduce costly information asymmetry.

For example, Wruck (1989) and Herzel and Smith (1993) suggest that some high-quality issuers avoid public issues in favor of private placements. In a private placement, the issuer may directly compensate the investor for costs of due diligence and quality inspection by selling the issue at a discount relative to the issue's market price. If the private placement investor holds on to the newly created block of shares, there may also be long-term benefits in terms of increased monitoring of the issuing firm's management.[25] Firms may also turn to underwriters for quality certification. Baron (1982), Booth and Smith (1986), Beatty and Ritter (1986), Titman and Trueman (1986) and Eckbo and Masulis (1992) all presume that underwriters have some ability and incentive to evaluate the extent to which the issuer's stock may be overpriced, and to avoid selling overpriced shares to the public. The incentive may emanate from an underwriter's risk of loss of reputation, or its risk of legal liability (e.g., Tinic, 1988; Blackwell, Marr, and Spivey, 1990).

[24] Dybvig and Zender (1991) argue that an appropriately structured managerial compensation contract would eliminate this underinvestment problem. Similarly, Admati and Pfleiderer (1994) point out that in a firm that has only investors who hold a fixed fraction of all its securities, management seeks to maximize shareholder wealth by always investing in positive NPV projects.

[25] It may also be the case that entrenched managers prefer a private placement. The offering price discount may be used as compensation to a friendly "white knight" investor for allowing management to maintain private benefits of control (see also Zwiebel, 1995). We return to this issue below.

Eckbo and Masulis (1992) generalize the Myers–Majluf framework by explicitly allowing current shareholder participation in the issue via a rights offer. Moreover, they introduce noisy but informative quality certification in the form of underwriting (standbys or firm commitment contracts). These refinements allow a realistic representation of the most commonly used flotation methods, and they result in a number of interesting predictions not available from Myers and Majluf (1984). In particular, as discussed in more detail in the subsequent section, the set of circumstances in which one expects a negative market reaction to equity issue announcements is considerably smaller.

To illustrate the shareholder takeup model, let $k \in [1, 0]$ denote the exogenously given and observable fraction of the issue that is taken up by current shareholders.[26] Moreover, let $C(k)$ denote total issue costs, which is the sum of direct costs d and expected wealth transfer to outside investors. As in Eckbo and Norli (2004), the expected profits π from issuing and investing can be written

$$\begin{aligned}\pi &= b - C(k)\\ &= b - d - \frac{I(1-k)\left[(a+b+I-d) - P\right]}{P},\end{aligned} \tag{1}$$

where P is the post-issue secondary market price of the issuer. P is determined by investors' equilibrium beliefs about a. In a separating equilibrium, P equals the full-information value of the post-issue company ($P = a + b + I - d$), with issue profits of $\pi = b - d$. In a pooling equilibrium, however, undervalued firms experience a positive wealth transfer as $P < a + b + I - d$.[27]

Equation (1) shows how the magnitude of any wealth transfer cost is attenuated by shareholder takeup k. Essentially, shareholder takeup acts like a form of financial slack. If $k = 1$, $\pi = b - d$ and the wealth transfer cost is zero, even if the market undervalues the stock ($P < a + b + I - d$). If $k < 1$, which means that some shareholders in a rights offer will sell their rights to outside investors rather than subscribe, adverse selection costs are positive for undervalued firms *even if the rights offer is expected to be fully subscribed in the end*. If the firm uses an uninsured rights offer when $k = 0$, current shareholders sell *all* the rights, and the entire issue is sold to outside investors. This is a worst-case scenario in terms of wealth-transfer costs: since there is no quality certification, uninsured rights generate the same potential for wealth transfers associated with the direct offer mechanism in Myers and Majluf (1984).

Eckbo and Masulis (1992) argue that their shareholder takeup model resolves the rights offer paradox: high-quality issuers gravitate towards flotation methods that minimize the potential for wealth transfer costs. Their key insight is to show that the wealth

[26] Because the fraction k reflects individual shareholder wealth constraints, it is in part exogenous to the firm. k is observable through subscription precommitments (published in the issue prospectus), and through the rights trading activity (trades occur when current shareholder do not want to participate).

[27] As discussed in Eckbo and Norli (2004), the profit function in equation (1) presumes that the offering price P_0 is set consistent with market beliefs $P_0 = P$. Thus, this function ignores the possibility of using an offering price discount to convey information. We return to the offering discount below.

transfer cost associated with an uninsured rights offer increases as k decreases. eventually making it optimal to add quality certification in a standby offering. As k approaches zero, it is optimal to abandon rights altogether, despite the low *direct* cost of rights. In sum, the optimal flotation method choice depends on k. It follows that, around the world, firms gradually avoid uninsured rights in response to a gradual reduction in the willingness of wealth-constrained shareholders to keep funding corporate growth. This is consistent with the time-trend away from uninsured rights evidenced in Table 10 and Table 11, as average firm size also increases over time. It is also consistent with the fact that smaller private firms, and firms listed on smaller international stock exchanges, still use rights today.

Under the shareholder takeup model of Eckbo and Masulis (1992), the cross-sectional variation in the use of rights is driven by factors that affect individual shareholders wealth constraints and incentives. These factors include personal wealth and degree of risk aversion, the magnitude of private benefits of control, and the availability of substitute mechanisms for maintaining control benefits (e.g., restricted voting share and pyramidal ownership structures). Regulatory changes, and changes in the issue-technology also plays a role. For example, Ursel and Trepanier (2001) present some evidence that the decline in Canadian rights issues to some extent coincides with regulatory changes—such as the expanded use of short-form prospectuses and shelf registration procedures—which lead to an increase in the relative costs of rights.

Eckbo and Norli (2004) extend the analysis of Eckbo and Masulis (1992) by formalizing a sequential, multistage issue game in which issuers at each stage have access to a menu of flotation methods. At the start of the game, issuer have access to uninsured rights, rights with standby underwriting, and private placements.[28] Consistent with the evidence in Table 6, the direct issue cost d is assumed to be lowest for uninsured rights. The standby underwriter and private placement investor perform noisy but informative quality certification. If, say, the private placement investor rejects purchasing the issuer based on its private evaluation, then the issuer either decides not to issue or moves on and decides between the remaining flotation methods in the next issue subgame. Thus, firms select among entire issue *strategies* and not just among individual flotation methods.

Eckbo and Norli (2004) show that there exists an equilibrium 'pecking order' of flotation methods in their issue game which depends on k. Figure 3 illustrates with a numerical example this pecking order.[29] The horizontal axis plots shareholder takeup k. The vertical axis plots total expected issue cost $C(k)$ for each of three alternative issue strategies. $C(k)$—which is linear in k—incorporates the issuer's participation constraint (equation (1) above), so these are equilibrium strategies. Denote a particular issue strategy as $\{x\}$. The steepest line in Figure 3 is for the "move straight to uninsured rights and

[28] One could substitute firm commitment underwriting for private placement without altering the basic model insights. Eckbo and Norli (2004) use private placements as their empirical laboratory is the Oslo Stock Exchange where uninsured rights, standby rights and private placements are the only observed flotation methods.

[29] See the Appendix of (Eckbo and Norli, 2004) for details of the parameter values.

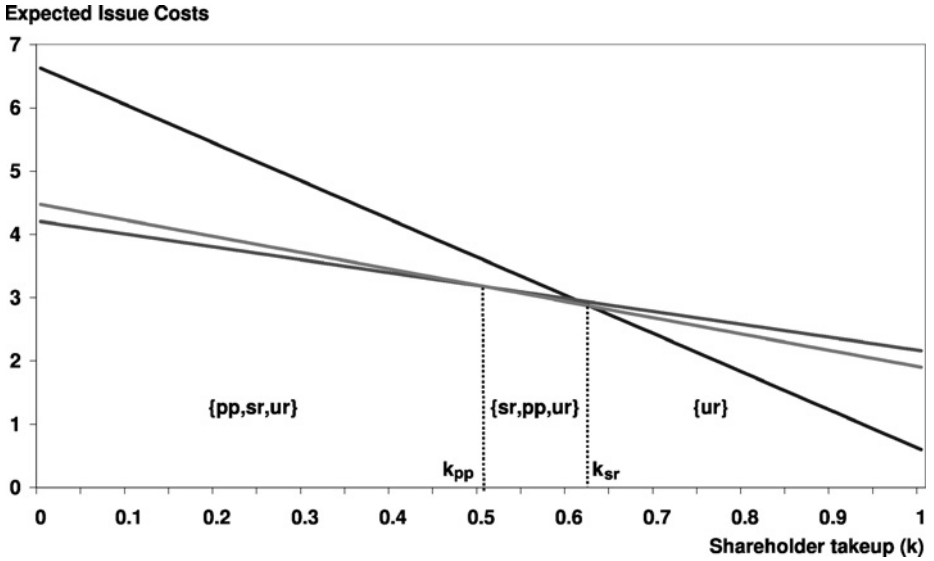

Fig. 3. Illustration of the flotation method pecking order. Source: Eckbo and Norli (2004). The horizontal axis plots shareholder takeup k. The vertical axis plots total expected issue cost $C(k)$ for each of three alternative issue strategies. $C(k)$ incorporates the issuer's participation constraint. The steepest line is $C(k)$ for the "move straight to uninsured rights and issue" strategy $\{ur\}$. The middle line is $C(k)$ for the strategy "start with standby rights, and if rejected try private placement, and if rejected again, sell the issue using uninsured rights" $\{sr, pp, ur\}$. The third and most horizontal line is $C(k)$ for the "start with a private placement, and if rejected try a standby rights, and if rejected again, sell the issue using uninsured rights" strategy $\{pp, sr, ur\}$. The critical values of k are denoted k_{pp} and k_{sr}. The optimal issue strategy is one that minimizes $C(k)$ conditional on k, i.e., the inner envelope of the three separate cost curves. Thus, it is an equilibrium for all issuers with shareholder takeup less than the critical value of $k_{pp} = 0.51$ to attempt a private placement first. When k is between $k_{pp} = 0.51$ and $k_{sr} = 0.62$, the equilibrium strategy is to attempt a standby rights offering first, while all issuers with k greater than $k_{sr} = 0.62$ go directly to the uninsured rights offer.

issue" strategy $\{ur\}$. The middle line is for the strategy "start with standby rights, and if rejected try private placements, and if rejected again issue using uninsured rights" $\{sr, pp, ur\}$. The third and most horizontal line is for the strategy "start with private placement, and if rejected try standby rights, and if rejected again issue using uninsured rights" $\{pp, sr, ur\}$. The critical values of k that separates these strategies are denoted k_{pp} and k_{sr}. The optimal issue strategy is one that minimizes $C(k)$, i.e., the inner envelope of the three separate cost curves. Thus, in Figure 3, it is an equilibrium for all issuers with shareholder takeup less than the critical value of $k_{pp} = 0.51$ to attempt a private placement first. When k is between $k_{pp} = 0.51$ and $k_{sr} = 0.62$, the equilibrium strategy is to attempt a standby rights offering first, while all issuers with k greater than $k_{sr} = 0.62$ go directly to the uninsured rights offer.

A central implication of this pecking order is that the probability of an issuer switching from rights to underwritten offer increases as k decreases even if a rights offer is

expected to be fully subscribed with the help of outside investors. There is growing evidence to support this prediction. Eckbo and Masulis (1992) and Singh (1997) report that the average level of shareholder takeup in U.S. rights offers is greater in uninsured rights offers than in standbys. Eckbo and Masulis (1992) also find that firms obtain substantial levels of subscription precommitments from large shareholders prior to selecting the uninsured rights method, with few such precommitments in standby rights. Information on subscription precommitments are published in the offering prospectus and are empirically useful in predicting k. As reviewed in Section 3 above, there is also substantial evidence more generally that flotation costs are lower for firms with greater ownership concentration, which are also the firms that tend to have greater values for k.

Internationally, where the rights method is much more prevalent, there is also substantial evidence consistent with a key role for shareholder takeup k. Bøhren, Eckbo, and Michalsen (1997) and Cronqvist and Nilsson (2005) study rights offers on the Oslo and Stockholm stock exchanges, respectively, and use the trading volume in rights to directly measure k.[30] They find that rights are more likely to be selected the greater the value of k. Moreover, Bøhren, Eckbo, and Michalsen (1997) show that the probability of switching from uninsured rights to standby rights declines with k, as predicted by Eckbo and Masulis (1992) and Eckbo and Norli (2004). Slovin, Sushka, and Lai (2000) find that the level of subscription levels is similar in standbys and uninsured rights in the U.K.[31] In their sample of French SEOs, Gajewski and Ginglinger (2002) report a greater ownership concentration for uninsured rights issuers than for standby rights issuers, and the lowest ownership concentration for underwritten public offerings. They also report that share allocations not taken up by the issuer's blockholders is much larger for underwritten public offerings than for uninsured rights and standbys. Using annual data on share ownership in Italy, Bigelli (1998) report that insiders' level of shareownership remains stable through the year of a rights offering, which is consistent with a high value of k.

4.3. Predicting the market reaction to issue announcements

Table 12 summarizes the empirical predictions of the adverse selection, shareholder takeup and pecking order theories for the stock market reaction to issue announcements as a function of the flotation method. Table 12 is restricted to models in which the firm considers issuing common stock only. The choice between different types of securities—the capital structure choice—is covered in several other chapters throughout this Handbook, and has also been previously reviewed by Harris and Raviv (1991).

Let AR denote the announcement-induced abnormal stock return of the issuer. We first discuss predictions for AR of models with only a *single* flotation method, of which Myers and Majluf (1984) is the most prominent. These models provide a useful starting

[30] Rights are traded on stock exchanges. If rights trade only once (sold by a current shareholder to an outside investor), then the trading volume in rights measure $1 - k$ directly.

[31] However, it is not clear from their study whether their "takeup" variable reflects total rights-subscription levels or only subscriptions by current shareholders.

Table 12
Predicted market reaction *AR* to SEO announcements as a function of the flotation method choice

Study	Model specifics	Model implications for *AR*
Myers and Majluf (1984)	Direct sale to public with no communication between firm and market. Current shareholders are passive bystanders to issue (they neither purchase new nor sell old shares). Managers maximize current shareholders' claim on firm, which amounts to maximizing the intrinsic (full-information) value of this claim	Separating equilibrium: $AR_{do} < 0$. Ceteris paribus, AR_{do} is more negative the greater the risk that the security is overvalued by market prior to the issue announcement. A pooling equilibrium ($AR_{do} = 0$) is more likely the greater the ratio $b/E(a)$
Krasker (1986)	Myers and Majluf (1984) but with varying investment size I	In the separating equilibrium, $AR_{do} < 0$ and more negative the greater is I
Heinkel and Schwartz (1986)	Issuers choose between uninsured rights, standbys and firm commitment offerings. Standbys is the most expensive flotation method and provide perfect quality *certification*. Firm commitment is simply a direct sale to market with no certification	Highest-quality issuers select standbys, intermediate-quality issuer select uninsured rights, while lowest quality issuers select firm commitments. $AR_{fc} < AR_{ur} < 0$ and $AR_{sr} > 0$
Giammarino and Lewis (1988)	Myers and Majluf (1984) but with an intermediary 'financier' who may reject the issue	Semi-separating equilibrium with $AR_{fc} > 0$
Eckbo and Masulis (1992)	Myers and Majluf (1984) but allowing current shareholder takeup of the (exogenous) fraction k of the issue, and informative but noisy quality certification by underwriters. Single-stage flotation method game	Optimal flotation method choice depends on k: Separating equilibrium where no low-k firms select uninsured rights. Adverse selection greatest for firm commitments, lowest for uninsured rights, with standbys in between: $AR_{fc} < AR_{sr} < AR_{ur} \leqslant 0$
Cooney and Kalay (1993); Wu and Wang (2005, 2006a)	Myers and Majluf (1984) but with possible managerial overinvestment ($b < 0$)	Separating equilibrium with $AR_{do} > 0$ due to prior market uncertainty about $b < 0$
Bøhren, Eckbo, and Michalsen (1997)	Eckbo and Masulis (1992) with uninsured rights and standbys only, but with varying underwriter quality certification ("effectiveness")	High-k issuers select uninsured rights regardless of firm quality, so no adverse selection ($AR_{sr} = 0$). Adverse selection in standbys if underwriter "ineffective" ($AR_{sr} < 0$), but positive selection if underwriter "effective" ($AR_{sr} > 0$)

(*Continued on next page*)

Table 12
(*Continued*)

Study	Model specifics	Model implications for *AR*
Eckbo and Norli (2004)	Eckbo and Masulis (1992) but with a multistage issue game. Private placement replaces firm commitments. If issuer is rejected by the private placement investor or the standby underwriter, it moves to the next subgame consisting of the remaining flotation method choices	Equilibrium where issuers pool over entire issue *strategies*, but where some issuers are rejected by the noisy quality inspection. High-k firms prefer the issue strategy $\{ur\}$ which implies $\{AR_{ur} = 0\}$. Intermediate-k firms prefer the strategy $\{sr, pp, ur\}$ which implies $\{AR_{sr} > 0, AR_{pp} = 0, AR_{ur} < 0\}$. Low-$k$ issuers prefer $\{pp, sr, ur\}$ implying $\{AR_{pp} > 0, AR_{sr} = 0, AR_{ur} < 0\}$

In all the models below, the firm knows the true value of its assets in place a while shareholders and outside investors only know the probability distribution over a. The firm needs to sell equity (no debt allowed) to raise the amount I required to invest in a short-lived project with net present value b. The models differ in their assumptions about managerial objectives and availability of flotation methods. AR_{do}, AR_{ur}, AR_{sr}, AR_{fc}, AR_{pp} denote the market reactions to "direct offering", "uninsured rights", "standby rights", "firm commitment", and "private placement", respectively. In Eckbo and Norli (2004), an issue strategy such as the one denoted $\{pp, sr, ur\}$ means "try private placement first, if rejected, try standby rights, if rejected again, do uninsured rights".

point for understanding the effects of adverse selection per se. We then turn to models where the firm is allowed to select from a menu of commonly used flotation methods, either in single-stage or in multi-stage (sequential) games.

4.3.1. Models with a single flotation method

Recall that the setting of Myers and Majluf (1984) is a direct equity sale to the public. Current shareholders are assumed to be passive and there are no mechanism for quality certification. In their separating equilibrium, some undervalued firms prefer not to sell shares, which implies that the pool of issuing firms is overpriced ex ante. The market therefore discounts issuers' stock price in response to news of the offer ($AR < 0$). Alternatively, in their pooling equilibrium, the value of b is sufficiently large for all firms to issue, which implies that the issue announcement conveys no new information to the market ($AR = 0$). Ceteris paribus, in their separating equilibrium, AR is more negative the greater the ex ante risk that the security is overvalued by the market. The latter implication helps distinguish the Myers and Majluf (1984) adverse selection model from a signaling model such as Miller and Rock (1985), in which external financing conveys negative information per se, regardless of the potential for security mispricing.

Strictly speaking, tests of the Myers and Majluf (1984) prediction $AR \leqslant 0$ requires a sample of direct equity sales to the public. As direct sales are rare events, no such experiment has been reported to date. Existing studies draw from the set of available flotation methods, which in U.S. studies is predominantly firm commitment offerings, while rights offerings dominate throughout the rest of the world. The subsequent theoretical work represents attempts to refine the single-flotation-method environment of Myers and Majluf (1984) in various ways, adding predictive power in samples dominated by more complex flotation methods.

Krasker (1986) allows the size of the investment project—and therefore the required financing amount I—to vary across firms. He derives a separating equilibrium in which greater amounts I implies greater adverse selection, so AR is more negative the greater the amount raised in the offering.

Giammarino and Lewis (1988) introduces a simple bargaining game between the issuer and an uninformed financial intermediary. The purpose is to examine the implications of allowing the purchaser of the issue to reject the offering (which never happens in Myers and Majluf (1984)). The issuer suggests an offer price that is either "high" or "low", and the financier accepts or rejects the offer. In their semi-pooling equilibrium, the high-value type always suggests a high offer price, while the financier randomizes between accepting and rejecting the high offer price, but always accepts a low offer price. The information content of the issue announcement depends on which issuer type is most eager to finance the project, measured by the ratio of assets in place to post-issue value. If the low-value type is more eager, it will find a way to avoid being rejected too often by the financier. This is accomplished by randomizing between the low price (which is always accepted by the financier) and the high price. In this equilibrium, the low-value type ends up being revealed in the separating part of the equilibrium, so $AR < 0$. Conversely, when the high-value type is relatively more eager to obtain financing, the equilibrium implies $AR > 0$. This latter equilibrium does not exist in a setting such as Myers and Majluf (1984) where b is constant across issue types, since then the low-value type will always be the most eager to obtain financing.

Cooney and Kalay (1993) and Wu and Wang (2005, 2006a) allow managers to overinvest ($b < 0$). In Cooney and Kalay (1993), it is possible for a firm with overvalued stock to issue stock to invest in negative NPV projects, while a firm with undervalued stock may still issue stock to avoid loosing very profitable NPV investment opportunities. Thus, in their model equity issuance has two effects, a negative signal about current assets in place and a positive signal about new investment opportunities, where either effect can dominate. In Wu and Wang (2005, 2006a) the overinvestment is introduced by explicitly assuming that managers enjoy a certain level of private benefits of control. In both papers, there is ex ante uncertainty about whether or not an issuer will try to fund a negative NPV project. They show that this type of uncertainty may produce a positive equilibrium market reaction to some equity issues. The positive reaction reflects the surprise when firms issue to fund projects with a greater value of b than expected.

The following numerical example illustrates a positive issue surprise effect by simply adding the shareholder takeup parameter k to the original Myers and Majluf (1984) model. Suppose the market does not know k ex ante, but believes that $k = 0$. Moreover, it is common knowledge that the firm's assets in place a may be in one of two equally likely states: "high" with $a = \$150$ or "low" with $a = 50$. In both states, the project NPV is $b = 20$. With $k = 0$ (which means we are back in the Myers–Majluf model), it follows that the firm in this example will only issue if it is in the low state.[32] This implies a pre-issue stock price p^- which reflects an underinvestment discount (capitalizing the value of the project only in the low state): $p^- = (150 \times 0.5 + (50 + 20) \times 0.5) = \$110$. If the firm announces a stock issue and reveals $k = 0$, the post-issue price will be $p^+ = (50 + 20) = \$70$. In this case, the firm sells the fraction $(100/210) \times 100 = 48\%$ of the firm in order to raise \$100, generating a market reaction of $AR = 100 \times (70 - 110)/110 = -36\%$.

However, suppose the issuer surprises the market by revealing $k = 1$ through the offering process. Since $k = 1$ implies that the firm prefers to issue in both states (there is no wealth transfer to outside investors), there is pooling and the issue announcement carries no information about the true state. Still, the announcement causes the market to eliminate the underinvestment discount, now capitalizing the value of the project in *both* states: $p^+ = \$120$ and $AR = 9\%$. In this example, new information revealing a high value of k reverses market expectations from a separating equilibrium to a pooling equilibrium, resulting in $AR > 0$.

It is clear from the above that the implied market reaction to issue announcements may be negative, zero, or positive in information settings that represent simple refinements of the original Myers and Majluf (1984) setup—even when preserving their single flotation method environment. We next describe predictions emanating from models allowing for a choice between several flotation methods.

4.3.2. Modelling the flotation method choice

In the first model of the flotation method choice, Heinkel and Schwartz (1986) allow issuers to choose between uninsured rights, standby rights and 'firm commitment' offerings. In their model, uninsured rights carry a risk of offering failure, while standby rights and firm commitment offers fully guarantee the offering proceeds. The standby underwriter fully reveals the issuer type while the firm commitment underwriter is uninformed. In equilibrium, the highest-valued issuers select standbys, intermediate-value issuer select uninsured rights, while the lowest-valued issuers select firm commitment offers. Thus, this model predicts $AR_{fc} < AR_{ur} < 0$ and $AR_{sr} > 0$.

In the Heinkel and Schwartz (1986) model, the quality certification in a standby rights offer makes this a more expensive flotation method than firm commitment offerings,

[32] Note that $k = 0$ still means that the firm could put on a fully subscribed rights offer. However, in such a rights offer, every subscriber would be a new shareholder.

which is counterfactual (Table 6). Moreover, there is no explicit role for current shareholder takeup. Eckbo and Masulis (1992) offers a menu of flotation methods which allows shareholder takeup (k) and informative but noisy quality certification by underwriters in both standbys and firm commitment offerings. As discussed above (equation (1)), shareholder takeup reduces the size of the offering to outside investors, acting like financial slack in Myers and Majluf (1984). In equilibrium, high-k firms select uninsured rights with little or no adverse selection, intermediate-k firms select standby rights, while low-k firms select firm commitments. They predict that $AR_{fc} < AR_{sr} < 0$ and that $AR_{ur} \approx 0$.

Building on Eckbo and Masulis (1992), Bøhren, Eckbo, and Michalsen (1997) model two flotation methods: uninsured rights and standbys. They refine the empirical prediction on announcement returns by varying the effectiveness of the underwriter in detecting overpriced issues. As in Eckbo and Masulis (1992) all high-k issuers select uninsured rights which results in $AR \approx 0$. Moreover, in an equilibrium with "ineffective" underwriter certification, some overvalued issuers decide to risk the certification process, leading to adverse selection in the pool of low-k firms selecting standby rights offerings, so $AR_{sr} < 0$. However, in an equilibrium with "effective" underwriters some low-k firms prefer not to issue rather than risk being detected by the quality certification process, so the standby pool exhibits positive selection and $AR > 0$.

Eckbo and Norli (2004) is the first model to allow a sequential flotation method choice. As discussed above, they prove the existence of a sequential pooling equilibrium in which issuers pool over entire issue strategies. Pooling results when the issue profits π in equation (1) is non-negative for both high-value and low-value firms. The issue methods are private placement, standby rights and uninsured rights. Both the private placement investor and the standby underwriter perform an informative but noisy quality inspection and may reject the issue. Recall the definition of an issue strategy, e.g., $\{pp, sr, ur\}$ which means "try a private placement first, if rejected try standby rights, and if rejected again do an uninsured rights offer". Although issuers pool over issue *strategies*, they may eventually end up using different flotation methods due to randomness in the quality inspection process. The predictions for the market reaction are as follows:

Eckbo and Norli (2004)—Pecking order. *Suppose k is known ex ante and that issuers follow the pecking order illustrated in Figure 3. Let "high k" mean $k \in [k_{sr}, 1]$, "medium k" mean $k \in [k_{pp}, k_{sr}]$ and "low k" mean $k \in [0,\ k_{pp}]$. It is part of a sequential pooling equilibrium for high-k issuers to select the strategy $\{ur\}$, for medium-k issuers to select the strategy $\{sr, pp, ur\}$ and for low-k issuers to choose $\{pp, sr, ur\}$. The associated market reaction AR to the issue announcement is as follows*:

	k high	k medium	k low
Uninsured rights:	$AR_{ur} = 0$	$AR_{ur} < 0$	$AR_{ur} < 0$
Standby rights:	off-equilibrium	$AR_{sr} > 0$	$AR_{sr} = 0$
Private placement:	off-equilibrium	$AR_{pp} = 0$	$AR_{pp} > 0$

The intuition behind these predictions for *AR* is as follows. Starting with the first line (uninsured rights), firms with high k prefer to issue using the relatively low-cost uninsured rights method. Since there is no inspection, there is also no information conveyed by the issue decision, thus $AR_{ur} = 0$. Firms with medium and low k values prefer quality inspection (Figure 3). Thus, issuers of uninsured rights with medium or low k have necessarily been rejected twice by the inspection, so $AR_{ur} < 0$.

Second, in the line for the standby rights method, medium-k issuers prefer standbys, creating a positive market reaction ($AR_{sr} > 0$) due to the positive inspection result. Low-k issuers prefer private placement (Figure 3). Thus, low-k issuers that issue using standbys have been rejected by the private placement inspection before accepted by the standby underwriter inspection. From the market's point of view, these two inspection results cancel out, so there is no new information and $AR_{sr} = 0$. Similarly, in the line for the private placement method, medium-k issuers that use private placement have first been rejected by the standby underwriter, thus $AR_{pp} = 0$. Low-k issuers prefer private placement (Figure 3), so the successful inspection result implies $AR_{pp} > 0$.

We now turn to a summary of the international evidence on SEO announcement returns, and then draw inferences about the theoretical predictions above.

4.4. Evidence on issue announcement returns

Abnormal returns are typically measured over the two-day window $[-1, 0]$ ending with the public announcement date (day 0), or over the three-day window $[-1, +1]$. Abnormal return to issuer i on day t is typically defined using a simple market model:

$$\gamma_{it} \equiv r_{it} - E(r_{it}) = r_{it} - (\alpha_i + \beta_i r_{mt}), \tag{2}$$

where r_{it} is the daily stock return in excess of the risk-free rate, r_{mt} is the daily excess return on the value-weighted CRSP market return, and α and β are estimated during some pre-event period. For event windows containing multiple periods, the cumulative abnormal return is found by adding daily abnormal returns. With the market model estimation, it is important not to "contaminate" the estimate of α with the well-known average stock price runup over the year prior to the typical U.S. stock issue. If this runup is treated as "normal" then the estimate of α will be overstated, resulting in a downward bias in the estimated abnormal return γ. One solution to this problem is to estimate the market model parameters using post-issue stock returns.

Some studies estimate γ directly by means of a conditional market model,

$$r_{it} = \alpha_i + \beta_i r_{mt} + \gamma_i d_t + \epsilon_{it}, \tag{3}$$

where d_{it} is a dummy variable that takes on a value of 1 during the event window and zero otherwise, and ϵ_{it} is the regression error term. If the event dummy d_t takes on a value of one over ω days in the event window, then the cumulative abnormal return over the event window is $\omega\gamma_i$.[33]

[33] See Thompson (1985, 1995) for details of this event-study approach.

The studies form average abnormal returns across a sample of N issues as $AR_t \equiv (1/N)\sum_i^N \gamma_{it}$ and report tests of the hypothesis that $AR_t = 0$. Statistical significance is inferred using either a t-statistic for the average, or a z-statistic

$$z_t = \frac{1}{\sqrt{N}} \sum_{j=1}^{N} \frac{\gamma_{it}}{\sigma_i}, \tag{4}$$

where σ_i is the time series estimate of the standard error of γ_{it}.[34] For large sample size N, this z-statistic has a standard normal distribution under the null hypothesis of a zero average abnormal return.

We have organized the evidence on average announcement effects to security offerings in three tables. Table 13 covers studies of SEOs by U.S. firms, classified by the flotation method. Table 14 show international evidence on SEOs, again by flotation methods. We separate U.S. from international studies as the international evidence show very different results than that of U.S. studies. Third, Table 15 show the announcement effect of straight and convertible debt offerings by U.S. firms.

4.4.1. Market reaction to SEOs in the U.S.

In this section, we highlight four main conclusions from the U.S. evidence. As surveyed by Eckbo and Masulis (1995), the perhaps most striking finding of papers published in the 1980s is the significantly negative market reaction to firm commitment offerings by U.S. firms. These papers are shown in Panel (a) of Table 13. For brevity, the table pools results for industrial and utility issuers—although it is well known that the market reaction to industrial issuers is more negative than for utility offerings. For example, while the two-day average abnormal return averages about -2% across the two issuer types (using sample-size weights), it averages about -3% for industrials and -1% for utilities (Asquith and Mullins, 1986; Masulis and Korwar, 1986; Mikkelson and Partch, 1986; Korajczyk, Lucas, and McDonald, 1990; Hansen and Crutchley, 1990; Eckbo and Masulis, 1992). The lower market reaction to utilities is consistent with adverse selection arguments as utilities generally have less discretion than industrial companies in timing the issue to short-term overvaluation. The regulatory process reduces discretion to time the market, either by slowing the issue approval process or by forcing the firm to issue at times determined in part by the incentives of the regulator.

In 1985, the Wall Street Journal changed its reporting system for SEO announcements with the effect of making it more costly to collect accurate issue announcement dates for broad, representative samples.[35] This, combined with the very strong inferences made from the earlier studies, probably explains why there is a drop in the

[34] Some studies report t-statistics using a cross-sectional estimate of the standard error. See Kothari and Warner (2007), Chapter 1 of this volume, for a discussion of various event-study procedures.

[35] Jung, Kim, and Stulz (1996): "Before 1985, the WSJ reports on equity issues as a regular news item. From 1985, most of the information on new issues is reported in the 'new securities issues column' which

Table 13
Average market reaction (*AR*, %) to announcements of seasoned equity offerings (SEOs) by U.S. firms, classified by flotation method

Study	Sample size	Sample period	*AR* (%)
(a) Firm commitments: $N = 15{,}017$; $AR_{fc} = -2.22^*$			
Asquith and Mullins (1986)	392	1963–1981	−1.6*
Masulis and Korwar (1986)	972	1963–1980	−1.85*
Mikkelson and Partch (1986)	80	1972–1982	−3.56*
Kalay and Shimrat (1987)	455	1970–1982	−3.36*
Korajczyk, Lucas, and McDonald (1990)	1,285	1974–1983	−2.94*
Hansen and Crutchley (1990)	109	1975–1982	−3.65*
Eckbo and Masulis (1992)	1,057	1963–1981	−2.0*
Jegadeesh, Weinstein, and Welch (1993)[a]	411	1980–1989	−1.16*
Slovin, Sushka, and Bendeck (1994)[a]	175	1973–1988	−2.87*
Denis (1994)	435	1977–1990	−2.49*
Bayless and Chaplinsky (1996)	1,884	1968–1990	−2.3*
Altinkilic and Hansen (2003)	1,703	1990–1997	−2.23*
Bethel and Krigman (2004)	2,592	1992–2001	−2.01*
Heron and Lie (2004)	3,658	1980–1998	−2.5*
D'Mello, Schlingemann, and Subramaniam (2005)	1,621	1982–1995	−1.87*
(b) Private placements: $N = 2{,}830$; $AR_{pp} = 2.45^*$			
Wruck (1989)	99	1979–1985	1.89*
Herzel and Smith (1993)	106	1980–1987	1.72*
Hertzel et al. (2002)	619	1980–1996	2.4*
Chaplinsky and Haushalter (2003)	1,050	1995–2000	3.49*
Krishnamurthy et al. (2005)	397	1983–1992	1.43*
Barclay, Holderness, and Sheehan (2005)	559	1979–1997	1.7*
(c) Uninsured rights:			
Eckbo and Masulis (1992)	53	1963–1981	−0.59
(d) Standby rights: $N = 349$; $AR_{sr} = -1.33^*$			
Hansen (1988)	102	1964–1986	−2.4*
Eckbo and Masulis (1992)	128	1963–1981	−0.70*
Singh (1997)	63	1963–1985	−1.07*
Heron and Lie (2004)	56	1980–1998	−1.10
(e) Shelf offerings: $N = 1{,}851$; $AR_{sh} = -0.66^*$			
Bhagat, Marr, and Thompson (1985)	93	1982–1983	−0.81*
Moore, Peterson, and Peterson (1986)[b]	84	1982–1983	−1.10*
Denis (1991)[c]	40	1982–1986	−1.00*
Heron and Lie (2004)	256	1980–1998	−1.30*

(*Continued on next page*)

Table 13
(*Continued*)

Study	Sample size	Sample period	*AR* (%)
Bethel and Krigman (2004)[b]	747	1992–2001	−0.24
Bethel and Krigman (2004)	391	1992–2001	−1.27*
Autore, Kumar, and Shome (2004)[c,d]	156	1990–2003	−1.16

The table focuses on studies that use daily stock return to measure the SEO announcement effect *AR*, and where the flotation method may be reasonably deduced from the sample selection criteria. The sample must include primary offerings, possibly in combination with secondary equity offerings. Some studies measure *AR* over the two-day window $[-1, 0]$ while others use a three-day window $[-1, +1]$, and the table does not make a distinction between these. Some studies also separate out industrials from utilities, and when they do, we report results averaged across both issuer types. The *AR* in the panel heading is the average across the studies in the panel, weighted by the respective sample sizes. The superscript * indicates that the *AR* is significantly different from zero at the 1% level.

[a]Sample is restricted to the first SEO following the IPO.

[b]The event day is the shelf registration day (not the offering announcement).

[c]Sample is restricted to firms that issue *both* shelf and nonshelf registered shares.

[d]This abnormal return is the sum of the abnormal returns around the registration and offering dates.

number of studies of SEO announcement effects after 1986. However, more recently, Jegadeesh, Weinstein, and Welch (1993), Slovin, Sushka, and Bendeck (1994), Denis (1994), Bayless and Chaplinsky (1996), Bethel and Krigman (2004), Heron and Lie (2004), and D'Mello, Schlingemann, and Subramaniam (2005) all confirm that the market reaction to firm commitment offerings in the U.S. is on average negative and about −2%. Overall, over the period 1963–1995 and using a sample-weighted average, the market reacted to a firm commitment equity offering announcement by discounting the second-hand market price of the issuer's shares, resulting in a statistically significant $AR_{fc} = -2.22\%$.

A second striking result from the 1980s is the finding of Wruck (1989) of a significantly positive two-day market reaction of 1.9% to 128 announcements of equity private placements. The type of security sold in her private placements includes primarily common stock (101 cases) but also preferred stock, convertible preferred stock, and warrants. Thus, Wruck's sample has a different equity security composition than the studies of firm commitment SEOs. As shown in Panel (b) of Table 13, several recent studies using substantially expanded samples confirm her finding of a significantly positive announcement effect. These include Herzel and Smith (1993), Hertzel et al. (2002),

contains mostly offering information. Hence, the event dates since 1985 reflect issues that are more likely to be anticipated because the announcement of an equity issue is typically made earlier (by days or weeks) via news-wire services than the WSJ listing. This biases the abnormal return estimate".

Chaplinsky and Haushalter (2003), Krishnamurthy et al. (2005), and Barclay, Holderness, and Sheehan (2005).[36] Over the period 1979–2000, the sample-weighted average market reaction to private placements is a significantly positive $AR_{pp} = 2.45\%$.

A third important finding is that selling SEOs via the rights method appears to affect the market reaction to the issue announcement, relative to that of both firm commitments and private placements. This impact was first demonstrated by Eckbo and Masulis (1992) who examine both uninsured rights and standbys (in addition to firm commitments), and is evident also in studies examining standbys only, such as Hansen (1988), Singh (1997) and Heron and Lie (2004). As shown in panels (c) and (d) of Table 13, uninsured rights are met with a neutral market reaction—$AR_{ur} = 0.59\%$—whereas standbys elicit a significantly negative market reaction on average. The market reaction to standbys is smaller than the size of the negative market reaction to firm commitment SEOs. Over the period 1963–1998, the sample-weighted average abnormal return to standby announcements is a statistically significant $AR_{sr} \approx -1.33\%$.

Fourth, Bhagat, Marr, and Thompson (1985), Moore, Peterson, and Peterson (1986), and Denis (1991) report that early users of the shelf-registration method for offering shares (under SEC Rule 415) experienced a significantly negative market reaction of about -1%. As discussed above (Table 3), the number of shelf-registered SEOs peaked in 1982 and 1983, almost disappeared in the period 1984–1991, and then picked up again, with a relatively large number occurring over the period 1997–2003. The announcement effect of this later period is reflected in the results reported by Heron and Lie (2004), Bethel and Krigman (2004), and Autore, Kumar, and Shome (2004). These more recent studies confirm the basic conclusion from the early sample period: despite the greater timing discretion afforded shelf-registered issuers, the average market reaction is no more negative for shelf issues than for non-shelf firm commitment offerings. Over the period 1982–2003, the sample-weighted average market reaction to the announcements of shelf-registered SEOs is small, but statistically significant: $AR_{sh} = -0.66\%$.

4.4.2. Market reaction to SEOs internationally

At the time of the survey of Eckbo and Masulis (1995) there were relatively few studies reporting the market reaction to security offerings internationally. With the exception of Japan (Table 11), rights issues (uninsured or standbys) are still the norm in smaller equity markets. Table 14 summarize the findings of international studies of SEOs where the flotation methods is reported to be either uninsured rights, standbys, private placements, firm commitments or a foreign offering using either American (ADR) or global (GDR) drawing rights. Note that Table 14 is restricted to studies that show results for each flotation method separately, eliminating, e.g., studies that pool uninsured and

[36] Chaplinsky and Haushalter (2003) report that on average announcement returns are positive for traditional PIPE issuers and negative for structured PIPE issuers. Brophy, Sialm, and Ouimet (2005) also report positive announcement effect for PIPE issuers.

Table 14
Average market reaction (*AR*, %) to announcements of seasoned equity offerings (SEOs) internationally, classified by flotation method

Country	Study	Sample size	Sample period	*AR* (%)
(a) Uninsured rights: $N = 484$; $AR_{ur} = 0.70$				
Korea	Kang (1990)	89	1984–1988	0.95%
Greece	Tsangarakis (1996)	55	1981–1990	3.97*
Norway	Bøhren, Eckbo, and Michalsen (1997)	74	1980–1993	1.55*
Italy	Bigelli (1998)	82	1980–1994	0.79
U.K.	Slovin, Sushka, and Lai (2000)	20	1986–1994	−4.96*
France	Gajewski and Ginglinger (2002)	57	1986–1996	−1.11*
Sweden	Cronqvist and Nilsson (2005)	107	1986–1999	0.19
(b) Standby rights: $N = 1{,}201$; $AR_{sr} = -1.32$*				
Japan	Kang and Stulz (1996)	28	1985–1991	2.21*
Norway	Bøhren, Eckbo, and Michalsen (1997)	114	1980–1993	−0.23
France	Gajewski and Ginglinger (2002)	140	1986–1996	−0.74*
Norway	Eckbo and Norli (2004)	143	1980–1996	−0.58
Sweden	Cronqvist and Nilsson (2005)	53	1986–1999	0.72
U.K.	Burton, Lonie, and Power (1999)[a]	37	1989–1991	−7.76*
U.K.	Slovin, Sushka, and Lai (2000)[b]	200	1986–1994	−2.90*
Hong Kong	Wu and Wang (2006b)	180	1989–1997	−3.37*
(c) Private placement: $N = 691$; $AR_{pp} = 3.12$*				
U.K.	Slovin, Sushka, and Lai (2000)[c]	76	1986–1994	3.31*
Norway	Eckbo and Norli (2004)	136	1980–1996	1.39
Sweden	Cronqvist and Nilsson (2005)	136	1986–1999	7.27*
Japan	Kato and Schallheim (1993)	76	1974–1988	4.28*
Japan	Kang and Stulz (1996)	69	1985–1991	3.88*
Hong Kong	Wu, Wang, and Yao (2005)	99	1989–1997	1.97*

standby rights in a single sample. Eckbo and Masulis (1995) survey several of these pooled rights and standby samples, including Marsh (1979) (U.K.), Loderer and Zimmermann (1987) (Switzerland), Hietala and Loyttyniemi (1991) (Finland), and Dehnert (1991) (Australia). The main conclusion in the earlier survey was that "the average market reaction is typically positive for uninsured rights and small, but negative for standbys" (p. 1046). They do not report studies on firm commitment offerings internationally.

The evidence summarized in Table 14 goes further. Starting with uninsured rights offerings in Panel (a), uninsured rights offers are associated with a neutral or positive market reaction in smaller markets such as Greece, Norway and Sweden, but a negative market reaction in larger markets such as France and the U.K. Tsangarakis (1996) and Bøhren, Eckbo, and Michalsen (1997) report a significantly positive market reaction

Table 14
(*Continued*)

Country	Study	Sample size	Sample period	*AR* (%)
(d) Firm commitments: $N = 1{,}064$; $AR_{fc} = 1.10^*$				
Japan	Kang and Stulz (1996)	185	1985–1991	0.51*
Japan	Cooney, Kato, and Schallheim (2003)	555	1974–1991	0.72*[d]
France	Gajewski and Ginglinger (2002)	18	1986–1996	−0.33
Hong Kong	Wu, Wang, and Yao (2005)	306	1989–1997	1.93*

In the panel headings, *N* is the aggregate sample size across all studies in the panel, and *AR* is sample-weighted average market reaction. The superscript * indicates that the *AR* is significantly different from zero at the 1% level. The table is restricted to studies that (1) use daily stock return to measure the SEO announcement effect *AR* and (2) report the announcement effect by individual f lotation method. For example, studies that pool uninsured and standby rights in one sample are excluded. Some studies measure *AR* over the two-day window $[-1, 0]$ while others use a three-day window $[-1, +1]$, and the table does not make a distinction between these. Some studies also separate out industrials from utilities, and when they do, we report result averaged across both issuer types.

[a]The authors do not indicate whether their rights sample is standbys or uninsured rights. However, judging from the sample frequency, and the information in Slovin, Sushka, and Lai (2000), we placed this study in the standby category.

[b]In 111 of the 200 cases, shareholder takeup is greater than 90%. For these cases, the announcement period return is reported to be −0.33% and statistically insignificant.

[c]The authors refer to these as "placings" or "bought deals" that increases shareholder dispersion.

[d]The event day is the board meeting date.

for Greece and Norway, respectively, while Cronqvist and Nilsson (2005) report an insignificant market reaction to uninsured rights offers in Sweden. Slovin, Sushka, and Lai (2000) reports a significantly negative market reaction to U.K. uninsured rights offers, while Gajewski and Ginglinger (2002) report a significantly negative market reaction in France also. The sample-weighted cross-country average is however a non-negative and statistically insignificant $AR_{ur} = 0.70\%$.

It should be noted that the cross-country average may hide important country-specific institutional effects, which often motivates a study of foreign issues. Thus, although Slovin, Sushka, and Lai (2000) report results for a relatively small sample (20) of uninsured rights, the significantly negative market reaction may emanate from economically important unique institutional characteristics of the London Stock Exchange. A similar argument goes for the negative effect for the 57 uninsured rights offers in France studied by Gajewski and Ginglinger (2002). We return to this issue below.

Second, Panel (b) of Table 14 shows that standby offering are met with a positive market reaction in Japan (Kang and Stulz, 1996), a neutral market reaction in Norway and Sweden (Bøhren, Eckbo, and Michalsen, 1997; Cronqvist and Nilsson, 2005), and a negative market reaction in the U.K. (Burton, Lonie, and Power, 1999; Slovin,

Sushka, and Lai, 2000) and a negative announcement effect in Hong Kong (Wu and Wang, 2006b). The sample-weighted average market reaction to standbys is significantly negative: $AR_{sr} = -1.32\%$.

Third, the market reaction to private placements is consistently positive and large across countries. The largest reported impact is in Sweden, where Cronqvist and Nilsson (2005) report a market reaction of 7.2% across 136 placements, followed by Japan with approximately 4% (Kato and Schallheim, 1993; Kang and Stulz, 1996), and the U.K. with 3.3% (Slovin, Sushka, and Lai, 2000). Significantly positive effects are also reported for private placements in Hong Kong (Wu, Wang, and Yao, 2005) and Norway (Eckbo and Norli, 2004). The sample-weighted average market reaction across these private placement studies is a significant $AR_{pp} = 3.12\%$, which is close in magnitude to the average market reaction to private placements in the U.S.

Fourth, with the exception of Japan and France, the relatively expensive firm commitment underwriting method has not yet spread internationally. Both Kang and Stulz (1996) and Cooney, Kato, and Schallheim (2003) report a small but statistically significant, positive average market reaction for Japan, while Gajewski and Ginglinger (2002) reports a statistically insignificant market reaction to firm commitment offerings in France. The sample-weighted average is an insignificant $AR_{fc} = 1.10\%$. Whether this surprising result holds up in samples of Japanese SEOs after 1992, as well as internationally as other countries start to adopt the firm commitment method, remains an interesting issue for future research.

Finally, while not shown in Table 14, recent papers have studied the average market reaction when firms announce foreign exchange listings—either foreign firms in the U.S. via American Depository Rights (ADRs) and U.S. firm globally via Global Depository rights (GDRs). Chaplinsky and Ramchand (2000) compare the stock price reactions of 349 global equity issues (involving a simultaneous sale of common equity at the same offer price in the U.S. market and one or more international markets) with 459 domestic equity issues that are sold exclusively in the U.S. market during 1986–1995. They find that all else equal, the negative stock price reaction that accompanies equity issues is reduced by 0.8 percent on average for global offers compared to domestic offers of similar size, issued during the same time period.[37]

Subsequent papers have confirmed the finding of Chaplinsky and Ramchand (2000) that firms announcing global issues have a lower stock price reaction as compared to announcements of domestic (U.S.) equity issues. For example, Wu and Kwok (2002) find that announcements of global equity issues result in a percentage point lower stock price reaction relative to comparable domestic issues. Errunza and Miller (2003) document that global equity offerings of foreign firms after their initial cross listing in the United States have a reduced stock price reaction (less by 1.5 percent) as compared to stock price reaction to SEOs of similar firms on the local exchanges.

[37] This result is based on a Heckman two-step procedure to adjust for selection bias. They also find that the announcement effect is more favorable as the number of new foreign investors rises. Also see Foerster and Karolyi (2000) for information on ADR SEOs.

Table 15
Average market reaction (*AR*, %) to announcements of debt offerings by U.S. firms

Study	Sample size	Sample period	*AR* (%)
(a) Stock price reaction to straight debt offerings: $N = 3{,}041$; $AR_{sd} = -0.22$			
Dann and Mikkelson (1984)	150	1969–1979	−0.37*
Mikkelson and Partch (1986)	171	1972–1982	−0.23
Eckbo (1986)	648	1964–1981	−0.10
Hansen and Crutchley (1990)	188	1975–1982	0.11
Shyam-Sunder (1991)	297	1980–1984	−0.11
Chaplinsky and Hansen (1993)	245	1974–1984	0.05
Johnson (1995)	129	1977–1983	0.32
Jung, Kim, and Stulz (1996)	276	1977–1984	−0.09
Howton, Howton, and Perfect (1998)	937	1983–1993	−0.50*
(b) Stock price reaction to convertible debt offerings: $N = 307$; $AR_{cd} = -1.8^*$			
Dann and Mikkelson (1984)	132	1969–1979	−2.30*
Mikkelson and Partch (1986)	33	1972–1982	−1.97*
Eckbo (1986)	75	1964–1981	−1.25*
Hansen and Crutchley (1990)	67	1975–1982	−1.45*

In the panel headings, N is the aggregate sample size across all studies in the panel, and *AR* is sample-weighted average market reaction. The superscript * indicates that the *AR* is significantly different from zero at the 1% level. The table focuses on studies that use daily stock return to measure the SEO announcement effect *AR*, and where the flotation method may be reasonably deduced from the sample selection criteria. Some studies measure *AR* over the two-day window $[-1, 0]$, while others use a three-day window $[-1, +1]$, and the table does not make a distinction between these. Some studies also separate out industrials from utilities, and when they do, we report results averaged across both issuer types.

4.4.3. Market reaction to corporate debt offerings

The basic adverse selection argument of Myers and Majluf (1984) strongly suggests that the market reaction to security offerings should be smaller the lower the risk that the security is overpriced. This implication is also a basic motivation for the financing pecking order of Myers (1984). Given the predictable contractual payment stream embedded in a debt contract—protected by bankruptcy law—the risk of market mispricing is almost certainly lower for a corporate debt instrument than for common stock. Thus, the market reaction to debt issues should therefore be smaller than for equity.

Table 15 lists studies reporting the stock-price announcement effect of straight and convertible debt offerings by U.S. firms. In Panel (a), the overall evidence is of a statistically insignificant market reaction to straight debt issuances. Dann and Mikkelson (1984) report a significantly negative average abnormal stock return of −0.37%, while Howton, Howton, and Perfect (1998) also report significantly negative market reaction of −0.50% over the two-day announcement period. However, the average market reac-

tion is small and insignificant in all of the subsequent studies by Mikkelson and Partch (1986), Eckbo (1986), Hansen and Crutchley (1990), Shyam-Sunder (1991), Chaplinsky and Hansen (1993), Johnson (1995), Jung, Kim, and Stulz (1996) and Howton, Howton, and Perfect (1998). The sample-weighted average across all of the studies is a statistically insignificant $AR_{sd} = -0.22\%$.

Straight debt issues are to some extent predictable as the maturity date approaches and the firm needs to refinance. Bayless and Chaplinsky (1991), Chaplinsky and Hansen (1993) and Jung, Kim, and Stulz (1996) develop models to predict whether an issuer will choose to sell a public issue debt or equity. Chaplinsky and Hansen (1993) examine issuers of public debt and find that issues have substantial predictability and that issuers have significantly lower earnings, significantly higher investment growth and debt refinancing needs in the years immediately preceding and following the offering. Gomes and Phillips (2005) examine private and public security issuance activity by publicly listed firms. They find that firms with higher levels of asymmetric information measured by analysts' earnings forecast errors or dispersion in earnings forecasts are less likely to issue common stock or convertibles relative to debt in the public capital markets, but these firms are more likely to issue equity and convertibles over debt in the private capital market. They also find that smaller public firms with higher risk, lower profitability and good investment opportunities are more likely to issue equity and convertibles privately, while firms experiencing stock price rise in the prior year relative to a benchmark portfolio are more likely to issue equity in the public market.

Since announcement returns represents only the unanticipated portion of the total price effect, this raises the question of whether partial anticipation explains the largely insignificant market reaction to straight debt issues in Panel (a) of Table 15. Eckbo (1986) addresses this issue by partitioning his sample according to the stated purpose of the issue (refunding versus finding of investment program), and according to risk (bond ratings). Presumably, the degree of market anticipation is lower the riskier the debt issue, and if the purpose is to fund new investment opportunities. However, Eckbo (1986) reports that none of the subsample results sorted in this fashion indicate a significant market reaction. Shyam-Sunder (1991) also find no effect of bond risk on announcement returns, as measured by bond ratings. Bayless and Chaplinsky (1991) develop a forecasting model for a firm's debt versus equity issuance choice and find larger announcement effects when a security that is not expected is issued. For example, debt issue announcements when an equity issue was expected have a positive 1% average abnormal stock return (1 day). Chaplinsky and Hansen (1993) partition the debt sample according to stated purpose of the issue, and find that the market reaction is insignificant except in the sample of 68 issues with "no purpose specified" where it is a significantly negative -0.63%. Overall, there are few indications that the evidence in Panel (a) is significantly affected by partial anticipation. However, this remains a topic for future research.

Finally, Panel (b) of Table 15 lists studies that report the stock market reaction to convertible debt offerings. Since convertibles are a hybrid of straight bonds and warrants, the risk of overpricing (of the warrant) is greater than for straight bonds. They are

Table 16
Summary of sample-weighted average market reaction (AR, %) to security offerings (aggregate sample size and sample period in parentheses)

Type of offering	U.S.	Foreign
A. SEOs		
Uninsured rights	$AR_{ur} = -0.59$ (53; 1963–1981)	$AR_{ur} = 0.70$ (484; 1980–1999)
Standby rights	$AR_{sr} = -1.33^*$ (349; 1963–1998)	$AR_{sr} = -1.32^*$ (1,201; 1980–1999)
Private placements	$AR_{pp} = 2.45^*$ (2,830; 1979–2000)	$AR_{pp} = 3.12^*$ (691; 1974–1999)
Firm commitments	$AR_{fc} = -2.22^*$ (15,017; 1963–2001)	$AR_{fc} = 1.10^*$ (1,064; 1974–1997)
Shelf offerings	$AR_{sh} = -0.66^*$ (1,851; 1980–2003)	n.a.
B. Debt offerings		
Straight debt	$AR_d = -0.24$ (2,615; 1964–1993)	n.a.
Convertible debt	$AR_{cd} = -1.82^*$ (307; 1964–1982)	n.a.

The AR reported in this table also appear in the panels headings in Tables 13, 14 and 15. The reported AR weighs each individual study in the panel with its sample size. Superscript * indicates statistical significance at the 1% level.

also less predictable than straight debt offerings. So, the expectation is that convertibles will be met with a stronger market reaction than straight debt issues. Dann and Mikkelson (1984), Mikkelson and Partch (1986), Eckbo (1986), and Hansen and Crutchley (1990) all report negative and statistically significant market reactions to convertible debt offerings. The sample-weighted average abnormal return is a statistically significant $AR_{cd} = -1.82\%$.

4.5. Implications of the announcement-return evidence

For convenience, the sample-weighted averages reported in these tables are summarized in Table 16. The significant price reaction to security offerings leaves little doubt that these corporate events typically convey significant new information to the market. As such, the evidence provides generic support for models of the issue decision that presume some form of asymmetric information between the issuer and the market.

What is more difficult to determine, of course, is the precise content of the new information that the market is reacting to. We discuss some possible inferences below. These are the result of cross-sectional analysis of the announcement effect, often performed using multivariate regressions with the announcement effect AR as dependent variable. The expected profits from issuing and investing shown in equation (1), and

the various theoretical models listed in Table 12 suggest a link between AR and a set of characteristics:

$$AR = f(m, C, k, q, \beta, \sigma, I, b/a, P), \quad m = ur, sr, fc, pp, \tag{5}$$

where the parameters are the flotation method choice ($m \in [ur, sr, fc, pp]$), direct and indirect issue costs (C), expected shareholder takeup of the issue (k), signal quality or the informativeness of the available issue-quality certification technology (q), private benefits of control (β), the ex ante risk that the security is overpriced (σ), growth as given by the size of the project's investment amount (I) and the size of the project's NPV relative to the value of assets in place (b/a), and market beliefs about the nature of firms' equilibrium flotation strategies. These beliefs imply an issue market price of P, which in some equilibria are lower than the true, intrinsic value, resulting in an undervaluation cost-component in C.

A caveat before proceeding with the results: it should be noted that the explanatory power of regressions of the type in equation (5) as reported in the literature is uniformly low, almost always less than 10%. More seriously, these cross-sectional regressions are typically estimated using linear estimators (such as OLS). Eckbo, Maksimovic, and Williams (1990) show that linear estimators (such as OLS and GLS) are biased and inconsistent when the issuer self-selects the timing of the event (in this case security issue) and derive a consistent, non-linear estimator.[38] Some studies (e.g., Bøhren, Eckbo, and Michalsen, 1997) report results with the nonlinear estimator, while others (e.g., Eckbo and Masulis, 1992) report that key inferences are unchanged when using OLS. Moreover, the potential for bias is smaller for utilities that are constrained by the regulatory process. However, for the vast majority of studies reporting cross-sectional regressions, the magnitude of the bias introduced by self-selection is largely unknown.

Adverse Selection and growth opportunities. In Myers and Majluf (1984), the market prices firms correctly only on average, causing some highly undervalued firms to avoid dilutive equity issues. Here, the information content is simply the adverse selection revealed by the firm's willingness to issue (separating equilibrium). The negative average market reactions to SEOs sold *to the market* in the U.S., such as in standby rights and firm commitment offerings, is consistent with this generic framework. Moreover, as pointed out by Eckbo and Masulis (1992), equity issues that are purchased by current shareholders (i.e., *not* sold to the market) results in pooling and therefore do not convey information. This prediction is also supported by the evidence on uninsured rights in Table 16, both in the U.S. and internationally.

The adverse selection model also implies that the market reaction to equity offerings should be more negative the greater the issue size (Krasker, 1986) and the greater the ex ante uncertainty that the issue is overpriced. The uncertainty hypothesis is supported by the evidence that debt offerings are met with little or no market reaction, while convertible debt offerings produce a negative effect that is only about half the size of the

[38] This issue is surveyed extensively in Li and Prabhala (2007) (Chapter 2 of this volume).

average market reaction to SEOs. Convertibles are a hybrid between debt and equity, and a convertible debt offering may be viewed by the market as a delayed equity issue (Stein, 1992). The uncertainty hypothesis is also supported by the finding that the market reaction to equity issues by regulated utilities is much smaller (though still significant) than the average market reaction to industrial issuers. The regulatory process required for a utility to issue equity reduces the issuer's discretion to time the issue to periods where the market is overvaluing the stock.

The evidence on the effect of issue size on the market reaction is mixed. While Jung, Kim, and Stulz (1996) find no relationship to issue size, Masulis and Korwar (1986), Korajczyk, Lucas, and McDonald (1990), and Bayless and Chaplinsky (1996) find a significantly negative relation between the announcement-induced abnormal return and the size of the offer.

As is evident from equation (1) in Section 4.2, the firm's incentive to issue is greater the greater the investment project's NPV (b). If b is sufficiently large relative to the value of assets in place a, then the firm will issue even it the shares are undervalued by the market. If b is sufficiently large relative to a for all firms, there is no adverse selection (pooling equilibrium) and no adverse market reaction to the issue announcement. However, in a separating equilibrium (with adverse selection), the market reaction will be more favorable the greater the ratio b/a. Since the value of b is unobservable to the econometrician, studies have used the issuer's B/M ratio or Tobin's Q as a proxy for "growth". The evidence is mixed: while Jung, Kim, and Stulz (1996) report a significantly positive relation between the market reaction to equity announcements and B/M ratios, several studies fail to find a significant relation (Barclay and Litzenberger, 1988; Dierkens, 1991; Pilotte, 1992; Denis, 1994).

Shareholder takeup. In Eckbo and Masulis (1992), shareholder takeup k simply acts like financial slack. The greater k, the smaller the issue sold to the market, and the lower the scope for wealth transfer from outside investors. Thus, the greater k, the smaller the market reaction to the issue announcement. In the notation of Table 16, the prediction is $AR_{fc} < AR_{sr} < 0$ and $AR_{ur} \approx 0$. This prediction is supported by the evidence on U.S. offerings: $AR_{fc} = -2.2\%$, $AR_{sr} = -1.3\%$ (both significantly different from zero and significantly different from each other), and $AR_{ur} = -0.6\%$ (not significant). There is also direct evidence that the takeup parameter k is highest in uninsured rights offerings, lowest in firm commitments, with standbys in between. Thus, the evidence supports the hypothesis that expected shareholder takeup affects the flotation method choice under adverse selection.[39]

Quality certification. In the vernacular of Eckbo and Masulis (1992), Bøhren, Eckbo, and Michalsen (1997), and Eckbo and Norli (2004), the significantly negative market

[39] Bøhren, Eckbo, and Michalsen (1997) and Cronqvist and Nilsson (2005) provide direct evidence on k. Generally speaking, the value of k depends on shareholder (personal) wealth constraints and demand for diversification by risk-averse investors. Moreover, k is likely to reflect the presence (if any) of individual shareholders' private benefits of control.

reaction to standbys and firm commitment offerings indicate that the signal quality of the underwriter certification technology only partially reveals the issuer's true quality. With perfect revelation and firm-value-maximization on the part of the issuing firms, the market reaction would be non-negative.[40] Thus, the evidence favors models that presume some form of imperfection in the underwriter's quality certification.

Shareholder monitoring. A private placement offers opportunities and incentives for communication between the issuer and the private placement investor which may alleviate ex ante investor nervousness with the possibility that the offer is overpriced. This may induce *positive* selection in the pool of private placement issuers. This is consistent with the evidence. As summarized in Table 16, the typical private placement offering of equity generates a significantly positive market reaction, with $AR_{pp} = 2.5\%$ in the U.S. and $AR_{pp} = 3.1\%$ internationally.

What is the nature of the positive information? Wruck (1989) and Herzel and Smith (1993) suggest that the positive announcement effect reflects the fact that the firm is willing to subject itself to increased monitoring and certification by a large, private placement investor. A positive announcement effect if also predicted by the variant of the Myers and Majluf (1984) model developed by Cooney and Kalay (1993) and Wu and Wang (2005), where managers are allowed to select value-decreasing investment projects. Cronqvist and Nilsson (2005) and Wu and Wang (2005) argue that large shareholders prefer a rights issue over a private placement in order to protect private benefits of control. Cronqvist and Nilsson (2005) conclude that family-controlled firms in Sweden avoid issue methods that dilute control benefits. Wu, Wang, and Yao (2005) and Wu and Wang (2006b) reach a similar conclusion after studying control-diluting placements and rights issues in Hong Kong. Thus, the selection of private placement carries a positive signal relative to a rights offer, which is also consistent with the evidence.

Do private placements in fact lead to increased monitoring? Empirically, Barclay, Holderness, and Sheehan (2005) conclude that there is little direct evidence of monitoring activities by private placement investors in the U.S. If this is in fact true, then the positive announcement effect of private placements represents positive information about the issuer per se, perhaps due to the certification role played by the private placement investor (Eckbo and Norli, 2004).

Managerial earnings expectations. Ross (1977) develops a model in which the firm's issue decision reflects private managerial information about the firm's future earnings prospects. Managers face personal bankruptcy costs and prefer to issue equity over debt when they have private information indicating a future decline in earnings, and vice versa for debt issues. This model implies a negative market reaction to an equity issue and a positive market reaction to a debt issue. While the empirical evidence is consistent with the first part of this prediction, the evidence contradicts the second part. The

[40] As discussed in Section 3 above, the focus of the underwriter is typically on certifying the existence and value (b) of the investment project, the validity of the firm's accounting statements, the firm's strategic plans, etc.

market reaction to straight debt offerings summarized in Table 16 is not statistically significantly different from zero. As shown by Eckbo (1986), even large debt issues—where the stated use of the proceeds is to fund the firm's investment program—do not elicit a positive market response.

Wealth transfer to bondholders. Holding the firm's investment policy constant, an equity issue reduces the risk of the firm's outstanding debt. However, it is unlikely that this effect explains much of the empirical evidence. While studies of bond returns in response to equity issues are difficult due to data constraints, Kalay and Shimrat (1987) find that equity issues on average cause bond prices to *fall* rather than increase. Moreover, as indicated above, there is little if any evidence that large debt issues cause equity prices to rise. In sum, the wealth transfer hypothesis is inconsistent with the evidence.

4.6. Signaling and the rights offer discount

Heinkel and Schwartz (1986) presents a model in which relatively high-quality uninsured rights issuers signal their quality to the market by *lowering* the rights offer discounts. They assume that a failed rights offer is costly for all issuers. Suppose there are two issuer types, "high" and "low", and let the two firms have the same ex ante market price P (before the rights offer announcement). The low type has a greater probability than the high type of experiencing a stock price reduction over the fixed rights offer period (say, four weeks) before the rights expire. If the rights subscription price P_0 is set close to P, the rights are expected to trade close to zero, and the probability that the offer will fail (because the stock price drops) is greatest for the low-value type. In the separating equilibrium considered by Heinkel and Schwartz (1986), the high-value firm signals its type by reducing the rights offer discount.

Alternatively, one may use a signaling models such as that of John and Williams (1985) to generate a *positive* impact of a rights offer discount, opposite to Heinkel and Schwartz (1986). As discussed by Hietala and Loyttyniemi (1991) and Bigelli (1998), in some European countries, a rights offer sometimes produces an increase in dividend yield. For example, if the rights offer does not affect the firm's dollar dividend per share, and the rights offer subscription price is set at a discount from the pre-offer stock price, then the dividend as a percent of the post-offer share price increases as the share price falls due to the discounted sale of shares. For a given dollar dividend, the increase in dividend yield is proportional to the discount in the rights offer price. The dividend yield will increase as long as the dividend per share is reduced by less than the share-split effect of the rights offer discount. A positive signaling effect of the dividend implication of a rights offer discount also reduces the expected cost of offering failure, as it increases the probability that the rights will be in the money at the expiration date.

We are aware of four studies that report evidence on the information content of rights offer discounts. First, with their sample of U.S. rights offers, Eckbo and Masulis (1992) regress the offering-day abnormal stock return (which in the U.S. contains the market

reaction to the news of the offering price) on offer-specific characteristics, including the discount and the flotation method. The estimated coefficient on the discount is insignificantly different from zero whether the issuer is an industrial firm or a public utility. The lack of a significant impact of the discount holds whether or not they account for subscription precommitments in uninsured rights. This is important because greater levels of subscription precommitments lower the risk of rights offer failure, thus reducing the signaling effect of the discount itself. Overall, they find no support for the proposition that the rights offer discount signals information (positive or negative) to the market about the true value of the issuer.

Second, using Norwegian standbys and uninsured rights offerings, Bøhren, Eckbo, and Michalsen (1997) also examine the information content of the rights offer discounts. In contrast to rights offerings in the U.S., Norwegian issuers are required to set the rights offer price a minimum of three weeks prior to the beginning of the rights offer period. With a minimum rights offer period in Norway of two weeks, this means that the issuer (and standby underwriter) must forecast the issuer's secondary market price at least five weeks ahead when determining the optimal offer price. The longer prediction period probably increases the risk of offering failure relative to the U.S., making the Norwegian rights offers a relatively powerful laboratory for examining signaling effects. They fail to find a statistically significant effect of the offer price discount on the market reaction to rights offer announcements.

Third, with a sample of U.S. utility standby rights offerings, Singh (1997) report that abnormal stock returns over the "rights settlement period" (i.e., the period from the day before the offer price release day and the following six days) are positively correlated with the offering price discount.[41] Since his sample includes fully guaranteed rights offerings only, there are no failure costs, so the signaling argument of Heinkel–Schwartz does not apply.

Finally, focusing specifically on dividend implications of rights issues, Bigelli (1998) reports a dividend-yield increase in more than 80% of his sample of Italian rights offers. He finds that the average market reaction to rights offer announcements is positive, and positively related to the subscription price discount. This is inconsistent with Heinkel and Schwartz (1986) but consistent with separating equilibria in which unanticipated dividend increases have information content. Further research is needed to establish whether dividend increases associated with rights issues have information content also in other issue markets.

[41] Singh (1997) reports that there are on average 30 trading days between the first public announcement of the standby and the "price release date" (the date on which the market first learns of the actual subscription price). The price release date typically coincides with the date of the price amendment of the offering prospectus, which is also typically the start of the offering.

5. Security offerings and market timing

Consider a company that faces a steady stream of new projects. In the standard corporate finance textbook, projects are executed if they have a positive net present value. If the owner of the project needs external financing, capital markets will provide the needed funds and the type of security has no effect on the project's value. In this setting, there is no room for timing a security offering. However, Graham and Harvey (2001) present survey evidence that suggests that managers are concerned about the appropriate timing of equity issues. Moreover, the stylized facts concerning the stock price dynamics around SEOs (a stock price runup prior to the issue, a negative market reaction to the announcement of the issue, and long-run returns that appear low compared to similar firms) seems to indicate that managers are timing these issues around periods of temporary overvaluation.

This section reviews various models that focus on explaining the timing of seasoned equity offerings. Prior to the mid 1990s, the low long-run stock returns were not commonly known. Thus, papers written prior to this period focused on explaining the stock price runup and the negative average announcement effect. Later models also had to explain post-issue stock price performance patterns. We discuss three classes of models: one based on rational market pricing, another with some non-rational agents, and finally a statistical model of "pseudo-timing".

5.1. Timing theories with rational market pricing

As discussed in Section 4, information asymmetry between managers and investors may create an incentive for managers to time an equity issue. Some undervalued firms will forgo profitable projects because the dilution costs of issuing undervalued equity borne by existing shareholders are too high relative to the project's profitability. Other undervalued firms will only issue if the project can be financed with debt. Myers (1984) builds on this insight and suggests that there is a financing choice pecking order in which firms only use equity as a last resort.

Korajczyk, Lucas, and McDonald (1992) and Choe, Masulis, and Nanda (1993) develop models of dynamic adverse selection that imply a relationship between equity issue activity and, respectively, firm specific information releases and the business cycle. The model of Korajczyk, Lucas, and McDonald (1992) predicts clustering of equity issues after information releases (especially quarterly and annual financial reports). Choe, Masulis, and Nanda (1993) observe that during periods of economic expansions, corporate investment opportunities are more profitable, and thus, adverse selection costs are lower. In these models, managers time the sale of equity offers to periods when information asymmetries are less severe. Bayless and Chaplinsky (1996) report that equity issues tend to cluster in periods with smaller average announcement effects. They interpret this pattern as evidence that issuers timing equity offerings to periods with lower levels of asymmetric information.

The model of Lucas and McDonald (1990) departs from other models of adverse selection in that they allow the firm's investment opportunity to be postponed. This gives undervalued firms an incentive to postpone an issue until the stock price is higher relative to the manager's valuation based on proprietary information. This implies that empirically we should obverse more equity issues following bull markets.

Projects that can be postponed as the firm waits for more favorable market conditions to issue equity can be viewed as real options. Carlson, Fisher, and Giammarino (2005, 2006) present a real option model with rational agents that can explain the stock price dynamics around seasoned equity offerings. We discuss these models in more detail below.

5.1.1. Adverse selection and the business cycle

In Choe, Masulis, and Nanda (1993), an adverse selection argument similar to Myers and Majluf (1984) is developed where firms choose between issuing debt and equity across business cycle expansions and contractions, where firms receive non-deferrable profitable investment opportunities, and they must issue debt or equity securities to pursue them.[42] If a firm issues debt, investors will demand either protective covenants or a price discount for anticipated asset substitution risk once the debt is issued. This imposes a debt issuance cost on all issuers. On the other hand, firms with undervalued equity will only issue equity when the dilution cost from selling undervalued stock is less than or equal to the debt issuance cost.[43] In the aggregate, the marginal equity issuer will find the dilution cost of issuing undervalued equity is just equal to the cost of debt issuance and will be indifferent to issuing debt or equity. All other firms will find that one of the two securities will dominate due to their lower issuance costs. Also, if a firm issues equity, then the market knows that the equity was not substantially underpriced, because if it was the firm would have issued debt. Thus, an equity announcement should be greeted with a negative price reaction because investors now know that the firms issuing equity are drawn from a less desirable distribution that is truncated from above and the opposite is true for firms issuing debt.

Choe, Masulis, and Nanda observe that corporate investment opportunities are typically more profitable in periods of economic expansions than during contractions. This can reduce the dilution effect of equity issuance, though the cost of debt issuance is relatively insensitive to the point in the business cycle when an offer occurs. In economic expansions it is common knowledge that the average firm issuing equity will be more profitable and the marginal equity issuer will need to be more underpriced ex ante, if its equity dilution effect is to equate to the debt issuance cost. In addition, all less underpriced firms will prefer to issue equity. Thus, fewer firms will choose to issue debt over

[42] Parts of this section are drawn from Eckbo and Masulis (1995).

[43] The dilution cost of issuing equity is assumed to be more than offset by the profits of the investment opportunity or else no investment would take place.

equity. As more profitable and more underpriced firms find it optimal to equity finance, the equity offer announcement effect (the adverse selection effect for the average equity issuer) is reduced, lowering the issuance cost of equity. Thus in economic expansions, the model predicts a smaller equity offer announcement effect and an rise in the relative frequency of equity offers.[44]

Consistent with the prior prediction, both Moore (1980) and Choe, Masulis, and Nanda (1993) find empirical evidence that the frequency of equity offers relative to debt offers rises in expansions, while at the same time the magnitude of the negative stock price reaction to firm commitment equity offer announcements decreases. In contrast, debt issues are insensitive to this equity issue mispricing effect. The evidence in Choe, Masulis, and Nanda (1993), Marsh (1982) and Taggart (1977) indicates that the number of straight debt offers does not fall in economic contractions and may in fact rise if interest rates also fall with the contraction. This latter effect may in part reflect debt refinancing activities in these periods.

The model of Choe, Masulis, and Nanda (1993) also predicts that the adverse selection effect increases as investor uncertainty concerning the value of assets in place rises. Schwert (1989) documents that stock price volatility varies over the business cycle, increasing during recessions.[45] Controlling for the effect of the business cycle, Choe, Masulis, and Nanda (1993) find that the relative frequency of equity issues is significantly negatively related to the issuer's daily stock return variance, which gives further empirical support to their adverse selection framework.

Several other hypotheses concerning the timing of equity offers can be extended to a business cycle environment. For example, under Myers (1984)'s pecking order hypothesis, firms are viewed as preferring to finance projects internally if possible, otherwise to issue low risk debt and to issue equity only as a last resort. Imposing an arbitrary limit on firm leverage, the timing of equity issues is affected by business cycle downturns that reduce internal sources of funds and raise leverage by lowering asset values, thereby making equity offers more attractive. However, this equity issuance scenario is inconsistent with the evidence found in Choe, Masulis, and Nanda (1993).

Another hypothesis is based on debt-equity wealth transfers predicted by Galai and Masulis (1976) and Jensen and Meckling (1976) to occur when leverage is unexpectedly revised. If a firm issues equity, thus lowering its leverage, debtholders gain since their risk premium continues to be paid in full, while their risk bearing falls. This tends to discourage management seeking to maximize shareholder wealth from undertaking equity offers, except when leverage has become unacceptably high. In economic contractions, debtholders bear greater risk and expect greater risk premiums. So in downturns, equity offers cause leverage to fall more, resulting in larger reductions in debt risk-bearing and

[44] If less profitable investment projects or projects with varying profitability are assumed, then the model predicts in economic expansions that fewer undervalued firms will forego equity financing because of their project's greater profitability.

[45] Schwert links this volatility increase to increases in operating leverage, which is likely to be positively related to investor uncertainty concerning the value of assets in place.

greater debtholder wealth gains. Thus, there are greater costs to equity issues in economic downturns, leading to a lower predicted frequency of equity offers and a more negative stock price reaction. However, the predicted positive price reaction of outstanding debt to equity offers under the wealth transfer hypothesis is not observed by Kalay and Shimrat (1987).

In the Stulz (1990) model of free cash flow, debt issuance becomes more attractive when a firm's free cash flow increases. In economic contractions, if earnings decline less sharply than capital spending, which is typically the case, then free cash flow can increase, which increases the attractiveness of debt offerings. The cost of debt issuance in the Stulz model is underinvestment in profitable projects, but this would tend to be less of a problem in economic downturns. Thus, debt issuance would appear to be predicted to rise in contractions under the Stulz model, which is contrary to the evidence in Marsh (1982) and Taggart (1977), but somewhat supported by the evidence reported by Choe, Masulis, and Nanda (1993). This prediction is also supported by the evidence found in Jung, Kim, and Stulz (1996), who observe that firms with relatively good investment opportunities measured by the market to book ratio, are significantly more likely to issue equity over straight debt.

Lucas and McDonald (1990) develop a dynamic model of the equity issuance process that predicts a greater frequency of equity issuance following a general stock market increase. They show that since firm's with temporarily underpriced stock have an incentive to postpone an offering until the stock price is higher, the resulting average pre-announcement price path of these issuing firms will be upward sloping. On the other hand, firms with temporarily overpriced stock will issue equity immediately as new investment opportunities arise. If the arrival of investment projects is uncorrelated with a firm's price history, then the average pre-equity offering announcement price path of temporarily overvalued stocks will be flat. As a result, the average preannouncement price path of all issuing firms will be upward sloping, as is typically observed in samples of firm commitment equity offers. Lucas and McDonald also argue that the market reaction to an equity issue announcement will be more negative for firms with higher pre-announcement period stock price gains, which is supported by the regression results of Masulis and Korwar (1986), Korajczyk, Lucas, and McDonald (1990), Eckbo and Masulis (1992), and Jung, Kim, and Stulz (1996).

As discussed in Section 4, Eckbo and Masulis (1992) point out that increased shareholder participation in equity issues reduces the incentives of firms with undervalued equity to postpone their offers since current shareholders capture part of any underpricing. At one extreme, when current shareholders purchase the entire issue (shareholder takeup $k = 1$), the firm issues immediately regardless of its current degree of underpricing. Thus, in a sample of issuers where the average level of shareholder participation is known to be large, the Eckbo and Masulis (1992) model predicts that there should be little or no stock price runup prior to the issue announcement. This prediction is supported by their evidence of little or no runup prior to an uninsured rights offer announcement, a modest positive runup prior to standby offer announcement and a larger positive runup effect prior to a firm commitment underwritten offer announcement.

Another hypothesis that predicts variation in the relative frequency of equity and debt offers over the business cycle is the belief of many practitioners that management prefers debt issuance when interest rates are historically low and prefers to issue stock when its price is historically high, regardless of whether this is caused by relatively low equity risk premiums or relatively high expected cash flows.[46] Since stock market prices tend to reflect future economic prospects, this hypothesis tends to predict increases in equity offers in economic expansions, when equity prices are relatively high and debt issues in economic contractions, when interest rates are also low.[47] These predictions are consistent with the evidence in Marsh (1982) and Taggart (1977), but only partially consistent with the evidence in Choe, Masulis, and Nanda (1993).

Bayless and Chaplinsky (1991) explore the effects of both firm-specific and macroeconomic variables on the security issue choice. The macroeconomic variables include the prior 3 month performance of the stock market (S&P 500), 3 month change in the Treasury bill interest rate and a corporate default premium. They find larger announcement effects when a security that is not expected is issued. Korajczyk and Levy (2003) also explore the effects of macroeconomic conditions and financial constraints on the security issue choice. They report that financially unconstrained firms act in a significantly different manner from financially constrained firms, which are defined as firms not paying cash dividends, not making net equity or debt repurchases and having a market to book ratio of greater than one. The lagged macroeconomic variables that they examine are: the term spread, the default spread and a three month equity market return. They find that unconstrained firms issue activity is significantly affected by macroeconomic variables, while for constrained firms, this is not the case, except for the lagged stock market return. They also find that equity issuance is more likely when the lagged three month average of two-day SEO announcement returns is less negative and when the issuer's prior one year abnormal stock returns is higher. Korajczyk and Levy also estimate firm target leverage and then use deviations from it as another explanatory variable for the security issue choice decision and find that a leverage deficit leads to a significant increase in debt issuance. Lastly, they report that target leverage is counter-cyclical for the unconstrained firms, while it is pro-cyclical for the constrained firms. Their results suggest that researchers should be concerned with whether an issuing firm is financially constrained or not and they should also consider including macroeconomic variables as controls in their analysis of offering announcement effects.

5.1.2. Optimal investments and equity offerings

As pointed out by Carlson, Fisher, and Giammarino (2005, 2006), it is commonly assumed that investments in risky projects will increase asset risk. Moreover, this assumption is difficult to square with the observation that post SEO long-run stock returns

[46] See, for example, the survey of CFOs by Graham and Harvey (2001).

[47] This equity issuance effect can also be reinforced when warrants and convertible securities are outstanding, since a rise in the stock price can push these options into-the-money and also make conversion forcing calls attractive for many firms.

are low compared to the stock returns of similar non-issuing firms (also shown in Section 5.3 below). However, they argue that this observation follows naturally when projects are viewed as options on the cash flow potentially generated by the project.

When project execution is flexible in time, a project becomes a real option. Managers can time the starting time of the project to maximize the value of the firm. An option to grow the company through execution of the project is a levered claim. The required return on a levered claim is higher than the required return on an unlevered claim on the same assets. Exercising the real option, i.e., making the investment necessary to start the projects, unlevers the claim. Thus, when firms grow they convert real options into assets in place. The assets may be risky, but an option on these assets is even riskier. Thus, when projects are financed using seasoned equity, the model predicts that realized returns on average should be lower after a SEO. This does not happen because the SEO is timed, but rather because there has been a fundamental shift in the riskiness of the firm's assets. Since growth options only are exercised when they move sufficiently in-the-money, the model also explains the pre-issue stock price runup.

In the model of Carlson, Fisher, and Giammarino (2005, 2006) the required return is endogenous and depends (among other things) on the optimally timed investment decisions made by the firm. If the expected return is assumed to be time varying but exogenous, more projects will become profitable as the discount rate drops. This will increase investments and lead some firms to raise capital. Thus, time varying expected returns predict that stock prices will rise prior to equity issues and that returns will be lower after the issue. Pastor and Veronesi (2005) develop a model of IPO waves along these lines. Their model predicts that IPOs should cluster and that such IPO waves should be preceded by high market return and followed by low market return.

The relationship between investments and stock return was first formalized by Cochrane (1991). In a production based asset pricing model, Cochrane shows that a firm's investment return (the rate of return obtained on the marginal real investment) should be equal to the stock return. Thus, when the real investment level is high, the marginal return on invested capital is low, and stock returns should be correspondingly low. Cochrane (2005) interprets this argument as a first-differenced version of Q-theory of investment. Zhang (2005) develops the Q-theoretical argument further. Zhang focuses on time varying expected return and shows how Q-theory, among other things, implies that firms conducting a SEO should have lower post-issue returns than otherwise similar firms. Lyandres, Sun, and Zhang (2005) explore the investment based explanation for the low long-run stock returns of SEO firms. They find the investment to asset ratios of SEO firms are about twice as large as the investment to asset ratios of non-issuing firms. Thus, under the Q-theory of investment, the expected return of SEO firms should be lower than the expected return for non-issuing firms.

In sum, the investment based theories predict that subsequent to an SEO, a firm will have lower market risk and thus, lower expected rates of return. This offers a potential explanation for the finding, discussed in detail in Section 5.3 below, that stock returns are relatively low—but not necessarily *abnormally* low—following SEOs or IPOs. It also suggests that matching an equity-issuing firm with a non-issuing firm based on size

and book-to-market ratio alone may be insufficient as a control for systematic risk. Such a match ignores the lower risk caused by the issuer's investment activity, and may lead to spurious evidence of "abnormal" post-issue returns.

5.1.3. Pseudo market timing

Schultz (2003) proposed pseudo market timing as another rational market explanation for the weak long-run stock returns observed after equity issues. The premise for the pseudo market timing hypothesis is that more firms issue equity as stock prices increase. It is irrelevant for the hypothesis why this happens, but, any of the rational theories discussed above could be the reason for increased issue activity as stock prices increases. Regardless of why the number of issues increases, the long-run performance has nothing to do with manager's predicting future returns. Schultz (2003) shows that if firms tend to issue stock after stock price increases (for whatever reason), on average issues will be followed ex post by underperformance. The reason is simple. Consider IPOs and suppose expected one-period returns are zero for all periods and all IPOs. Moreover, the return distribution is a bimodal $+10\%$ and -10% in each period. Let there be a single IPO at time zero. If the return in period one is -10%, there will be no new IPOs at time one. Alternatively, suppose the return in period one is $+10\%$ and that there are four IPOs in this period. Now, compute the one-period abnormal buy-and-hold return for these two equally likely sample paths. It is 2% for the "up" sample and -10% for the "down" sample, with an equally weighted average of -4%. Schultz (2003) refers to this result as "pseudo market timing" because it may easily be confused by the researcher with real forecasting ability on the part of issuing firms' managers.

Several authors have explored to what extent pseudo market timing can explain the low return observed after IPOs. Dahlquist and de Jong (2004), Viswanathan and Wei (2004), and Ang, Gu, and Hochberg (2005) argue that pseudo market timing only is a potential explanation for the low post issue return when samples are small. Based on simulation experiments, all papers conclude that pseudo market timing is highly unlikely to be the main explanation for the low post issue stock market returns. The simulation experiments assume a stationary event generating process. Schultz (2004) show that one cannot reject a null that IPOs follow a nonstationary process and goes on to argue that, although pseudo market timing is a small sample problem, it is likely to be important in practice. Note that Schultz (2003)'s pseudo-timing argument also holds in principle for other security issuances, and in particular for SEOs where the matched-firm technique also have produced evidence of long-run underpricing by issuing firms (discussed below).

5.2. Timing theories with non-rational market pricing

5.2.1. Timing of firm-specific returns

The timing hypothesis ("windows-of-opportunity") builds on the notion that investors are overly optimistic about the prospects of issuing firms, and as a consequence prices

do not fully incorporate managerial incentives to time equity issues. This results in initial overpricing of issuing firms and a subsequent long-run underperformance when investors correct this initial mispricing over time.

The overconfidence hypothesis of Daniel, Hirshleifer, and Subrahmanyam (1998) is closely related, but is derived in a formal model and carries some explicit empirical predictions. The overconfidence hypothesis is based on the assumption that investors are overconfident about the precision of their private information, but not about the precision of public information. Overweighting private information relative to public information causes underreaction to new *public* information. Thus, the theory predicts that discretionary corporate events (such as equity issues) associated with abnormal announcement period returns, on average should be followed by long-run abnormal performance of the same sign as the average announcement period abnormal return, and there should be a positive correlation between announcement period abnormal returns and post-offer long-run abnormal returns.

Several empirical papers have explored different aspects of the timing and overconfidence hypotheses. Teoh, Welch, and Wong (1998) look at discretionary accruals in the years around an equity offering. The idea is that if investors are overly optimistic about the prospect of firms issuing equity, they would be willing to buy more shares and pay higher prices for them. As a result, issuing firms have incentives to cultivate this optimism by reporting inflated earnings before an equity offer. Both papers find evidence of earnings management prior to SEOs. For example, Teoh, Welch, and Wong (1998) find that although cash flows from operations on average decline prior to the SEOs, the reported discretionary accruals cause earnings to peak around the offer dates. Moreover, the amount of discretionary accruals prior to the seasoned equity offering is negatively related to the post-issue long-run stock return performance. The authors view this as evidence in favor of timing and overly optimistic investors. However, this issue is not settled as Shivakumar (2000) produces contradictory evidence using the specification of Teoh, Welch, and Wong (1998).

Cornett, Mehran, and Tehranian (1998) employ a direct test of the relationship between the incentive to time an issue and the subsequent stock return performance. They study voluntary and involuntary SEOs by commercial banks. Capital regulations in the banking industry state that banks are not allowed to have total capital ratios below a certain level. If the total capital ratio falls below the regulated lower bound, a bank may need to issue new equity to raise their capital ratio. Cornett, Mehran, and Tehranian (1998) define an involuntary SEO as an issue by a bank with capital ratio close to or below the required minimum ratio. If timing is driving the long-run underperformance of SEOs, we should expect to see less or no underperformance for involuntary issues. The results support the timing hypothesis, showing no abnormal three-year post issue stock return performance for the involuntary issues, while the voluntary issues show significant underperformance.

Brous, Datar, and Kini (2001) perform another test of the timing and overconfidence hypotheses. They argue that if managers are timing equity issues and investors systematically underreact to the issue announcements, we should expect to see that investors

are disappointed when firms convey their post-issue earnings. That is to say, post-issue earnings announcement on average should be associated with negative stock price reactions. However, their results show no evidence of abnormal stock price reactions to the earnings announcements.

Kang, Kim, and Stulz (1999) tests the overconfidence hypothesis using data on Japanese public and private equity offerings. The non-negative announcement period abnormal return to Japanese equity offerings supports the view that equity offerings are regarded as good news in Japan. Nonetheless, they document post-issue negative long run abnormal performance. Taken at face value, this is evidence goes against the overconfidence hypothesis, but is consistent with investment based theories of equity issuance.

5.2.2. Timing the market

Baker and Wurgler (2000) document that the proportion of equity in total new issues, termed "the equity share", is negatively correlated with future aggregate equity market returns. For example, when the equity share was in its top historical quartile, the average market return in the following year was -6%. This could suggest that managers are able to time the market component of their company's returns. However, Baker, Ruback, and Wurgler (2007) is cautious about this interpretation. They suggest that: "A more plausible explanation is that broad waves of investor sentiment lead many firms to be mispriced in the same direction at the same time. Then, the *average* financing decision will contain information about the *average* (i.e., market level) mispricing, even though individual managers are perceiving and responding only to their *own* firm's mispricing".

Butler, Grullon, and Weston (2005a) question that timing ability or investor sentiment explain the predictive power of the equity share. They suggest that the apparent ability to time the market can be understood as a form of aggregate "pseudo market timing". They point out that on an ex-post basis equity share value tends to be high around market peaks and low around market troughs. Thus, it is the tendency to issue equity when prices are high that leads to a spurious relationship between equity share and future stock returns when measured ex post. They go on to argue that if equity tends to be issued when current prices are high, then equity issuance activity should go down during unexpected market declines—making pre-shock equity issuance look relatively high and post-shock equity issuance look relatively low. Thus, aggregate pseudo market timing should be most pronounced around market shocks. This prediction is supported by evidence that the predictive ability of the equity share is driven by the Great Depression (1920–1931) and the 1973–1974 Oil Crisis.

The main point in Butler, Grullon, and Weston (2005a) is that pseudo market timing can appear as real timing ability in small samples. Baker, Taliaferro, and Wurgler (2004) show that this problem extends to all time-series predictive regressions based on managerial decision variables. Moreover, it is a special case of the small sample bias studied

by, among others, Stambaugh (1986, 1999).[48] For example, when a financial ratio such as book-to-market is used as a predictive variable, it will "pseudo-time" the market since the book-to-market ratio is hard-wired to rise as the market falls. There is an extensive literature on how to estimate the bias that this causes in predictive regressions. Using simulations, Baker, Taliaferro, and Wurgler (2004) report that pseudo-timing accounts for less than two percent of the predictive power of the equity share. However, the role of the pseudo-timing when the econometrician also allows for a non-stationary economic environment remains to be determined.

The debate about what causes the apparent ability of firms to time their equity issues to periods that are followed by low market returns is still inconclusive. Rational explanations along the lines of Carlson, Fisher, and Giammarino (2005, 2006) and Pastor and Veronesi (2005) are interesting and consistent with the arguments and results of several papers that empirically investigate long-run performance following security offerings. Next we turn to an in depth review of this long-run stock return literature.

5.3. Evidence on long-run post-issue stock returns

Stocks generate surprisingly low returns over holding periods of 2–5 years following an equity issue date, as first shown for SEOs by Stigler (1964) and later reconfirmed and extended to IPOs by Ritter (1991) and more recent SEOs by Loughran and Ritter (1995). As discussed above, to some researchers, this long-run return evidence challenges the efficient markets hypotheses and motivates the development of behavioral asset pricing models. Responding to this challenge, Brav and Gompers (1997), Brav, Geczy, and Gompers (2000), Eckbo, Masulis, and Norli (2000), Eckbo and Norli (2005), and Lyandres, Sun, and Zhang (2005) present large-sample evidence that the low post-issue return pattern is consistent with standard multi-factor pricing models, and tend to be concentrated in small growth stocks with active investment programs. Thus, the low post-issue returns may be a manifestation of the more general finding in Fama and French (1992) that small growth stocks tend to exhibit low returns during the post-1963 period, or simply reflect the fact that asset pricing models have especially poor explanatory power for small growth stocks.

However, the proper interpretation of the low long-run returns following security issuances remains an unsettled issue. Ritter (2003) states that "the long-run performance evidence shows that in general the market underreacts to the [equity issue] announcements" (p. 262). Given the importance of the long-run performance evidence for the overall question of corporate timing and market efficiency, we provide a detailed review of the long-run performance evidence following IPOs, SEOs as well as corporate debt issues. We also report new updated abnormal return estimates of issuer abnormal returns

[48] See Baker, Taliaferro, and Wurgler (2004) for a more extensive list of papers that have studied this small sample bias.

based on security offerings made over the 1980–2001 sample period, and compare these to the extant literature.

5.3.1. Sample selection

The choice of sample period generally affects the statistical significance of reported abnormal return estimates.[49] Shorter sample periods reduce statistical power, while different sample periods have varying exposure to the problem of cross-correlation of overlapping holding-period returns (discussed extensively by Kothari and Warner (2007) in Chapter 1 of this volume). The literature uses security offer samples from as early as 1961 (Mitchell and Stafford, 2000) and as late as 2003 (Lyandres, Sun, and Zhang, 2005), with the bulk of the existing studies sampling from the 1980s and the early 1990s. The primary data source after 1980 is SDC, while earlier samples typically are found by searching the Wall Street Journal for issue announcements or relying on the SECs now defunct Registered Offerings of Securities database. Stock returns are almost always drawn from CRSP Daily Stock Price and Returns database.

Some authors exclude issues by public utilities on the grounds that the regulatory agencies make utility issues relatively predictable. Utility issues occurred on relatively frequent basis in the 1970s, and again as a result of deregulations in the late 1990s (Eckbo, Masulis, and Norli, 2000). As discussed above, the market reaction to SEOs is significantly smaller for utility issuers than for industrial issuers. Thus, it matters whether the utility issues are pooled in the long-run performance analysis. It is also customary to exclude issuers with stock price less than $5, as well as unit offerings and simultaneous offerings of other securities. Issues by foreign corporations, closed-end funds, unit investment trusts, and real estate investment trusts are also customarily excluded. Moreover, most studies require data on book value of equity, taken from Compustat, which further reduces sample size.

Our sample selection for the long-run analysis below is as follows. We start with the overall sample of 80,627 security issues from Section 2.3 above. Recall that this sample already ensures that the issuing firm is found on the CRSP tape for the relevant period. We then exclude the following issues using information from SDC: (1) ADRs and GDRs, (2) simultaneous offerings of debt and equity, (3) simultaneous offerings of international issues, (4) unit offerings, (5) offers with missing SDC information on offering proceeds, and (6) offerings after year 2000. The last restriction ensures five years of post-issue stock return data. These six criteria reduces the total sample to 54,283. We then apply restrictions specific to CRSP: (7) CRSP share code must be either 10 or 11 (ordinary common shares), (8) the issuer must be listed on NYSE/AMEX/Nasdaq,

[49] Figure 3 in Eckbo and Norli (2005) presents a striking illustration of the impact of sample period on the average holding period return. Due to the slump in the stock market in the mid-1970s, a study of long-run returns following IPOs (which starts with the first Nasdaq IPOs in 1973), will easily conclude that the IPO portfolio underperform the *risk-free* rate if the sample period ends prior to the mid-1980s.

and (9) information on market value of equity must be available. This results in a total sample of 44,986.

The breakdown of the total sample of 44,986 offerings across different types of security offerings is shown below. The second column of numbers indicates the sample size when we also require the issuer to have Compustat information on equity book-to-market ratio (B/M). The latter constraint is imposed when we identify non-issuing firms matched on B/M.[50]

Sample for the survey's long-run analysis ($N = 44{,}986$)

Security type	Total	B/M available
IPO	5,907	5,403
SEO	6,698	6,285
Private placement of equity	506	506
Preferred equity	1,530	1,412
Convertible debt	1,157	897
Private placement of debt	9,584	8,584
Public straight debt issue	18,447	17,360

We start the abnormal return analysis using the matched firm technique which requires B/M information. We then report the results of risk adjustments using factor regressions of portfolios of issuing firms.

5.3.2. *Cumulative buy-and-hold returns for issuers versus matched firms*

The typical buy-and-hold experiment involves buying the issuing firm's stock in the month following the issue month, and holding the stock for a period of three to five years or until delisting, whichever comes first. In a sample of N issues, the average return over a holding period of T months is computed as the average cumulative (T-period) return, also referred to as $\overline{\text{BHR}}$ (for "buy-and-hold return"):

$$\overline{\text{BHR}} \equiv \frac{1}{\omega_i} \sum_{i=1}^{N} \left[\prod_{t=\tau_i}^{T_i} (1 + R_{it}) - 1 \right], \tag{6}$$

where R_{it} denotes the return to stock i over month t, and ω_i is stock i's weight in forming the average holding-period return ($\omega_i = 1/N$ when equal-weighting). The

[50] Book value is defined as "the Compustat book value of stockholders equity, plus balance sheet deferred taxes and investment tax credits (if available), minus the book value of preferred stock. Depending on availability, we use the redemption, liquidation, or par value (in that order) to estimate the value of preferred stock" (Fama and French, 1993, p. 8). If available on Compustat, the issuer book value of equity is also measured at the end of the year prior to the issue year. If this book value is not available, we use the first available book value on Compustat starting with the issue year and ending with the year following the issue year. On average, the first available book value is found 6.1 months after the offer date. Brav and Gompers (1997) look a maximum of 12 months ahead for book values while Brav, Geczy, and Gompers (2000) look a maximum of 18 months ahead.

effective holding period for stock i is T_i, where T_i in the analysis below is either five years or the time until delisting or the occurrence of a new SEO, whichever comes first. Kothari and Warner (1997), Barber and Lyon (1997) and Lyon, Barber, and Tsai (1999) provide simulation-based analyses of the statistical properties of test statistics based on long-run return metrics such as BHR. In Chapter 1 of this volume, Kothari and Warner (2007) survey the main statistical conclusions from this analysis.[51]

The matched-firm technique equates the *expected* return to issuing firms with the *realized* return to a non-issuing firm, usually matched on firm characteristics such as industry, size and book-to-market ratio. The abnormal or unexpected return BHAR is then

$$\mathrm{BHAR}_{\mathrm{Issuer}} \equiv \mathrm{BHR}_{\mathrm{Issuer}} - \mathrm{BHR}_{\mathrm{Matched\,firm}}. \tag{7}$$

Table 17 shows average five-year buy-and-hold returns following security offerings by U.S. firms that took place over the period 1980 through 2000, classified by the type of issuer.[52] As in Eckbo, Masulis, and Norli (2000) and Eckbo and Norli (2005), the matched firms are selected from all CRSP-listed companies at the end of the year prior to the issue-year and that are not in our sample of issuers for a period of five years prior to the offer date. We first select the subset of firms that have equity market values within 30% of the equity market value of the issuer. This subset is then ranked according to book-to-market ratios. The size and book-to-market matched firm is the firm with the book-to-market ratio, measured at the end of the year prior to the issue year, that is closest to the issuer's ratio. Matched firms are included for the full five-year holding period or until they are delisted, whichever occurs sooner. If a match delists, a new match is drawn from the *original* list of candidates described above.

[51] An alternative to $\overline{\mathrm{BHR}}$ is to estimate the average monthly return to a strategy of investing in the stocks of issuers and hold these for up to T periods. The T-period return would then be formed as the *cumulative average* (portfolio) return, or

$$\overline{\mathrm{CMR}} \equiv \prod_{t=\tau}^{T}\left[1 + \frac{1}{\omega_t}\sum_{i=1}^{N_t} R_{it}\right] - 1.$$

As noted by Kothari and Warner (2007), depending on the return generating process, the statistical properties of $\overline{\mathrm{BHR}}$ and $\overline{\mathrm{CMR}}$ can be very different. Notice also that while $\overline{\mathrm{CMR}}$ represents the return on a feasible investment strategy, $\overline{\mathrm{BHR}}$ does not. You obtain $\overline{\mathrm{CMR}}$ by investing one dollar in the first security issue at the beginning of the sample period, and then successively rebalancing this initial investment to include subsequent issues as they appear (and N increases), all with a T-period holding period. In contrast, $\overline{\mathrm{BHR}}$ is formed in event time—and thus presumes prior knowledge of the magnitude of N. Thus, estimates of $\overline{\mathrm{CMR}}$ are better suited than estimates of $\overline{\mathrm{BHR}}$ to address the question of whether investors have an incentive to take advantage of a potential market mispricing of security issues. Most of the empirical studies using the matched firm technique report results based on $\overline{\mathrm{BHR}}$, which we follow here. In the subsequent section, however, we discuss portfolio benchmark returns based on asset pricing models, which uses the return concept $\overline{\mathrm{CMR}}$ on a monthly basis, i.e., without the T-period cumulation.

[52] Utilities are firms with CRSP SIC codes in the interval [4910, 4939].

Table 17
Five-year buy-and-hold stock percent returns ($\overline{\text{BHR}}$) for U.S. issuers and size- and book-to-market matched control firms, 1980–2000

Type of security issued	N	Equally-weighted $\overline{\text{BHR}}$				Value-weighted $\overline{\text{BHR}}$			
		Issuer	Match	Diff	$p(t)$	Issuer	Match	Diff	$p(t)$
A. Issues by industrial firms ($N = 20{,}262$)									
Initial public offerings	5,018	35.7	53.8	−18.0	0.010	52.8	67.6	−14.8	0.208
Seasoned equity offerings	4,971	49.9	79.5	−29.7	0.000	79.8	105.7	−26.0	0.026
Private placement of equity	506	13.0	57.1	−44.1	0.000	31.1	54.1	−23.0	0.223
Preferred equity	379	43.8	96.7	−52.9	0.000	79.1	113.6	−34.5	0.238
Convertible debt	897	46.5	86.9	−40.4	0.006	46.5	83.6	−37.1	0.068
Private placement of debt	4,228	76.0	89.2	−13.2	0.002	87.0	97.0	−10.0	0.282
Straight debt	4,263	77.6	94.6	−17.0	0.000	71.2	88.0	−16.8	0.000
B. Issues by banks and financial institutions ($N = 16{,}521$)									
Initial public offerings	385	71.7	51.1	20.6	0.154	112.1	50.7	61.5	0.233
Seasoned equity offerings	655	98.3	98.3	0.0	0.999	75.6	73.4	2.3	0.870
Preferred equity	573	104.6	72.1	32.5	0.000	59.5	48.3	11.1	0.310
Private placement of debt	3,478	138.0	86.5	51.5	0.000	102.4	50.4	52.0	0.000
Straight debt	11,430	116.0	76.9	39.2	0.000	88.2	40.5	47.8	0.000
C. Issues by public utilities ($N = 3{,}664$)									
Seasoned equity offerings	659	116.3	135.4	−19.1	0.012	100.6	132.9	−32.3	0.010
Preferred equity	460	79.4	103.0	−23.5	0.000	70.4	85.1	−14.7	0.104
Private placement of debt	878	87.2	95.2	−8.0	0.270	44.0	70.6	−26.6	0.002
Straight debt	1,667	75.0	92.9	−17.9	0.000	63.7	80.7	−17.0	0.001

Buy-and-hold percent returns are defined as:

$$\overline{\text{BHR}} \equiv \omega_i \sum_{i=1}^{N} \left[\prod_{t=\tau_i}^{T_i} (1 + R_{it}) - 1 \right] \times 100.$$

When equal-weighting, $\omega_i \equiv 1/N$, and when value-weighting, $\omega_i = MV_i/MV$, where MV_i is the issuer's common stock market value (in 1999 dollars) at the start of the holding period and $MV = \sum_i MV_i$. The abnormal buy-and-hold returns shown in the column marked "Diff" represent the difference between the $\overline{\text{BHR}}$ in the "Issuer" and "Match" columns. The rows marked "N" contain number of issues. The p-values for equal-weighted abnormal returns are p-values of the t-statistic using a two-sided test of no difference in average five-year buy-and-hold returns for issuer and matching firms. The p-values for the value-weighted abnormal returns are computed using $U \equiv \omega' x/(\sigma\sqrt{\omega'\omega})$, where ω is a vector of value weights and x is the corresponding vector of differences in buy-and-hold returns for issuer and match. Assuming that x is distributed normal $N(\mu, \sigma^2)$ and that σ^2 can be consistently estimated using $\sum_i \omega_i (x_i - \bar{x})^2$, where $\bar{x} = \sum_i \omega_i x_i$, U is distributed $N(0, 1)$.

Table 17 shows issuers on average underperform their matched firms when $\overline{\text{BHR}}$ is formed using equal-weights. For industrial issuers (Panel A), the five-year differ-

ence in the buy-and-hold returns of issuers and matched firms ranges from −52.0% for preferred equity placements ($N = 379$) to −13.2% for private placements of debt ($N = 4{,}228$). For IPOs ($N = 5{,}018$), the difference in buy-and-hold returns is −18.0% and −29.7% for SEOs ($N = 4{,}971$). Straight debt issues ($N = 4{,}263$) are associated with a difference in $\overline{\text{BHR}}$ of −17.0% while the return difference is 40.4% for convertible debt issues ($N = 897$). All return differences are statistically difference from zero at the one percent level.

Going from equal-weighting to value-weighting the returns alters the results dramatically. With value-weights, none of the differences are statistically different from zero at the one percent level, with the exception of *straight debt* issues (p-value of 0.000). Moreover, SEOs underperform their matched firms with a p-value of 0.026. Since value-weighting gives additional weight to above-average successful firms (relative to equal-weighting), the reduction in underperformance is expected. However, the fact that straight debt issuers in the value-weighted category reliably underperform matched firms while most other equity-type of issues do not is surprising.

Turning to security issuers by banks and financial institutions, there is no evidence of underperformance and some evidence of significant overperformance relative to the matched firms. With equal-weighting, financial issuers outperform matched firms when issuing preferred equity ($N = 573$) and straight debt placed either publicly ($N = 11{,}430$) or privately ($N = 3{,}478$). Value-weighting has almost no impact on the performance measure, except that preferred equity is no longer associated with abnormal performance relative to the matched firms.

As shown in the third panel of Table 17, issues by public utility companies produce underperformance similar to that of industrial issuers. The exception is private placements of equity ($N = 878$) which produces statistically insignificant underperformance for the equal-weighted buy-and-hold measure. Private placements do, however, significantly underperform using the value-weighted measure, as do SEOs ($N = 659$) and issuers of straight debt ($N = 1{,}667$).

Table 18 lists published studies that present evidence on buy-and-hold returns for several of the security sales in Table 17. For IPOs, and consistent with the results in Table 17, the studies of Brav, Geczy, and Gompers (2000), Ritter and Welch (2002) and Eckbo and Norli (2005) show insignificant abnormal returns over both three-year and five-year time horizons. For SEOs, the studies with the largest samples are Jegadeesh (2000), Brav, Geczy, and Gompers (2000), Eckbo, Masulis, and Norli (2000) and Clarke, Dunbar, and Kahle (2001). These show evidence of significant negative performance (3-year or 5-year), ranging from −4% to −34%. This is consistent with the −30% abnormal buy-and-hold return for the SEOs in Table 17. There is also negative, relative performance following private placements of equity (Hertzel et al., 2002; Krishnamurthy et al., 2005). Interestingly, Krishnamurthy et al. (2005) show that investors who participate in the private placement discount realize a normal post-issue, long-run performance.

Turning to debt offerings, with the exception of Eckbo, Masulis, and Norli (2000), there is consistent evidence of negative performance following convertible debt issues

Table 18
Average difference in equal-weighted buy-and-hold returns for U.S. issuers ($\overline{\text{BHR}}_i$) and size- and book-to-market matched control firms ($\overline{\text{BHR}}_m$)

Study	Issuer type	Sample size	Sample period	Holding period	$\overline{\text{BHR}}_i - \overline{\text{BHR}}_m$
A. IPOs					
Brav and Gompers (1997)	All	3,407	1972–1992	5 yrs	1.9%[a]
Brav and Gompers (1997)	All	934	1972–1992	5 yrs	16.5%*[b]
Brav, Geczy, and Gompers (2000)	All	3,501	1975–1992	5 yrs	6.6%
Ritter and Welch (2002)	All	6,249	1980–2001	3 yrs	−5.1%
Eckbo and Norli (2005)	All	5,365	1972–1998	5 yrs	−2.4%
B. SEOs					
Spiess and Affleck-Graves (1995)	All	1,247	1975–1989	3 yrs	−22.8%*
Lee (1997)	All	1,513	1976–1990	3 yrs	−20.3%*[c]
Jegadeesh (2000)	All	2,992	1970–1993	5 yrs	−34.3%*
Brav, Geczy, and Gompers (2000)	All	3,775	1975–1992	5 yrs	−26.3%*
Eckbo, Masulis, and Norli (2000)	Ind	3,851	1964–1995	5 yrs	−23.2%*
Kahle (2000)	Ind	1,739	1981–1992	3 yrs	−14.7%*
Clarke, Dunbar, and Kahle (2001)	All	3,092	1984–1996	3 yrs	−14.3%*[d]
Clarke, Dunbar, and Kahle (2001)	All	174	1984–1996	3 yrs	−3.3%*[e]
C. Private placements of equity					
Hertzel et al. (2002)	All	591	1980–1996	3 yrs	−23.8*
Krishnamurthy et al. (2005)	All	275	1983–1992	3 yrs	−38.4%*[f]
Krishnamurthy et al. (2005)	All	273	1983–1992	3 yrs	−1.24%[g]
D. Straight debt offerings					
Spiess and Affleck-Graves (1999)	All	392	1975–1989	5 yrs	−14.3%
Kahle (2000)	Ind	523	1981–1992	3 yrs	−9.5%
Eckbo, Masulis, and Norli (2000)	Ind	981	1964–1995	5 yrs	−11.2%
Eckbo, Masulis, and Norli (2000)	Util	348	1964–1995	5 yrs	−10.4%*
Butler and Wan (2005)	Ind	799	1975–1999	5 yrs	−24.0%*[h]

(*Continued on next page*)

(Lee and Loughran, 1998; Spiess and Affleck-Graves, 1999; Kahle, 2000; Lewis, Rogalski, and Seward, 2001). For straight debt offerings, however, the literature shows insignificant long-run performance (Spiess and Affleck-Graves, 1999; Kahle, 2000, and industrial issuers in Eckbo, Masulis, and Norli, 2000). This contrasts with the results in Table 17 where debt issuers significantly underperform non-issuing matched firms. While the magnitudes of the abnormal returns are similar for straight debt issues in Table 17 and Table 18, the much larger sample size in Table 17 appears to provide greater precision, causing the null of zero abnormal performance to be rejected at the 0.1% level or better.

Measurement problems aside, underperformance following straight debt issues represents an enigma: there is little adverse selection as the choice of debt over equity is

Table 18
(*Continued*)

Study	Issuer type	Sample size	Sample period	Holding period	$\overline{\text{BHR}}_i - \overline{\text{BHR}}_m$
E. Convertible debt offerings					
Spiess and Affleck-Graves (1999)	All	400	1975–1989	5 yrs	−37.0%*
Lee and Loughran (1998)	All	986	1975–1990	5 yrs	−30.4%*
Eckbo, Masulis, and Norli (2000)	Ind	459	1964–1995	5 yrs	−16.1%
Kahle (2000)	Ind	527	1981–1992	3 yrs	−18.1%*
Lewis, Rogalski, and Seward (2001)	All	566	1979–1990	5 yrs	−26.5%*
Butler and Wan (2005)	Ind	303	1975–1999	5 yrs	−24.0%*[h]

Buy-and-hold percent returns are defined as:

$$\overline{\text{BHR}} \equiv \frac{1}{N}\sum_{i=1}^{N}\left[\prod_{t=\tau_i}^{T_i}(1+R_{it})-1\right]\times 100.$$

Superscript * indicates significantly different from zero at the 1% level.
[a]Sample of non-venture-backed IPOs.
[b]Sample of venture-backed IPOs.
[c]Sample of primary issues. Matching firms are matched on size, book-to-market and prior annual return.
[d]Sample of completed SEOs.
[e]Sample of cancelled SEOs.
[f]Returns to non-participating investors (who do not buy shares in the private placement).
[g]Returns to participating investors (those who also capture the discount in the offering).
[h]Abnormal returns are insignificant when also matching on liquidity.

often thought to be associated with managerial beliefs that the firm's future earnings prospects are good (e.g., Ross, 1977). So why would debt issuers underperform non-issuing firms matched on size and B/M? Moreover, why would this underperformance be close to the magnitude for SEOs? The answer may reflect a combination of statistical problems with buy-and-hold return $\overline{\text{BHR}}$, as well as the matched firm technique producing the wrong benchmark for measuring the true systematic risk of issuing firms. In the subsequent section, we address this issue by measuring abnormal performance to issuing firms using both a monthly return horizon and a risk adjustment emanating from factor regressions.

Eckbo and Norli (2005) also examine the frequency of company delistings from the stock exchange due to bankruptcy/liquidation over the five-year period following IPOs. The idea is that low post-issue returns may be driven by a greater exit due to bankruptcy/liquidation compared to the rate for the matched firms. However, they find no evidence that the rate of bankruptcy/liquidations (or delisting due to takeover) differs across issuer and their matches.

5.3.3. Average monthly abnormal returns using factor pricing regressions

In this section, we use empirical asset pricing models to generate portfolio expected returns. An asset pricing model is estimated using monthly returns, with the intercept term in the pricing model (also referred to as "Jensen's alpha" from Jensen (1968), or simply α) as the measure of the average monthly abnormal return. The most commonly used empirical asset pricing models in this literature are of the multi-factor (APT) type in general, and the three-factor model of Fama and French (1993) in particular.[53]

The factor pricing analysis proceeds as follows. Let r_{pt} denote the return on issuer–portfolio p in excess of the risk-free rate, and assume that expected excess returns are generated by a K-factor model,

$$E(r_{pt}) = \beta_p' \lambda, \tag{8}$$

where β_p is a K-vector of risk factor sensitivities (systematic risks) and λ is a K-vector of expected risk premiums. The return generating process can be written as

$$r_{pt} = E(r_{pt}) + \beta_p' f_t + e_{pt}, \tag{9}$$

where f_t is a K-vector of risk factor shocks and e_{pt} is the portfolio's idiosyncratic risk with expectation zero. The factor shocks are deviations of the factor realizations from their expected values, i.e., $f_t \equiv F_t - E(F_t)$, where F_t is a K-vector of factor realizations and $E(F_t)$ is a K-vector of factor expected returns.

Regression equation (9) requires specification of $E(F_t)$, which is generally unobservable. To get around this issue, it is common to replace the raw factors F with factor mimicking portfolios. Specifically, consider the excess return r_{kt} on a portfolio that has unit factor sensitivity to the kth factor and zero sensitivity to the remaining $K-1$ factors. Since this portfolio must also satisfy equation (8), it follows that $E(r_{kt}) = \lambda_k$. Thus, when substituting a K-vector r_{Ft} of the returns on factor-mimicking portfolios for the raw factors F, equations (8) and (9) imply the following regression equation in terms of observables:

$$r_{pt} = \beta_p' r_{Ft} + e_{pt}. \tag{10}$$

Equation (10) generates portfolio p's returns, and inserting a constant term α_p yields the alpha measure of abnormal return.

We estimate alphas using two models which include the Fama and French (1993) factors as well as two additional characteristics-based risk factors:

$$r_{pt} = \begin{cases} \alpha_p + \beta_1 \,\mathrm{RM} + \beta_2 \,\mathrm{SMB}_t + \beta_3 \,\mathrm{HML}_t + e_t, \\ \alpha_p' + \beta_1 \,\mathrm{RM} + \beta_2 \,\mathrm{SMB}_t + \beta_3 \,\mathrm{HML}_t + \beta_4 \,\mathrm{UMD} + \beta_5 \,\mathrm{LMH} + e_t, \end{cases} \tag{11}$$

where r_{pt} is the excess return to an equal-weighted portfolio of issuers, RM is the excess return on the CRSP value weighted market index. SMB and HML are the Fama and

[53] See, e.g., Connor and Korajczyk (1995) and Ferson (2003) for extensive surveys of multifactor models.

French (1993) size and book-to-market factors. UMD is a momentum factor inspired by Carhart (1997) and constructed as the returns difference between the one-third highest and the one-third lowest CRSP performers over the past 12 months. LMH is the Eckbo and Norli (2005) turnover factor, defined as a portfolio long in low-turnover stocks and short in high-turnover stocks.

The alpha estimates are reported in Table 19 for equity issuers, and Table 20 for debt issuers. As first reported by Eckbo and Norli (2005), the estimated coefficients on the turnover factor LMH tend to be both a greater and more significant than the coefficients on the momentum factor UMD. When the coefficient on LMH is significant, the extended model increases the regression R^2 marginally above the Fama–French model. Moreover, when significant, the estimated coefficients on both UMD and LMH are typically negative, indicating that issuers tend to be relatively liquid, growth stocks.

When using the Fama–French model, the alphas are significant and negative for private placements of equity (panel F of Table 19) and for private placements of straight debt (panels D and F in Table 20). However, the alpha estimates are insignificant in all samples when using the extended model. There is ample evidence that the momentum factor UMD helps explain the cross-section of expected stock returns. Evidence that the turnover factor LMH is also priced is found in Eckbo and Norli (2002 and 2005). Assuming UMD and LMH are indeed priced risk factors, then the results in Table 19 and Table 20 fail to reject the hypothesis of zero post-issue abnormal performance.

Table 21 shows the alpha estimates reported in much of the literature that uses factor regressions to estimate post-issue abnormal performance. For IPOs, and with the exception of non-venture-backed IPOs studied by Brav and Gompers (1997), the alphas are statistically insignificantly different from zero (Brav, Geczy, and Gompers, 2000; Ritter and Welch, 2002; Eckbo and Norli, 2005). For SEOs, and with the exception of Jegadeesh (2000), all large-sample studies (3,000+ SEOs) also report insignificant alphas. These include Brav, Geczy, and Gompers (2000), Eckbo, Masulis, and Norli (2000), and Lyandres, Sun, and Zhang (2005). For portfolios of SEOs, the Fama–French model tend to produce larger (and sometimes significant) alphas than extended models adding UMD, LMH and, most recently, the investment factor of Lyandres, Sun, and Zhang (2005). Overall, assuming these factors are priced, the null of zero abnormal post-SEO performance is not rejected.

Finally, studies of debt issues also find alphas that are indistinguishable from zero. The largest sample is found in Eckbo, Masulis, and Norli (2000), who study a total of 1,329 straight debt issues and 459 convertible debt offerings, report insignificant alpha estimates for both types of debt issues. Spiess and Affleck-Graves (1999) report significantly negative alphas for a constrained sample of debt issuers, where issues by a given company that take place within five years of each other are excluded. However, Butler and Wan (2005) show that adding a liquidity factor (much like the turnover factor of Eckbo and Norli (2005) produces insignificant alpha estimates also for the type of restricted sample used by Spiess and Affleck-Graves (1999). Thus, again assuming

Table 19
Monthly abnormal equal-weighted portfolio return (α_p) following IPOs, SEOs, and equity private placements (PPEs), 1980–2000

α_p	RM	SMB	HML	UMD	LMH	R^2
A. Sample of 5,128 IPOs by industrial firms						
−0.16 (0.492)	1.14 (0.000)	1.17 (0.000)	−0.29 (0.006)			0.838
0.25 (0.416)	0.95 (0.000)	1.03 (0.000)	−0.27 (0.020)	−0.19 (0.061)	−0.53 (0.006)	0.863
B. Sample of 779 IPOs by banks and financial firms						
−0.10 (0.695)	1.09 (0.000)	0.75 (0.000)	0.61 (0.000)			0.616
0.03 (0.922)	1.06 (0.000)	0.74 (0.000)	0.60 (0.000)	−0.10 (0.278)	−0.06 (0.726)	0.618
C. Sample of 5,127 SEOs by industrial issuers						
−0.18 (0.167)	1.20 (0.000)	0.92 (0.000)	−0.11 (0.057)			0.923
0.18 (0.125)	1.04 (0.000)	0.80 (0.000)	−0.09 (0.073)	−0.17 (0.000)	−0.45 (0.000)	0.949
D. Sample of 878 SEOs by banks and financial firms						
−0.16 (0.378)	1.12 (0.000)	0.52 (0.000)	0.77 (0.000)			0.720
−0.09 (0.650)	1.10 (0.000)	0.51 (0.000)	0.77 (0.000)	−0.05 (0.421)	−0.05 (0.650)	0.720
E. Sample of 693 SEOs by public utilities						
0.06 (0.744)	0.62 (0.000)	0.05 (0.374)	0.65 (0.000)			0.458
−0.08 (0.644)	0.74 (0.000)	0.15 (0.008)	0.61 (0.000)	0.01 (0.829)	0.34 (0.002)	0.481
F. Sample of 506 PPEs by industrial issuers						
−0.48 (0.066)	1.15 (0.000)	1.14 (0.000)	−0.37 (0.001)			0.783
−0.04 (0.884)	1.03 (0.000)	1.11 (0.000)	−0.40 (0.000)	−0.32 (0.000)	−0.21 (0.178)	0.811

Starting in February 1980, a firm is added to the portfolio in the month following the month of the IPO and held for five years or until delisting (if sooner). The IPO sampling stops in 12/2000 while the abnormal return estimation ends in December 2002. Abnormal returns are estimated using the following asset pricing model:

$$r_{pt} = \alpha_p + \beta_1 \,\mathrm{RM} + \beta_2 \,\mathrm{SMB}_t + \beta_3 \,\mathrm{HML}_t + \beta_4 \,\mathrm{UMD} + \beta_5 \,\mathrm{LMH} + e_t,$$

where r_{pt} is the portfolio excess return, RM is the excess return on the CRSP value weighted market index, SMB and HML are the Fama and French (1993) size and book-to-market factors, UMD is a momentum factor constructed as the returns difference between the one-third highest and the one-third lowest CRSP performers over the past 12 months, and LMH is the Eckbo and Norli (2005) turnover factor (a portfolio long in low-turnover stocks and short in high-turnover stocks). The coefficients are estimated using OLS. Standard errors are computed using the heteroskedasticity consistent estimator of White (1980). The numbers in parentheses are p-values. R^2 is the adjusted R-squared.

liquidity is a priced risk factor, one cannot reject the null of zero abnormal performance following debt offerings by U.S. firms.[54]

[54] Brav et al. (2005) examine institutional lender pricing of (private) loans to equity-issuing firms. They report lower loan yields for equity-issuers relative to non-issuing firms. This is further evidence consistent with the proposition that the relatively low post-issue equity returns reflect lower risk.

Table 20
Monthly abnormal equal-weighted portfolio return (α_p) following public (SDOs) and private (PPDs) offerings of straight debt, 1980–2000

α_p	RM	SMB	HML	UMD	LMH	R^2
A. Sample of 4,546 SDOs by industrial issuers						
−0.16 (0.116)	1.12 (0.000)	0.10 (0.100)	0.43 (0.000)			0.887
0.04 (0.674)	1.05 (0.000)	0.06 (0.217)	0.42 (0.000)	−0.13 (0.000)	−0.16 (0.018)	0.906
B. Sample of 12,191 SDOs by banks and financial firms						
0.04 (0.820)	1.32 (0.000)	−0.05 (0.469)	0.68 (0.000)			0.798
0.21 (0.233)	1.28 (0.000)	−0.07 (0.354)	0.66 (0.000)	−0.13 (0.009)	−0.08 (0.486)	0.807
C. Sample of 1,710 SDOs by public utilities						
−0.03 (0.865)	0.65 (0.000)	−0.11 (0.093)	0.70 (0.000)			0.444
−0.18 (0.387)	0.79 (0.000)	0.02 (0.796)	0.64 (0.000)	−0.01 (0.774)	0.43 (0.001)	0.472
D. Sample of 4,730 PPDs by industrial issuers						
−0.29 (0.021)	1.18 (0.000)	0.48 (0.000)	0.43 (0.000)			0.887
0.06 (0.654)	1.04 (0.000)	0.40 (0.000)	0.42 (0.000)	−0.21 (0.000)	−0.31 (0.000)	0.931
E. Sample of 3,931 PPDs by banks and financial firms						
−0.08 (0.691)	1.44 (0.000)	0.28 (0.004)	0.65 (0.000)			0.770
0.13 (0.543)	1.32 (0.000)	0.19 (0.057)	0.67 (0.000)	−0.07 (0.165)	−0.33 (0.030)	0.780
F. Sample of 923 PPDs by public utilities						
−0.29 (0.021)	1.18 (0.000)	0.48 (0.000)	0.43 (0.000)			0.887
−0.24 (0.319)	0.80 (0.000)	0.05 (0.529)	0.66 (0.000)	−0.03 (0.708)	0.28 (0.052)	0.444

Starting in February 1980, a firm is added to the portfolio in the month following the month of the SDO and held for the minimum of five years and its delisting date. The SDO sampling stops in 12/2000 while the abnormal return estimation ends in December 2002. Abnormal returns are estimated using the following asset pricing model:

$$r_{pt} = \alpha_p + \beta_1 \,\mathrm{RM} + \beta_2 \,\mathrm{SMB}_t + \beta_3 \,\mathrm{HML}_t + \beta_4 \,\mathrm{UMD} + \beta_5 \,\mathrm{LMH} + e_t$$

where r_{pt} is the portfolio excess return, RM is the excess return on the CRSP value weighted market index, SMB and HML are the Fama and French (1993) size and book-to-market factors, UMD is a momentum factor constructed as the returns difference between the one-third highest and the one-third lowest CRSP performers over the past 12 months, and LMH is the Eckbo and Norli (2005) turnover factor (a portfolio long in low-turnover stocks and short in high-turnover stocks). The coefficients are estimated using OLS. Standard errors are computed using the heteroskedasticity consistent estimator of White (1980). The numbers in parentheses are p-values. R^2 is the adjusted R-squared.

5.4. Robustness issues

The matched-firm technique discussed above uses firm characteristics (size and B/M) to adjust for priced risks, while the factor regression approach uses a set of prespeci-

Table 21
Average monthly abnormal equal-weighted portfolio return (α) for three-to-five year holding periods following securities offerings by U.S. firms

Study	Issuer type	Sample size	Sample period	Holding period	α
A. IPOs					
Brav and Gompers (1997)	All	3, 407	1972–1992	5 yrs	−0.49%*[a]
Brav and Gompers (1997)	All	934	1972–1992	5 yrs	0.09%[b]
Brav, Geczy, and Gompers (2000)	All	3, 501	1975–1992	5 yrs	−0.19%
Ritter and Welch (2002)	All	6, 249	1973–2001	3 yrs	−0.21%
Eckbo and Norli (2005)	All	5, 365	1972–1998	5 yrs	0.40%[c]
Eckbo and Norli (2005)	All	5, 365	1972–1998	5 yrs	0.18%[d]
B. SEOs					
Jegadeesh (2000)	All	2, 992	1970–1993	5 yrs	−0.31%*
Brav, Geczy, and Gompers (2000)	All	3, 775	1975–1992	5 yrs	−0.19%
Eckbo, Masulis, and Norli (2000)	Ind	3, 315	1964–1995	5 yrs	−0.05%[d]
Eckbo, Masulis, and Norli (2000)	Ind	3, 315	1964–1995	5 yrs	−0.14%[e]
Eckbo, Masulis, and Norli (2000)	Util	880	1964–1995	5 yrs	−0.13%[d]
Bayless and Jay (2003)	Ind	1, 239	1971–1995	5 yrs	−0.54%*
Krishnamurthy et al. (2005)	All	1, 477	1983–1992	3 yrs	−0.36%*
Eckbo and Norli (2005)	Ind	1, 704	1964–1995	5 yrs	−0.03%[c]
Lyandres, Sun, and Zhang (2005)	All	6, 122	1970–2003	3 yrs	0.02%[f]
D'Mello, Schlingemann, and Subramaniam (2005)	All	1, 621	1982–1995	3 yrs	−0.31%*
C. Private placements of equity					
Hertzel et al. (2002)	All	619	1980–1996	3 yrs	−1.18%*
Krishnamurthy et al. (2005)	All	276	1983–1992	3 yrs	−0.77%*
D. Straight debt offerings					
Spiess and Affleck-Graves (1999)	All	392	1975–1989	5 yrs	−0.29%*
Eckbo, Masulis, and Norli (2000)	Ind	981	1964–1995	5 yrs	−0.10%
Eckbo, Masulis, and Norli (2000)	Util	348	1964–1995	5 yrs	−0.22%
Butler and Wan (2005)	Ind	799	1975–1999	5 yrs	−0.18%[g]

(*Continued on next page*)

fiedportfolios as proxies for pervasive risks. Either approach suffers from potential "bad model" problems in terms of representing the true asset pricing model. Since tests for abnormal returns are always a joint test of the risk factors assumed to generate expected return, it is therefore useful to provide information on the sensitivity of abnormal return estimates to alternative model specifications. Moreover, factor regressions may suffer from non-stationarity in the estimated parameters that may be predictable using publicly available information. Also, Loughran and Ritter (2000) point out that the factor mimicking portfolios used in the regressions for estimating alphas contain issuing firms, and they argue that this "contamination" may reduce the power of the tests.

Table 21
(*Continued*)

Study	Issuer type	Sample size	Sample period	Holding period	α
E. Convertible debt offerings					
Spiess and Affleck-Graves (1999)	All	400	1975–1989	5 yrs	−0.31*
Eckbo, Masulis, and Norli (2000)	Ind	459	1964–1995	5 yrs	−0.31%

The table reports the time-series estimate of the constant term α resulting from regressing the excess return on a portfolio of issuing firms on a set of pricing factors in an empirical asset pricing model. The issuer portfolio is formed using equal-weights. The issuer's stock typically enters the portfolio in the month following the issue month, and is held from three to five years. Superscript * indicates that the α is statistically significantly different from zero at the 1% level.
[a]Sample of non-venture-backed IPOs.
[b]Sample of venture-backed IPOs.
[c]Pricing model with Fama–French, momentum and liquidity factors.
[d]Pricing model with macroeconomic risk factors.
[e]Pricing model with Fama–French factors.
[f]Pricing model with Fama–French, momentum and investment factors.
[g]Pricing model with Fama–French and liquidity factors.

Eckbo, Masulis, and Norli (2000) examine these robustness issues for their sample of SEOs and debt issues. Below, we discuss their approach, repeat their analysis using our data, and draw qualitative inferences.[55] Overall, this discussion serves to illustrate that the main conclusion of zero long-run abnormal performance following issue-activity is robust.

5.4.1. Alternative and omitted risk factors

The matched-firm technique. The matched-firm technique produces evidence of abnormal post-issue stock returns while the factor regression approach does not. This raises the question of whether the characteristics-based matched-firm technique omits priced risk factors. To check this, Eckbo, Masulis, and Norli (2000) and Eckbo and Norli (2005) estimate the abnormal return (alpha) to a zero-investment portfolio that is long in issuer stocks and short in matched firms. This portfolio controls for any omitted risk factor with identical factor betas across issuer and matched firm, effectively combining the two standard matched-firm and asset pricing techniques.

To illustrate, suppose the true set of risk factors is given by the vector F, and that only a subset F_1 of this vector is included in the regression model, with the complement vector F_2 omitted. Let I denote issuer and M matched firm. The "issuer–match"

[55] Detailed results are available upon request.

regression is then

$$r_I - r_M = (\alpha_I - \alpha_M) + (\beta_{1I} - \beta_{1M})F_1 + \epsilon, \tag{12}$$

where $\epsilon = (\beta_{2I} - \beta_{2M})F_2 + u$, where u is a white noise error term. The definition of a "good match" is that β_I is close to β_M. For example, if the size and B/M matching often used in the literature in fact produces a good match, then you expect the "issuer–match" regression to have both a small alpha and values of beta close to zero. Alternatively, if the matching technique fails to control for important risk factors, then the zero-investment "issuer–match" portfolio will contain significant factor loadings.

Eckbo, Masulis, and Norli (2000) (SEOs and debt offerings), Eckbo and Norli (2005) (IPOs), and this survey (all issue categories) all lead to the conclusion that the zero-investment portfolio exhibit significant factor loadings in the extended Fama–French model, but that the alpha of this portfolio is not significantly different from zero. This is consistent with the proposition that the technique of matching on size and B/M is insufficient to control for important risk exposures of the issuing firms. Lyandres, Sun, and Zhang (2005) reach a similar conclusion for their sample of SEOs after performing a three-way sort of size, B/M and investment intensity.

Alternative factor structures. Eckbo, Masulis, and Norli (2000) use a model with six prespecified macro factors: the value-weighted CRSP market index, and factor mimicking portfolios for the return spread between Treasury bonds with 20-year and one-year maturity, the return spread between 90-day and 30-day Treasury bills, the seasonally adjusted percent change in real per capita consumption of nondurable goods, the difference in the monthly yield change on BAA-rated and AAA-rated corporate bonds, and unexpected inflation.[56] This six-factor model produce regression R^2 similar to the Fama–French model, and the alphas are uniformly indistinguishable from zero.

Eckbo, Masulis, and Norli (2000) also report alpha estimates when the time series of the demeaned, raw macroeconomic factors is used rather than factor-mimicking portfolios. Raw macro factor shocks are interesting in part because they are not affected by stock market mispricing (if any). Also, factor-mimicking portfolios contain measurement error vis-à-vis the true risk factors, which raw factors avoid. On the other hand, there is measurement error induced by the demeaned raw macroeconomic factors themselves. It is difficult to determine a priori which of the two sources of measurement error is most severe (and thus whether factor mimicking is superior).[57] In any event, the alpha estimates remain insignificantly different from zero, though somewhat larger in absolute value than those for regressions based on factor-mimicking portfolios.[58]

[56] These factors also appear in, Ferson and Harvey (1991), Evans (1994), Ferson and Korajczyk (1995), Ferson and Schadt (1996), and Eckbo and Smith (1998) among others.

[57] Factor mimicking portfolios are required when estimating risk premiums (denominated in returns).

[58] Eckbo, Masulis, and Norli (2000) report that a similar conclusion emerges when alpha is estimated using factors extracted from the covariance matrix of returns using the principal components approach of Connor and Korajczyk (1988). Although principal component factors do not have intuitive economic interpretations, they provide yet another factor structure useful for sensitivity analysis.

5.4.2. Time-varying factor loadings

Nonstationary factor loadings may produce (i) significant performance in subperiods, (ii) predictable changes in factor loadings which affect the alpha estimates, and (iii) significant effect of using value-weighted instead of equal-weighted issuer portfolios.

Nonstationarities. Eckbo, Masulis, and Norli (2000) examine holding periods of between one and five years. For example, with a two-year holding period, firms enter the SEO issuer portfolio as before, but exit after only two years (or at a subsequent security offer or delisting, whichever occurs earlier). This serves to check whether any subperiod abnormal performance is washed out in the averaging of returns over the five-year holding period. The conclusion emerging from the analysis of one-to-five-year holding periods remain the same: none of the alphas are significantly different from zero.

Eckbo, Masulis, and Norli (2000) also reestimate alphas using factor-mimicking portfolios that are continuously updated. That is, the portfolio weights are constructed using a rolling estimation period where the factor loadings are reestimated every month. This rolling estimation procedure relaxes the stationarity assumption on the factor-mimicking weights. The alphas are again all insignificant.

Predictable changes in factor loadings. Eckbo, Masulis, and Norli (2000) and Eckbo and Norli (2005) reexamine the null hypothesis of zero abnormal performance using a conditional factor model framework.[59] They follow Ferson and Schadt (1996) and assume that factor loadings are linearly related to a set of L known information variables Z_{t-1}:

$$\beta_{1pt-1} = b_{p0} + B_{p1} Z_{t-1}. \tag{13}$$

Here, b_{p0} is a K-vector of "average" factor loadings that are time-invariant, B_{p1} is a $(K \times L)$ coefficient matrix, and Z_{t-1} is an L-vector of information variables (observables) at time $t-1$. The product $B_{p1} Z_{t-1}$ captures the predictable time variation in the factor loadings. After substituting equation (13) into equation (10), the return-generating process becomes

$$r_{pt} = b'_{p0} r_{Ft} + b'_{p1}(Z_{t-1} \otimes r_{Ft}) + e_{pt}, \tag{14}$$

where the KL-vector b_{p1} is $\mathrm{vec}(B_{p1})$ and the symbol $\otimes$ denotes the Kronecker product.[60] This factor model is estimated after adding a constant term α_p, which equals zero under the null hypothesis of zero abnormal returns. The information variables in Z_{t-1} include the lagged dividend yield on the CRSP value-weighted market index, the lagged 30-day Treasury bill rate, and the lagged values of the credit and yield curve spreads, BAA–AAA and TBILLspr, respectively. The alpha estimates all remain insignificantly different from zero.

[59] A survey of conditional factor model econometrics is found in Ferson (1995).

[60] The operator $\mathrm{vec}(\cdot)$ vectorizes the matrix argument by stacking each column starting with the first column of the matrix.

Value-weighted issuer portfolios. The results reported above are based on equal-weighted issuer portfolios. With value-weights, relatively successful firms gradually increase their portfolio weights. If the relatively low return of issuers is driven by "losers", then value-weighting increases the average portfolio return and possibly the abnormal performance parameter alpha. The literature is fairly unanimous on this issue: alphas with value-weighted issuer portfolios appears less negative than for equal-weighted portfolios, and they sometimes provide evidence of issuer *over*performance relative to matched firms.

5.4.3. Issue-purged factors

Loughran and Ritter (2000) argue that it is counterproductive to generate factor-mimicking portfolios without excluding security issuers from the stock universe. Inclusion of security issuers in the factor portfolios results in the factor regressions having the same firm on both sides of the regression (albeit with a small weight in the factor portfolio). They argue that this substantially reduces power to detect abnormal return via the estimated alpha.

Note that, under the null hypothesis of zero abnormal performance, purging the factor-mimicking portfolios for ex post issuing firms biases the tests in favor of finding a significant alpha. This, of course, means that failing to reject the null hypothesis even with purged factor portfolios *a fortiori* supports the market efficiency hypothesis over the market over/underreaction proposition.

Eckbo, Masulis, and Norli (2000) report that, on average, 11.1% of the firms in the factor-mimicking portfolios also make SEOs during the subsequent five years. They purge their factors by eliminating a firm from the factor-mimicking portfolios if the firm issued equity (primary offerings) over the previous five years. Lyandres, Sun, and Zhang (2005) also report results based on purged factors. The main conclusion of both studies is zero abnormal returns when using issuer-purged factor regressions.

6. Conclusions and issues for future research

The economics of security offerings has generated considerable empirical research interest over the past two decades. This survey alone identifies more than 280 studies largely restricted to public seasoned security offerings for cash—and we have surely missed some. In addition, there are a large number of related studies discussed in other surveys in this Handbook, including those on IPO underpricing (Ljungqvist, 2007), security swaps associated with corporate takeovers and restructurings (Betton, Eckbo, and Thorburn, 2007; Eckbo and Thorburn, 2007; Hotchkiss et al., 2007), stock compensation to employees (Aggarwal, 2007), private equity (Gompers, 2007), and credit markets (Drucker and Puri, 1989). In all of these settings, the issuer faces both direct and indirect flotation costs that depend on (1) constraints imposed by security regulations, (2)

the range of available flotation method choices, (3) underwriter competition, (4) information asymmetries between issuer and outside investors, and (5) the efficiency of market pricing. This survey discusses each of these five determinants of flotation costs. Several findings emerge, as well as new questions for future research, some of which are discussed below.

Public security offerings for cash are vulnerable to conflicts of interests. These conflicts have created rationales for substantial regulatory protections of investors and requirements on issuers. The legal requirements are designed to ensure that investors receive adequate information disclosure and they limit the "aggressive" marketing by the issuer. In general, legal systems, tax codes and securities regulations and the treatment of investors of a country are likely to have a significant bearing on the level of security offering activity. In the U.S., major regulatory milestones include the Securities Act of 1933 (establishing issue registration and disclosure rules), the Securities Exchange Act of 1934 (requiring periodic public disclosures via annual 10-K, quarterly 10-Q and occasional 8-K statements), the move to adopt generally accepted accounting standards (GAAP), the introduction in 1982 of "shelf registration" rules for relatively low-risk issuers (SEC Rule 415), registration exemptions aimed at reducing regulatory costs and improving the liquidity of privately placed securities by privately held companies and foreign issuers in 1990 (SEC Rule 144A), the establishment of Self Regulatory Authorities (NYSE, NASD) who impose various listing requirements and regulate many activities of broker-dealers and underwriters, and most recently, the creation as of December 2005 of a new category of issuers called "well-known seasoned issuers". These issuers are given automatic shelf registration status and may have oral or written communications with investors before during and after the offering process.

Looking internationally, there has been an increase in disclosure regulation and increased regulation and enforcement of insider trading activity. Moreover, parallel to U.S. securities regulation developments, similar national regulatory authorities are developing around the globe. In 1998, the International Organization of Securities Commissions (IOSC)—a global organization of national security regulators-adopted a comprehensive set of objectives and principles of securities regulation, which today are recognized by the world financial community as international benchmarks for all markets.

Additional research is needed to increase our understanding of the impacts of national securities laws, corporation laws and bankruptcy laws for firm issuance decisions. More cross country analyses could help in this regard. Moreover, we need a better understanding of the effects of political processes on these critical legal statutes. How does political corruption influence issuance costs and security issuance choice? How strong are the financial incentives of the dominant economic powers in a nation to limit potential competition through restrictions on capital market development and what are the most effective mechanisms for overcoming these effects? How important are particular reforms that reduce the barriers to global capital market activity in promoting national financial and economic development?

Regulatory changes provide interesting laboratories for examining empirically the exogenous determinants of issue costs and issuers' choice of security and flotation meth-

ods. On the one hand, the large increase in the aggregate amount of securities offerings over the past 25 years suggest that the stricter disclosure requirements has had a positive effect on firms' incentives to issue securities. However, additional analysis is needed of the specific effects of the new SEC securities regulations on disclosure requirements, shelf registrations and the creation of "well-known seasoned issuers". Do these regulatory changes have a significant effect on flotation costs, the choice of offering methods, the types of securities issued and timing of offerings? Is there evidence that these new rules lower asymmetric information between issuers and investors? How do the new regulations affect the frequency of foreign security issues in the U.S.?

One of the early regulatory experiments that financial economists studied was SEC Rule 415, known as shelf registration. This regulatory change was designed to lower issue costs. As we show in Table 3, only fifteen percent of the SEOs by U.S. firms employ the shelf registration procedure (half of the debt issuers use shelf registration). SEO shelf offerings tend to be relatively large-but infrequent. The apparent reluctance to take advantage of the relatively low-cost shelf registration procedure is puzzling. It is possible that shelf registration exacerbates adverse selection in issue markets, and is therefore selected only by relatively transparent firms (where the information asymmetry is relatively low). Such self-selection of the issue method suggests that the market reaction to shelf issues should be no lower than the market reaction to traditional non-shelf (underwritten) issues, which is broadly consistent with the reported empirical evidence.

As a general matter, the field would benefit from further analysis of the endogeneity of the choice of security offered and flotation method. The existing literature generally adjusts for endogeneity using predictive models of the issuer's choice of securities and issue method with very modest explanatory power. In estimating such a model, we need to know to what extent are the types of securities issued, their flotation costs and issuance method affected by issuer investment and financing characteristics, asset structure, capital structure, industry identity and the issuer's corporate governance? We also need better predictive models of an issuer's choice of security to sell. Hence, there is a need for further theoretical and empirical research to improve the explanatory power of these predictive models. After which, we need to re-evaluate the robustness of the major results in the prior literature.

Another important regulatory experiment is the 2002 enactment of Sarbanes–Oxley. This landmark legislation has imposed substantial corporate governance constraints and obligations on publicly held companies, preempting state corporation law in a number of areas. A number of the interesting questions are raised by the law. What are the effects of Sarbanes–Oxley on domestic and foreign issuers of securities in the U.S.? How does this law affect auditor independence and the reliability of auditor certification of the financial statements or the market reaction to news of issuer–auditor disagreements? How does this law change the likelihood of earnings restatements and shareholder reactions to new financial statements? What is the importance of board of directors' powers relative to shareholder powers and the potential benefits of giving shareholders stronger voting rights and control rights in determining the security issuance decision and the costs of security issuance? We need a clearer understanding of how security contract

characteristics can be altered to better align the interests of different classes of securities and to protect against the extraction of private benefits of controls by managers.

Turning to specific determinants of issue costs, we survey a large body of empirical research on the underwriting function in general and on the determinants of underwriter compensation more specifically. The field continues to only partially understand the effects of asymmetric information between issuers/underwriters and outside investors and use of various institutional mechanisms to limit this effect such as the right to renege on primary offering buy orders, restrictions on short selling by underwriters, restrictions on short selling by investors and lock-up provisions on insiders, the use of overallotment options, the choice of auditor, price stabilization, shareholder suits against issuers and underwriters, the effects of new SEC disclosure regulations and how important are certain accounting rules.

How important is security liquidity to flotation costs and how can this liquidity be improved cheaply? How important is it to have short selling opportunities or an active option market for the stock? Do these opportunities increase security price volatility and does this increase the costs of liquidity? To what extent do various information producers such as financial analysts, bond rating agencies, auditors, market makers/exchanges that report bids, asks and transaction prices, and investment bank fairness opinions reduce heterogeneous expectations among investors and increase securities trading and their liquidity? There is also a need to further investigate of the degree of interdependence of underpricing, underwriting spreads, out of pocket expenses and the probability of offer withdrawal and why these relationships appear to vary qualitatively by type of security, which is somewhat puzzling.

Another important question is how underwriter competition is impacted by the entry of commercial banks and foreign financial institutions. What are the fundamental services offered by underwriters and how do these services enhance share liquidity in the primary and secondary markets and what are the impacts on security prices? Further analysis is needed on the impacts of investment banking competition, and the interrelationship of underwriting services for debt and equity offerings with M&A advisory services.

How does learning take place in security contract innovation in the private equity market (venture capital term sheets), private placement market and public security markets. For example, how have bond covenants, and microfinancing mechanisms evolved? To what extent are innovations triggered by widely covered scandals, which broadcast problems in existing contracting technology? Are there spillover effects in contracting technology across security markets and across countries? What determines the speed of technology transfers?

Empirical research in this area is constrained by the availability and reliability of databases within the reach of university budgets. One important area that is under-studied because of a lack of data is corporate bond issue activity. We know very little about the flotation process for corporate bonds. What are its unique institutional features of the corporate bond offering process? However, new databases will soon be available in this area allowing researchers to investigate many interesting questions. What are

the determinants of flotation costs and how is it impacted by bond seniority, collateral, affiliated company guarantees, maturity, sinking funds, call protection, and the instrument's liquidity and interest rate volatility and changes in the issuer's capital structure and financial condition?

We reconfirm the empirical fact—first established by Mikkelson and Partch (1986)—that public seasoned equity issues for cash (that is, SEOs) are rare corporate financing events. Eckbo and Norli (2006) report that for a sample of 6,000+ IPOs from the period 1980–2005, about half of the IPO firms undertake *no* public follow-on offering over the remainder of the sample period (regardless of the security type), and only one-quarter follow on with a SEO. The low issuance activity is relevant for the more general question of firms' capital structure choice, and for a pecking order theory in particular.

Fama and French (2005) show that including employee compensation and equity swaps in mergers and acquisitions in a broader definition of seasoned equity issues leads to the conclusion that the typical firm issues equity every year. They view this high frequency of equity issues as evidence against the Myers (1984) pecking order. However, it is questionable whether the type of information asymmetry assumed in Myers and Majluf (1984)—which motivates Myers (1984)'s pecking order—is relevant for employee stock repurchases and option holdings. Also, equity swaps to finance mergers and acquisitions introduce two-sided information asymmetry, which can under some reasonable conditions place equity at the *top* of a (modified) pecking order. Clearly, additional research on the theoretical placement of equity swaps in a pecking order, as well as on the trade-off between debt and equity issues is required, before we can have confidence in the ability (or lack thereof) of the pecking order to explain the nature of and motivations for firms' issuing behavior.

There is a large empirical literature providing estimates of the market reaction to security issue announcements, both in the U.S. and internationally. This market reaction is interesting in part because it shows a significant equity price dilution affect, even for issuers who hire reputable underwriters to market their shares. This evidence is broadly consistent with primary issue markets being characterized by adverse selection. Research extending the basic intuition provided by Myers and Majluf (1984) adverse selection model has shown that the amount of price dilution also depends on the degree to which the issuer's own shareholders participate in the issue (in a rights offer), the existence of strong investment opportunities as well as on the sequential nature of the issuer's flotation method choice. It is also important to recognize that the Myers and Majluf model assumes strong management alignment of interest with old shareholders, which may or may not be the case. The various equilibria from these adverse selection models predict a negative, zero or positive market reaction to SEOs, which points to the importance of using carefully "controlled experiments" when testing more generalized theories of issuing behavior, e.g., such as the pecking order.

The literature on announcement effects represents such "controlled experiments" and has produced several interesting findings. The typical firm commitment underwritten offering in the U.S. is met with a statistically significant negative market reaction of close to -2%, which represents a dilution in dollar terms equal to approximately 15%

of the proceeds of the typical SEO. If one views this dilution effect as an issue cost (which is arguably the case), then it swamps even relatively high firm commitment underwriting costs. Differential average market reactions across issues and issuer types are also important. The market reaction is less negative for regulated utilities, for smaller issues, for less risky securities such as debt, for issue methods that involve preemptive rights, for shelf offerings, and for private placements (which tend to elicit a positive market reaction).

These empirical regularities are broadly consistent with the predictions of separating equilibria reflecting adverse selection in issue markets. For SEOs internationally, where the equity flotation method typically involves preemptive rights, the empirical evidence is also largely consistent with theories of adverse selection. Samples of foreign issues are interesting both because they allow a study of rights (which have largely disappeared in the U.S.), and because they provide greater variation in institutional and ownership characteristics of issuing firms. We expect future studies of foreign security issues to contribute substantially towards our understanding of the economics of the issuance process.

The survey ends with a review of the empirical literature on post-issue stock returns—so-called "long-run" performance studies—and we complement this literature with our own performance estimates. The key theoretical question in this literature is whether firms are able to exploit their private information at the expense of outside investors. In the vernacular of Loughran and Ritter (1995), are firms able to time their equity issues to temporary "windows of opportunity", when it is possible to sell overpriced equity to new investors? Do investors who purchase and hold the new shares through the subsequent price correction period realize a negative risk-adjusted (abnormal) holding-period stock return?

The literature is in substantial agreement that the average realized two-to-five-year holding period (raw) returns following equity issues is significantly lower than the average return realized by non-issuing firms matched to have similar size and book-to-market value. We show that this result also holds for security issues beyond SEOs and IPOs, such as private equity issues, and issues of straight and convertible debt. The extant evidence that issuers underperform non-issuing matched firms appears convincing. The controversy starts when one interprets this underperformance as a measure of abnormal returns to issuers. In the jargon of asset pricing theory, the difference between the return to issuers and non-issuing matched firms is a measure of abnormal (or unexpected) returns, only if the two types of firms have identical exposures to priced risk factors. A number of studies have shown that the assumption of equal risk exposures is unlikely to hold.

Recent research also indicates that security issuers often exercise large real investment options around the same time. Theory predicts that converting investment options to assets in place should cause risk profiles—and therefore issuers' expected returns—to fall. This has the effect of making their initial "matching firms" too risky in the post-issue period. This mismatch causes the benchmark expected returns of the "matching" firms to be too high and thus, the long term performance of issuers is biased downward.

This discussion points to the futility of using non-issuing firms matched on size and book-to-market ratio to benchmark risk. This may not be surprising when one considers that issuers self-select both the timing and type of security to issue. The similarity in firm size and book-to-market ratio notwithstanding, firms that decide to issue and invest are likely to be in a different economic state and at different points in their life cycle than firms that either do not invest or use internal equity to finance investment.

The empirical asset pricing approach allows a more consistent and plausible way of identifying and correcting for the true risk exposures of issuers. While we lack a unified asset pricing theory with a priori identifiable factors, there is ample evidence that large portfolios that in addition to market risk captures firm characteristics such as equity size, book-to-market ratio, return momentum and (perhaps) liquidity, explain a significant portion of the cross-section of expected stock return. Using these portfolios as risk factors, the difference between the average returns to issuers and non-issuing matched firms become negligible. Thus, the joint hypothesis of the risk model and market efficiency in pricing new securities issues cannot be rejected at conventional levels of confidence. We provide a broad update of this result across several types of new issues, such as public and private placements of equity and different types of debt issues. Overall, this part of the survey leads us to conclude that the long-run performance literature to date fails to provide systematic evidence in favor of behavioral models of either issuer or market behavior.

Research on security offerings continues to advance rapidly. It is currently being strongly influenced by advances in asset pricing theories, market microstructure, optimal capital structure and financing theories, theories of corporate governance, agency and optimal contracting. The development of new databases on security offerings outside the U.S. and of various fixed income and hybrid securities in the U.S. and elsewhere is also stimulating new empirical research on security offerings. At the same time, researchers are incorporating more institutional features regarding laws, regulations, taxes and political considerations into their analyses of the security offering process. The end result is a much richer understanding of the complexities of the security offering process and how much we still need to learn.

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Chapter 7

IPO UNDERPRICING*

ALEXANDER LJUNGQVIST[1]

Leonard N. Stern School of Business, New York University, 44 West 4th Street, Suite 9-160, New York, NY 10012, USA
e-mail: aljungqv@stern.nyu.edu

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[1] Address for correspondence: Stern School of Business, New York University, Suite 9-160, 44 West Fourth Street, New York, NY 10012-1126. Phone 212-998-0304. Fax 212-995-4220.

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Abstract

When companies go public, the equity they sell in an initial public offering tends to be underpriced, resulting in a substantial price jump on the first day of trading. The underpricing discount in the United States averaged more than 20% during the 1990s, implying that firms left considerable amounts of money on the table. What explains this phenomenon?

This chapter reviews the principal theories that have been proposed to explain IPO underpricing and discusses the empirical evidence. Theories of underpricing can be grouped under four broad headings: asymmetric information, institutional, control, and behavioral. The key parties to an IPO transaction are the issuing firm, the bank underwriting and marketing the deal, and the new investors. Asymmetric information models assume that one of these parties knows more than the others, and that the resulting information frictions give rise to underpricing in equilibrium. Institutional theories focus on three features of the marketplace: litigation, banks' price stabilizing activities once trading starts, and taxes. Control theories argue that underpricing helps shape the shareholder base so as to reduce intervention by outside shareholders once the company is public. Finally, behavioral theories assume the presence of 'irrational' investors who bid up the price of IPO shares beyond true value.

Broadly speaking, the empirical evidence supports the view that information frictions have a first-order effect on underpricing. At the same time, the enormous variation in the extent of underpricing over time raises doubt in some people's mind whether information-based explanations on their own can account for the huge amounts of money left on the table in hot markets, such as the internet bubble of 1998–2000. Arising from this debate, there is continued interest in behavioral explanations, cross-country tests that exploit interesting institutional differences, conflicts of interest within investment banks, and the use of auctions to market and price IPOs.

Keywords

initial public offerings, underpricing, investment banks, asymmetric information, behavioral finance

1. Introduction

Going public marks an important watershed in the life of a young company. It provides access to public equity capital and so may lower the cost of funding the company's operations and investments. It also provides a venue for trading the company's shares, enabling its existing shareholders to diversify their investments and to crystallize their capital gains from backing the company—an important consideration for venture capitalists. The act of going public itself shines a spotlight on the company, and the attendant publicity may bring indirect benefits, such as attracting a different caliber of manager. At the same time, the company acquires new obligations in the form of transparency and disclosure requirements, and becomes accountable to a larger group of relatively anonymous shareholders who will tend to vote with their feet (by selling the shares) rather than assist the company's decision-makers in the way a venture capitalist might.

Most companies that go public do so via an initial public offering of shares to investors. IPOs have interested financial economists for many decades. Early writers, notably Logue (1973) and Ibbotson (1975), documented that when companies go public, the shares they sell tend to be underpriced, in that the share price jumps substantially on the first day of trading. Since the 1960s, this 'underpricing discount' has averaged around 19% in the United States, suggesting that firms leave considerable amounts of money on the table. Underpricing has tended to fluctuate a great deal, averaging 21% in the 1960s, 12% in the 1970s, 16% in the 1980s, 21% in the 1990s, and 40% in the four years since 2000 (reflecting mostly the tail-end of the late 1990s internet boom).[2] Clearly, underpricing is costly to a firm's owners: shares sold for personal account are sold at too low a price, while the value of shares retained after the IPO is diluted. In dollar terms, IPO firms appear to leave many billions 'on the table' every year in the U.S. IPO market alone.

This remarkable empirical regularity inspired a large theoretical literature in the 1980s and 1990s trying to rationalize why IPOs are underpriced. The resulting theoretical models in turn have been confronted with the data over the past fifteen years or so. This chapter will outline the main theories of IPO underpricing and discuss the empirical evidence.

Theories of underpricing can be grouped under four broad headings: asymmetric information, institutional reasons, control considerations, and behavioral approaches. The best established of these are the asymmetric information based models. The key parties to an IPO transaction are the issuing firm, the bank underwriting and marketing the deal, and investors. Asymmetric information models assume that one of these parties knows more than the others. Baron (1982) assumes that the bank is better informed about demand conditions than the issuer, leading to a principal-agent problem

[2] Underpricing averages are based on data available on Jay Ritter's website (http://bear.cba.ufl.edu/ritter/ipodata.htm).

in which underpricing is used to induce optimal selling effort. Welch (1989) and others assume that the issuer is better informed about its true value, leading to an equilibrium in which higher-valued firms use underpricing as a signal. Rock (1986) assumes that some investors are better informed than others and so can avoid participating in overvalued IPOs. The resulting winner's curse experienced by uninformed investors has to be countered by deliberate underpricing. Finally, Benveniste and Spindt (1989) assume that underpricing compensates better-informed investors for truthfully revealing their information before the issue price is finalized, thus reducing the expected amount of money left on the table.

Institutional theories focus on three features of the marketplace: litigation, banks' price stabilizing activities once trading starts, and taxes. Control theories argue that underpricing helps shape the shareholder base so as to reduce intervention by outside investors once the company is public. Behavioral theories assume either the presence of 'irrational' investors who bid up the price of IPO shares beyond true value, or that issuers suffer from behavioral biases causing them to put insufficient pressure on the underwriting banks to have underpricing reduced.

Broadly speaking, the empirical evidence supports the view that information frictions (including agency conflicts between the issuing company and its investment bank) contribute to IPO underpricing. The evidence regarding institutional theories is more mixed, not least because we still observe underpricing in countries where litigation, price stabilization, and taxes play no role in the IPO market. Control theories are relatively new and the final word is still out on their plausibility. Behavioral approaches, finally, are at present still in their infancy, though what evidence is available is generally consistent both with the presence of overoptimistic investors and with behavioral biases among the decision-makers at IPO firms.

The empirical IPO literature has become increasingly sophisticated, focusing on testing specific hypotheses or entire models, sometimes in a structural econometric fashion, rather than simply describing the phenomenon of underpricing or correlating it with more or less ad hoc variables. The move towards more sophisticated, theory-led tests is a very positive development. As we will see, it has on more than one occasion led to received wisdom being overturned.

In addition to becoming more sophisticated econometrically, the empirical IPO literature has also increasingly recognized the importance and power of the institutional framework within which IPOs are conducted. To provide a benchmark, consider the way the typical IPO is conducted in the U.S. Having chosen an investment bank to lead-manage its IPO, the company first files a registration (or S-1) statement with the Securities and Exchange Commission, containing descriptive and accounting information about the company's history, business model, performance, and so on. The S.E.C. vets the information for misstatements and omissions, a process which takes several weeks. Once the S.E.C. declares the offer 'effective', the investment bank introduces the company to institutional investors on a so called 'road show'. The managers pitch the company's investment case, and the investors provide feedback in the form of more or less explicit, but always non-binding, indications of interest. On the basis of these

indications of interest, which are recorded in a 'book', and the state of the market, the investment bank proposes an offer price to the company. Once priced, investors are asked to confirm their indications of interest, shares are allocated, and a few hours later, trading begins. This process is known as bookbuilding.

The precise details of the institutional framework potentially have a bearing on the efficiency of the capital-raising process. For instance, regulatory constraints imposed on the bank conducting the deal concerning the pricing or allocation of IPO shares can influence the extent of underpricing, as can the way pricing-relevant information is gathered, aggregated, and paid for. This recognition has recently sparked another trend: interest in the IPO experience of countries other than the U.S. Despite the fact that IPO practices appear to become more homogeneous around the world (see Ljungqvist, Jenkinson, and Wilhelm, 2003), institutional frameworks differ in ways that allow sharper tests of theoretical predictions. The United Kingdom, for example, is interesting for the fact that integrated (one-stop-shop) securities houses familiar from Wall Street compete with financial intermediaries that specialize in either corporate finance advice or stockbroking, but do not perform both functions. What services the intermediary offers very likely affects the internal conflicts of interest it is subject to. Or take Taiwan. The Taiwan Stock Exchange does not permit bookbuilding and instead operates a discriminatory-price auction system that prices IPOs based on investors' bids, and investors pay what they bid. This would seem a suitable way to price IPOs from a revenue-maximization point of view, except that the market regulator in Taiwan also imposes various constraints on the auction process which typically lead to widespread underpricing.

The empirical IPO literature is now fairly mature—the main stylized facts have been established, and most theories have been subjected to rigorous empirical testing. We know that IPOs are underpriced and that the extent of underpricing, and the number of companies going public, fluctuates over time. Broadly speaking, there is a large body of evidence supporting the view that information frictions (including agency conflicts between the issuing company and its investment bank) have a first-order effect on underpricing. Still, there is continued interest in at least four areas: behavioral approaches to explain why the extent of underpricing varies over time, peaking during the recent 'dot-com bubble'; tests exploiting cross-country differences in institutional frameworks; work shedding light on the allegedly conflicted behavior of investment banks during the stock market boom of the late 1990s; and the potential for using auction mechanisms to price and allocate IPOs.[3]

[3] There is surprisingly little literature on IPO auctions, especially regarding the potential costs and benefits of moving from bookbuilding to auctions for pricing IPOs. Jagannathan and Sherman (2006) surveys the international experience of using IPO auctions in a large number of countries, concluding that auctions have fallen out of favor in the last ten or 15 years. Derrien and Womack (2002) show that in France, where issuers can choose between bookbuilding and auctions, auctions are associated with lower and less variable underpricing than are bookbuilding IPOs.

Within the available space, it is impossible to do justice to all theoretical and empirical contributions. Therefore, I have focused my discussion on the main "milestone" papers that have shaped the way I think about this literature. Inevitably, this reflects my tastes. Notable surveys embodying somewhat different tastes include Ritter and Welch (2002) and Ritter (2003).

2. Evidence of underpricing

Underpricing is estimated as the percentage difference between the price at which the IPO shares were sold to investors (the offer price) and the price at which the shares subsequently trade in the market. In well-developed capital markets and in the absence of restrictions on how much prices are allowed to fluctuated by from day to day, the full extent of underpricing is evident fairly quickly, certainly by the end of the first day of trading, and so most studies use the first-day closing price when computing initial underpricing returns. Using later prices, say at the end of the first week of trading, typically makes little difference.

In less developed capital markets, or in the presence of 'daily volatility limits' restricting price fluctuations, aftermarket prices may take some time before they equilibrate supply and demand. The Athens Stock Exchange, for instance, specified daily volatility limits of plus or minus eight percent during the 1990s. Thus for many underpriced IPOs, the first-day return would equal 8% by force of regulation. In such cases, it makes more sense to measure underpricing over a longer window.

In the U.S. and increasingly in Europe, the offer price is set just days (or even more typically, hours) before trading on the stock market begins. This means that market movements between pricing and trading are negligible and so usually ignored. But in some countries (for instance, Taiwan and Finland), there are substantial delays between pricing and trading, and so it makes sense to adjust the estimate of underpricing for interim market movements.

As an alternative to computing percentage initial returns, underpricing can also be measured as the (dollar) amount of 'money left on the table'. This is defined as the difference between the aftermarket trading price and the offer price, multiplied by the number of shares sold at the IPO. The implicit assumption in this calculation is that shares sold at the offer price could have been sold at the aftermarket trading price instead—that is, that aftermarket demand is price-inelastic.

Figures 1–3 provide evidence of underpricing in a range of countries. The U.S. probably has the most active IPO market in the world, by number of companies going public and by the aggregate amount of capital raised. Over long periods of time, underpricing in the U.S. averages between 10 and 20 percent, but as Figure 1 shows, there is a substantial degree of variation over time. There are occasional periods when the average IPO is *over*priced, and there are (more frequent) periods when waves of companies go public at quite substantial discounts to their aftermarket trading value. In

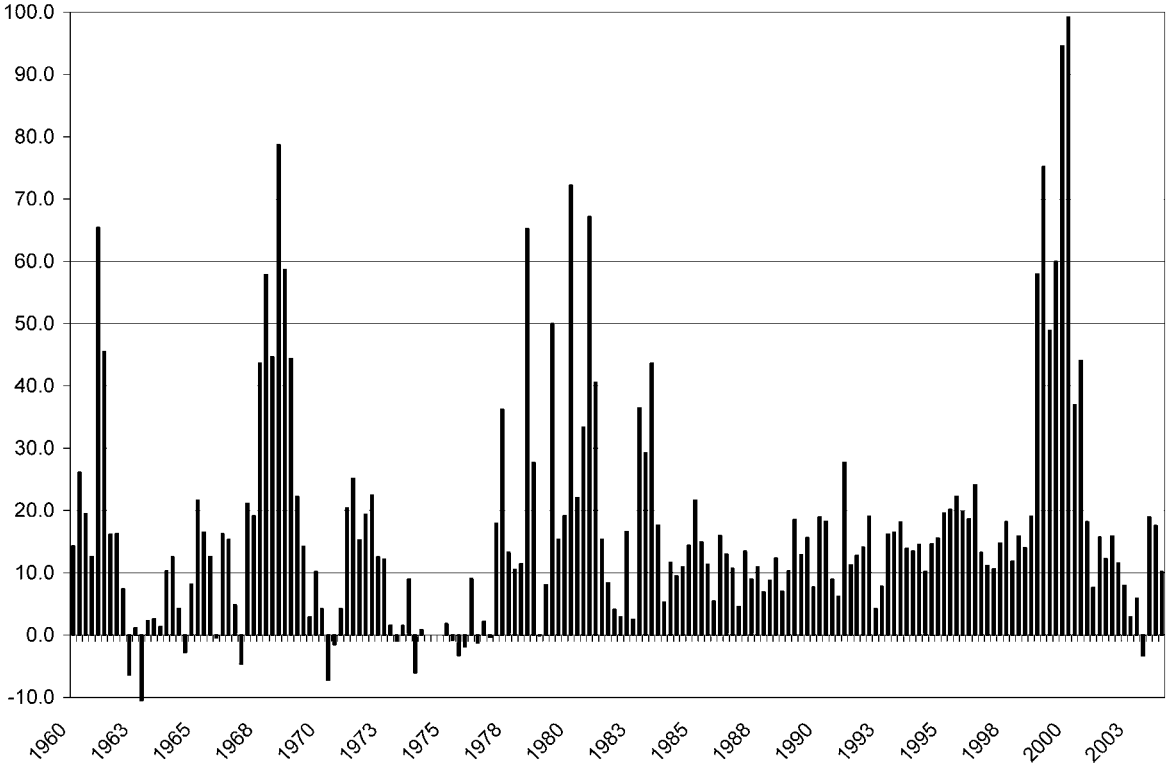

Fig. 1. Initial IPO returns in the United States, 1960 to 2003. The figure reports quarterly equal-weighted average initial IPO returns in % for 14,906 IPOs completed in the United States between 1960 and 2003, calculated as the first-day closing price over the IPO offer price less one. Source: Jay Ritter. Data used by permission.

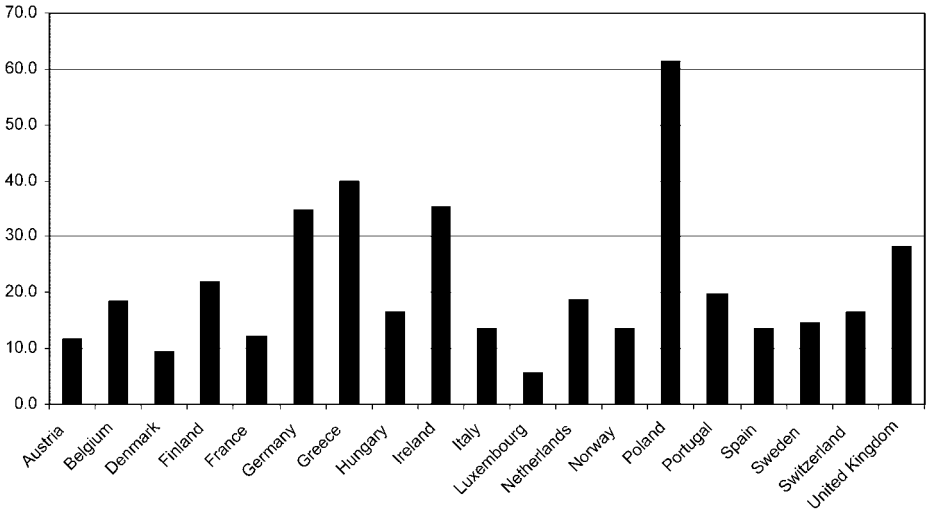

Fig. 2. Initial IPO returns in Europe, 1990 to 2003. The figure reports equal-weighted average initial IPO returns in % for 19 European countries, calculated as the aftermarket trading price over the IPO offer price less one. Aftermarket trading prices are measured on the first day of trading in all countries except France and Greece, where they are measured on the fifth day of trading due to daily volatility limits. IPOs are identified by the author using a range of sources including national stock exchanges, Thomson Financial's SDC global new issue database, Dealogic's Equityware, and news searches. Due to cross-listings, some companies go public outside their home country. The figure shows initial IPO returns by country of *listing*. Aftermarket trading prices are mostly from Datastream, with missing data hand filled from news searches. Between 1990 and 2003, 4,079 IPOs were completed in the 19 countries shown in the figure. This breaks down as follows: Austria (83), Belgium (102), Denmark (69), Finland (70), France (679), Germany (583), Greece (301), Hungary (54), Ireland (22), Italy (158), Luxembourg (5), Netherlands (77), Norway (167), Poland (214), Portugal (33), Spain (47), Sweden (180), Switzerland (68), and the United Kingdom (1,167). Source: author's calculations.

1999 and 2000, for instance, the average IPO was underpriced by 71% and 57%, respectively. In dollar terms, U.S. issuers left an aggregate of $62 billion on the table in those two years alone. Such periods are often called 'hot issue markets'. Given these vast amounts of money left on the table, it is surprising that issuers appear to put so little pressure on underwriters to change the way IPOs are priced. A recent counter-example, however, is Google's IPO which unusually for a U.S. IPO, was priced using an auction.

Figures 2 and 3 report average initial IPO returns for 19 European countries over the period 1990–2003, and for eight Asia-Pacific and eight Latin American countries over the period 1990–2001. Clearly, the extent of underpricing varies from country to country. For instance, it is markedly lower in France than in Germany, and higher in Asia than in Latin America. It is likely that these cross-country differences are at least in part related to differences in the institutional framework within which IPOs are priced and allocated.

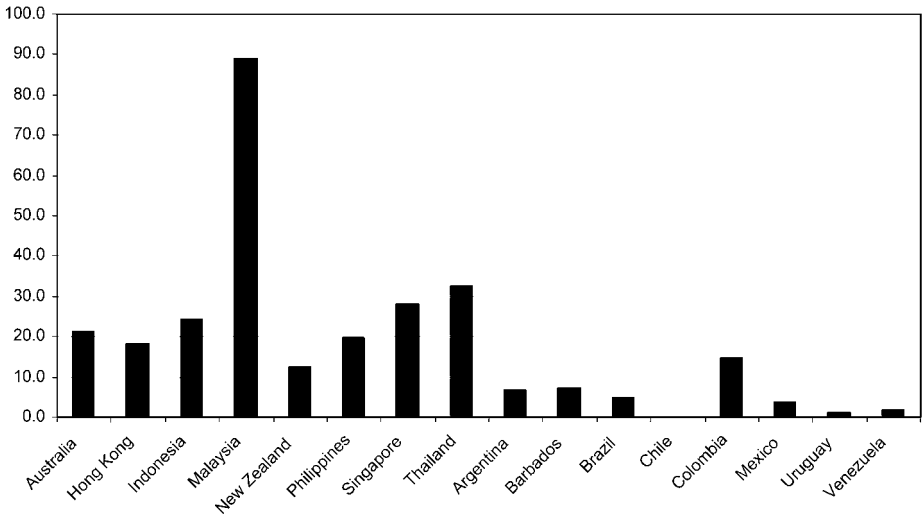

Fig. 3. Initial IPO returns in Asia-Pacific and Latin America, 1990 to 2001. The figure reports equal-weighted average initial IPO returns in % for eight Asian-Pacific and eight Latin American countries, calculated as the aftermarket trading price over the IPO offer price less one. Aftermarket trading prices are measured on the first day of trading. IPOs are identified by the author using a range of sources including national stock exchanges, Thomson Financial's SDC global new issue database, Dealogic's Equityware, and news searches. Due to cross-listings, some companies go public outside their home country. The figure shows initial IPO returns by country of *listing*. Aftermarket trading prices are mostly from Datastream, with missing data hand filled from news searches. Between 1990 and 2001, 2,716 IPOs were completed in the 16 countries shown in the figure. This breaks down as follows: Australia (633), Hong Kong (523), Indonesia (213), Malaysia (506), New Zealand (51), Philippines (91), Singapore (313), Thailand (251), Argentina (25), Barbados (1), Brazil (13), Chile (7), Colombia (3), Mexico (79), Uruguay (1), and Venezuela (6). Source: author's calculations.

3. Asymmetric information models

3.1. The winner's curse

The key parties to an IPO transaction are the issuing firm, the bank underwriting and marketing the deal, and the investors buying the stock. Asymmetric information models of underpricing assume that one of these parties knows more than the others. Perhaps the best-known asymmetric information model is Rock's (1986) winner's curse, which is an application of Akerlof's (1970) lemons problem. Rock assumes that some investors are better informed about the true value of the shares on offer than are investors in general, the issuing firm, or its underwriting bank. Informed investors bid only for attractively priced IPOs, whereas the uninformed bid indiscriminately. This imposes a 'winner's curse' on uninformed investors: in unattractive offerings, they receive all the shares they have bid for, while in attractive offerings, their demand is partly crowded out by the informed. Thus, the return uninformed investors earn conditional on receiving an

allocation is below the simple average underpricing return shown in Section 2. In the extreme case, the uninformed are rationed completely in underpriced IPOs and receive 100 percent allocations in overpriced IPOs, resulting in average returns that are negative.

When conditional expected returns are negative, uninformed investors will be unwilling to bid for IPO allocations, so the IPO market will be populated only with (equally) informed investors. Rock assumes that the primary market is dependent on the continued participation of uninformed investors, in the sense that informed demand is insufficient to take up all shares on offer even in attractive offerings.[4] This requires that conditional expected returns are non-negative so that the uninformed at least break even.[5] In other words, all IPOs must be underpriced in expectation. This does not remove the allocation bias against the uninformed—they will still be crowded out by informed investors in the most underpriced offerings—but they will no longer (expect to) make losses on average, even adjusted for rationing. Note that it is not rationing *per se* that necessitates underpricing; it is instead the bias in rationing, with uninformed investors expecting more rationing in good than in bad offerings.

Rock's model requires one more assumption. Collectively, firms seeking to go public benefit from underpricing, because it is the key to ensuring the continued participation in the IPO market of the uninformed, whose capital is needed by assumption. Individually, on the other hand, underpricing is clearly costly to a firm going public. This creates an incentive for an individual firm to free-ride by underpricing too little. Beatty and Ritter (1986) argue that as repeat players, investment banks have an incentive to ensure that new issues are underpriced by enough lest they lose underwriting commissions in the future. Investment banks thus coerce issuers into underpricing. Of course, they cannot underprice too much for fear of losing underwriting market share.

3.1.1. Testable implications and evidence

Adjusted for rationing, uninformed investors earn zero initial returns. Informed investors' conditional returns just cover their costs of becoming informed.

[4] This ad hoc assumption is actually unnecessary, because a situation where everyone is informed is not in fact an equilibrium. Imagine that all remaining investors are informed. Only attractively priced IPOs will succeed and all others will fail for lack of buyers. But then, assuming that becoming informed is costly, this creates an incentive to stay uninformed and to free-ride on the information of the other investors instead. The investor would simply bid for IPO shares indiscriminately, receiving shares in the attractive IPOs but not in the unattractive ones (which will still fail)—clearly a profitable strategy. Since every investor faces the same incentive, no one would choose to become informed, so unattractive offerings would no longer fail. But if no one is informed, there is an incentive to become informed, in order to avoid the unattractive IPOs. So a situation in which no one is informed is not an equilibrium either, unless becoming informed is prohibitively expensive.

[5] How realistic is the assumption that issuers must pay for the uninformed investors' participation in an offering? If, as Rock asserts, the resources of the informed are limited, the uninformed could simply invest through the informed investors, in exchange for a fee, to avoid the mistake of buying into overpriced issues. (Renaissance Capital Corporation, for instance, manages a mutual fund called 'IPO Plus Aftermarket Fund'.) This is one of the reasons why investment funds exist in the first place: there are economies of scale in becoming informed.

At the heart of the winner's curse model is the idea that, if properly adjusted for rationing, uninformed investors' abnormal returns are zero, on average—that is, just enough to ensure their continued participation in the market. This implication has been tested extensively in the context of countries that impose strict allocation rules. The earliest study is Koh and Walter's (1989) analysis of Singapore, where during the 1970s and 1980s oversubscribed IPOs were allocated by random ballot. Thus two investors bidding for the same number of shares had an equal chance of receiving an allocation. Using data on 66 IPOs, Koh and Walter show that the likelihood of receiving an allocation was negatively related to the degree of underpricing, and that average initial returns fall substantially, from 27% to 1%, when adjusted for rationing.

Levis (1990) conducts a similar analysis for the U.K. Though now no longer in regular use, the preferred IPO method in the U.K. until the early 1990s was the 'offer for sale', which required that allocations be pro-rated in the event of over-subscription. The unconditional average degree of underpricing for the 123 IPOs in Levis' sample is 8.6%, but this declines to 5.14% or less for medium-sized and small applications conditional on being allocated stock. Thus while rationing reduces the initial returns among small investors, it does not drive them down to zero. Keloharju (1993) provides similar evidence for Finland, though he also shows that investors placing *large* orders lose money on an allocation-weighted basis. In Israel, this latter finding seems to hold true more generally: uninformed IPO investors do not appear to break even at all. Amihud, Hauser, and Kirsh (2003) find that uninformed investors earned a *negative* allocation-weighted initial return in Israel in the early 1990s, of −1.2% on average.

Whether the informed investors' conditional underpricing return just covers the cost of their information production is harder to test in the absence of data on the cost of becoming informed. Of course, the sheer magnitude of money left on the table in certain periods and certain countries documented in Section 2 strongly suggests it is unlikely that underpricing solely compensates investors for becoming informed.

How severe is the allocation bias in practice? The answer depends on who is informed and who is not, a distinction that mostly defies precise empirical testing. Several studies have looked at institutional versus retail investors. Needless to say, it cannot be ruled out that the information asymmetry is most severe *within* groups, rather than between institutional and retail investors. Nevertheless, this approach has yielded some interesting insights. Hanley and Wilhelm (1995), for example, show that there is little difference in the size of allocations institutions receive in underpriced and overpriced issues. Thus institutions do not appear to cherry-pick the best offerings. Aggarwal, Prabhala, and Puri (2002), on the other hand, find that institutional investors earn greater returns on their IPO allocations than do retail investors, largely because they are allocated more stock in those IPOs that are most likely to appreciate in price.

Underpricing is lower if information is distributed more homogeneously across investor groups.

Rock's (1986) winner's curse model turns on information heterogeneity among investors. Michaely and Shaw (1994) argue that as this heterogeneity goes to zero, the

winner's curse disappears and with it the reason to underprice. By focusing on a segment of the IPO market in which heterogeneity is likely to be low, this prediction can be tested. According to Michaely and Shaw, institutional investors largely avoid IPOs of master limited partnership (MLPs), for a variety of tax reasons. If the informed investors are mainly institutions, and retail investors are mainly uninformed, information heterogeneity among investors in MLPs should be low. Consistent with this prediction, Michaely and Shaw show that average underpricing among 39 MLP IPOs completed between 1984 and 1988 is −0.04%. For comparison, underpricing among non-MLP IPOs over the same time period averaged 8.5%.

The greater is ex ante uncertainty, the higher is expected underpricing.

A key empirical implication, due to Ritter (1984) and formalized in Beatty and Ritter (1986), is that underpricing should increase in the ex ante uncertainty about the value of the IPO firm. Beatty and Ritter provide the following intuition. An investor who decides to engage in information production implicitly invests in a call option on the IPO, which will be exercised if the 'true' price exceeds the strike price, that is, the price at which the shares are offered. The value of this option increases in the extent of valuation uncertainty. Thus, more investors will become informed the greater the valuation uncertainty. This raises the required underpricing, since an increase in the number of informed investors aggravates the winner's curse problem.

This hypothesis has received overwhelming empirical support, though it is worth noting that all other asymmetric-information models of IPO underpricing reviewed later in this chapter also predict a positive relation between initial returns and ex ante uncertainty. Thus, most empirical studies of IPO underpricing face the challenge of controlling for ex ante uncertainty, whatever theory they are trying to test. The various proxies that have been used in the literature loosely fall into four groups: company characteristics, offering characteristics, prospectus disclosure, and aftermarket variables.

Popular proxies based on company characteristics include age (Ritter, 1984; Megginson and Weiss, 1991; Ljungqvist and Wilhelm, 2003, and others), measures of size such as log sales (Ritter, 1984), or the industry the company is from (Benveniste et al., 2003). Among offering characteristics, a popular proxy for valuation uncertainty is gross proceeds. However, Habib and Ljungqvist (1998) show that, as a matter of identities, underpricing is strictly decreasing in gross proceeds even when holding uncertainty constant.[6] This clearly makes it unsuitable as a proxy for valuation uncertainty. Other proxies include the number of uses of IPO proceeds as disclosed in the prospectus (Beatty and Ritter, 1986) and the number of risk factors listed in the prospectus (Beatty and Welch, 1996). However, in the absence of rules standardizing what uses and risks must be disclosed, it is unclear whether variation in these measures reflects underlying differences in uncertainty or merely in drafting. A potentially more promising approach

[6] Essentially, this follows because IPO proceeds are positively correlated with the number of newly issued shares, whereas the post-IPO share price is negatively correlated with that number because of dilution.

might be to identify specific uses or risk factors that, if present, indicate higher uncertainty. Ljungqvist and Wilhelm (2003), for instance, argue that firms intending to use their IPO proceeds mainly to fund "operating expenses" rather than investment or debt repayment are potentially more risky. Finally, aftermarket variables such as trading volume (Miller and Reilly, 1987) or volatility (Ritter, 1984, 1987) rely on information which was not in fact available at the time of the IPO. Indeed, it is even possible that such variables are endogenous to the outcome of the IPO. For instance, heavily underpriced IPOs tend to generate more investor interest and so more after-market trading, with the causation running from underpricing to after-market trading behavior rather than the other way around.

Underwriters that underprice too much (too little) lose business from issuers (investors).

Consistent with Beatty and Ritter's (1986) claim that underwriters coerce issuers into underpricing to prevent uninformed investors leaving the IPO market, Nanda and Yun (1997) find that overpricing (but not high levels of underpricing) lead to a decrease in the lead underwriter's own stock market value, whereas moderate levels of underpricing are associated with an increase in stock market value, perhaps indicating that underwriters can extract quid pro quo benefits from investors to whom they allocate moderately underpriced shares. In a similar vein, Dunbar (2000) finds that banks subsequently lose IPO market share if they either underprice or overprice too much, squarely supporting Beatty and Ritter's claim.

Underpricing can be reduced by reducing the information asymmetry between informed and uninformed investors.

As underpricing represents an involuntary cost to the issuer, there are clear incentives to reduce the information asymmetry and the resulting adverse selection problem between informed and uninformed investors. Habib and Ljungqvist (2001) generalize the notion that issuers have an incentive to reduce underpricing, and model their optimal behavior. They argue that if issuers can take costly actions that reduce underpricing, they will do so up to the point where the marginal cost of reducing underpricing further just equals the marginal benefit. This marginal benefit is not measured by underpricing itself, but by the reduction in the issuer's wealth loss that underpricing implies. Wealth losses and underpricing are not the same: compare an issuer who floats a single share with one who floats the entire company. Clearly the latter's wealth would suffer much more from underpricing, giving him a stronger incentive to take costly actions to reduce underpricing. Using data for a large sample of IPOs completed on Nasdaq in the early 1990s, Habib and Ljungqvist find that issuers optimize, in the sense that spending an additional dollar on reducing underpricing would reduce wealth losses by 98 cents at the margin—resulting in a net benefit that is statistically zero.

A specific way to reduce the informational asymmetry is to hire a prestigious underwriter (Booth and Smith, 1986; Carter and Manaster, 1990; Michaely and Shaw, 1994) or a reputable auditor (Titman and Trueman, 1986). By agreeing to be associated with an offering, prestigious intermediaries "certify" the quality of the issue. For

instance, if reputation capital is valuable, prestigious banks will refrain from underwriting low-quality issuers. The information content of the firm's choice of intermediaries may therefore reduce investors' incentives to produce their own information, which in turn will mitigate the winner's curse.

The empirical evidence on this point is mixed. Early studies, focusing on data from the 1970s and 1980s, have tended to find a negative relation between various measures of underwriter reputation and initial returns. Carter and Manaster (1990) provide a ranking of underwriters based on their position in the 'tombstone' advertisements in the financial press that follow the completion of an IPO. This ranking, since updated by Jay Ritter, is much used in the empirical IPO literature. Megginson and Weiss (1991) measure underwriters' reputation instead by their market share, and this approach too is widely used. In practice, results are typically not very sensitive to the choice of underwriter reputation measure.

Results are, however, highly sensitive to the period studied. Beatty and Welch (1996), who use data from the early 1990s, show that the sign of the relation has flipped since the 1970s and 1980s, such that more prestigious underwriters are now associated with *higher* underpricing. This has sparked a debate, still ongoing, about the causes of this shift. One hypothesis, favored by Loughran and Ritter (2004), is that banks have begun to underprice IPOs strategically, in an effort to enrich themselves or their investment clients. Another is that top banks have lowered their criteria for selecting IPOs to underwrite, resulting in a higher average risk profile (and so higher underpricing) for their IPOs.

Habib and Ljungqvist (2001) argue that part of the shift may be due to endogeneity biases. Issuers don't choose underwriters randomly, nor do banks randomly agree which companies to take public (see Fernando, Gatchev, and Spindt, 2005, for further analysis of the latter point). Thus the choices we actually observe are presumably made by optimizing agents. Moreover, issuers likely base their choices, at least in part, on the underpricing they expect to suffer. This leads to endogeneity bias when regressing initial returns on underwriter choice. For instance, a company that is straightforward to value will expect low underpricing, and so has little to gain from the greater certification ability of a top bank. A high-risk issuer, on the other hand, will expect substantial underpricing in the absence of a prestigious underwriter. Taking this into account, Habib and Ljungqvist show that the sign flips back to being negative even in the 1990s.

3.2. Information revelation theories

Over the past decade, the strict pro-rata allocation rules that give rise to Rock's (1986) winner's curse have given way in many countries to bookbuilding methods which give underwriters wide discretion over allocations. Bookbuilding involves underwriters eliciting indications of interest from investors which are then used in setting the price. If—as Rock assumes—some investors are better informed than either the company or other investors, eliciting their information before setting the price becomes one of the key tasks for the investment bank taking a company public.

However, in the absence of inducements, revealing positive information to the underwriter is not incentive-compatible. Doing so would, presumably, result in a higher offer price and so a lower profit to the informed investor. Worse still, there is a strong incentive to actively misrepresent positive information—that is, to claim that the issuer's future looks bleak when it doesn't—to induce the underwriter to set a lower offer price. The challenge for the underwriter is therefore to design a mechanism that induces investors to reveal their information truthfully, by making it in their best interest to do so.

Benveniste and Spindt (1989), Benveniste and Wilhelm (1990), and Spatt and Srivastava (1991) show that bookbuilding can, under certain conditions, be such a mechanism. After collecting investors' indications of interest, the bank allocates no (or only a few) shares to any investor who bid conservatively. This mitigates the incentive to misrepresent positive information: doing so results in exclusion from the IPO. Investors who bid aggressively and so reveal favorable information, on the other hand, are rewarded with disproportionately large allocations of shares. The more aggressive are investors' bids, the more the offer price is raised. However, to ensure truth-telling the allocations have to involve underpriced stock. If the underwriter left no money on the table, truthful reporting would again not be incentive-compatible.

It follows that imposing constraints on the underwriter's allocation discretion can interfere with the efficiency of this mechanism. For instance, requiring that a certain fraction of the shares be allocated to retail investors, as is common in parts of Europe and Asia, reduces underwriters' ability to target allocations at the most aggressive (institutional) bidders and so may force them to rely more on price than on allocations to reward truth-telling. This hurts the issuing firm: underpricing all shares by $1 but skewing allocations so that co-operative investors reap most of the underpricing profits is preferable to having to underprice all shares by $2 to generate the same dollar reward for co-operative investors on smaller allocations.

Even though their IPOs are underpriced, issuers benefit from these arrangements. Bookbuilding allows them to extract positive information and raise the offer price in response—even though the price will rise further in the after-market because some money has to be left on the table. Thus the price revision over the course of bookbuilding and the first-day underpricing return are positively correlated. This is often referred to as the 'partial adjustment' phenomenon (Hanley, 1993). Cross-sectionally, the more positive the information (and so the greater the incentive to withhold it), the more money has to be left on the table.

If underwriters and institutional investors deal with each other repeatedly in the IPO market, the cost of information acquisition can be reduced. In a repeated game, investors must weigh the one-off gain from lying against the possibility of being excluded from not only the current but all future IPOs managed by this underwriter. This change to the incentive compatibility constraint implies that banks that are more active in the IPO market have a natural advantage in pricing IPOs: their larger IPO deal flow allows them to obtain investors' cooperation more cheaply than less active underwriters could.

A second advantage of repeated interaction is that is allows underwriters to 'bundle' offerings across time. To ensure continued access to lucrative IPOs in the future, investors will from time to time buy poorly received IPOs, as long as the loss they suffer in any given IPO does not exceed the present value of future rents they expect to derive from doing business with the underwriter. This leads to an important implication for the allocation patterns we expect to see. Underwriters should treat regular investors more favorably than occasional investors even when the latter bid more aggressively into the book than the former. This follows because the value of the bank's underwriting activities depends more on the future cooperation of regular investors than on being able to price any given IPO more fully.

3.2.1. Extensions

The Benveniste and Spindt (1989) paradigm has been extended in numerous ways. Benveniste and Wilhelm (1990) investigate its interaction with Rock's (1986) winner's curse. If bookbuilding succeeds in extracting the informed investors' private information, the informational asymmetry among investors will be reduced. This, in turn, reduces the winner's curse and thus the level of underpricing required to ensure uninformed investors break even. As argued earlier, regulatory constraints on allocation decisions, common outside the U.S., reduce the effectiveness of bookbuilding, because they undermine underwriters' ability to reward informed investors for truth-telling. Such constraints can therefore weaken underwriters' ability to reduce the winner's curse, again resulting in higher underpricing.[7]

Giving underwriters discretion over allocation decisions is not the only way to lower information acquisition costs. Generally, any tool that allows the underwriter to more directly and exclusively target the reward at those investors who reveal their private information can reduce the overall cost of information acquisition, to the benefit of issuers. One such tool, proposed by Benveniste, Busaba, and Wilhelm (1996), is the promise of selective price support—effectively, a put option offered selectively to co-operative investors. In many countries underwriters intervene in the after-market to prevent prices from falling below the offer price. Empirical evidence suggests this 'money-back guarantee' benefits large investors especially, who are likely to be the type of investors underwriters seek to involve in the bookbuilding process.[8]

Busaba, Benveniste, and Guo (2001) show that underwriters can reduce the required extent of underpricing if the issuer has a credible option to withdraw the offering. Downplaying positive information increases the likelihood that the issuer will withdraw, which reduces an investor's gain from misrepresenting positive information. This in turn reduces the reward required to induce truthful revelation. Consistent with this

[7] Note that here the *existence* of underpricing is due to asymmetric information and a winner's curse, while institutional factors affect the level/extent of underpricing.

[8] I will discuss price support more fully in Section 4.2.

prediction, James and Wier (1990) find that companies that have secured lines of credit before their IPOs (and thus have a more credible threat to withdraw) experience lower underpricing.

In the Benveniste and Spindt framework, investors incur no cost in becoming informed. If information production is costly, underwriters need to decide how much information production to induce. Sherman and Titman (2002) explore this question in a setting where more information increases the *accuracy* of price discovery, resulting in a trade-off between the (issuer-specific) benefit of greater pricing accuracy and the cost of more information production.

The idea of costly information production is further investigated by Benveniste, Busaba, and Wilhelm (2002) and Benveniste et al. (2003) who link the underwriter's capacity to 'bundle' IPOs over time to the empirical observation that IPOs tend to occur in waves. The central idea is that valuation uncertainty is composed of a firm-specific and an industry component. Obtaining information about the industry component allows investors to evaluate other offerings in that industry more cheaply. Such economies of scale could result in too few firms going public, because the first firm to do so must compensate investors for their whole valuation effort, while later firms can 'free-ride' on the information production.[9] By establishing networks of regular investors, underwriters may be able to reduce this negative externality. To do so, they compensate investors for their information costs across a *sequence* of offerings. This is consistent with the observation that investment banks tend to specialize in particular industries, and that companies tend to go public in industry-specific 'waves'.

3.2.2. Testable implications and evidence

The most direct tests of bookbuilding theories of IPO underpricing are Cornelli and Goldreich (2001, 2003) and Jenkinson and Jones (2004). These studies exploit proprietary datasets from two different European investment banks. The datasets contain information on the bids institutional investors submitted into the book, as well as the allocations they received. Such data are usually kept confidential, so their availability provides a rare opportunity to test information revelation theories of underpricing. Two potential drawbacks are that the sample sizes are relatively small, and that the results are bank-specific and so may not generalize to other banks. Indeed, the fact that Jenkinson and Jones' results are at odds with those of Cornelli and Goldreich, as we will see, may in large part be due to differences in the sophistication with which the two banks carry out bookbuilding.

[9] The idea that information spillovers can cause IPO clustering is explored in three papers that are not based on the Benveniste–Spindt information-acquisition framework. Booth and Chua (1996) point out that when many companies come to market, the marginal cost of information production is lower, so average underpricing falls. Mauer and Senbet (1992) argue that IPO companies that start trading in the secondary market may reduce the valuation uncertainty surrounding companies with similar technologies which are in the process of going public. Stoughton, Wong, and Zechner (2001) develop a model in which one firm's IPO provides information about industry prospects, thus causing many similar companies to go public soon after.

Cornelli and Goldreich (2001, 2003) have access to the IPO books of a leading European investment bank active in up to 37 cross-border IPOs outside the U.S., including a number of privatizations. They observe essentially two different types of bids: strike (or market) orders and price-limited bids. Unlike strike orders, price-limited bids specify a maximum price an investor is willing to pay for a given number of shares. Thus such bids arguably convey more information to the underwriter than strike orders. In the Benveniste–Spindt framework, investors submitting price-limited bids should therefore receive disproportionately larger allocations than investors submitting strike orders, and this allocation bias should become more pronounced, the more aggressive the price limit.

The results generally support the Benveniste–Spindt model. Cornelli and Goldreich (2001) find that price-limited bids receive 19 percent greater allocations than strike orders. The value of an additional price-limited bid to the underwriter should depend on how much information it has already gathered from other investors. Consistent with this conjecture, Cornelli and Goldreich show that investors submitting price-limited bids receive larger allocations when the book contains fewer limit bids. Finally, more aggressive limit bids yield larger allocations than less aggressive ones, as predicted.

Allocations are not only related to the characteristics of the bid, they are also driven by the characteristics of the bidder. Frequent bidders receive larger allocations (relative to their bid size) than infrequent bidders, consistent with the prediction that regular investors should be favored over occasional ones even when the latter bid more aggressively.

In their 2003 follow-on article, Cornelli and Goldreich ask whether limit orders do reveal pricing-relevant information. On average, final offer prices are closely related to the limit orders in the book, in particular those submitted by large and by frequent bidders. The underwriter sets the offer price close to the quantity-weighted average of the limit prices in the book. Limit bids are especially influential when they indicate a consensus among bidders. Taken together, these findings provide strong support for Benveniste and Spindt's (1989) view that bookbuilding serves to extract information from investors.

Jenkinson and Jones (2004) have data for 27 IPOs managed by a different European investment bank. The allocation and pricing decisions of this bank differ markedly from Cornelli and Goldreich's, and provide less support for bookbuilding theories of IPO underpricing. Price-limited bids are much rarer at this bank, and they are not associated with favorable allocations. The main allocation pattern this bank has in common with Cornelli and Goldreich's is that more frequent bidders are treated preferentially. Jenkinson and Jones interpret their findings as "cast[ing] doubt upon the extent of information production during the bookbuilding period".

There are many possible reasons why Jenkinson and Jones' findings look so different from Cornelli and Goldreich's, beyond uncontrollable differences in the types of deals examined. The most obvious are based on differences in the sophistication with which these two European investment banks carry out bookbuilding. First, a bank's ability to extract information is larger the more active it is in the IPO market, since a higher rate

of future deal flow increases the investor's incentive to co-operate with the bank today. Since the authors have revealed the identity of their respective bank to me, I am able to confirm that Cornelli and Goldreich's bank is associated with substantially larger deal flow.

Second, Benveniste and Spindt's (1989) argument assumes that the bank has access to a set of *informed* investors whose information it seeks to elicit with the help of favorable allocations of underpriced stocks. The quality of the information it acquires is clearly related to the quality of the investors it has access to. And it is not unreasonable to assume that banks differ in the quality of their investor networks. Indeed, bids by U.S. investors comprise only 1% of the sample in Jenkinson and Jones versus 13% in Cornelli and Goldreich. In sum, it appears likely that Cornelli and Goldreich's bank is both more active and better connected and thus in a better position to extract pricing-relevant information from investors.

No corresponding bookbuilding data are available for U.S. banks. Thus, whether these European results can be generalized to the U.S. depends on how similar bookbuilding techniques are in Europe and the U.S. Ljungqvist, Jenkinson, and Wilhelm (2003) provide evidence from 65 countries showing that the quality of bookbuilding—as measured by the underpricing cost of inducing truthful information reporting—heavily depends on whether a U.S. bank lead-manages the issue and on whether U.S.-based investors are targeted. Indeed, bookbuilding by non-U.S. banks targeted at their domestic (non-U.S.) clients appears to provide no pricing advantage over fixed-price offerings completed without bookbuilding.

Controlling for the fact that issuers *choose* whether to hire U.S. banks and have their IPOs marketed to U.S. investors, Ljungqvist, Jenkinson, and Wilhelm (2003) show that underpricing is reduced by 41.6% on average when U.S. banks and U.S. investors are involved. This benefit doesn't come free: U.S. banks charge higher underwriting fees than do domestic banks. But on net, 73% of issuers would have been worse off had they chosen local banks and local investors instead, in the sense that the resulting increase in underpricing cost would have exceeded the savings on the underwriting fees. The median firm switching to the 'cheaper' strategy would have suffered a reduction in net proceeds of US$11.7 million. These findings are consistent with the prediction that access to informed (U.S.) investors favors certain U.S. investment banks.

While no other datasets have yet matched the level of detail of Cornelli and Goldreich's (2001, 2003) and Jenkinson and Jones' (2004), several studies have used *aggregate* allocation data on the fractions of an IPO allocated to institutional and retail investors, respectively. If institutions are more likely to be informed than retail investors, this allocation split can be thought of as a crude approximation of the extent to which underwriters favor informed investors in their allocation decisions.

Hanley and Wilhelm (1995), for instance, use a sample of 38 U.S. IPOs conducted by a leading (unnamed) investment bank over the period 1983–1988. IPO allocations clearly favor institutions over retail investors: institutions are allocated 66.8% of the average IPO. Cross-sectionally, institutional allocations are larger the more the offer price exceeds the midpoint of the indicative filing range established at the beginning

of bookbuilding. Positive price revisions presumably follow when informed investors reveal positive information, and this is precisely when underwriters need to reward cooperative investors with favorable allocations. At the same time, however, institutions are given similar allocations in overpriced as in underpriced deals, which is consistent with the prediction that underwriters 'bundle' IPOs over time and regular investors sometimes are expected to buy 'cold' IPOs.

Aggarwal, Prabhala, and Puri (2002) analyze a more recent dataset covering 164 IPOs managed by nine different banks in 1997 and 1998. As in Hanley and Wilhelm (1995), institutional investors are allocated the lion's share of IPO stock and institutional allocations increase in the price revision relative to the filing range. Underpricing, in turn, is larger the more stock institutions were allocated. This makes sense within the Benveniste–Spindt framework, since underwriters likely use both price (i.e., underpricing) and quantity (i.e., allocation size) to ensure truthful revelation of particularly positive information.

Ljungqvist and Wilhelm (2002) depart from the previous two studies by estimating the *structural* links between IPO allocations, price revisions, and initial returns. They argue that these three variables are jointly determined, in the sense that the degree of price revision depends on how much (positive) information investors reveal, which in turn depends on their expected economic reward in the form of allocations of underpriced stock. Using aggregate allocation data from France, Germany, the U.K., and the U.S., they find that price revisions increase in institutional allocations and vice versa, and initial returns increase in price revisions but decrease in institutional allocations. The latter result suggests that constraints on the size of institutional allocations—which are widespread in France and (during the early 1990s) in the U.K.—result in underwriters relying more on price than on quantity to reward truthful revelation. This is costly to issuers, since blanket underpricing rewards both informed and uninformed bidders.

There is one key prediction of the Benveniste and Spindt (1989) framework that can be tested without proprietary bid or allocation data. Revisions in the offer price and the number of shares offered during bookbuilding likely reflect investors' level of interest and the aggregate nature of their information. An IPO for which positive information is revealed should be priced towards the upper end of the indicative price range (or if the information is particularly positive, above the range) whereas a less well received offering should be priced towards the lower end. Benveniste and Spindt's model suggests that underpricing should be concentrated among the IPOs drawing the highest level of pre-market interest. In other words, even though the underwriter adjusts the price upwards, he does so only partially, in order to leave enough money on the table to compensate informed investors for their truthful revelation. Hanley (1993) was the first to provide empirical evidence of this 'partial adjustment' phenomenon. Numerous subsequent studies have corroborated this finding, both in the U.S. and internationally.

Loughran and Ritter (2002) criticize Hanley's (1993) interpretation of the partial adjustment phenomenon, by showing that underwriters, when setting the offer price, do not fully incorporate *public* information in the form of pre-pricing returns on the market index. (See also Bradley and Jordan, 2002.) This appears to contradict the Benveniste–

Spindt (1989) framework, since public information is freely available and so there is no need to compensate investors for it by leaving money on the table. Loughran and Ritter prefer a behavioral explanation, which will be discussed more fully in Section 6.3. In short, when the IPO is doing poorly (and so the price is likely to be revised downwards), issuers bargain hard with the underwriter over the issue price. When the IPO is doing well (and so the price is likely to be revised upwards), issuers are complacent. This leads to an asymmetric relation between prior market returns and offer price revisions, at least to the extent that the state of the market correlates with how the IPO is doing.

Lowry and Schwert (2004) reexamine this question. While their findings confirm the existence of a positive and statistically significant relation between offer price revisions and pre-pricing market returns, they argue that this effect is negligible economically. Edelen and Kadlec (2005), too, reexamine Loughran and Ritter's (2002) critique, and show that the apparent asymmetry may be driven by sample selection bias. In a sample of *completed* IPOs, negative market returns have indeed no effect on offer price revisions. But negative market returns have a significant impact on the decision to withdraw the IPO. When this is taken into account using the Heckman (1979) approach, the asymmetry disappears.

Whether symmetric or asymmetric, public information appears not to be fully priced. Why not? In contrast to Loughran and Ritter (2002), Edelen and Kadlec (2005) propose a *rational* explanation, noting that issuers must trade off the proceeds from the IPO against the probability of the IPO succeeding. In the context of a search model, aggressive pricing increases the probability of failure. When comparable firms' valuations are low, the IPO is likely to generate relatively little 'surplus' for the issuer. Therefore, the issuer has little to lose if the deal fails, and pushes the underwriter to extract as high proceeds as possible, even though this implies a greater risk of the deal failing. When comparable firm valuations are high, the issuer is unwilling to risk failure because there is much to be gained from going public. In this situation, the issuer does not insist on aggressive pricing. Thus as comparable firms' valuations increase, so too does the degree of underpricing.

3.3. Principal-agent models

Theories of bookbuilding stress the important role of investment banks in eliciting information that is valuable in price-setting, and the benefit of giving them discretion over allocation decisions. Some authors—most prominently perhaps Loughran and Ritter (2004)—stress the 'dark side' of these institutional arrangements, by highlighting the potential for agency problems between the investment bank and the issuing firm.

A multitude of regulatory investigations following the bursting of the late 1990s 'dot-com bubble' has recently revived academic interest in agency models of IPO underpricing. For instance, the fact that underpricing represents a wealth transfer from the IPO company to investors can give rise to rent-seeking behavior, whereby investors compete for allocations of underpriced stock by offering the underwriter side-payments. Such side-payments could take the form of excessive trading commissions paid on unrelated

transactions (Loughran and Ritter, 2002), an activity that Credit Suisse First Boston was fined $100 million for in 2002.[10] Or investment bankers might allocate underpriced stock to executives at companies in the hope of winning their future investment banking business, a practice known as 'spinning'. In either case, the underwriter stands to gain from deliberately underpricing the issuer's stock.

Underwriting fees are typically proportional to IPO proceeds, and thus inversely related to underpricing. This provides a countervailing incentive to keep underpricing low. But at times, it is conceivable that the bank's private benefits of underpricing greatly exceed this implied loss of underwriting fees.

The theoretical literature linking agency conflicts and IPO underpricing goes back more than 20 years. Early models focused on how a bank's informational advantage over issuing companies might allow the bank to exert sub-optimal effort in marketing and distributing the stock. If effort is not perfectly observable and verifiable, banks find themselves in a moral hazard situation when acting as the issuers' agents in selling an IPO. Baron and Holmström (1980) and Baron (1982) construct screening models which focus on the underwriter's benefit from underpricing. In a screening model, the uninformed party offers a menu or schedule of contracts, from which the informed party selects the one that is optimal given her unobserved type and/or hidden action. The contract schedule is designed to optimize the uninformed party's objective, which, given its informational disadvantage, will not be first-best optimal. An example is the various combinations of premium and deductible that a car insurer may offer in order to price-discriminate between different risks (unobservable type) or to induce safe driving (hidden action).

To induce optimal use of the underwriter's superior information about investor demand, the issuer in Baron's model delegates the pricing decision to the bank. Given its information, the underwriter self-selects a contract from a menu of combinations of IPO prices and underwriting spreads. If likely demand is low, it selects a high spread and a low price, and *vice versa* if demand is high.[11] This optimizes the underwriter's unobservable selling effort by making it dependent on market demand. Compared with the first-best solution under symmetric information, the second-best incentive-compatible contract involves underpricing in equilibrium, essentially since its informational advantage allows the underwriter to capture positive rents in the form of below-first-best effort costs.

The more uncertain the value of the firm, the greater the asymmetry of information between issuer and underwriter, and thus the more valuable the latter's services become, resulting in greater underpricing. This is a further rationalization for the empirical observation that underpricing and proxies for *ex ante* uncertainty are positively related.

[10] Source: NASD Regulation, Inc., news release dated January 22, 2002.

[11] There is empirical support for the notion of a menu of compensation contracts. Dunbar (1995) shows that issuers successfully offer underwriters a menu that minimizes offering costs by inducing self-selection.

Biais, Bossaerts, and Rochet (2002) combine the agency cost setting of Baron (1982) with Benveniste and Spindt's (1989) assumption that some investors hold pricing-relevant information worth extracting before the offer price is set. In such a setting, the investment banker could collude with the informed investors, to the potential detriment of the issuing company. Biais, Bossaerts, and Rochet derive an optimal IPO mechanism that maximizes the issuer's proceeds. In this mechanism, the IPO price is set higher the fewer shares are allocated to (uninformed) retail investors. Allocating more to institutional investors when their private signals are positive (i.e., when the IPO price should be set higher) is consistent with Benveniste and Spindt's information acquisition argument. Conversely, allocating more to retail investors when institutional investors' signals are less positive while at the same time lowering the IPO price lessens the winner's curse.

3.3.1. Testable implications and evidence

In principle, issuers can mitigate agency conflicts in two ways: they can monitor the investment bank's selling effort and bargain hard over the price, or they can use contract design to realign the bank's incentives by making its compensation an increasing function of the offer price. Ljungqvist and Wilhelm (2003) provide evidence consistent with monitoring and bargaining in the U.S. in the second half of the 1990s. They show that first-day returns are lower, the greater are the monitoring incentives of the issuing firms' decision-makers (say the CEO). Monitoring incentives are taken to increase in the relevant decision-maker's equity ownership level and the number of personal shares he sells at the time of the IPO. Higher equity ownership gives the decision-maker a greater stake in the outcome of the pricing negotiations, while underpricing stock sold for personal account represents a direct wealth transfer from the decision-maker to IPO investors.

Ljungqvist (2003) studies the role of underwriter compensation in mitigating conflicts of interest between companies going public and their investment bankers. Making the bank's compensation more sensitive to the issuer's valuation should reduce agency conflicts and thus underpricing. Consistent with this prediction, Ljungqvist shows that contracting on higher commissions in a large sample of U.K. IPOs completed between 1991 and 2002 leads to significantly lower initial returns, after controlling for other influences on underpricing and a variety of endogeneity concerns. These results indicate that issuing firms' contractual choices affect the pricing behavior of their IPO underwriters. Moreover, the empirical results cannot reliably reject the hypothesis that the intensity of incentives is optimal, and so that contracts are efficient.

A potentially powerful way to test the agency models is to investigate the underpricing experience of IPOs that have little or no informational asymmetry between issuer and bank. The two most prominent cases in point involve underwriters that own equity stakes in the IPO company and situations where a company underwrites its IPO itself. Some interesting evidence along these lines is available for the U.S. Muscarella and Vetsuypens (1989) study a set of 38 self-underwritten investment bank IPOs in the 1970s and 1980s. Since issuer and underwriter are identical, there can be no agency problem.

However, these 38 investment bank IPOs appear to have been underpriced by roughly as much as other IPOs, which Muscarella and Vetsuypens interpret as contradicting the agency models.

There are only so many investment banks taking themselves public, so Muscarella and Vetsuypens' (1989) approach does not lend itself straightforwardly to large-sample testing. But over the course of the 1990s, investment banks emerged as an important pre-IPO shareholder group in many IPO companies (Ljungqvist and Wilhelm, 2003). Often, they acquired stakes in these companies indirectly, via their venture capital operations. By the year 2000, investment banks were pre-IPO shareholders in 44% of companies going public. These equity stakes should reduce their incentives to underprice the stock to the issuer's detriment, and the size of this effect should be proportional to the size of their equity stake.

The evidence reported in Ljungqvist and Wilhelm (2003) supports both these predictions. The greater the investment bank's equity holding, the lower are first-day underpricing returns. This finding contrasts with the earlier result of Muscarella and Vetsuypens (1989) that investment banks underwriting their own IPOs suffered as much underpricing as other issuers. However, the negative relation between investment bank equity holdings and underpricing does not appear to depend on whether the investment bank acted as lead underwriter. Focusing on venture-backed IPOs only, Li and Masulis (2003) also find that initial returns decrease in the size of investment banks' pre-IPO equity holdings, though in their case, the effect is more pronounced for lead underwriters than for other syndicate members.

How widespread is the self-dealing behavior alleged in recent regulatory investigations into IPO practices? In general, this is hard to address empirically. For instance, banks do not typically publish the kind of allocation data necessary to examine 'spinning'. Notwithstanding Congressional disclosure of IPO allocations to executives at WorldCom and the class action suit over spinning against eBay, Inc., the relevant data are unlikely to become available in a systematic fashion.

The link between allocations and trading commissions is potentially more readily observable. In an innovative paper, Reuter (2004) combines data on the recipients of the brokerage commissions paid by U.S. mutual funds with data on the mutual funds' equity holdings. The fund holdings data are used to approximate IPO allocations, on the assumption that funds do not trade their IPO allocations in any systematic way (that is, in a way that is correlated with the variables of interest). Reuter finds a positive relation between the commissions mutual funds paid to lead managers and the size of reported holdings in the managers' IPOs. One interpretation is that fund managers 'buy' underpriced IPO allocations with their trading commissions. Another is that underwriters allocate IPOs to clients they have strong relationships with, which includes executing much of the clients' trades.

Reuter's (2004) point estimates suggest that investment banks received 85 cents in trading commissions per dollar of underpricing gain allocated to mutual funds in 1996–1998. Assuming trading commissions were used to 'buy' underpriced IPO allocations, banks appear to have been very good at capturing the lion's share of the rent over that

time period. Interestingly, however, in 1999 the point estimate falls to only 19 cents in trading commissions per dollar of underpricing gain. Thus at the height of the IPO bubble, the 'price' of underpriced IPO allocations seems to have dropped substantially. In fact, in aggregate dollar terms, almost the entire increase in money left on the table in 1999 appears to have accrued to mutual funds, with banks' revenue from trading commissions largely unchanged in 1999 compared to earlier years. This is hard to reconcile with the view that banks deliberately increased underpricing during the IPO bubble: if they did, they were curiously inept at profiting from it.

3.4. Underpricing as a signal of firm quality

The final group of asymmetric information models reverses Rock's assumption regarding the informational asymmetry between issuing firms and investors. If companies have better information about the present value or risk of their future cash flows than do investors, underpricing may be used to signal the company's 'true' high value. This is clearly costly, but if successful, signaling may allow the issuer to return to the market to sell equity on better terms at a later date. In the words of Ibbotson (1975), who is credited with the original intuition for the IPO signaling literature, issuers underprice in order to 'leave a good taste in investors' mouths'. Allen and Faulhaber (1989), Grinblatt and Hwang (1989), and Welch (1989) have contributed theories with this feature.

Suppose there are two types of firms, denoted high-quality and low-quality, which look indistinguishable to investors. Firms raise equity in two stages, via an IPO and at a later date. High-quality firms have incentive to credibly signal their higher quality, in order to raise capital on more advantageous terms. Low-quality firms have incentive to mimic whatever high-quality firms do. The proposed signal in the IPO signaling models is the issue price.

With some positive probability, a firm's true type is revealed to investors before the post-IPO financing stage. This exposes low-quality issuers to the risk that any cheating on their part will be detected before they can reap the benefit from imitating the high-quality issuers' signal. This makes separation between the two types possible. Provided the risk of detection and the implied reduction in IPO proceeds are sufficiently great to deter the low-quality firms from imitating the high-quality ones, a high-quality firm can influence investors' after-market beliefs about its value by deliberately leaving money on the table at the IPO. This money is 'recouped' when the firm returns to the market at a later date. Low-quality firms refrain from mimicking the signal (i.e., from underpricing) because the risk of detection means they may not be able to recoup the cost of the signal later.

Signaling models are open to the challenge that the proposed signaling device may be dominated by other signals. Would firms really choose the underpricing signal if they had a wider range of signals to choose from? Such a range could include the choice of particularly reputable underwriters (Booth and Smith, 1986), auditors (Titman and Trueman, 1986), or venture capitalists (Megginson and Weiss, 1991; Lee and Wahal, 2004), each of whom could perform a certification-of-quality role; the

quality of the board of directors, and in particular the choice of non-executive directors, who similarly would put their reputation on the line; and direct disclosure of information to IPO investors, backed by a mechanism designed to deter fraudulent disclosure (Hughes, 1986).

3.4.1. Testable implications and evidence

The signaling models generate a rich set of empirical implications predicting that underpricing is positively related to the probability, size, speed, and announcement effect of subsequent equity sales.[12] In common with the other asymmetric information theories of underpricing, the signaling models also predict a positive relation between underpricing and the ex ante uncertainty about firm value. This follows because a noisier environment increases the extent of underpricing that is necessary to achieve separation.

One of the most notable empirical tests of the signaling models is due to Jegadeesh, Weinstein, and Welch (1993). Using data on IPOs completed between 1980 and 1986, Jegadeesh, Weinstein, and Welch find that the likelihood of issuing seasoned equity and the size of seasoned equity issues increase in IPO underpricing, as expected. However, they note that these statistically significant relations are relatively weak economically. For instance, the least underpriced quintile of IPOs face a 15.6% likelihood of issuing seasoned equity, compared to 23.9% in the most underpriced quintile. The results are equally consistent with a pooling equilibrium: firms pool at the IPO and reissue equity only once the market learns their true quality. Consistent with the possibility of pooling, Jegadeesh, Weinstein, and Welch find that post-IPO share price returns better explain whether a company subsequently raises equity than the degree of IPO underpricing.

As Michaely and Shaw (1994) note, the decision how much money to leave on the table and whether to reissue equity later on are not independent of each other in the signaling framework. The same logic applies to the size of any seasoned equity offering. Thus, these decisions should be modeled simultaneously. Michaely and Shaw estimate a simultaneous system using underwriter reputation to identify the underpricing equation and post-IPO performance to identify the equation modeling the size of the seasoned equity offering. The results do not support the signaling models: the decision how much to underprice is not significantly related to the reissue decision and vice versa, consistent with Jegadeesh, Weinstein, and Welch (1993).

Welch (1996) endogenizes the decision how long to wait before returning to the equity market. The longer a firm waits, the greater is the probability that nature will reveal its true value. Thus a high-quality firm can afford to wait longer, but the cost of this strategy is that it may not receive funds when it most needs them. Empirically, Welch finds that the time to SEO increases in IPO underpricing while firms that return to the market earlier do so after experiencing high post-IPO stock market returns.

[12] For a survey of seasoned equity offers more generally, see Chapter 6 by Eckbo, Masulis, and Nørli in this volume.

Usually, companies announcing seasoned equity offerings experience negative announcement-date returns. In the signaling framework, we would expect a less negative stock price reaction in response to SEO announcements by 'high-quality' companies, which under separation means companies that underpriced their IPOs by more. Both Jegadeesh, Weinstein, and Welch (1993) and Slovin, Sushka, and Bendeck (1994) find evidence consistent with this prediction.

Spiess and Pettway (1997) add an interesting observation to the empirical literature on IPO signaling models. In their data, pre-IPO shareholders sell personal shares at the IPO in half of all IPOs, and such insider selling is no less common among the more underpriced firms. This suggests that insiders at high-quality firms do not wait to realize the benefit of their underpricing signal by delaying their sales of personally held shares. Such behavior seems inconsistent with the logic of the signaling models.

4. Institutional explanations

We now turn to three 'institutional' explanations for IPO underpricing. First, the litigiousness of American investors has inspired a *legal insurance* or *lawsuit avoidance* hypothesis. The basic idea, which goes back at least to Logue (1973) and Ibbotson (1975), is that companies deliberately sell their stock at a discount to reduce the likelihood of future lawsuits from shareholders disappointed with the post-IPO performance of their shares. This explanation is somewhat U.S.-centric, in that underpricing is a global phenomenon, while strict liability laws are not. The risk of being sued is not economically significant in Australia (Lee, Taylor, and Walter, 1996), Finland (Keloharju, 1993), Germany (Ljungqvist, 1997), Japan (Beller, Terai, and Levine, 1992), Sweden (Rydqvist, 1994), Switzerland (Kunz and Aggarwal, 1994), or the U.K. (Jenkinson, 1990), all of which experience underpricing. Still, it is possible that lawsuit avoidance is a second-order driver of IPO underpricing.

The second institutional approach is based on the practice of price support. One of the services that underwriters provide in connection with an IPO is *price stabilization*, intended to reduce price drops in the after-market for a few days or weeks. Perhaps surprisingly, such 'price manipulation' is legal in many countries, including the U.S. (1934 Securities Exchange Act, Rule 10b-7, since replaced by Regulation M). Statistically, price stabilization results in fewer observations of overpricing, and so shifts up the observed mean initial return.

Third, there may be tax advantages to IPO underpricing. This results in a trade-off between the tax benefit and the dilution cost of underpricing. Depending on their tax situation, managers may prefer more or less underpricing.

4.1. Legal liability

Stringent disclosure rules in the U.S. expose underwriters and issuers to considerable risk of litigation by investors on the grounds that material facts were mis-stated or omitted from the IPO prospectus. Lowry and Shu (2002) estimate that nearly 6 percent of

companies floated in the U.S. between 1988 and 1995 subsequently were sued for violations relating to the IPO, with damages awarded to plaintiffs averaging 13.3% of IPO proceeds.

Tinic (1988), Hughes and Thakor (1992), and Hensler (1995) argue that intentional underpricing may act like insurance against such securities litigation. Lawsuits are obviously costly to the defendants, not only directly—damages, legal fees, diversion of management time, etc.—but also in terms of the potential damage to their reputation capital: litigation-prone investment banks may lose the confidence of their regular investors, while issuers may face a higher cost of capital in future capital issues. Hughes and Thakor propose a trade-off between on the one hand minimizing the probability of litigation, and hence minimizing these costs, and on the other maximizing the gross proceeds from the IPO (and thus the underwriter's commission thereon). Crucially, they assume that the probability of litigation increases in the offer price: the more overpriced an issue, the more likely is a future lawsuit. In addition, they predict that underpricing reduces not only (i) the probability of a lawsuit, but also (ii) the probability of an adverse ruling conditional on a lawsuit being filed, and (iii) the amount of damages awarded in the event of an adverse ruling (since actual damages in the U.S. are limited by the offer price).

As a point of legal fact, the amount of damages that can be awarded in lawsuits filed under Section 11 of the 1933 Securities Act increases in the difference between the offer price and the subsequent (lower) trading price. Thus, underpricing reduces the likely damages. This in turn reduces the probability of litigation assuming the size of expected damages affect class-action lawyers' incentives to file a suit.

4.1.1. Testable implications and evidence

Tinic (1988) proposes that the enactment of the 1933 Securities Act represents a regime shift that potentially allows us to test the legal liability hypothesis. Prior to the 1933 Act, the principle of *caveat emptor* largely protected issuers and investment banks against litigation risk, and so underpricing should have been low. After 1933, litigation risk should have featured more prominently when investment banks priced deals, and so underpricing should have increased. Moreover, banks with a comparative advantage at due diligence might, post-1933, feel less need to insure against lawsuits by means of underpricing, leading to a negative relation between a bank's experience and initial returns.

Tinic identifies a sample of 70 IPOs completed between 1923 and 1930 and compares their average underpricing to that of a sample of 134 IPOs completed between 1966 and 1971. As predicted, average underpricing was lower before 1933, but the difference is not particularly large: 5.2% in 1923–1930 versus 11.1% in 1966–1971. Moreover, it is well-documented that underpricing varies immensely over time (see Ibbotson and Jaffe, 1975 and Figure 1 in Section 2 of this chapter), so we cannot rule out that Tinic's results are driven by factors other than increased litigation risk. Drake and Vetsuypens (1993), for instance, show that average initial returns in the six years *after* Tinic's sample pe-

riod (1972–1977) were actually lower than between 1923 and 1930. Evidence based on the enactment of the 1933 Securities Act is thus inconclusive.

Tinic also finds that more experienced underwriters were associated with lower underpricing in the post-1933 sample but not before. This is consistent with his prediction that greater due diligence skills reduce the need for underpricing as a form of protection against lawsuits. On the other hand, simple certification arguments yield the same prediction, so as a test of the legal insurance hypothesis, the relation between underwriter experience and underpricing has little power. Moreover, as discussed in Section 3.1, this relation appears to have changed sign in the 1990s (Beatty and Welch, 1996). However, it is not impossible to rationalize a positive relation within the legal insurance hypothesis: more prestigious underwriters may have deeper pockets and so are more worth suing, leading them to rely more heavily on underpricing. Evidence based on the relation between underpricing and underwriter experience thus also appears inconclusive.

A potentially more promising research avenue is to investigate the predicted negative link between underpricing and the probability of litigation, and to do so cross-sectionally. Drake and Vetsuypens (1993) study a sample of 93 IPO firms that were sued and compare them to a sample of 93 IPOs that were not sued, matched on IPO year, offer size, and underwriter prestige. Sued firms are just as underpriced as the control sample, and underpriced firms are sued more often than overpriced firms. Drake and Vetsuypens interpret these findings as inconsistent with the legal insurance hypothesis.

Lowry and Shu (2002) argue that such an *ex post* comparison misses the point because it does not truly consider the *probability* of being sued. Empirical analysis of the link between underpricing and the probability of litigation needs to be careful about the following simultaneity problem: firms choose a certain level of underpricing to reduce the probability of litigation, but the level of underpricing they choose depends on the probability of being sued. Put differently, greater underpricing reduces litigation risk, but greater litigation risk requires more underpricing.

Due to this simultaneity problem, ordinary least squares estimates are likely biased. Lowry and Shu propose a two-stage least squares approach. As identifying variables, they use prior market-index returns in the underpricing equation and the IPO firm's expected stock turnover in the litigation equation. The authors motivate these choices on the basis of prior work and economic common sense, but do not test whether they are valid[13] or strong[14] identifying variables statistically. Loughran and Ritter (2002) found a positive relation between lagged index returns and underpricing, but there is no reason

[13] A necessary and sufficient condition for instrument validity is that the system satisfy the order and rank conditions. The order condition is easy to check. It requires that the variable be correlated with the endogenous variable of the first-stage regression, but not with the endogenous variable of the second-stage regression. A variety of formal tests are available. Stock turnover appears to fail the order condition (see Lowry and Shu, 2002, Table 5, p. 329).

[14] Weak instruments may aggravate the effect of simultaneity bias, rather than solving it. To be considered strong, an instrument needs to be highly correlated with the first-stage endogenous variable. Staiger and Stock (1997) recommend a cut-off of $F = 10$. On this basis, Lowry and Shu's instruments would appear to be weak.

to expect lagged index returns to affect lawsuits many years later. This makes lagged index returns a plausible instrument for underpricing. Damages generally increase in the number of shares traded at the allegedly misleading prices, so stock turnover may be a plausible instrument for litigation risk a priori.[15]

The OLS and 2SLS estimates give rise to radically different conclusions. The OLS results suggest that underpricing decreases in the incidence of (actual) lawsuits, suggesting that firms underprice less the more often they are sued. The sign of this relation flips in the 2SLS model. Here, underpricing increases in the predicted probability of lawsuits, consistent with the lawsuit avoidance hypothesis. Interestingly, greater underpricing does not appear to have much deterrence effect: the probability of being sued does not decrease in the instrumented underpricing return, at least not at conventional significance levels.

Lowry and Shu's study is sensitive to econometric concerns, and using more careful tools than prior work it finds evidence consistent with the proposition that firms use underpricing as a form of insurance against future litigation. Unfortunately, their empirical model is not able to gauge the *economic* magnitude of this effect (because their system cannot identify all relevant parameters). They are thus unable to say if litigation risk has a first-order effect on underpricing.

4.2. Price stabilization

Rather than forming a symmetric distribution around some positive mean, underpricing returns typically peak sharply at zero and rarely fall below zero. In a controversial paper, Ruud (1993) takes these statistical regularities as her starting point to argue that IPOs are *not* deliberately underpriced. Rather, IPOs are priced at expected market value but offerings whose prices threaten to fall below the offer price are stabilized in after-market trading. Such price stabilization would tend to eliminate the left tail of the distribution of initial returns, and thus lead to the appearance of a positive average price jump. Thus what we observe in the data may not be the unconditional expectation of true initial returns but the mean conditional upon underwriter intervention in the aftermarket. Estimating the unobserved unconditional mean of the return distribution in a Tobit model, Ruud finds that average (logged) first-day returns are indeed close to zero.

This largely statistical view of the origins of IPO underpricing leaves little room for economics. Why would underwriters stabilize prices in the first place? Subsequent theoretical work on price stabilization has stressed its role in reducing underpricing. Benveniste, Busaba, and Wilhelm (1996) formalize Smith's (1986) notion of price stabilization as a mechanism that 'bonds' underwriters and investors. Because their dollar fees increase in gross proceeds, underwriters have a natural incentive to raise the offer

[15] Though note that empirically, stock turnover does correlate with underpricing, violating the order condition. Strictly speaking, the system estimated in Lowry and Shu relies for identification on the functional form of the probit equation modeling litigation risk, not on the use of instrumental variables.

price. Following a bookbuilding exercise, they could, for instance, overstate investor interest and price the IPO aggressively. Clever IPO investors will recognize this adverse incentive and, in the absence of any counteracting force, may not cooperate in the bookbuilding exercise in the first place. By implicitly committing themselves to price support—which is costlier, the more the offer price exceeds 'true' share value—underwriters may convince investors that the issue will not be intentionally overpriced.

According to Benveniste, Busaba, and Wilhelm (1996), the main beneficiaries of price support should be the institutional investors who participate in bookbuilding.[16] Using the Rock (1986) framework discussed in Section 3.1, Chowdhry and Nanda (1996) instead view retail investors as the main beneficiaries of price support. Analytically, we can think of price support as a put option written by the underwriter and held by the IPO investors, in the sense that stabilizing activities put a floor under early after-market prices and thus act as insurance against price falls. This may reduce the uninformed investors' winner's curse. Indeed, price support may be a more efficient way of counteracting the winner's curse than Rock's solution that all IPOs be underpriced on average, because price support is extended in the states of the world when uninformed investors suffer the most: overpriced offerings. Underpricing, on the other hand, is a blunter instrument because (absent price discrimination) it is offered to both uninformed and informed investors.

4.2.1. How widespread is price support?

Direct evidence of price support is limited because stabilizing activities are generally notifiable, if at all, only to market regulators, and not to investors at large. Thus it is hard to identify which IPOs were initially supported, how the intensity of intervention varied over time, and at what time support was withdrawn. Most work therefore relies on indirect evidence. For instance, one might investigate after-market microstructure data for behavior indicative of price support, and relate it to the underwriter's pre-market activities such as bookbuilding. This is particularly promising on NASDAQ, where underwriters can, and usually do, become market-makers for the companies they take public.

The microstructure variables of interest are the bid–ask spreads that underwriters charge (especially compared to competing market-makers who are not part of the original IPO syndicate); who provides 'price leadership' (by offering the best bid and ask prices); who trades with whom and in what trade sizes; what risks underwriters take in the after-market; and how much inventory dealers accumulate (indicating that they are net buyers). Schultz and Zaman (1994) and Hanley, Kumar, and Seguin (1993) find microstructure evidence consistent with widespread price support, especially among weak IPOs. Using proprietary Nasdaq data that identifies the transacting parties, Ellis,

[16] After all, if retail investors provide no pricing-relevant information in the pre-market, there is no reason to reward them by offering them price support.

Michaely, and O'Hara (2000) show that the lead IPO underwriter always becomes the dominant market-maker and accumulates sizeable inventories over the first 20 trading days. Underwriters buy back substantially more stock in 'cold' offerings (those that opened below their offer prices and never recovered in the first 20 days) than in 'hot' offerings (those that never fell below their offer prices in the first 20 days). These inventory accumulation patterns are strong evidence of price support activities, and indicate that such activities persist for a perhaps surprising length of time.

Asquith, Jones, and Kieschnick (1998) use a mixture-of-distributions approach to gauge how widespread price support is. Mixture-of-distributions models assume that the observed distribution is a mixture of two (or more) normal distributions with different means and standard deviations. They tend to be useful when modeling heavily skewed empirical distributions (such as underpricing returns). The technique estimates the fraction of the observations coming from each underlying distribution along with their means and standard deviations. Imposing the assumption that the data are generated by two (and no more) underlying distributions, one for supported offerings and one for unsupported ones, they argue that about half of all U.S. IPOs appear to have been supported in 1982–1983.

4.2.2. Testable implications and evidence

From the perspective of understanding why IPOs are (or appear to be) underpriced, the main empirical questions are (1) whether price support alone can account for positive underpricing returns and, assuming it cannot, (2) what effect the presence of price support has on the level of underpricing that results.

Asquith, Jones, and Kieschnick (1998) investigate whether observed underpricing is the byproduct of price support, as Ruud proposes, or whether it may have independent causes. Using the aforementioned mixture-of-distributions approach, they estimate the average underpricing returns for the two hypothesized distributions of supported and unsupported IPOs. If Ruud is correct in saying that there is no deliberate underpricing, then the initial return distribution of unsupported offerings should have a mean of zero. This, however, is not what Asquith, Jones, and Kieschnick find. Instead, the distribution interpreted as reflecting unsupported firms has mean underpricing of about 18 percent, while the distribution interpreted as reflecting supported IPOs has zero mean underpricing.

This suggests that underpricing is caused by factors other than price support. But the apparently widespread practice of price support may still affect how underpriced an IPO ends up being. We saw earlier that both Benveniste, Busaba, and Wilhelm (1996) and Chowdhry and Nanda (1996) predict that price support reduces the need to underprice, albeit for different reasons. Benveniste, Erdal, and Wilhelm (1998) try to distinguish between the two theories' contrasting predictions regarding who benefits from price support using detailed transactions data for 504 U.S. firms floated in 1993 and 1994. They find that it is overwhelmingly large (presumably institutional) traders who execute sell orders in stabilized offerings, rather than small (presumably retail) traders.

This lends support to the view that price support is offered mainly for the benefit of institutional investors, as modeled by Benveniste, Busaba, and Wilhelm (1996).

However, what remains unclear is whether, and by how much, the provision of price support reduces the required degree of underpricing.

4.3. Tax arguments

Perhaps surprisingly, underpricing may be advantageous from a tax point of view. Rydqvist (1997) explores this possibility in the context of Swedish IPOs. The argument is simple. Before 1990, Sweden taxed employment income much more heavily than capital gains. This created an incentive to pay employees by allocating appreciating assets in lieu of salaries. One such appreciating asset is underpriced stock, allocated preferentially to the firm's own employees at the IPO. In 1990, the Swedish tax authorities made underpricing-related gains subject to income tax, removing the incentive to allocate underpriced stock to employees. Underpricing then fell from an average of 41% in 1980–1989 to 8% in 1990–1994.

A similar argument is put forward by Taranto (2003). A quirk of U.S. tax laws may increase senior managers' incentive to underprice their company's IPO. Holders of managerial or employee stock options pay tax in two steps. First, when they exercise the option, they pay income tax on the difference between the strike price and 'fair market value'. Second, when they eventually sell the underlying stock they acquired at exercise, they pay capital gains tax on the difference between 'fair market value' and the sale price. Since the capital gains tax liability is deferred, and since capital gains tax rates are typically lower than income tax rates, managers prefer 'fair market value' to be as low as possible. U.S. tax law considers 'fair market value' for options exercised in conjunction with an IPO to be the offer price, rather than the price that will prevail in the market once trading begins. This then generates an incentive to underprice.[17]

While it is unlikely that tax alone can explain why IPOs are underpriced, the tax benefit from underpricing may help explain the cross-section of underpricing returns. Taranto's (2003) empirical results are generally consistent with this argument, in that they show companies to be more underpriced the more they rely on managerial and employee stock options. However, it is possible that boards award stock options to protect managers from dilution in anticipation of the underwriter underpricing the stock. Thus the direction of causation is unclear.

5. Ownership and control

Going public is, in many cases, a step towards the eventual separation of ownership and control. Ownership matters for the effects it can have on management's incentives to

[17] A similar argument applies to restricted stock grants. Holders of unvested restricted stock can elect to pay income tax before vesting, based on 'fair market value'. Once the stock vests and is sold, capital gains tax becomes due on the difference between 'fair market value' and the sale price.

make optimal operating and investment decisions. In particular, where the separation of ownership and control is incomplete, an agency problem between non-managing and managing shareholders can arise (Jensen and Meckling, 1976): rather than maximizing expected shareholder value, managers may maximize the expected private utility of their control benefits (say, perquisite consumption) at the expense of outside shareholders.

Two principal models have sought to rationalize the underpricing phenomenon within the context of an agency cost approach. Their predictions are diametrically opposed: while Brennan and Franks (1997) view underpricing as a means to entrench managerial control and the attendant agency costs by *avoiding* monitoring by a large outside shareholder, Stoughton and Zechner's (1998) analysis instead suggests that underpricing may be used to minimize agency costs by *encouraging* monitoring.

5.1. Underpricing as a means to retain control

Brennan and Franks (1997) argue underpricing gives managers the opportunity to protect their private benefits by allocating shares strategically when taking their company public. Managers seek to avoid allocating large stakes to investors for fear that their non-value-maximizing behavior would receive unwelcome scrutiny. Small outside stakes reduce external monitoring, owing to two free-rider problems. First, because it is a public good, shareholders will invest in a sub-optimally low level of monitoring (Shleifer and Vishny, 1986). Second, greater ownership dispersion implies that the incumbent managers benefit from a reduced threat of being ousted in a hostile takeover (Grossman and Hart, 1980). The role of underpricing in this view is to generate excess demand. Excess demand enables managers to ration investors so that they end up holding smaller stakes in the business.

5.1.1. Testable implications and evidence

The principal testable implication of the Brennan–Franks model is that underpricing results in excess demand and thus greater ownership dispersion. Using detailed data on individual bids and allocations in 69 U.K. IPOs completed between 1986 and 1989, Brennan and Franks confirm that large bids are discriminated against in favor of small ones, an effect that is stronger the more underpriced and oversubscribed the IPO. However, the protection of private benefits of control may not be the only reason why managers favor greater dispersion. Booth and Chua (1996) argue that owners value a more dispersed ownership structure because it likely results in a more liquid secondary market for their shares. In Zingales (1995), a more diffuse ownership structure helps managers negotiate a higher price when selling their controlling shareholding some time after the IPO. Thus, a link between underpricing and ownership dispersion is not sufficient evidence in favor of Brennan and Franks' model.

Zingales (1995) assumes that an IPO is frequently only the first stage in a multi-period sell-out strategy which will culminate in the complete transfer of ownership and control from the original founders to new owners. Brennan and Franks, on the other

hand, assume that the IPO is designed to *prevent* a transfer of control in spite of the partial transfer of ownership. Who is right? The empirical evidence is more nearly consistent with the staged-sale notion. Pagano, Panetta, and Zingales (1998) document that most Italian IPOs are followed by private sales of controlling blocks to large outside investors. Indeed, control turnover is twice as common in newly listed firms as in the universe of unlisted companies. In the U.S., control turnover in the first five years is 29 percent in IPO firms with at least five years of trading history prior to flotation and 13 percent for younger companies (Mikkelson, Partch, and Shah, 1997). Similarly, officers and directors in U.S. IPOs on average own 66 percent of equity before the IPO and 44 percent immediately afterwards, which is reduced to 29 percent over the subsequent five years, and to 18 percent ten years later (Mikkelson, Partch, and Shah, 1997).

Underpricing-induced ownership dispersion is not the only way to protect private benefits of control. An obvious alternative is to put in place takeover defenses or simply to issue non-voting stock. Field and Karpoff (2002) show that a majority of U.S. firms deploy at least one takeover defense just before going public, especially when private benefits of control appear large and internal monitoring mechanisms look weak—that is, when managers' compensation packages are unusually generous, their own equity stakes are small, and non-directors play a smaller role in corporate governance. Interestingly, however, these firms are still underpriced—though we do not know whether they are *less* underpriced than firms that choose to entrench their managers via the Brennan–Franks mechanism—so the protection of private benefits is unlikely to be the only explanation of underpricing, at least in the U.S.

Issuing non-voting shares would guarantee that managers could retain control of the company and all attendant private benefits. Whether it dominates the Brennan–Franks underpricing mechanism is an empirical matter. Non-voting shares tend to trade at lower multiples than voting shares. This voting discount could be smaller or larger than the money left on the table via underpricing. Smart and Zutter (2003) find that U.S. companies that issue non-voting stock in their IPOs are less underpriced and have higher institutional ownership after the IPO. This is consistent with the notion that non-voting stock can substitute for the Brennan–Franks mechanism. At the same time, Smart and Zutter find that non-voting IPO shares trade at lower multiples, though they do not investigate how these compare with the monetary benefit of reduced underpricing.

Arugaslan, Cook, and Kieschnick (2004) take issue with Smart and Zutter's (2003) study on econometric grounds, pointing out that the main reason why IPOs involving non-voting stock are less underpriced than voting-stock IPOs is that they are larger. Size in turn is an important determinant of institutional investors' stock selection, and may thus be driving the higher post-IPO institutional ownership Smart and Zutter observe among non-voting-stock IPOs.

Underpricing and the resulting excess demand will shield managers from outside monitoring only to the extent that outside investors do not assemble large blocks once trading has begun. Brennan and Franks (1997) suggest that such open-market purchases may not be profitable. If the market anticipates the gains that would accrue if management were monitored by a sufficiently large outside shareholder, prices will rise in

response to large-scale buying. This will tend to make it unprofitable to assemble a large block of shares in the aftermarket, the more so the more diffuse the ownership structure is to start with. Empirically, however, this argument meets with little success. Field and Sheehan (2004) find next to no relation between the creation of new blocks after the IPO and the level of underpricing at the IPO.

5.2. *Underpricing as a means to reduce agency costs*

Brennan and Franks (1997) implicitly assume that, in the wake of the separation of ownership and control, managers try to maximize their expected private utility by entrenching their control benefits. However, it could be argued that managers should actually seek to minimize, rather than maximize, their scope for extracting private benefits of control. Why? Agency costs are ultimately borne by the owners of a company, in the form of lower IPO proceeds and a lower subsequent market value for their shares. To the extent that managers are part-owners, they bear at least some of the costs of their own non-profit-maximizing behavior. If their stakes are large enough so that the agency costs they bear outweigh the private benefits they enjoy, it will be in their interest to reduce, not entrench, their discretion.

Based on this intuition, Stoughton and Zechner (1998) observe that, in contrast to Brennan and Franks, it may be value-enhancing to allocate shares to a large outside investor who is able to monitor managerial actions. Monitoring is a public good as all shareholders benefit, whether or not they contribute to its provision. Since a large shareholder will monitor only in so far as this is privately optimal (which is a function of the size of her stake), there will be too little monitoring from the point of view of both shareholders and incumbent managers. To encourage better monitoring, managers may try to allocate a particularly large stake to an investor. However, if the allocation is sub-optimally large from the investor's point of view (say, because it is not easily diversified), an added incentive may be offered in the form of underpricing. Such underpricing may not even represent an opportunity cost: in the absence of monitoring, the firm would have had to be floated at a lower price anyway, owing to outside shareholders anticipating higher agency costs.

A closer look at Stoughton and Zechner's model is constructive. The selling mechanism is modeled as a two-stage process akin to bookbuilding. In the first stage, issuers extract the demand schedule from a likely monitor and set the offer price such that this investor optimally demands a large enough number of shares to subsequently engage in effective monitoring. In the second stage, small investors are allocated shares at the same price (unless price discrimination is possible, which in practice it rarely is). Rationing is observed at this stage, as small investors would like to buy further shares at the low offer price.

Why are the predictions of Brennan and Franks and Stoughton and Zechner so different? There are at least two reasons. The first is the different institutional environments in which the models are placed. Brennan and Franks effectively model an IPO mechanism involving prices that are fixed rather than responsive to demand and shares that are allo-

cated pro rata. Stoughton and Zechner, on the other hand, model a bookbuilding regime with discretionary allocations. In a pro-rata regime Stoughton and Zechner would have difficulty allocating enough stock to the large shareholder to ensure effective monitoring. In a bookbuilding regime, Brennan and Franks would not need to underprice as much to discriminate against large investors: absent pro rata allocation rules, the issuer (and underwriter) could simply select which investors to exclude from allocations. This illustrates the importance of the institutional assumptions made in IPO modeling.

Second, Stoughton and Zechner assume that managers internalize the agency costs they impose on outside investors, via the lower price that investors are willing to pay for the stock. This internalization is absent from the Brennan–Franks model.

The ownership and control dimension is a promising, albeit nascent, field in the study of IPO underpricing. Much more empirical evidence is needed before we can assess the validity of the theoretical contributions and before we can say whether control considerations are of first or second-order importance when offer prices are set.

6. Behavioral explanations

In the late 1990s initial returns increased substantially. As pointed out in Section 2, U.S. issuers left an aggregate of $62 billion on the table in 1999 and 2000 alone. Many researchers are doubtful whether informational frictions, the risk of lawsuits, or control considerations could possibly be severe enough to warrant underpricing on this scale. As a consequence, some argue we should turn to behavioral explanations for IPO underpricing. Behavioral theories assume either the presence of 'irrational' investors who bid up the price of IPO shares beyond true value, or that issuers are subject to behavioral biases and therefore fail to put pressure on the underwriting banks to have underpricing reduced. This literature is still in its infancy.[18]

The IPO market is a good setting in which to study the effect of 'irrational' investors on stock prices. IPO firms by definition have no prior share price history and tend to be young, immature, and relatively informationally opaque. Not surprisingly, therefore, they are hard to value, and it seems reasonable to assume that investors will have a wide range of priors about their market values. In Section 6.2, we will review one recent theory of IPO underpricing that builds on this assumption. In Section 6.3, we will turn to a model of behaviorally challenged managers. We begin, however, with a discussion of a model of rational 'informational cascades'.

6.1. Cascades

Welch (1992) shows that 'informational cascades' can develop in some forms of IPOs if investors make their investment decisions sequentially: later investors can condition

[18] For a survey of behavioral corporate finance more generally, see Chapter 4 by Baker, Ruback, and Wurgler in this volume.

their bids on the bids of earlier investors, rationally disregarding their own information. Successful initial sales are interpreted by subsequent investors as evidence that earlier investors held favorable information, encouraging later investors to invest whatever their own information. Conversely, disappointing initial sales can dissuade later investors from investing irrespective of their private signals. As a consequence, demand either snowballs or remains low over time.

The possibility of cascades gives market power to early investors who can 'demand' more underpricing in return for committing to the IPO and thus starting a positive cascade. It is in this sense that cascades may play a role in explaining IPO underpricing. But cascades are not inevitable. In bookbuilding cascades do not develop because the underwriter can maintain secrecy over the development of demand in the book. Less underpricing is therefore required. Bookbuilding also offers the issuer the valuable option to increase the offer size if demand turns out to be high (either unconditionally, by issuing more shares, or conditionally, by giving the underwriter a so called overallotment option).[19]

If investors can communicate freely, cascades also do not form, for then investors can learn the entire distribution of signals. Yet Welch (1992) shows that issuers are better off with cascades than with free communication, because free communication aggregates all available information which maximizes the issuing company's informational disadvantage compared to investors. Moreover, preventing free communication reduces the chance that one investor's negative information becomes widely known, and so reduces the likelihood that the IPO will fail.

6.1.1. Testable implications and evidence

Arguing that underwriters with national reach can more easily segment the market and so prevent communication among investors than can local or regional underwriters, Welch (1992) derives several testable implications. Most importantly, compared to locally or regionally distributed IPOs, IPOs managed by national underwriters are predicted to be less underpriced. While this implication has not been tested explicitly, it relates to the literature on the relation between underpricing and underwriter reputation discussed earlier, at least to the extent that market-share or tombstone-ranking measures of reputation correlate with the bank's geographic reach. Recall that the sign on the relation between underpricing and underwriter reputation has flipped since the 1970s and 1980s, which implies mixed support for the cascades model.

On the other hand, Welch (1992) also stresses the factors determining which issuer chooses which type of underwriter. Specifically, in the presence of fixed costs, the more risk averse and capital-constrained the issuer, the greater the benefits of national distribution. Thus the choice of underwriter is not random, implying that simple OLS estimates

[19] Overallotment options entitle the underwriter to purchase additional shares (usually 15% of the offer size) from the issuer at the IPO price. Such options are sometimes called 'green shoes'.

of the relation between underpricing and the bank's geographic reach (or underwriter reputation) must be interpreted with caution. This reinforces Habib and Ljungqvist's (2001) argument discussed in Section 3.1, albeit on the basis of a different model of IPO underpricing.

At a more basic level, Amihud, Hauser, and Kirsh's (2003) analysis of demand and allocations in Israeli IPOs supports Welch's (1992) prediction that demand is either extremely low or there is oversubscription, with few cases in between.

In conclusion, Welch's cascades model remains one of the least explored explanations of IPO underpricing.

6.2. Investor sentiment

Behavioral finance is interested in the effect on stock prices of 'irrational' or 'sentiment' investors. The potential for such an effect would seem particularly large in the case of IPOs, since IPO firms are young, immature, and relatively informationally opaque and hence hard to value. The first paper to model an IPO company's optimal response to the presence of sentiment investors is Ljungqvist, Nanda, and Singh (2004). They assume some sentiment investors hold optimistic beliefs about the future prospects for the IPO company. The issuer's objective is to capture as much of the 'surplus' under the sentiment investors' downward-sloping demand curve as possible, that is, to maximize the excess valuation over the fundamental value of the stock. Flooding the market with stock will depress the price, so the optimal strategy involves holding back stock in inventory to keep the price from falling. Eventually, nature reveals the true value of the stock and the price reverts to fundamental value. That is, in the long-run IPO returns are negative, consistent with the empirical evidence in Ritter (1991) and others. This assumes the existence of short sale constraints, or else arbitrageurs would trade in such a way that prices reflected fundamental value even in the short term.

Regulatory constraints on price discrimination and inventory holding prevent the issuer from implementing such a strategy directly. Instead, the optimal mechanism involves the issuer allocating stock to 'regular' institutional investors for subsequent resale to sentiment investors, at prices the regulars maintain by restricting supply. Because the hot market can end prematurely, carrying IPO stock in inventory is risky, so to break even in expectation regulars require the stock to be underpriced—even in the absence of asymmetric information. However, the offer price still exceeds fundamental value, as it capitalizes the regulars' expected gain from trading with the sentiment investors, and so the issuer benefits from this mechanism.

6.2.1. Testable implications and evidence

The model generates a number of new and refutable empirical predictions. Most obviously, the model predicts that companies going public in a hot market subsequently underperform, both relative to the first-day price and to the offer price. Underperformance relative to the first-day price is not surprising; it follows from the twin assumptions of

sentiment investors and short-sale constraints (see Miller, 1977). Underperformance relative to the offer price is a stronger prediction. It follows because the offer price exceeds fundamental value by an amount equal to the issuer's share in the surplus extracted from the sentiment investors. Purnanandam and Swaminathan (2004) lend support to the prediction that the offer price can exceed fundamental value. They show that compared to its industry peers' multiples, the median IPO firm in 1980–1997 was overpriced at the offer by 50%. Interestingly, it is the firms that are most overpriced in this sense which subsequently underperform. Cook, Jarrell, and Kieschnick (2003) refine this analysis by conditioning on hot and cold markets. They find that IPO firms trade at higher valuations only in hot markets, consistent with the spirit of the Ljungqvist, Nanda, and Singh (2004) model. Cornelli, Goldreich, and Ljungqvist (2006) use data from the grey market (the when-issued market that precedes European IPOs and that involves mostly retail traders) to show that long-run underperformance is concentrated among those IPOs whose grey market prices were particularly high. They also report evidence suggesting that grey market investors do not update their prior beliefs about the value of an IPO in an unbiased fashion.

Ofek and Richardson (2003) show that high initial returns occur when institutions sell IPO shares to retail investors on the first day, and that such high initial returns are followed by sizeable reversals to the end of 2000, when the 'dot-com bubble' eventually burst. This is precisely the pattern Ljungqvist, Nanda, and Singh (2004) predict.

At the heart of Ljungqvist, Nanda, and Singh's (2004) story is the idea that banks market IPOs and that it matters whom they target in their marketing. Cook, Kieschnick, and Van Ness (2006) find a significant positive relation between promotional activities (proxied by the number of newspaper articles mentioning the IPO firm in the prior six months) and the valuations at which IPOs are sold, which they interpret as evidence that investment bankers manage to sell overvalued IPO stock to retail investors to the benefit of the issuer and the investment bank's regular clients.

Using German data on IPO trading by 5,000 retail customers of an online broker, Dorn (2002) documents that retail investors overpay for IPOs following periods of high underpricing in recent IPOs, and for IPOs that are in the news. Consistent with the Ljungqvist, Nanda, and Singh (2004) model, he also shows that 'hot' IPOs pass from institutional into retail hands. Over time, high initial returns are reversed as net purchases by retail investors subside, eventually resulting in underperformance over the first six to 12 months after the IPO.

The model may also be able to reconcile the conflicting empirical evidence regarding the relation between underpricing and long-run performance. Ritter (1991) documents that underpricing and long-run performance are negatively related, while Krigman, Shaw, and Womack (1999) find a positive relation. In the Ljungqvist, Nanda, and Singh (2004) model, the relation is not necessarily monotonic. In particular, the relation is negative only if the probability of the hot market ending is small. If the hot market is highly likely to end, the issuer optimally reduces the offer size, implying regular investors hold smaller inventories and so require less underpricing to break even. At the

same time, the reduction in offer size aggravates long-run underperformance, given the negative slope of the sentiment demand curve.

Recall from Section 3.1 that the empirical evidence on the relation between underwriter reputation and underpricing is mixed. Consistent with evidence from the 1990s (Beatty and Welch, 1996), Ljungqvist, Nanda, and Singh (2004) predict that underpricing *in*creases in underwriter reputation. Underwriters enjoying a large IPO deal flow can more easily punish regular investors who attempt to free-ride on the inventory-holding strategy by dumping their shares prematurely, before the price falls. This in turn implies that the more active banks can underwrite larger IPOs, as more inventory can be held over time. Since underpricing is compensation for the expected inventory losses in the face of a non-zero probability that the hot market will end before all inventory has been unloaded, the more active underwriters will be associated with greater underpricing.

6.3. Prospect theory and mental accounting

Loughran and Ritter (2002) propose an explanation for IPO underpricing that stresses behavioral biases among the decision-makers of the IPO firm, rather than among investors. Combining prospect theory-style reference-point preferences with Thaler's (1980, 1985) notion of mental accounting, Loughran and Ritter argue that issuers fail to 'get upset' about leaving millions of dollars 'on the table' in the form of large first-day returns because they tend to sum the wealth loss due to underpricing with the (often larger) wealth gain on retained shares as prices jump in the after-market. Such 'complacent' behavior benefits the investment bank if investors engage in rent-seeking to increase their chances of being allocated underpriced stock.

Loughran and Ritter (2002) assume that the decision-maker's initial valuation beliefs are reflected in the mean of the indicative price range reported in the issuing firm's IPO registration statement. This belief serves as a reference point against which the gain or loss from (as opposed to the expected utility of) the outcome of the IPO can be assessed. The offer price for an IPO routinely differs from this reference point, either because the bank 'manipulated' the decision-maker's expectations by low-balling the price range, or in reflection of information revealed during marketing efforts directed at institutional investors. As argued earlier, offer prices appear only to 'partially adjust' (Hanley, 1993) in the sense that large positive revisions from the reference point are associated with large initial price increases from the offer price during the first day of trading. Such partial adjustment is consistent with both the Benveniste and Spindt (1989) information-acquisition model of IPO underpricing and Loughran and Ritter's complacency argument.

The decision-maker perceives a positive revision from the reference point as a wealth gain (assuming he retains shares after the IPO). At the same time, a positive initial return is perceived as a wealth loss under the assumption that shares could have been sold at the higher first-day trading price. If the perceived gain exceeds the underpricing loss, the decision-marker is satisfied with the IPO underwriter's performance at the IPO.

6.3.1. Testable implications and evidence

Ljungqvist and Wilhelm (2005) use the structure suggested by Loughran and Ritter's (2002) behavioral perspective to test whether the CEOs of recent IPO firms make *subsequent* decisions consistent with a behavioral measure of their perception of the IPO's outcome. Specifically, they investigate whether CEOs deemed 'satisfied' with the underwriter's performance according to Loughran and Ritter's story are more likely to hire their IPO underwriters to lead-manage later seasoned equity offerings. Controlling for other known factors, IPO firms are less likely to switch underwriters for their SEO when they were deemed 'satisfied' with the IPO underwriter's performance. Underwriters also appear to benefit from behavioral biases in the sense that they extract higher fees for subsequent transactions involving 'satisfied' decision-makers.

While these tests suggest there is explanatory power in the behavioral model, they do not speak directly to whether deviations from expected utility maximization determine patterns in IPO initial returns. More work is needed.

7. Concluding remarks

The empirical IPO literature is now fairly mature. We know that IPOs are underpriced in virtually all countries and that the number of companies going public and the extent of underpricing fluctuate over time. There is a large body of theoretical work explaining IPO underpricing, and most theories have been subjected to rigorous empirical testing. Broadly speaking, the empirical evidence supports the view that information frictions (including agency conflicts between the issuing company and its investment bank) have a first-order effect on underpricing. Specifically,

- The bulk of underpricing-related gains accrue to informed (or at least institutional) investors; uninformed (or at least retail) investors earn little or no excess returns from investing in IPOs.
- In the cross-section, underpricing increases in the ex ante uncertainty surrounding a firm's valuation.
- There is ample evidence suggesting that some investors are informed and that their information influences the investment bank's choice of offer price.

At the same time, the enormous variation in the extent of underpricing over time raises doubt in some people's mind whether information-based explanations on their own can account for the huge amounts of money left on the table in hot markets, such as the internet bubble of 1998–2000.

Against this background, vigorous debate continues between two broad views of what causes underpricing: the Benveniste and Spindt (1989) perspective which emphasizes the necessity of underpricing if the underwriter is to efficiently extract pricing-relevant information from better informed investors and thereby maximize the issuer's expected proceeds, and the agency view commonly associated with Jay Ritter's work which stresses the self-interested nature of investment banks. The sometimes strident tone of

this debate on both sides belies the fact that the truth is probably somewhere in between. For the information-acquisition mechanism of Benveniste and Spindt to work, underwriters need to be given discretion over the way they price and allocate IPO shares. Allocation discretion, in turn, may well aggravate an agency problem between the issuer and its banker arising from the fact that bankers deal repeatedly with institutional investors but infrequently with issuers.

Arising from this debate, there is continued interest in at least four areas:

(a) behavioral approaches to explain why the extent of underpricing varies so much over time;
(b) tests exploiting cross-country differences in institutional frameworks;
(c) work shedding light on the allegedly conflicted behavior of investment banks during the market boom of the late 1990s; and
(d) the potential for using auction mechanisms to price and allocate IPOs.

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Chapter 8

CONGLOMERATE FIRMS AND INTERNAL CAPITAL MARKETS*

VOJISLAV MAKSIMOVIC

Robert H. Smith School of Business, University of Maryland, College Park, MD 20742, USA
e-mail: vmax@rhsmith.umd.edu

GORDON PHILLIPS

Robert H. Smith School of Business and NBER, University of Maryland, College Park, MD 20742, USA
e-mail: gphillips@rhsmith.umd.edu

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Abstract

Conglomerate firm production represents more than 50 percent of production in the United States. Given the size of production by conglomerate firms, understanding the costs and benefits of this form of organization has important implications. Several studies have shown that there exists a discount in stock market value of conglomerate firms relative to single-segment focused firms. This discount represents an economically important puzzle. Early literature came to the conclusion that the conglomerate discount was the result of problems with resource allocation and internal capital markets. Recent empirical literature has found that self-selection by firms with different investment opportunities can explain the conglomerate discount. Additional theoretical and empirical research has shown how a model of profit-maximizing firms with different abilities and investment opportunities across divisions can explain observed resource allocation by conglomerate firms.

Keywords

conglomerates, multidivisional firms, firm organization, investment, internal capital markets.

1. Introduction

In this chapter we survey the large literature on corporate diversification in corporate finance. For corporate finance, the primary questions about diversification are: "When does corporate diversification affect firm value?" And, "When diversification adds value, how does it do so?" By a diversified firm in corporate finance, we usually mean a firm that operates in more than one industry, as classified by the Standard Industrial Code (SIC).[1]

Questions about the relation between diversification and value arise naturally from the larger problem of determining how the boundaries of firms should be set. Coase (1937) argues that boundaries are set at the point at which the costs of carrying out transactions within a firm equal those of carrying them out in the open market or in another firm. Thus, for corporate diversification to be of interest, it must be that the cost of carrying out transactions within the firm are affected if it contains more than one industry within its boundaries. Implicit in this belief is that the skills and resources which are required to operate efficiently differ materially across industries, and that the *diversity* of operating environments affects the cost of performing transactions within the firm. These cost differences could be due to financial externalities across industries, such as improved risk sharing within the firm, or real externalities that could arise due to the use of a shared factor of production, such as the attention of the firm's decision makers.

Diversification across industries is also of interest to researchers because data on most intra-firm decisions is in general hard to acquire. By contrast, some data on how firm revenues and capital expenditures are distributed across the industries is readily available, which makes the research on diversification a good starting point for studying the more general problem of setting firm boundaries.

A more pragmatic reason for studying corporate diversification is that corporate managers face decisions about diversifying and refocusing their firms. In addition, managers face decisions about investing across multiple businesses they operate. Companies such as Berkshire Hathaway and General Electric generate large amounts of cash that can be invested in different business or returns to shareholders via dividends. Empirical data about how such decisions worked out in the past may be useful in strategic planning. Estimates of specific of costs and benefits might also be useful to investors and to regulators.

The corporate finance literature on diversification took off with the discovery of the conglomerate discount by Lang and Stulz (1994) and Berger and Ofek (1995). Our review therefore begins with a discussion of these papers and of subsequent work that has extended and reinterpreted their results. We then briefly discuss the theoretical

[1] In practice, researchers usually define firms as diversified if they generate less then 90% of their revenues in a single SIC code industry. Industries are commonly defined at the 3-digit level, although some studies use the 2-digit or 4-digit levels. Scharfstein (1998) is an exception in using a more qualitative criterion for diversification.

approaches that have been developed to explain the conglomerate discount and its investment decisions in Section 3. The empirical research motivated by these studies is reviewed in Section 4. Section 5 concludes.[2]

2. The conglomerate discount

2.1. Documenting the discount: Early research

In contemporary corporate finance the seminal papers on conglomerates are Lang and Stulz (1994) and Berger and Ofek (1995). Essentially, these papers decomposed conglomerate firms into their constituent industry segments and then valued these segments using the "comparables" approach to valuation. These papers found that the typical conglomerate is undervalued and selling at a discount compared to a collection of comparable single-segment firms. The existence of this conglomerate discount presents a puzzle. While Lang and Stulz (1994) do not take a position on the provenance of the discount, the early literature on conglomerates sought to explain this puzzle by arguing that conglomerates are subject to greater agency problems than single-segment firms. As a result, managers of conglomerate firms destroy value. By implication stockholder value would be maximized if most firms were organized as a single segment firms.

Since Lang and Stulz (1994) and Berger and Ofek (1995) are the seminal papers in the study of conglomerates it is worth examining their methodology in some detail. Preceding work on conglomerates in the industrial organization and strategy literatures had examined differences in ex-post accounting performance between conglomerates and single-segment firms. By contrast, Lang and Stulz (1994) and Berger and Ofek (1995) start from the question: "When do shareholders gain from diversification?" where gain is measured by the relative value of the diversified firm compared to single-segment firms in the same industry. To adjust for scale, firm value is in the first instance proxied by Tobin's q, the market value of the firm (equity and debt) divided by an estimate of the replacement value of the firm's assets.[3] To obtain the comparables, for each division of a conglomerate Lang and Stulz (1994) compute mean Tobin's q of single-segment firms operating in the same 3-digit SIC code. The conglomerate's comparable q is then found by the weighed average of the divisional qs. While the weights used can be derived in several ways, Lang and Stulz show that to obtain an unbiased estimate of the comparable, a division's weight should be computed as the ratio of the replacement cost of a division's assets to the replacement cost of the whole conglomerate's assets. However, as replacement values are generally unavailable, Lang and Stulz use book values in their place. The conglomerate discount is defined to be the difference between

[2] By its nature, this type of review inevitably omits many significant papers. Interested readers may want to consult other summaries of the literature, such as Martin and Savrak (2003).

[3] In some of their tests Lang and Stulz (1994) use the ratio of market to book values of a firm. The results are very similar.

a conglomerate's Tobin's q and its comparable q computed in the manner described above.

Lang and Stulz measure diversification in two ways. As their principal measure they count the number of the business segments that each firm reports in the Business Information File of Compustat. They use segment information from the Business Information File to compute two Herfindahl indices of diversification for each firm: an index computed from by using segment sales data and a second index computed from data on assets per segment.

Lang and Stulz main statistical tests consist of annual cross-sectional regressions for the period 1978 to 1990. They first regress firms' Tobin's qs on a constant and four dummy variables, $D(j)$, $j = 2, \ldots, 5$. The jth dummy variable takes on the value 1 if the conglomerate has more than j segments in different SIC codes. Thus, $D(j)$ can be interpreted as the marginal contribution to q of diversifying from $j - 1$ to j segments. In a second round of tests they replace Tobin's q as the dependent variable by the conglomerate discount, computed using comparables as above.

Across the annual cross-sectional regressions, Lang and Stulz consistently find that the coefficient of $D(2)$ is negative and significant, indicating that a two-segment firm sells at a discount both to single-segment firms in general, and to "comparable" single-segment firms, as defined above. There is much less evidence for the existence of a marginal effect of diversification on the discount for a larger number of segments. Lang and Stulz also show that a substantial portion of the discount remains even after controlling for differences in size and in the extent to which the firm faces financial constraints, as proxied, following Fazzari, Hubbard and Peterson (1988), by whether or not it pays dividends.

In addition, Lang and Stulz investigate whether the discount can be explained by differences in the propensity of single-segment and diversified firms to invest in research and development. Since the firm's balance sheet does not fully capture investment in R&D, the Tobin's qs of firms that engage in a great deal of R&D are going to be overstated relative to those of firms that engage in less R&D. If it were the case that single-segment firms were relatively R&D intensive, this relative valuation effect could explain the conglomerate discount. Lang and Stulz find that this is not the case. Thus, Lang and Stulz conclude that the diversification discount that they find cannot be explained by "reporting biases or subtle advantages of diversified firms".

The existence of a conglomerate discount naturally leads to the question: Are multi-segment firms worth less than single-segment firms because they diversify, or do less valuable firms choose to diversify?[4] The evidence from summary statistics is not clear-cut. Lang and Stulz find that single-segment firms that diversify have lower qs than single-segment firms that do not choose to diversify. However, the industry-adjusted q

[4] It is also possible that the decision to diversify is not causally related to the discount. This possibility is discussed below.

of diversifiers prior to diversification is not lower than that of non-diversifiers. Thus, the conglomerate discount is not explained by the low performance of firms that choose to become diversifiers.[5] However, not all findings they report are statistically significant or point in the same direction.

Thus, Lang and Stulz show the existence of a conglomerate discount. However, they judge their evidence to be "less definitive on the question of the extent to which diversification hurts performance". They find that the evidence is consistent with notion that firms diversify because they face diminishing returns in their industries. Lang and Stulz argue that to establish whether this is the case requires a more detailed disaggregated analysis and an explicit model.

Berger and Ofek (1995) confirm the Stulz and Lang result that there exists a conglomerate discount in the range of 13–15% of firm value for the period 1986–1991. They also investigate further potential causes of the discount. They find that the discount is smaller when the firm is not too diversified and all the segments are in the same 2-digit SIC code. They also find evidence that cross-subsidization and overinvestment contribute to the discount, and more limited evidence that diversified firms obtain tax benefits.

Berger and Ofek compute the estimated value of each segment in three related ways using a valuation approach similar to the multiples approach of Lang and Stulz. Berger and Ofek multiply each segment's assets, sales or earnings, reported in the Compustat industry segment database, by the corresponding median valuation multiple. The industry median is obtained by matching the segment to all the single-segment firms with sales above \$20m in the most refined SIC code that contains at least five such firms. The valuation multiples are the ratios of the single-segment firms' total value (as proxied by the market value of equity and book value of debt) to the its reported assets, sales or earnings.[6]

Berger and Ofek also investigate whether diversified firms destroy value by overinvesting in unprofitable industries. Their measure of over-investment is the ratio of the sum of a conglomerate's capital expenditures and depreciation in 3-digit SIC code industries whose median Tobin's q in the bottom quartile, to the conglomerate's total sales. They find that overinvestment so defined is associated with a loss of excess value.

Next, Berger and Ofek investigate whether cross-subsidization can explain the conglomerate discount. They regress the firm's excess value on an indicator which takes a value of one if the firm has a segment with a negative cash flow and zero otherwise.[7] The coefficient of this negative cash flow dummy is negative for diversified firms and

[5] Graham, Lemmon and Wolf (2002) reach the opposite conclusion. Their study is discussed below.

[6] Berger and Ofek do not use the conglomerate discount directly as their dependent variable, but the natural logarithm of the ratio of the actual firm value to the imputed value obtained by multiplying the reported accounting value by the appropriate multiplier. This number they term excess value.

[7] To compute excess value they estimate separate multiples in each industry for segments that have positive cash flows and those that do not.

indistinguishable from zero for single-segment firms. They thus conclude that having a segment with negative cash flows reduces the value of diversified firms by a greater amount than it reduces the value of focused firms.

Berger and Ofek also compare the long-term debt of diversified firms with the total debt level that would be predicted by summing the debt levels of a collection of single-segment firms that match the diversified firm's segments in size, profitability and investment opportunities. They find that while diversified firms borrow more than predicted, this effect is minor.

In sum, Berger and Ofek argue that their results provide evidence of a "significant loss of value in corporations that followed a diversification strategy in the 1980s". They also supply potential explanations for this loss. First, they find that conglomerate firms invest more in low-q industries. Thus high investment in low-q industries by conglomerate firms is associated with lower value. Second, they find that having a negative cash flow division lowers the value of a conglomerate. They interpret this loss in value as arising from "the subsidization of poorly performing segments contributing to the value loss from diversification".

Using a different methodology, Comment and Jarrell (1995) provide complementary evidence about the valuation of conglomerate firms during the 1978–1989 period. They find that increases in focus, subsequent to asset sales, are associated with increases in value. Their results are summarized in Figure 1.

Figure 1 shows that, on average, increases (decreases) in focus are associated with positive (negative) abnormal stock returns in the year in which focus increases.[8] They also find that some of the presumed economies of scope, such as the ability to support more debt and the ability to reduce transactions in the capital markets, are not exploited more by diversified firms.

The early evidence in Lang and Stulz, and Berger and Ofek shows convincingly that conglomerates sell at a discount when compared to benchmark industry single-segment firms. It is also consistent with the notion that the discount is caused by inefficient operations and that, as Comment and Jarrell argue, the presumed economies of scope do not appear to be exploited. However, both Lang and Stulz and Berger and Ofek draw the reader's attention to potential deficiencies with the data. These potential problems raise several questions:

- To what extent are the well known difficulties with the data material to the estimates of the discount?
- Do the comparables used fully take into account the differences between single-segment and diversified firms? Clearly firms choose their organizational form and this choice may be related to firm and industry characteristics.
- Can the differences in valuation be explained? Do conglomerate firms and single segment firms invest differently?

[8] For a discussion of some of the difficulties in interpreting long-run event studies, see the chapter by Kothari and Warner (2006) (Chapter 1 in this volume).

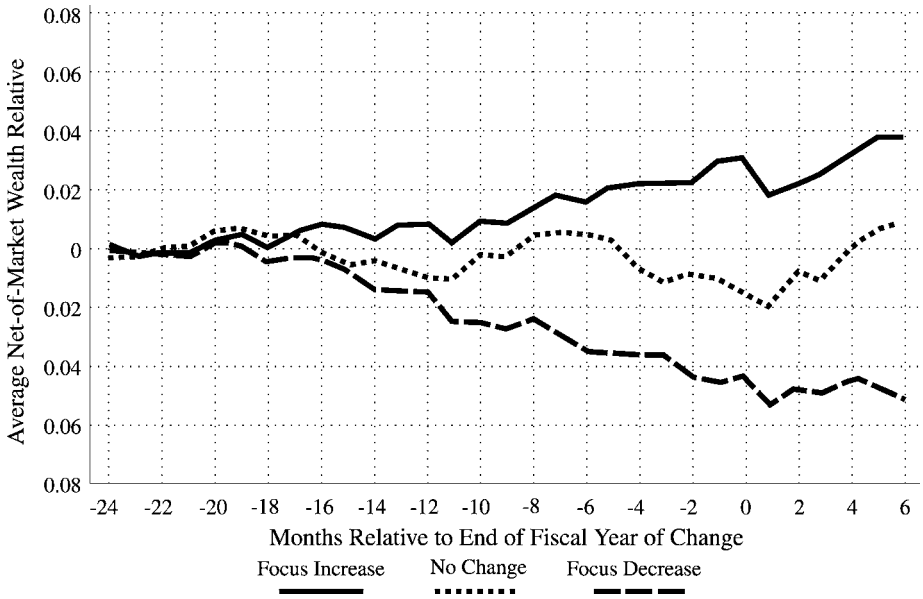

Fig. 1. Event-study showing the average wealth effect of focus changes for three groups of firms segmented by the direction of focus change. The sample consists of fiscal years in the period 1978–1989 for exchange-listed firms. Plotted points represent, for each group of firms, the average month-by-month value of a SI initial investment in the firm less the corresponding month-by-month value of a $1 initial investment in the CRSP equally-weighted market portfolio. Month zero is defined as the last month of the fiscal year of the change in focus, Focus is measured by a Herfindahl index defined on revenue. There are 5,088 fiscal-years with increases in the Herfindahl index, 4,469 with decreases, and 7,056 with no change. Source: Comment and Jarrell (1995), Journal of Financial Economics, Vol. 74, p. 74.

We will be reviewing how the literature has addressed these issues in the remainder of this chapter.

2.2. Initial caveats: The data

Research in firm organization is particularly tricky because researchers are required to look inside the corporation to assess the efficiency of resource allocation between various subunits. Such data is not readily available, and much of the data that is available is subject to potential manipulation and reporting biases. The data problems mean that researchers in this area must pay special attention to data issues and to the potential for measurement error.

The principal data source for the early research on conglomerates is the Compustat Industry Segment (CIS) database. Pursuant to the Statement of Financial Standards (SFAS) No. 14 and SEC Regulation S-K, after 1977 firms were required to report certain audited segment information on segments whose assets, sales or profits are deemed

material by exceeding 10% of the firms' consolidated totals.[9] The CIS database contains information for such segments on net sales, earnings before interest and taxes (EBIT), depreciation, capital expenditures, and assets, as well as the total number of reported segments for the firm. This data is available for all active Compustat firms except utility subsidiaries and is easy for most researchers to access.

There are, however, several well-known problems with CIS data. Firms self-report segment data and changes in the number of reported segments may reflect changes in reporting practice. Hyland (1997) finds that up to a quarter of reported changes in the number of segments stem from changes in reporting policy, not changes in the level of diversification.[10] The reporting requirement also only applies to segments that meet a 10% materiality condition. Thus, segments reported by large firms may be span several industries.[11] Moreover, there is no presumption that a self-reported segment approximates a single industry. According to SFAS 14, a segment is distinguished by the fact that its constituents "are engaged in providing a product service or a group of related products and services ... to unaffiliated customers". Thus, segments may be vertically integrated. The 4-digit SIC in which they are classified by CIS are assigned by COMPUSTAT, not by the firms themselves. This last problem is quite severe: using Census data Villalonga (2004a, 2004b) shows that in over 80% of cases the SIC code assigned by COMPUSTAT is not the code of the segment's largest industry. Taken together, these problems raise the possibility that a substantial number of segments are misclassified into 4-digit SIC codes and that a substantial number of firms that report only one segment in fact operate in related or vertically integrated industries.[12]

Several researchers have used alternative data sources from the US Bureau of Census which do not rely on data which is aggregated up to segment level by firms. Maksimovic and Phillips (1998, 2001, 2002, 2007) and Schoar (2002) use the Longitudinal Research Database (LRD), maintained by the Center for Economic Studies at the Bureau of the Census.[13] The LRD database contains detailed plant-level data on the value of shipments produced by each plant, investments broken down by equipment and buildings, and the number of employees. The LRD tracks approximately 50,000 manufacturing plants every year in the Annual Survey of Manufactures (ASM) from 1974 to 2003. The ASM covers all plants with more than 250 employees. Smaller plants are randomly selected every fifth year to complete a rotating five-year panel. Note that while the annual

[9] Revised disclosure requirements, SFAS 131, superseded SFAS 14 in 1997. Most of the studies that use Compustat data discussed in this review rely on pre-1997 data. Under SFAS 131 firms do not have to report line of business data unless they are organized that way for performance evaluation (Berger and Hahn, 2003).

[10] See also Denis, Denis and Sarin (1997), Pacter (1993) and Hayes and Lundholm (1996).

[11] Villalonga (2004a, 2004b) notes that the maximum number of 4-digit segments belonging to a single firm for her sample of firms drawn from the BITS database of the U.S. Bureau of Census is 133.

[12] Note that the definition of relatedness according to SFAS 14 does not correspond to the SIC classification. Thus, divisions from different 2-digit SIC codes may be related according to SFAS 14.

[13] For a more detailed description of the Longitudinal Research Database (LRD) see McGuckin and Pascoe (1988).

data is called the Annual Survey of Manufactures, reporting is not voluntary for large plants and is not voluntary once a smaller firm is selected to participate in a rotating panel. All data has to be reported to the Censuc Bureau by law and fines can be levied for misreporting.

Annual Survey of Manufactures offers several advantages over Compustat: First, it is comprehensive and covers both public and private firms in manufacturing industries. Second, coverage is at the plant level, and output is assigned by plants at the four-digit SIC code level. Thus, firms that produce under multiple SIC codes are not assigned to just one industry. Third, plant-level coverage means that plants can be tracked even when they change owners.

Villalonga (2004a, 2004b) uses the Business Information Tracking Series (BITS) database, also from the Bureau of the Census. BITS provides data between 1989 and 1996 for all U.S. business establishments, private and public, in all some 50 million establishment-year observations.[14] For each establishment, the BITS database contains data on the number of employees, the payroll and on the identity and revenue of the firm that owns it. Each establishment is assigned to a 4-digit SIC code.

Because the BITS database covers all sectors of the economy and is not limited to the manufacturing sector like the LRD, it is more comprehensive. However, since the available data for each establishment is limited, BITS cannot be used to determine an establishment's productivity.

Villalonga (2004a, 2004b) links the BITS dataset with COMPUSTAT, enabling her to determine the composition of a Compustat firm without relying on SFAS 14 disclosures. She then recomputes the conglomerate discounts of the COMPUSTAT firms that she has linked, using as comparables those COMPUSTAT firms that BITS data identifies as being single-segment firms.

The results are startling. Villalonga finds that diversified firms trade at a significant *premium* over single-segment firms, as so classified using BITS. When COMPUSTAT segment data is used to classify firms, Villalonga obtains the standard conglomerate discount obtained in the earlier literature.

Villalonga explores several possible explanations for this discrepancy. A fundamental difference between BITS and COMPUSTAT is that former treats vertical integration as a form of corporate diversification, whereas the latter does not. However, when Villalonga reconstitutes BITS segments to group together vertically integrated businesses and recomputes the discount she still obtains a conglomerate premium.

These results highlight the fact that COMPUSTAT segments are related by construction, at least in the eyes of the firms. Thus, measures of diversification based on COMPUSTAT data may implicitly be measures of unrelated diversification. It is thus possible that diversification, measured by COMPUSTAT is a measure of inefficient diversification (hence the discount). Villalonga also raises the possibility that Compustat segments are lumped together to avoid disclosing to competitors which segments are most lucrative.

[14] An establishment is a location where a firm conducts business, such as a plant, a store or a warehouse.

The firms classified as single segment in BITS are smaller than the firms classified as single segment in COMPUSTAT. If as, suggested by Maksimovic and Phillips (2002) size is positively correlated with productivity, then the premium that Villalonga finds using BITS data may be occurring because she is implicitly comparing conglomerates, which are larger, with unproductive small single-segment firms.

Finally, several interesting results showing that alternative measures of diversification may affect the interpretation of current results are obtained by Denis, Denis and Yost (2002). They examine global diversification over time. These firms are not necessarily diversified industrially. They document that global diversification results in average valuation discounts of the same magnitude as those for industrial diversification. Analysis of the changes in excess value associated with changes in diversification status reveals that increases in global diversification reduce excess value. One possible implication of their results that is consistent with Maksimovic and Phillips (2002) is that as firms expand they take on less profitable projects but ones that still may have positive NPV, thus reducing *ratio* measures of excess value.

Denis, Denis and Yost (2002) also find that firms that are both globally and industrially diversified do not suffer a diversification discount on average, suggesting that global diversification may in this case benefit firm value. This result is driven by the latter half of the sample period, in which firms that are both globally and industrially diversified are valued at a premium relative to single segment, domestic firms. Their results imply that the value and costs of diversification may change over time.

2.3. Self-selection and the endogeneity of the decision to become a conglomerate

The early research on the conglomerate discount relied on the comparison of conglomerates' divisions with a control sample of comparables using single-segment firms chosen using heuristic criteria described above. The implicit assumption was that conglomerate and single-segment firms faced the same investment opportunities and were of similar ability.

This way of selecting comparables raises issues on two grounds. First, it ignores potentially observable differences between the divisions and the matching single-segment firms that might affect valuation. Second, the heuristic matching procedures implicitly assume that firms become conglomerates randomly, and not as argued by Maksimovic and Phillips (2002), because they differ in material ways from firms that remain single-segment. If the decision to diversify is not random, and is instead based on information observed by the firm but not by the researcher, then the estimation procedure must take into account the endogeneity of the decision.[15]

The underlying hypothesis in the discount literature is that the value of firm i at time t relative to its comparables, V_{it} is a linear function of a set of control variables X_{it} and

[15] For early discussions of this endogeneity in the context of corporate finance decisions, see Eckbo, Maksimovic and Williams (1991) and Prabhala (1997). Chapter 2 in this volume (Li and Prabhala, 2007) contains a much more comprehensive discussion of selection issues in this type of research.

on whether the firm is a conglomerate, denoted by the indicator variables D_{it} which takes on the value 1 if the firm is a conglomerate and 0 if it is not.

$$V_{it} = \beta_1 + \beta_2 X_{it} + \beta_3 D_{it} + e_{it}, \tag{1}$$

where e_{it} is an error term.

A necessary condition for the OLS estimate of coefficient β_3 to be unbiased is for D_{it} to be independent from the error term e_{it} in equation (1). The earlier literature, such as Lang and Stulz, implicitly assume that this condition holds and that conglomerate status can be treated as being exogenous in the estimation. But suppose instead that the firm's decision to operate in more than one industry depends on a set of characteristics W_{it} and a stochastic error term u_{it}. Specifically assume that $D_{it} = 1$ when $\lambda W_{it} + u_{it} > 0$ and $D_{it} = 0$ when $\lambda W_{it} + u_{it} < 0$. Then, the coefficient of in equation (1) will be biased if, as seems plausible, a common determinant of both the value V_{it} and the decision to become conglomerate is omitted from estimated equation (1).

Several recent empirical papers on the conglomerate discount, by Campa and Kedia (2002), Graham, Lemmon and Wolf (2002), Lamont and Polk (2002) and Villalonga (2003, 2004a, 2004b) address these issues. Maksimovic and Phillips (2002) gives an equilibrium justification for the endogeneity of the discount and also empirically shows that there is a size-efficiency relationship that holds for conglomerate and single-segment firms.

The most direct evidence on the importance of self-selection in the determination of conglomerate discounts is provided by Graham, Lemmon and Wolf (2002).[16] They show directly that diversification through acquisitions creates a measured discount in the sense of Berger and Ofek (1995) even when the diversification is value increasing. Using a sample of 356 mergers that occurred between 1978 and 1995 and (i) which met the Berger and Ofek criteria of inclusion in the sample of diversifiers and (ii) for which they had data on both the bidder and the target, Graham et al. show that acquirers register a discount computed in the sense of Berger and Ofek in a two-year window surrounding the acquisition. However, the greater part of this discount can be explained by the fact that the targets are selling at a discount relative to single-segment firms prior to the merger. Thus, much of the discount associated with corporate diversification by acquisition cannot be attributed to the costs associated with operating more diversified firms but can be attributed to the fact that diversifying firms are on average acquiring assets already valued at a discount relative to the industry benchmarks. To the extent that conglomerate firms engage in more acquisition activity than single-segment firms (as shown in Maksimovic and Phillips, 2007), it is possible that their growth pattern might induce a discount even when it is value maximizing.

Campa and Kedia (2002) also argue that the documented discount of diversified firms is not by itself evidence that diversification destroys value. They use three alternative

[16] See Chevalier (2000) for a related argument.

econometric techniques in an attempt to control for the endogeneity of the diversification decision—firm fixed effects, simultaneous-equation estimation using instrumental variables and Heckman's two-step procedure. Their data is from COMPUSTAT and their sample and the measurement of excess value follow the earlier literature. Segments of multiple-segment firms are valued using median sales and asset multipliers of single-segment firms in that industry. The imputed value of a segment is obtained by multiplying segment sales (asset) with the median sales (asset) multiplier of all single-segment firm-years in that SIC. The imputed value of the firm is the sum of the segment values.

Campa and Kedia find a strong negative relation between a firm's choice to be diversified and its value. Firms that are diversified have a lower value than firms that do not. However, once the endogeneity between the decision to be diversified and firm value is taken into account, the diversification discount always drops, and sometimes turns into a premium.

The statistical modeling of the endogeneity of conglomerate status, in turn, raises questions about the nature of the decision to become conglomerate. In their statistical specification, Campa and Kedia implicitly assume that the decision to remain diversified is itself endogenous in each period. This is appropriate if the decision to diversify is easily reversible. However, if the decision is costly to reverse, then it is natural to focus attention on the endogeneity of the decision to diversify (as opposed to the endogeneity of the decision to maintain conglomerate status), or more generally on changes in the level of diversification.

Villalonga (2004a, 2004b) focuses on the decision to become diversified. Using a Compustat for the years 1978–1997 she identifies 167 firm years in which single-segment firms diversified. Her control sample consists of 40,757 single-segment firm years. She adopts a two-stage procedure. In the first stage, she uses a probit model to obtain the probability that a firm becomes diversified, which she terms the propensity to diversify. For the probits Villalonga tries several specifications, including one that uses the same explanatory variables as Campa and Kedia (2002).

In the second stage Villalonga controls for the estimated propensity to diversify in determining whether becoming diversification destroys value. She uses two types of matching estimators (the methods proposed by Dehejia and Wahba, 1999, and Abadie and Imbens, 2002) and Heckman's (1979) correction for selection bias. As in Campa and Kedia's (2002) tests, Heckman's method directly corrects for biases due to unobserved characteristics of firms that choose to diversify. The matching estimators use the estimate of the propensity to merge as one of the characteristics for finding matching non-diversifying single-segment firms that are comparable to the diversifying single-segment firms. Consistent with Campa and Kedia (2002), Villalonga finds that the decision to diversify did not affect the value of the 167 firms that she identifies as having diversified during her sample period.

Lamont and Polk (2002) adopt a different approach and a difference definition of the extent of diversification in their study of the relation between diversification and value. They argue that a key characteristic of an industry is the ratio of investment to

capital stock. In their view a firm that operates in industries that have a greater disparity of investment to capital stock ratios is more diversified than a firm that operates in industries that have similar investment to capital stock ratios. Thus, for each 2-digit SIC code industry to which COMPUSTAT assigns the firm's segments, Lamont and Polk calculate the median investment to capital ratio among the single-segment firms. The measure of a conglomerate firm's diversity in year t is then computed as σ, the weighted standard deviation of these median ratios for all segments.

Lamont and Polk argue that changes in σ over time can be decomposed into endogenous and exogenous components. The exogenous change in diversity, $\Delta\sigma_X$, is the change in diversity between $t-1$ that would have occurred if COMPUSTAT had assigned the firm in the current year to precisely the same 2-digit SIC codes as in the previous year. The endogenous change in diversity, $\Delta\sigma_N$, is the change in diversity that occurs because the 2-digit SIC codes assigned to the firm have changed between years $t-1$ and t.

Lamont and Polk use COMPUSTAT data for 1,987 diversified firms during the period 1980–1997. They find that 80% of the variation in firms' diversity is due to exogenous industry shocks. In their regressions they regress the change in excess value on $\Delta\sigma_X$ and $\Delta\sigma_N$ alone and with control variables such as lagged σ. They find that increases in both $\Delta\sigma_X$ and $\Delta\sigma_N$ reduce firm's excess value. They interpret the negative coefficient of $\Delta\sigma_X$ as evidence that diversification reduces firm value. This finding persists even when plausible measurement error is taken into account. Lamont and Polk (2002) also analyze similarly defined changes in diversity of leverage, cash flows and sales growth one at a time. They do not find that "exogenous" changes in diversity of these variables have a significant negative effect by themselves.

Lamont and Polk's interpretation of their results on investment diversity are in sharp contrast to Campa and Kedia (2002) and Villalonga (2004a, 2004b) and have not been fully reconciled with these studies. Villalonga (2003) argues that Lamont and Polk's measure does not pick up "diversification" as traditionally measured in the literature—the presence of the firm's operations in more than one industry—but "diversity" which is the within firm dispersion of some industry characteristics. Indeed, she reports tests that show that measures of diversification, such as the number of two digit industries that the firm operates in are uncorrelated with Lamont and Polk's measure of exogenous cash flow diversity $\Delta\sigma_X$. However, this observation raises the question of which measure better captures economic differences between firms.

3. Theory explaining the conglomerate discount and organizational form

The early literature on the conglomerate discount leaves several questions unanswered. Perhaps the most fundamental of them is why there should be a conglomerate discount? Is the existence of a discount evidence of bad investment choices or is the discount an endogenous outcome of a process by which different types of firms optimally select

different types of expansion paths, given different investment opportunities? If there is evidence of inefficient investment choices, why do they occur?

Conceptually, the conglomerate discount is an unlikely subject for academic research. In most introductory corporate finance classes MBA students are painstakingly taught that firms should maximize the net present value of their investments, not the ratio of market value to replacement cost. In fact, they are explicitly warned that maximizing the latter, which is equivalent to maximizing the profitability index, leads to inefficient investment choices in the presence of capital constraints.[17] Yet when we evaluate the performance of conglomerates, we do so using the conglomerate discount, which is equivalent to comparing the profitability indices of conglomerate and single-segment firms. We do this because of the practical difficulties of obtaining properly scaled measures of value, and not because the literature has shown that it is a measure of a relevant measure of performance.

In this section, we review the theoretical frameworks that have been used to motivate the recent empirical literature on diversification and the investment of diversified firms. We begin with the literature which assumes there is a "bright" side of conglomerates—that conglomerates internal allocation of financial capital has benefits. This literature assumes that firms would not become conglomerates unless there is some benefit of doing so in terms of allocating financial capital within the firm. However, this literature does not explain why there is a discount. Implicitly the literature on the bright side of conglomerates assumes that the discount would be larger if the conglomerate's segments were stand alone single-segment firms, which prompts questions about the appropriate comparables to use in determining the discount. We illustrate this line of research with Stein's (1997) model of how diversified firms' internal capital markets lead to a different selection of investment projects than when firms operate in a single industry. Second, we discuss Matsusaka's (2001) model of how organizational competencies may drive the diversification decision.

Third, we discuss the literature which takes the opposite perspective and models how conflicts of interest between the firm's managers and the firm's owners may lead to inefficient diversification. Fourth, several models taking the same perspective of inefficient diversification have argued that intra-firm bargaining in firms operating in several different environments leads to poor investment choices (Rajan, Servaes and Zingales, 2000; Scharfstein and Stein, 2000).

Finally, we end with discussion of equilibrium models of the conglomerate firm which show that the conglomerate discount can arise endogenously and that conglomerate investment is a profit-maximizing approach to differential investment opportunities.

The papers that we review are only a small portion of the theoretical literature on the conglomerate firm. The models are all highly stylized and rather informally presented. In part, this is because data constraints make it very hard to test complex structural models of intra-firm dynamics. They are nonetheless important for our purposes because

[17] See, for example, Brealey and Myers (2003) and Ross, Westerfield and Jordan (2006, p. 283).

they have motivated several of the empirical studies we examine below. In the interest of brevity, we do not discuss several models which deserve a separate review, including Berkovitch, Israel and Tolkowsky (2005), Faure-Grimaud and Inderest (2005), Fluck and Lynch (1999) and Inderst and Meuller (2003).

3.1. Efficient internal capital markets

Stein (1997) analyzes how internal capital markets create value and the optimal size and scope of such markets. In Stein's model firms consist of either a single stand-alone project or of several projects overseen by a headquarters. Stein assumes that each project's managers obtain private benefits from managing their project. These benefits are higher for better projects. The private benefits give managers an incentive to overstate their project's prospects. This is known to potential investors, who therefore supply less capital than the managers request. As a result, good projects are capital rationed if they operate as individual firms.

Stein assumes that a conglomerate's headquarters has the ability to monitor the projects it oversees. It uses its information in two ways. First, it can transfer capital from one project to another. Second, it can appropriate for itself some of the private benefits of the project managers, albeit at the cost of diluting the incentives of the managers.

Because the headquarters can extract private benefits from several projects simultaneously it has the incentive to allocate capital to the better projects. The ability to transfer funds across projects, allocating some more funds than they would be able to raise as stand-alone firms, and others less, makes better allocation possible.

A key assumption in Stein (1997) is that as the number of projects overseen by the headquarters increases, the quality of monitoring provided by the headquarters declines. However, as the number of projects the quarters oversees increases, the headquarters in Stein's model also gains in two ways. First, the value of its ability to transfer funds from the worst to the best projects increases. Second, if the project payoffs are not perfectly correlated the volatility of the firm's payoffs declines and it becomes able to raise more funds from the capital market, thereby reducing credit rationing and increasing value. The firm reaches its optimal size when the marginal decline in value due to declining monitoring ability is equal to the marginal increase resulting from the relaxation of financing constraints and the funding of good projects.

The theory also has implications for the optimal scope of the firm. Stein addresses two effects which work in opposite directions. To the extent that the returns of different divisions of a conglomerate are uncorrelated diversification increases the value of the headquarters' ability to direct investment funds and raise capital externally. However, there may be another effect at work. Because headquarters' allocation decisions are dependent on the *ranking* of investment projects rather than their absolute values, and to the extent that accurate rankings are more likely to be made if all projects are within the same industry (because valuation errors are likely to be correlated), diversification is costly.

Thus, Stein suggests that diversification is value increasing when valuation errors are small and when the returns of projects within an industry are highly correlated, Diversification is value reducing when valuation errors are likely to be large and when the payoffs of projects within industries are likely to have a low correlation.[18]

3.2. Conglomerates and organizational competencies

Matsusaka (2001) develops a matching model to explain why conglomerate firms exist. In his model firms have different organizational competencies. The organizational competencies are somewhat transferable across industries. When sales decline in an industry it is not optimal for firm to go out of business. Instead it should diversify into new lines of business in order to find a good match between their organizational competence and the line of business. If they find a good match they may transit into the new industry and exit their original industry.

Matsusaka's (2001) elegant framework generates several predictions. Diversifying firms trade at a discount because on average the match between their organizational competence and their existing main divisions is bad. Because the match in the new industry may also turn out to be bad, many diversification attempts are in fact reversed. However, the announcement of a diversification is a signal that the firm is worth maintaining, resulting in a positive announcement effect. The theory also predicts that successful diversifiers quit their original industry. Thus the theory is quite consistent with the early evidence on the diversification discount (e.g., Lang and Stulz, 1994, and Berger and Ofek, 1995), as diversification results from a poor match between industries and firm's organizational competence, and on announcement returns (e.g., Schipper and Thompson, 1983; Hubbard and Palia, 1998) which document positive or non-negative returns to changes in the level of diversification.

3.3. Diversification and the failure of corporate governance

Given the message from the early literature that diversification destroys value, the obvious question is why we observe so many diversified firms. One plausible answer is that while diversification destroys investor value it benefits the managers of corporations. Thus diversification might arise as a result of a failure of corporate governance which should be penalizing managers who diversify inappropriately.

Jensen (1986) and Stulz (1990) argue that managers may obtain increased status and perquisites when they diversify their firms. Diversification allows managers to act on a broader stage, and in particular may allow them to participate in "hot" and exciting industries. It may also be easier to skim from a diversified firm (Bertrand and Mullainathan, 2001).

[18] The model does not analyze the possibility that a focused firm may rank projects correctly but over- or under-invest in the aggregate because the valuation errors it makes are correlated across projects.

Diversification may also yield concrete career benefits, because experience running a complex diversified firm might provide experience that the increases the value of the manager's future employment prospects (Gibbons and Murphy, 1992). On the other side of the coin, diversification may entrench the manager because it may be harder to find a replacement who has a demonstrated ability in managing the firm's particular mix of businesses (Shleifer and Vishny, 1989).

Taken together, the literature on agency makes a powerful prima fasciae case that agency conflicts may drive unprofitable diversification. An issue in determining the extent to which this is the case is that most of the contributions are set in a partial equilibrium framework. Thus, it is not clear why the incentives are not set in ways that penalize unprofitable diversification. Moreover, it is not clear why diversification is inefficient. A rational empire-building CEO of a diversified firm can in principle decentralize its operations and provide incentives to the managers running the firm's divisions so that firm value is not destroyed. Thus, it must either be the case that increasing the firm's scope the firm itself destroys value or that managers of firms that diversify are irrational and have a hubristic belief in their ability to run acquired businesses (Roll, 1986).

There have been only a few attempts to analyze the manager's incentive to diversify in a more general model of the trade-offs. This is in part because the incentives of, and the constraints faced by, the board of directors, the party that formally employs the manager, are not well understood.[19]

Aggarwal and Samwick (2003) model the diversification process by assuming that the board maximizes the value of the firm. The key assumption is that diversification, which is assumed to be value destroying, is not contractible and cannot be forbidden by the board. The CEO benefits from diversification, because it enables him to diversify his risk and because he has private gains from diversification. The board can attempt to motivate the manager to work harder by tying his compensation to firm value. However, this type of compensation has a byproduct of increasing the manager's risk exposure, making value destroying diversification more attractive. In equilibrium, managerial compensation is set as a result of contracting in a standard principal agent problem where managerial effort is costly.

In Aggarwal and Samwick (2003) the manager's compensation w is given by $w = w_0 + \alpha\pi + \gamma n$, where α and γ are constants chosen by the firm, n is the amount of diversification and π is the firm value. Firm value is given by $\pi = x - n + \varepsilon(n)$, where x is the costly managerial effort and $\varepsilon(n)$ is a normally distributed shock to firm value with zero mean and variance σ^2/n. For the manager, diversification has three consequences. First, it affects the value of the corporation and thereby the manager's compensation through the α term. Second, it enables the manager to diversify risks since it reduces the risk of the corporation σ^2/n. Third, diversification enters directly in to the

[19] See Hermalin and Weisbach (1998) for a theoretical model in which the relationship between the board of directors and the CEO evolves over time.

manager's utility function because it affects the value of his proprietary benefits. Given the assumed relation between diversification and value, and the assumed compensation contract, the firm's directors can affect the manager's actions by tying his rewards to performance.

The board of directors offer the CEO a linear contract based on π and n. The CEO chooses the level of diversification n and effort x. The π is realized and the CEO is compensated on π and n.

This framework leads to some interesting predictions, which differ from those that would be derived by intuition alone. For example, suppose that there is an exogenous increase in the amount of private benefits that the manager can gain from diversification that is value destroying for the firm. In equilibrium it would be optimal to increase his performance pay in order to reduce his incentive to diversify. However, in an interior equilibrium this increase will not be enough to totally negate the effect of the exogenous increase in private benefits from diversification. As a result, empirically we would observe contemporaneous increases in incentive based pay and in diversification. However, the positive correlation would not be an indication of a causal relation. More generally, the empirical relation between incentives and diversification shows that the interpretation of simple correlations between incentive based compensation and diversification is not straightforward.

Aggarwal and Samwick (2003) derive testable relations regarding changes in firm value, incentive compensation and level of diversification in response to changes in exogenous parameters, such as managerial risk aversion or the ability to gain private benefits from diversification. They estimate this relation on about 1600 firms in the 1990s using COMPUSTAT, CRSP and ExecuComp data. The pattern of relations they find is consistent with their model's predictions for the case in which diversification decisions are driven by increases in managers' private benefits from diversifying.The advantage of an explicit modeling approach as in Aggarwal and Samwick (2003) is that it yields a set of transparent predictions that can be taken to data and checked for consistency. For this clarity to be attained the researcher has to take a point of view about the underlying relation. Other initial structures, in which, for example, the board can monitor and approve diversification or where not all diversification reduces value—may yield different predictions on the value of diversification.

3.4. Diversification and the power within the firm

Another strand in the literature argues that investment decisions within diversified firms are driven by the need to moderate conflicts of interests between different divisions and different levels of the hierarchy within the firm. The starting point for this research are the observations by Lamont (1997) and Shin and Stulz (1998) that diversified firms capital expenditures are not as sensitive to proxies of industry opportunities as focused firms. Such distortions would be unlikely to occur in the standard agency framework where the CEO has an incentive to maximize firm value so as to maximize his ability

to expropriate investors. While such distortions might occur in more complex agency models, where top management diversifies out of career concerns or to reduce risk, it is also plausible that the distortions be caused by intra-firm conflicts.

In the classic influence cost model of intra-firm conflict, Meyer, Milgrom and Roberts (1992) model a resource process where lower-level managers of a firm attempt to lobby top management to increase the investment flows available to their firm. The lobbying is costly, but in equilibrium top managers infer the true value of investment opportunities by observing the costly lobbying. Thus, the lobbying leads to inefficiency but does not lead to misallocation of resources.

In Scharfstein and Stein (2000), managers of divisions which lack investment opportunities have a low opportunity cost of their time and therefore engage lobbying which is creates costs for the firm as a whole. An efficient response to such lobbying might be for the firm's owners to bribe the managers of weaker divisions to desist. However, the top managers of firms are themselves the agents of the firm's owners and this affects how they pay off the divisional managers. Scharfstein and Stein (2000) derive conditions under which top management finds it optimal to bribe troublesome divisional managers by giving them too large a share of the investment budget rather than with cash. This occurs because top managers cannot directly expropriate the firm's capital budget whereas they can extract benefits from any operating funds that they would have used to pay divisional managers. Thus, to reduce the cost of lobbying, top management overinvests in the divisions with poor growth opportunities.[20]

A central assumption of this approach is that the top management has limited power over the divisional managers. An alternative response by top managers who do have such power might be to change the reporting structure within these divisions or add extraneous task which can be easily monitored to the divisional managers' workload so as to increase the opportunity cost of their time and thereby reduce their propensity to lobby. Another possibility might be for the firm to sell or spin off its weaker divisions.

Rajan, Servaes and Zingales (2000) explore another implication of limited head office power over divisions. They argue that while top management can direct capital expenditures across divisions it cannot commit to a future distribution out of the value created by the investment. The distribution of the surplus is determined through negotiations between divisions after the surplus has been realized. The inability of top management to commit to a distribution means that a division's investment choices may be distorted.

A key assumption about the ex-post bargaining process between divisions is that the divisions' bargaining power is influenced by their initial investment decisions. As a result, it might be in the top management's interest to initially allocate initial investment capital in a way that will influence the outcomes of future bargaining between divisions over the distribution of the surplus rather than to maximize value. Given a distribution of capital across divisions, divisional managers will update their predictions about the

[20] See also Fulghieri and Hodrick (1997).

likely outcomes of bargaining over the surplus and make investment choices accordingly. It is in the top management's interest to allocate initial investment funds in ways that induce the divisional managers to choose projects that maximize the firm's value.

Hence, in RSZ top management uses the initial allocation of investment to divisions as a commitment device to substitute for its inability to commit to a distribution of surplus. This form commitment is clearly not as efficient as a first-best case in which top management can commit to the distribution of profits that the divisions realize. Empirically, the capital expenditures of conglomerates might seem, and would be, less efficient than those of single-segment firms. However, they are value maximizing given the constraints that top managers face.

RSZ make specific assumptions about the way the bargaining between divisions works and obtain predictions about the distortions that arise. Specifically they assume that each division can choose to invest in two types of investment projects. "Efficient" projects are value maximizing. "Defensive" projects produce less value, but the value generated can be better defended against redistribution to other divisions. The top management's problem is to allocate the right amount of capital to each division and to motivate the divisional management to invest the capital in the efficient project.

The divisional manager's incentive to choose a defensive project is higher when the surplus generated by the efficient project, which he has to partially give up in ex-post bargaining with other divisions, is high relative to the manager's share of the other divisions' surplus that he expects to gain in bargaining. Under plausible assumptions, this occurs when the manager's division has better investment opportunities than the other divisions. As a result, perverse investment incentives are more likely to occur in firms with divisions facing diverse investment opportunities.

The RSZ model predicts that the value of diversified firms is inversely related to the diversity in their investment opportunities. The model also predicts that capital transfers will occur from large high-value divisions to small low-value divisions. Both of these predictions are testable. We discuss these tests later.

A central feature of most theoretical models of the conglomerate firm is that they are partial equilibrium in the sense that they do not analyze the firm's internal allocation of capital in the context of the market for whole firms and partial-firm assets. As Maksimovic and Phillips (2001) show, there is a large market for assets in which conglomerates are important players. Thus, as an alternative to distorting the firm's investment expenditures, a firm facing the problems modeled by RSZ might trade divisions to obtain a diversified portfolio of assets that faces comparable investment opportunities. Thus, a generalized RSZ framework might suggest that the firm can operate on an alternative margin, yielding the prediction that at times when the market for firms' assets is active, firms are less likely to distort investment flows.

3.5. Neoclassical modelof conglomerates and resource allocation

The case in which firms maximize value and there are no unresolved agency problems provides a benchmark for an analysis of conglomerate growth and diversification.

Arguably, if investment patterns in conglomerates can be predicted by a neoclassical model, then the effort in explaining misallocation of resources by managers may be better directed at examining other forms of shareholder expropriation. Maksimovic and Phillips (2002) consider a neoclassical model where firms differ because managerial and organizational talent or some other fixed resource varies across firms. Interestingly, the neoclassical model for conglomerate firms was introduced after the initial models of power within the firm. It has motivated empirical models of investment within the conglomerate firm and also endogeneity and sample selection models.

In Maksimovic and Phillips (2002) the firm decides endogenously whether to produce in one or in several industries. As in Coase (1937) and Lucas (1978), it is assumed that there are diseconomies of scale within firms. Firms exhibit neoclassical decreasing returns-to-scale, so that their marginal costs increase with output. Specifically, firms use the variable inputs of labor, and capacity units to produce output.

In each industry, firms with higher organizational ability or talent can produce more output with the same amount of input, and thus have higher productivity, than firms with lower ability or talent. Thus, differences in talent have greater economic significance when output prices are high. The productivity with which any given firm operates plants can differ across industries in which it operates. For a given output price and a given talent level, there are decreasing returns to scale in each industry in which the firm operates and at the level of the whole firm.

For concreteness, consider a population of firms that can operate in a maximum of two industries, which we denote as industry 1 and industry 2, respectively. The productivity of each firm can be modeled by a vector (d_1, d_2), where the firm's talent in industry i is d_i. Firms that have a higher productivity in industry i, d_i, produce more output for a given level of inputs if they choose to operate in industry i. All firms are assumed to be price-takers and to produce a homogeneous output. Firms use two inputs: industry-specific homogeneous production capacity k and labor l. Further assume that firms can trade capacity with other firms in the same industry or build capacity at price r per unit. For tractability, we assume that each unit of capacity produces one unit of output. For each firm, the profit function is

$$d_1 p_1 k_1 + d_2 p_2 k_2 - r_1 k_1 - r_2 k_2 - \alpha l_1^2 - \alpha l_2^2 - \beta (l_1 + l_2)^2, \tag{2}$$

where p_i and r_i are the prices of output and capacity in industry $i = 1$ or 2, α and β are positive cost parameters, and k_i is the capacity the firm maintains in industry i. The profit function embodies the assumption of neoclassical diminishing returns within each industry (the αl_i^2 terms) and the assumption that when organizational talent is a scarce resource, costs depend on the firm's total size (the $\beta(l_1 + l_2)^2$ term). A firm is diversified if $k_1 > 0$ and $k_2 > 0$ and single segment if capacity in only one of the two industries is greater than 0.

The model can be solved at the firm level to give the firm's optimal capacity (k_1, k_2) in each of the industries as a function of its own productivity vector (d_1, d_2), and industry-level variables, demand (p_1, p_2) and the cost of capacity (r_1, r_2). Optimal outputs by the firms in each industry can be obtained by direct optimization. Dropping the firm

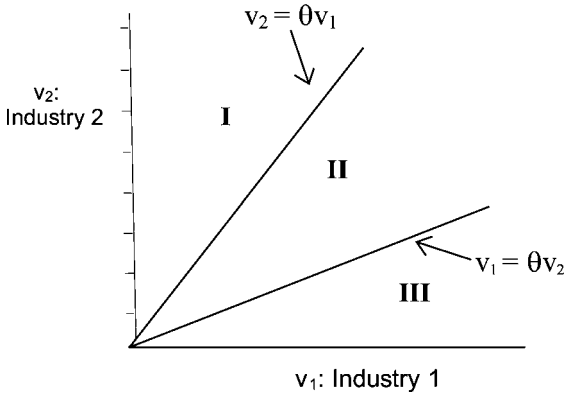

Fig. 2. Optimal production with differing ability across industries.

subscripts and defining $v_i = d_i p_i - r_i$, it can be shown that the optimum output for a firm, assuming conglomerate production, is given by

$$k_1 = \frac{(\alpha+\beta)(d_1 p_1 - r_1) - \beta(d_2 p_2 - r_2)}{2\alpha(\alpha+2\beta)} = \frac{(\alpha+\beta)v_1 - \beta v_2}{2\alpha(\alpha+2\beta)},$$
$$k_2 = \frac{(\alpha+\beta)(d_2 p_2 - r_2) - \beta(d_1 p_1 - r_1)}{2\alpha(\alpha+2\beta)} = \frac{(\alpha+\beta)v_2 - \beta v_1}{2\alpha(\alpha+2\beta)},$$

for $v_2 > \beta v_1/(\alpha+\beta)$ and $v_2 < (\alpha+\beta)v_1/\beta$. For values of v_1, v_2 outside of this range, a firm will choose to be a single-segment firm.

Figure 2 illustrates which firms choose to be either conglomerates or single-segment firms. Letting $\theta = (\alpha+\beta)/\beta$, we can illustrate optimal organizational form across industries.[21] If $v_2 > \theta v_1$, then the firm will produce only in industry 1, so that $k_2(v_1, v_2) = \frac{v_2}{2(\alpha+\beta)}$ and $k_1(v_1, v_2) = 0$. Similarly, if $v_1 > \theta v_2$, then $k_1(v_1, v_2) = \frac{v_1}{2(\alpha+\beta)}$ and $k_2(v_1, v_2) = 0$.

Firms in region II optimally choose to be conglomerates, whereas firms in regions I and III choose to produce in a single segment. Specialization is optimal if the firm is much more productive in one industry than the other; diversification is optimal if the productivities are similar. Thus, the decision to diversify depends in part on the firm's comparative productivity in the two industries. An implication of this result is that, all else being equal, a conglomerate's large segment is more productive than its small segment.

The relation between productivity and focus in a population of firms depends both on the distribution of ability within these firms and on the distribution of ability across firms. If organizational talent is industry-specific, firms that are highly productive in

[21] The figure assumes that $r_1 = r_2$. More general cases are discussed in Maksimovic and Phillips (2002).

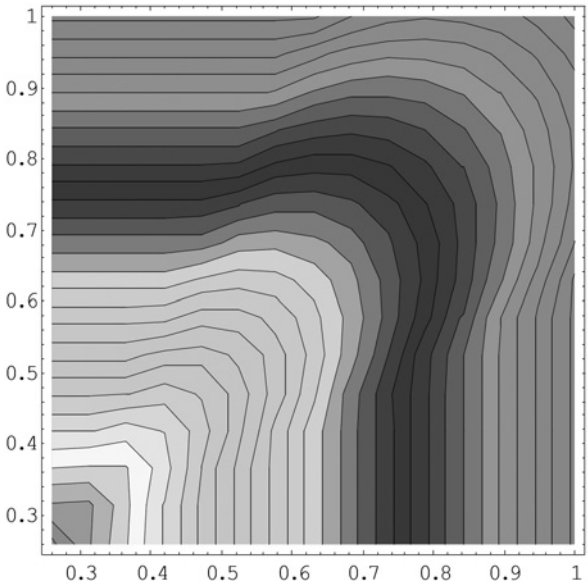

Fig. 3. Market-to-book value contour plot.

one industry are likely to be relatively less productive in the other industries and thus are more likely to operate in a single industry. Firms whose organizations are not highly adapted to any one industry are less focused. By contrast, if organizational talent is not industry-specific, so that $d_1 = d_2$, all firms divide their production equally between the industries. In this case, there is no relation between productivity and focus, and there are no differences in productivity across segments. Larger firms, however, are more productive than smaller firms across all segments.

We can show this relation between the productivity in industry 1 (d_1) and productivity in industry 2 (d_2) graphically. In Figure 3, we plot "iso-valuation" lines, plotting a firm's market-value-to-book-value (replacement cost of assets) ratio as a function of its productivity in industry 1 (d_1) and 2 (d_2).[22] We can define a firm's market over book as follows:

$$\frac{\text{MV}}{\text{BOOK}} = \frac{d_1 p_1 k_1 + d_2 p_2 k_2 - \alpha l_1^2 - \alpha l_2^2 - \beta (l_1 + l_2)^2}{r_1 k_1 + r_2 k_2}. \tag{3}$$

The axes of Figure 3 are a firm's productivity in productivity in industry 1 (d_1) and 2 (d_2). The band (the height if the graph were 3D) of the graph tells us the amount produced in each industry and equivalently the average market value to book value of

[22] In this simple context the market-to-book ratio is equivalent to Tobin's Q.

the firm. Each band in the figure represents firms with equal market value to book value ratios.

We can observe that for a firm to produce in two distinct industries near a 45 degree line in the center of the graph, it has to have *higher* productivity than firms with equivalent market value to book value ratios. Equivalently, if we match by productivity (or size) single segment firms in two industries to a conglomerate firm producing in both industries, the conglomerate firm will have a *lower* market value to book value ratio than the weighted average of the single segment firms. Thus one cannot in general conclude that multi-segment firms with lower market to book ratios are allocating resources inefficiently.

We now illustrate the effect when we generalize the model allowing firms to produce across ten different industries. We illustrate this using two numerical examples that show how differences in organizational talent across industries causes firms to choose to operate segments of different sizes and different observed productivities.

In each example we take the number of industries to be ten. We assume there are 25,000 potential firms, each of which is assigned firm-specific ability for each of the ten industries. In terms of the previous discussion and the empirical work, high ability is the same as high productivity. We draw the ability assignment d from a normal distribution with a mean ability of 1 and a standard deviation of 0.5. The output and input prices and the cost parameters in all industries are held constant (in this case we set the parameters from equation (1) as follows: $p = 200$, $r = 200$, $\alpha = 5$, $\beta = 2$). In the first example, firm ability is industry-specific. Firms' ability to manage in one industry is independent of their ability to manage in the other industries. Thus, the draws are independent and identically distributed both within firms and across firms. In the second example, there is a firm-specific effect: The draws within a firm for each of the ten industries are correlated. We draw the common ability from a normal distribution with a mean equal to 0 and standard deviation equal to 0.25. We add this common ability to the random industry ability drawn earlier. Thus, part of a firms' ability can be applied equally to all industries. In each case we determine the industries in which it is optimal for each firm to produce and also the amount of each firm production in each industry, given the price of output and the prices of inputs. We keep track separately of firms that choose to produce in one industry only, two industries only, etc., up to firms that choose to produce in all the industries (if such firms exist). Thus, we have simulated data on one-segment firms, two-segment firms, etc. For all firms with a given number of segments, we rank the segments by size, and we compute the mean firm ability d for that segment.

In Figure 4 we allow the draws of firm ability in each of the 10 industries to be independent. We call the industry in which the firm produces its "segments". We label the segment in which the firm produces the most its segment #1, the industry in which produces its second most, its "segment #2", increasing this for each of the firm's remaining segments. The height of the graph (z-axis) gives the managerial ability *and* equivalently the size of the firm in that industry in which the firm produces. Each row of the figure

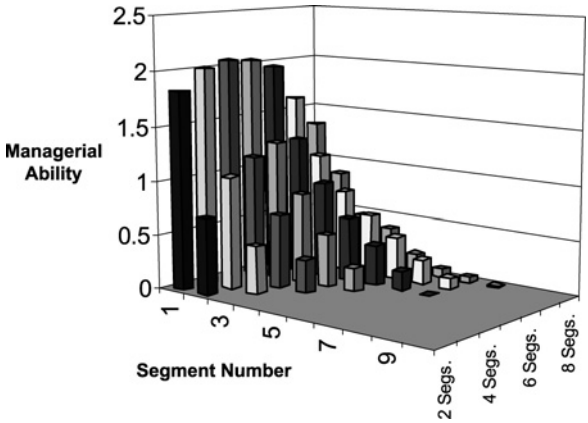

Fig. 4. Ability by segment. Model with no common managerial ability across industries.

thus contains the average of productivity by segment number (x-axis) for firms with a given number of segments (y-axis).

Figure 4 thus illustrates the case in which the assignment of firm ability is independent across industries in which the firm produces. The figure shows how average firm talent in the economy varies by the number of segments a firm operates in and by segment rank. As predicted, the figure shows that within firms the main segments of conglomerates have higher productivity than peripheral segments. As we go across the number of segments in which a firm operates equally ranked segments at first become more productive and then less productive. The drop-off in productivity occurs because it is very unlikely that any single firm is productive in all ten industries. Thus, firms that choose to produce in many industries are likely to have mediocre ability in all of them. In this simulated example, no firms in the sample produce in all the industries. A simple OLS regression on the simulated data shows that firms' mean productivity is positively and significantly related to their focus, measured by the Herfindahl index, and size. These relations between focus and productivity are obtained even without assuming the existence of agency costs.

In Figure 5, we allow ability in each segment to have a firm-specific component, so that a firm which highly productive in one industry is likely to be highly productive in other segments. As in Figure 4, the height of the graph (z-axis) gives the managerial ability *and* equivalently the size of the firm in that industry in which the firm produces. Each row of the figure thus contains the average of productivity by segment number (x-axis) for firms with a given number of segments (y-axis).

In Figure 5, we still see that the main segments are more productive than the peripherals. However, now equally ranked segments are more productive in firms that operate in more segments. Firms that choose to operate in many segments are on average more productive. Interestingly, a simple OLS regression shows that firms' mean productivity

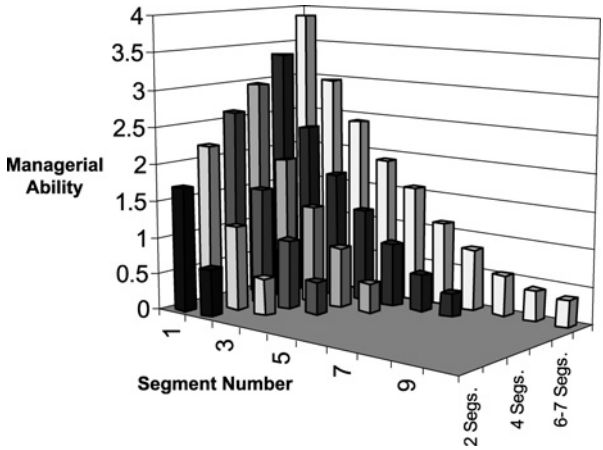

Fig. 5. Ability by segment. Model with common managerial ability across industries.

is again positively and significantly related to their focus, measured by the Herfindahl index, and size, albeit less so than with no common firm talent.

While the simple model makes predictions about the distribution of firms' production, this distribution of production across industries depends on the distribution of ability. However, ability is hard to measure. As a result, the predictions on the distribution of segment size and productivity industries do not directly differentiate the model from other models which predict that firms inefficiently expand into industries outside their core competence. To differentiate the neo-classical from other views, it is necessary to obtain predictions about the firm's responses to exogenous shocks to the industry environment. We discuss this below.

More recently, Gomes and Livdan (2004) embed and calibrate the model in Maksimovic and Phillips (2002) in a dynamic setting.[23] They show explicitly that for the parameter values they select the calibrated model is consistent with Lang and Stulz's (1994) findings on the diversification discount. They can also reproduce Schoar's (2002) finding that expanding focused firms are less productive after diversification than non-expanding focused firms.

[23] Gomes and Livdan (2004) argue that the models differ in certain respects. However, these differences do not affect any of the main intuitions. In essence, the differences come down to technical assumptions that ensure the existence of an equilibrium in which some firms specialize and others do not. Maksimovic and Phillips' implicitly assumes that a firm that chooses to produce in two industries has higher costs than would two identical firms that together produce the same output as the diversified firm but that are *constrained* to specialize in one industry each. By contrast, Gomes and Livdan assume that there is a fixed cost to producing in any industry. Both assumptions serve to counterbalance the assumption of diminishing returns to scale in each industry which both papers make, and which would otherwise make diversification more attractive.

4. Investment decisions of conglomerate firms

We next review the recent evidence on the conglomerate discount and conglomerate firms' investment decisions by examining first the investment and resource allocation decision of existing conglomerate firms. We then review the literature on spinoffs and divestitures of conglomerate firms.

There have been four major ways that the literature has addressed how conglomerate firms may invest differentially. First, there has been a branch that has examined whether conglomerate firms have differential investment—cash flow sensitivity. Second, there have been studies examining investment allocation across projects by firms within a single industry. The advantage of the single-industry studies is that in controls for differences investment opportunities that might be hard to measure. Third, several studies have examined how firms should invest when faced with differential opportunities based on the neoclassical investment model. Fourth, studies have examined divestitures and spin-offs for evidence of decreased agency costs after the divestiture. We review each of these areas in turn.

4.1. Investment–cash flow sensitivity

The models of conglomerate investment relate the conglomerate firm's investment expenditures in each segment to the segment's investment opportunities and to the state of the firm's internal capital market.

Neoclassical theory suggests that the firm's level of investment should depend only on its perceived investment opportunities measured by the firm's marginal Tobin's q, where marginal Tobin's q is the value of the investment opportunity divided by the cost of the required investment.[24]

Shin and Stulz (1998) and Scharfstein (1998) use this relation between Tobin's q and investment to examine how a firm's internal capital market allocates investment. If the internal capital market is as efficient as the public market for capital we would expect to see a similar relation between investment and Tobin's q for the segments of conglomerates and for single-segment firms.

One set of tests estimates an investment equation on single-segment firms and conglomerates' segments. Consider equation (4)

$$i_j = z_j\gamma + q_j\beta + \zeta_j, \tag{4}$$

where i is the firm's capital expenditures, q is the marginal Tobin's q and z is a vector of exogenous explanatory variables. For single segment firms the marginal Tobin's q

[24] Tobin's q is usually defined as the value of the firm (equity and debt claims) scaled by the replacement value of the firm's assets. In the corporate finance literature this quantity is often approximated by the ratio of the market value of a firm's assets (market value of equity + book value of assets − book value of equity-deferred taxes) to the book value of assets. See Whited (2001).

is usually proxied by the firm's average Tobin's q.[25] For conglomerate segments we cannot observe the segment's average q directly, but must use a proxy. The usual proxies in the diversification literature are based on the average or median Tobin's qs of single-segment firms operating in segment j's industry.

When equation (4) is run via OLS, the coefficient β is higher in single-segment firms than in conglomerates, suggesting that conglomerates' segments are insufficiently responsive to differences in investment opportunities. This implies that conglomerates overinvest when opportunities are low and underinvest when they are better (Scharfstein, 1998).

A second set of tests recognizes that in an imperfect financial market the firm's investment expenditures may depend on its cash flow as well as on its marginal Tobin's q. For a conglomerate, a segment's investment may depend both on its own cash flows and on the cash flows of the whole firm. Thus, we can augment the investment equation by putting in the cash flows of the segment and that of the whole firm in the investment equation,

$$i_j = z_j\gamma + q_j\beta + \delta\,\mathrm{CF}_j + \phi\,\mathrm{CF}_{-j} + \zeta_j, \tag{5}$$

where CF_j is the cash flow of segment j and CF_{-j} is the cash flow of entire conglomerate less segment j.

Shin and Stulz (1998) argue that if the internal capital market is working efficiently investment will not depend on a segment's cash flow but on that of the firm as a whole and $\phi \gg \delta$.

It is reasonable to suppose that in an efficient internal capital market the level of investment in one segment will be affected by the level of investment opportunities in other segments. Thus, as further test of the efficiency of the internal capital market equation (5) can be augmented by estimates of Tobin's q for the firm's other segments $-j$.

Using COMPUSTAT Shin and Stulz (1998) examine the workings of internal capital markets of about 14,000 conglomerates for the period 1980 to 1992, paying careful attention to data issues (see the Appendix to their paper). They find that (a) the investment of a conglomerate segment depends more on its own cash flows than on the cash flows of the firm's other segments (δ exceeds ϕ); (b) in highly diversified firms, a segment's cash flow is less sensitive to its cash flow than in comparable single-segment firms, (c) a segment's investment increases with its q but is not related to the other segments' qs, and (d) the segments with the highest qs have the same cash flow sensitivity δ as other segments.

In sum, Shin and Stulz (1998) find that the internal capital market does not equalize the effect of cash shortfalls across segments. At the same time, a segment's investment is affected by the cash flows of the other segments, notwithstanding differences in Tobin's q across segments. They conclude that conglomerates internal capital markets do not meet their standard of efficiency.

[25] See Hayashi (1982) and Abel and Eberly (1994) for the conditions under which the marginal Tobin's q is well proxied by the average Tobin's q.

Shin and Stulz's results suggest that conglomerates may invest less efficiently than single-segment firms, and that, while firm's internal financial markets are integrated, the integration is partial so that the markets are not allocatively efficient. These studies, based on COMPUSTAT data, stand in marked contrast to the findings of MP (2002) using LRD data, who find that conglomerate investment is, on the whole, efficient.

More recent work has tried to reconcile the findings of these papers. As is often the case in research on conglomerates, the issues center on the thorny issue of measurement of the within firm quantities, in this case investment and Tobin's q.

A key variable which is difficult to measure at the conglomerate-segment level is Tobin's q. As discussed above, the COMPUSTAT based literature attempts to proxy Tobin's q for a segment by using observed qs of "comparable" firms. Whited (2001) directly tests whether the findings of the COMPUSTAT based literature can be attributed to measurement error caused by the use of segments' qs based on estimated derived from "comparable" single-segment firms.

Whited's arguments can be illustrated with equation (1). As noted above, we cannot observe q directly, but must use a proxy, perhaps based on the average Tobin's qs of single segment firms operating in segment j's industry. Whited (2001) models the consequences of the use of a noisy proxy on the estimates of coefficients of β in equation (1) and β, δ and ϕ in equation (2) above. Suppose that the relation between the proxy, p and the Tobin's q takes the following form:

$$p_j = \alpha + q_j + \varepsilon_j.$$

We can eliminate z from this system by regressing all the variables on z and using the residuals. For simplicity we can also initially fold the variables CF_j and CF_{-j} with the other exogenous variables into z. Doing so we obtain

$$\tilde{i}_j = \tilde{q}_j\beta + \tilde{\zeta}_j, \tag{6}$$

$$\tilde{p}_j = \tilde{q}_j + \tilde{\varepsilon}_j. \tag{7}$$

These equations can be used to generate a set of eight moments such as

$$E\big(\tilde{i}_j^2\big) = \beta^2 E\big(\tilde{q}_j^2\big) + E\big(\tilde{\zeta}_j^2\big), \qquad E(\tilde{i}_j\tilde{p}_j) = \beta E\big(\tilde{q}_j^2\big),$$
$$E\big(\tilde{p}_j^2\big) = E\big(\tilde{q}_j^2\big) + E\big(\tilde{\varepsilon}_j^2\big),$$
$$E\big(\tilde{i}_j\tilde{p}_j^2\big) = \beta E\big(\tilde{q}_j^3\big), \qquad E\big(\tilde{i}_j^2\tilde{p}_j\big) = \beta^2 E\big(\tilde{q}_j^3\big), \quad \text{etc.}$$

The estimation technique consists of replacing the eight left-hand side moments with their sample estimates and then using GMM to find a vector of six right-hand side unobservable quantities $(\beta, E(\tilde{q}_j^2), E(\varepsilon_j^2), E(\zeta_j^2), E(\tilde{q}_j^3), E(\tilde{q}_j^4))$. This vector is one that comes closest to minimizing the distance between the left-hand and right-hand sides of equations, when evaluated using the minimum variance GMM weighting matrix derived by Erickson and Whited (2000).

The estimate of sensitivity of investment β is obtained from $\beta = E(\tilde{i}_j^2\tilde{p}_j)/E(\tilde{i}_j\tilde{p}_j^2)$. Given the estimate of β, the remaining moment conditions can then be solved to give the

other unknowns. Because the estimator provides estimates of $E(\tilde{q}_j^2)$, $E(\varepsilon_j^2)$ and $E(\zeta_j^2)$, Whited (2001) also obtains estimates of the R^2 of the first equation, that is the proportion of the variation of capital investment explained by the true Tobin's q, as well as the R^2 of the second equation, the proportion of the variation of p's (the proxy for Tobin's q) variation explained by the true q.

Whited (2001) reestimates equations (4) and (5) correcting for the possible error measurement error in the estimates of Tobin's q. She finds that the corrected estimate of β in equation (4) when estimated over conglomerate segments is insignificantly different from the estimate of β for single-segment firms. Thus, she finds that the previous findings of inefficient investment by conglomerates segments may be due to measurement error. She also finds that the corrected estimates of ϕ and δ in equation (5) are insignificantly different from zero, suggesting that the previous finding that the firm's internal capital market is at least partially inefficient might also have been caused by measurement error.

While the formal tests in Whited (2001) are specific to the model she investigates, they raise a serious concern about the use of segment Tobin's qs derived from COMPUSTAT data in all studies of intra-firm investment efficiency.

Maksimovic and Phillips (2007) argue that previous studies of investment using Compustat data are subject to another form of measurement error: They exclude a major type of investment expenditure by conglomerates. MP show that single-segment and conglomerate firms differ both in the level of total investment and the *type* of investment. The overall level of capital expenditures on existing plants by conglomerates and single-segment firms in U.S. manufacturing industries is similar. However, conglomerates and single-segment firms differ markedly in their rates of purchases of new plants, even when controlling for segment size. Thus, the COMPUSTAT based studies which use segment capital expenditures as a proxy for investment and do not include acquisitions exclude a major category of investment by conglomerates. Using LRD data, for each single-segment firm and conglomerate segment MP predict $\overline{\text{FD}}_j$ the probability that the segment will be run a financial deficit if it invests at the level predicted by its productivity and industry conditions not taking account whether it is a conglomerate segment or not. They then run the regressions of the following form:[26]

$$\text{acq}_j(\text{or } i_j) = z_j\gamma + \overline{\text{FD}}_j\beta + \delta\,\text{cong} \times \overline{\text{FD}}_j + \phi\,\text{cong}_j + \varphi\,\text{TFP}_j + \zeta_j,$$

where acq_j is a measure of segment j's acquisition activity, i_j is a measure of segment j's capital expenditures, TFP_j is the segment's industry standardized productivity and cong_j is a dummy that takes a value of 1 if the segment belongs to a conglomerate and 0 otherwise. Maksimovic and Phillips (2007) finds that $\beta < 0$, so that a predicted financing deficit leads to a reduction of acquisition and capital expenditure. However,

[26] The regressions in Maksimovic and Phillips (2007) allow for differences across types of industries, but these differences suppressed in this exposition.

$\delta > 0$, indicating that belonging to conglomerate segments reduces a segment's financing constraints. The effect is particularly striking for the rate of acquisitions, which is considerably higher for conglomerates segments, even the ones predicted to run a financing deficit. In further analysis MP show that this effect is greater for the more efficient conglomerate segments and that subsequent to acquisition the acquired plants either maintain or improve their productivity on average. Thus, using LRD data and using TFP together with industry conditions as a measure of investment opportunities MP find no evidence for a negative effect of the internal financial market on resource allocation.[27]

More generally, Maksimovic and Phillips (2002) argue that specifications such as (5) above may be problematical since (a) the decision to become a conglomerate is endogenous and there is likely to be selection bias and (b) the investment of a conglomerate segment does not depend in the same way on investment opportunities as that of a conglomerate firm which maximizes value across different segments. Thus, the estimate of growth opportunities derived from a single-firm Tobin's qs may be an inappropriate for the study of investment by conglomerate segments.

4.2. Industry studies

Four case-studies exploring the workings of internal capital markets in specific industries provide another form of evidence on the workings of internal capital markets is provided by. Lamont (1997) studies investment decisions of diversified oil companies following the oil price shock of 1986 when oil prices plunged by over 50%. Khanna and Tice (2001) study the responses of diversified in response to Wal-Mart's entry into their market. Campello (2002) studies banking. Guedj and Scharfstein (2004) analyze the effect of organizational scope on the development strategies and performance of biopharmaceutical firms.

The oil price drop of 1986 provides a natural experiment for the effect of external demand shocks on a conglomerates internal capital market. Lamont identifies approximately 40 non-oil segments owned by 26 oil companies. He tests whether the investment of these non-oil segments of oil firms segments depends on the firm's internal capital market by comparing their capital expenditures with the capital expenditures of similar segments owned by firms less-dependent on the price of oil. Lamont shows that following a significant negative oil price shock, non-oil segments owned by oil companies significantly cut their investment in 1986 compared to the control group of segments not owned by oil companies. Thus, firm-level adverse shock in the oil segment was transmitted to the other segments. Moreover, Lamont finds evidence that the oil companies overinvested in their non-oil segments in prior to the oil price drop.

[27] Maksimovic and Phillips (2007) do not have data on prices paid for the acquisitions. Thus, they cannot determine if the observed increases in productivity are enough to compensate the acquiring firms for the costs of the acquisitions.

Lamont's (1997) interpretation has been queried by Schnure (1997). Schnure examines the cash positions of the 26 oil companies over the period 1985–1986 and finds little evidence that they faced cash constraints. For example, more than half the oil companies in the sample repurchased stock in 1986, many increased dividends and the cash holdings of the sample increased substantially in 1986. This suggests that the relation between the oil price shock and the investment by non-oil segments of oil companies is more complex than the simple transmission of a negative shock via internal capital markets.[28]

Khanna and Tice (2001) examine the responses of discount retailers in response to Wal-Mart's entry into their local markets in the period between 1975 and 1996. Prior to Wal-Mart's entry most markets had several incumbent discount retailers. Khanna and Tice identify 24 stand-alone incumbent discount retailers and 25 incumbent discount divisions of diversified firms. They examine the effect of organizational form by studying the incumbents' responses to Wal-Mart's entry while controlling for factors such as productivity and size.

Khanna and Tice find that conditional on staying in a market following Wal-Mart's entry, diversified firms invest more than focused firm and their investment in more sensitive to their own productivity levels than that of focused firms. They find evidence that diversified firms transfer funds away from failing discount divisions. Moreover, diversified firms appear to be quicker in deciding whether to stay and compete with Wal-Mart or to exit the market.

Some caveats are in order. The diversified firms in Khanna and Tice are for the most part retailers, albeit with non-discount divisions. Thus, their study addresses the effect of capital markets in related diversification. The discount retailing divisions of diversified firms tend to be more productive than the stand-alone firms with which they are compared, raising the possibility of self-selection in the decision to become diversified. However, overall Khanna and Tice conclude that internal capital markets work well for these firms and that the competitive responses of diversified firms are more efficient than those of focused retailers.

Campello (2002) examines the internal capital markets in financial conglomerates (bank holding companies) by comparing the responses of small subsidiary and independent banks to monetary policy. These conglomerates are not diversified across different industries. The advantage of examining diversification within an industry is that it is easier to control for differences in their investment opportunities. Campello finds that internal capital markets in financial conglomerates relax the credit constraints faced by smaller bank affiliates and that internal capital markets lessen the impact of Fed policies on bank lending activity.

Guedj and Scharfstein (2004) contrast the research and development strategies and subsequent performance of small biopharmaceutical firms with those of more mature

[28] The model in Rajan, Servaes and Zingales (2000) suggests that the relative decline in the investment opportunities in oil have made the oil segment less willing to acquiesce to uneconomic transfers to other segments.

firms. The former have no history of successful drug development and are typically focused on one stand-alone project, such as the development of a specific drug, whereas the latter usually have the option of picking among several projects to develop. To the extent that the projects are discrete, the large firms closely resemble the theoretical model of internal capital markets in Stein (1997).

Guedj and Scharfstein analyze a sample of 235 cancer drugs that entered clinical trials in the period 1990–2002. In order to be marketed in the U.S. a drug has to undergo three separate phases of clinical trials. In each phase more information is revealed about the drug's prospects. These trials are expensive, and after each phase is completed the sponsoring firm must determine whether to proceed onto the next stage or whether to curtail the development of the particular drug.

Guedj and Scharfstein find that standalone firms are more likely to push drugs that have completed Phase I trials into Phase II trials. However, standalone firms also have much worse results at Phase II. This pattern especially evident for those standalone firms that have large cash reserves. Thus, as in Stein (1997), single-product firms do not abandon projects optimally, whereas managers of multi-project firms shift resources in response to new information. In that light firm diversification can be viewed as a response to an agency conflict between the managers of single-product firms and shareholders.

Khanna and Tice (2001), Campello (2002), and Guedj and Scharfstein (2004) identify several specific advantages of internal capital markets. Lamont (1997) identifies a potentially countervailing disadvantage: a tendency to transmit investment shocks to the firm's main division to unrelated projects.[29] We next look at attempts to analyze the effect of internal capital markets on a broader scale.

4.3. Efficient internal capital markets

Stein's (1997) model suggests that there is a positive relation between the internal market's efficiency and the amount of external capital a diversified firm raises. Moreover, the efficiency of external capital markets is greater when a firm has more divisions and when the investment opportunities across divisions are not correlated.

Peyer (2001) and also Billet and Mauer (2003) test predictions on how conglomerate firms allocate firms across divisions. For diversified firms, Payer estimates the firm's excess external capital raised as the difference between the firm's use of external capital compares and an estimate of how much a matching portfolio of single-segment firms would have used.

For each diversified firm Peyer obtains the amount of external capital used as the difference between the external capital raised from outside investors and the external capital returned to outside investors.

[29] Maksimovic and Phillips (2002) also find that the operations of peripheral units of conglomerates are cut back much more severely in recessions than their main units. It is unclear whether these cuts occur because of a reduction of the resources available to the firm's internal capital market or because a shock triggers off a re-evaluation of the firm's long-term strategy. Schnure's (1997) results suggests that it might be the latter.

He also computes the firm's imputed use of external capital: for each of the diversified firms' divisions he computes the external capital that would have been raised by the been the median single-segment firm in the same 3-digit SIC code as the division. These estimates are then weighted by divisional sales to obtain the firm's imputed net external capital need. The firm's excess net external capital (EEC) raised by the diversified firm is then computed as

$$\text{EEC} = \frac{\text{Net external capital used} - \text{Imputed net external capital used}}{\text{Lagged book value of assets}}.$$

Peyer estimates the following regression:

$$\begin{aligned}\text{EEC} = {} & \alpha_i + \beta_i + \gamma_1(\text{ICM size})_{i,t} + \gamma_2(\text{ICM efficiency})_{i,t-1} \\ & + \gamma_3(\text{Informational asymmetry})_{i,t-1} \\ & + \gamma_4(\text{Informational asymmetry} \times \text{ICM efficiency})_{i,t-1} \\ & + \gamma_5(\text{Capital need})_{i,t} + \gamma_6(\text{Relative value})_{i,t-1} + \gamma_7(\text{Firm size})_{i,t-1}.\end{aligned}$$

Motivated by Stein (1997), Peyer uses the inverse of the Herfindahl index and the coefficient of variation in q across the firm's divisions as measures of Internal Capital Market (ICM) size.[30]

As a measure of ICM efficiency use RSZ's Relative Value Added by Allocation (RVA), where RVA is defined as

$$\text{RVA}_j = \sum_{k=1}^{n} \frac{\text{BA}_{jk}}{\text{BA}_j}(q_{jk} - \bar{q}_j) \times \text{IAI}_{jk},$$

where BA_j is the book value of assets of firm j, BA_{jk} is the book value of assets of segment k *and* IAI is a measure of the excess investment in segment k.[31]

RVA has the following interpretation: IAI is given a positive weight when the division has relatively good investment opportunities ($q_j - \bar{q} > 0$) and a negative weight when the firm has relatively bad investment opportunities ($q_j - \bar{q} < 0$). Thus a positive RVA indicates that the ICM is efficient because additional investment in being channeled into segments with better than average (for the firm) investment opportunities.

Peyer uses several measures of informational asymmetry: the ratio of intangible to tangible assets, residual variance of daily stock returns and the dispersion in analysts' forecasts. He also computes two additional variables. Excess capital need is measured by Excess internal cash flow = (internal cash flow − imputed internal cash flow)/lagged book value of assets. Relative firm valuation (to control for the propensity of firms to

[30] Peyer also uses diversity as a measure in one of his runs. Following Rajan, Servaes and Zingales (2000) diversity is defined as the standard deviation of the segment asset-weighted imputed q divided by the equally weighted average imputed segment q. As noted above, RSZ predict a negative relation between diversity and ICM efficiency.

[31] We discuss the IAI below. Other measures of excess investment used by Peyer perform similarly.

issue equities after a run-up) is measures using the Lang and Stulz (1994) and Berger and Ofek (1995) measures. Firm size is measured using market valuations.

Peyer finds that firms with efficient ICMs and diversified firms use more net external capital than comparable standalone firms. Measures of information asymmetry are negatively correlated with the use of external capital. The relation is attenuated for firms with efficient ICMs.

EEC is positively related to excess value, especially for firms that have efficient ICMs and firms with larger ICMs. Peyer interprets the positive correlation between the use of external capital and firm value supports the notion that diversified firms are raising external capital to invest in a firm-value-increasing manner.

For robustness, Peyer examines changes in EEC in response to changes in the explanatory variables. He finds that increases in ICM efficiency and increases in the size of the ICM are positively related to changes in EEC. Increases in information asymmetry have a smaller negative effect on EEC if the firm has an efficient ICM. Moreover, there exists an association between the increased use of external capital and firm valuations, measured as in Berger and Ofek (1995).

In all, the Peyer (2001) findings that more efficient ICM firms and firms with larger ICMs use more external capital makes and have a higher firm provides empirical support for Stein (1997).

Billet and Mauer (2003) construct an index of the diversified firm's internal capital market that includes the amount of subsidies and transfers and the efficiency of these flows. Subsidies to division i of firm j are calculated as:

$$\text{Subsidy}_{ij} = \text{Max}(\text{Capital expenditures}_{ij} - \text{After tax cash flow}_{ij}, 0).$$

They calculate the potential transfer from division i to other divisions as:

$$\text{Potential transfer}_{ij} = \text{Max}(\text{After tax cash flow}_{ij} - w_{ij} * \text{dividends}_j - \text{CAPX}_{ij}, 0).$$

Dividends are determined at the firm level. The firm-level dividends are weighted by w_{ij}, the share of assets division i represents of the firm j's assets in the calculation of potential transfers.

Billet and Mauer demonstrate that funds flow toward financially constrained efficient divisions of conglomerates and that these types of transfers to constrained segments with good investment opportunities increase firm value. They show that the higher the transfers to financially constrained segments with good investment opportunities, the higher the overall valuation of the conglomerate.

4.4. Bargaining power within the firm and differential investment opportunities

Rajan, Servaes and Zingales (2000) (RSZ) examine how differential investment opportunities within the firm affect investment efficiency. The empirical tests in RSZ are of two kinds. First, they test whether conglomerates distort their investment expenditures

by underinvesting in divisions with better growth opportunities and overinvesting in divisions with worse opportunities. Second, they test their model's predictions about the relation been distortions and the diversity of the firm's operations.

RSZ find that diversified firms invest more in segments with good opportunities than in segments with poor opportunities. However, conglomerates might still misallocate investment flows relative to comparable single-segment firms. Specifically, their theoretical model predicts that segments with good investment opportunities and above average resources will transfer assets to segments with poorer investment opportunities and below average resources.[32] The purpose of the transfer is to reduce the threat that segment with poorer investment opportunities and resources will expropriate the better segments ex-post, thereby improving the better segments' investment incentives.

RSZ cannot directly observe resource transfers between a diversified firm's segments. Instead, they have to infer those transfers for each segment by comparing the segment's investment to the investment of comparable single-segment firms. They attribute differences between the actual investment and the investment of comparable single-segment firms to transfers across divisions. However, RSZ also allow for the possibility that conglomerates may systematically over-invest relative to single-segment firms because they have better access to capital. Thus RSZ measure of the extent to which a segment deviates from its benchmark, the Industry-Adjusted Investment (IAI), subtracts out the weighted average industry-adjusted investment across all the segments of a firm. Thus,

$$\mathrm{IAI}_{jkt} = \frac{I_k}{\mathrm{BA}_k} - \frac{I_k^{ss}}{\mathrm{BA}_k^{ss}} - \sum_{k=1}^{n} w_k \left(\frac{I_k}{\mathrm{BA}_k} - \frac{I_k^{ss}}{\mathrm{BA}_k^{ss}} \right),$$

where I_k is the investment in segment k, BA_k is the book value of assets in segment k, is the (asset-weighted) ratio of the capital expenditures to assets of comparable single-segment firms, and w_k is the ratio of segment k's assets to the firm's assets.

In the econometric model they take to data, RSZ predict that a segment's investment depends on the magnitude of its asset-weighted investment opportunities relative to those of the rest. In particular, their model predicts that an increase in diversity should decrease investment in segments that have asset-weighted investment opportunities above the firm average, and increase investment in segments below the firm average.

To test their model, RSZ divide up the segments of each diversified firm in each year along two dimensions (above vs. below average investment opportunities, above vs. below average resources) to obtain a 2×2 classification matrix of all the segments in their sample. Then for each firm in each year they sum up the IAIs for the firm's segments that fall into each cell receive (thus, in each year each firm will have four observations for the transfers, one for each cell, although some may be missing).

[32] The RSZ model is discussed above in Section 3.4.

RSZ run the following regression equation separately for the segments in each cell of the classification matrix:

$$\sum_{k=1}^{m(j,t)} \text{IAI}_{jkt} = \alpha + \beta \frac{1}{q_{jt}} + \gamma(\text{Diversity})_{jt} + \delta(\text{Firm sales})_{jt} + \text{controls} + \varepsilon_{jt},$$

where $\sum_{k=1}^{m(j,t)} \text{IAI}_{jkt}$ is the sum of the IAI across the $m(j,t)$ segments belonging to firm j at time t in the cell, and q_{jt} is the equally weighted average qs of firm j segments at time t and the firm's diversity is measured as the standard deviation of the firm's weighted segment qs divided by the mean q, or

$$\text{Diversity}_{jt} = \sqrt{\sum_{k=1}^{m(j,t)} \frac{1}{m(j,t)-1}\left(w_{jkt}q_{jkt} - \frac{\sum_{k=1}^{m(j,t)} w_{jkt}q_{jkt}}{m(j,t)}\right)} \Bigg/ \frac{\sum_{k=1}^{m(j,t)} q_{jkt}}{m(j,t)}.$$

The control variables include the firm fixed effects and calendar year dummies.

The predictions of the RSZ model are summarized in Table 1.

Investment falls in high opportunity segments with high resources as the firm's diversity increases (cell (1)). Investment increases in low opportunity segments with low resources as diversity increases (cell (4)). Investment increases with diversity in high opportunity resource segments (cell (2)). Investment falls with diversity in large unprofitable segments (cell (1)).

These predictions contrast this with Efficient Internal Market models that emphasize the positive aspects of internal capital markets: top management has the option to reallocate resources from divisions with low investment opportunities to divisions with high investment opportunities. An increase in the diversity increases the value of this option and, thus, should increase the amount of resources transferred to segments with better investment opportunities. Thus, if firms' internal capital markets are efficient, we would observe $\gamma > 0$ in cells (1) and (2) and $\gamma < 0$ in cells (3) and (4) as increases in diversity make transfers between segments more valuable.

Table 1
Predictions of the RSZ Model

	Segments with resources > firm avg. resources	Segments with resources < firm avg. resources
Segments with $Q >$ firm average Q	(1) $\gamma < 0$	(2) $\gamma > 0$
Segments with $Q <$ firm average Q	(3) $\gamma < 0$	(4) $\gamma > 0$

By contrast, Scharfstein and Stein's (2000) model of intra-firm bargaining would imply that the least productive divisions receive transfers from the most productive divisions. Again, an increase in diversity will lead to an increase in this transfer. That model would predict $\gamma < 0$ in cells (1) and (2) and $\gamma > 0$ in cells (3) and (4).

RSZ test their model on 13,947 firm-years in the sample data is obtained from COMPUSTAT for the period 1980–1993. They separate regressions for each cell of Table 1 and obtain parameter estimates that accord with the predictions in the table.

RSZ perform extensive robustness checks. They also verify that (a) investment deviations that they that they classify as value increasing actually are positively related with to diversified firms' value and (b) that diversity itself is negatively related to firm value.

To summarize, even though some transfers in the right direction increase with diversity (cells (2) and (3) in the table above), RSZ find that on average as diversity increases, investment in segments with above-average opportunities becomes too small and investment in segments with below average opportunities becomes too large. This leads reduces the value of the firm of diverse firms.

4.5. Investment under a profit—maximizing neoclassical model

The Maksimovic and Phillips (2002) model differs form the preceding literature in several regards. First, the tests are motivated by the neoclassical profit-maximizing model. The model assumes that each firm has a corporate ability or talent, a fixed resource. It chooses the industries in which it operates so as to extract the maximum value from its ability, diversifying and focusing in response to demand shocks, and the consequent changes in the opportunity cost of assets, across industries. Thus, the focus of the model is not specifically on how well the internal capital market works, but on whether the diversified firms expand in segments in which they have a comparative advantage.

An implication of the MP model is that the decision to diversify is endogenous and depends on segment productivity and industry demand shocks. This implies that the use of single-segment firms as benchmarks for the values of conglomerates' segments is subject to selection bias.

Second, in empirical tests MP use plant-level Survey of Manufactures LRD data to classify each firm's plants into 3-digit SIC code industries. Thus, their classification of firms' assets in not subject to the same discretion that characterizes COMPUSTAT segment data. Moreover, their sample is larger than that of comparable studies. However, the Survey of Manufactures only covers manufacturing industries, so MP, cannot separately identify manufacturers who also operate outside manufacturing.

Third, instead of analyzing capital expenditures at the segment level, MP analyzes the growth in value added. Thus, their measure takes into account growth through whole and partial firm acquisitions as well as through direct capital expenditures.[33]

[33] Maksimovic and Phillips (2007) show that diversified firms are more likely to grow through acquisitions than single-segment firms.

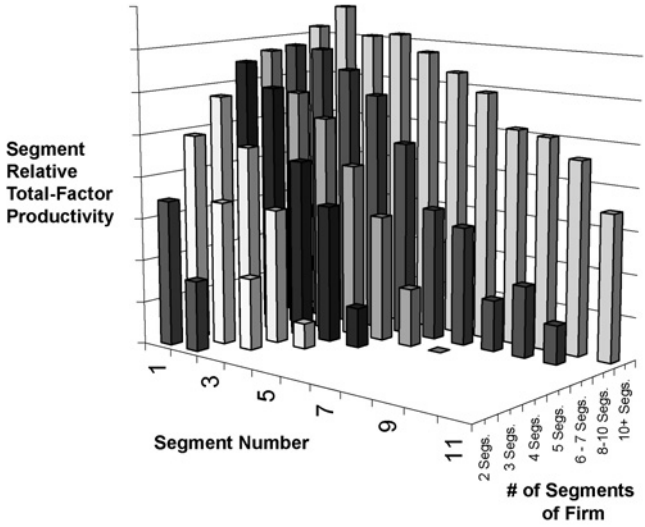

Fig. 6. Productivity ordered by segment size. Segment productivity estimated from LRD plant-level data.

Fourth, MP do not use Tobin's qs of single-segment firms to proxy for a segment's growth options. Instead, they use the industry growth in real total value added to obtain industry level measures of investment opportunities. To provide a measure of segment productivity at the micro level, they benchmark each plant in an industry against every other plant in the industry to obtain each plant's predicted real value added in each year given the inputs (capital, energy, labor and materials) the plant used in that year. They use the difference between the plant's actual value added and the predicted value as a measure of the plant's relative productivity. They aggregate up their measure plant productivity to derive the segment-level Total Factor Productivity (TFP) for each year.[34]

Using LRD data, MP can directly observe how the productivity of diversified firms' segments varies by the number of segments and the segment's relative size within the firm. Figure 6 summarizes the data. Controlling for the number of segments in a diversified firm, TFP decreases as the segment's relative size within the firm falls.

The pattern of productivity in Figure 6 is consistent with a neoclassical model in which firms spread their operations across a range of industries in which they have a comparative advantage and in which they have decreasing returns to scale.[35] Consistent with the model, larger firms are more productive on average than smaller firms. However, Figure 6 can also be given an agency interpretation: large productive firms may

[34] Schoar (2002) shows that TFP at the firm level predicts the conglomerate discount for diversified firms.

[35] Decreasing returns to scale may arise from the production technology. More broadly, a firm may perceive itself as having decreasing returns to scale because expansion may provoke a competitive response by rival firms.

waste resources by diversifying into industries in which they do not have a comparative advantage.

To distinguish between these interpretations, Maksimovic and Phillips (2002) examine how firms respond to industry demand shocks. According to their model, firms should grow the segments in which they are particularly productive and that have received a positive demand shock. They should reduce the growth of segments in which they are not efficient and which have received a negative demand shock.

To see this, recall from Section 3.5 that the output of a conglomerate firm i in industry 1 depends on $v_{1i} = d_{1i}p_1 - r_1$. Suppose that there is positive demand shock in industry 1. First, output prices increase, $\Delta p_1 > 0$. Second, the price of capacity in the industry also increases, $\Delta r_1 > 0$. Productive firms in the industry increase output in industry 1. More formally, they experience an increase in their v_{1i} because the marginal positive effect of a price rise, $d_{1i} \times \Delta p_1$, outweighs the effect of an increase in the cost of capacity Δr_1. The higher the ability d_{1i}, the more capacity a firm adds in response to a positive price shock.

The effect of a price shock in industry 1 on the marginal producers not is more complex. If the effect of the expansion by the productive firms on Δr_1 is minor, then the marginal firms may also expand, although at a slower rate than the more productive producers. However, if the price of capacity is bid up sufficiently high so that for some firms with small d_{1i}, $d_{1i} \times \Delta p_1 - \Delta r_1 < 0$, then these marginal producers will sell some capacity to more productive producers and focus instead in industry 2. These firms' operations in industry 1 decline not only relative to those of more productive firms, but in absolute size as well.[36]

The MP model also generates another testable prediction regarding cross-segment effects. When managerial capacity is a fixed factor of production, investment decisions by conglomerate firms in one segment create opportunity costs for investments in other industries in which they operate. Thus, segments' investment decisions will depend on the relative demand growth across all the industries in which the conglomerate operates. Specifically, suppose that there is a large positive demand shock in one of the industries in which a conglomerate operates. If the conglomerate's segment in that industry is highly productive, it will grow relatively fast. This growth increases the conglomerate's costs in other segments, thus decreasing the other segments' optimal size. Thus, a conglomerate which has a productive segment in an industry that has received a positive demand shock will grow more slowly than it otherwise would have in its *other* segments.

Suppose, instead, that the conglomerate had an unproductive segment in a fast growing industry. Then the conglomerate may find it optimal to divest or reduce operations in the high growth industry for two reasons. The positive demand shock in the industry will have increased the value of its capacity, increasing a low productivity conglomerate's

[36] Here we assume that the effect of a demand increase in industry 1 affects v_1 only and does not affect v_2. Appendix A discusses both effects.

opportunity cost of staying in the industry rather than selling out to a high productivity producer. This effect is amplified because any reductions in growth or divestitures in a segment in which the conglomerate is less productive will produce positive externalities in its segments. Hence, a conglomerate which is a relatively unproductive producer and therefore divests or grows more slowly in an industry that has received a positive demand shock will grow faster than it otherwise would have in its *other* segments.

The predictions concerning cross-segment effects are derived in Maksimovic and Phillips (1999, 2002) and briefly reviewed in Appendix A. They differ from predictions of models that stress influence costs, which suggest that resources are transferred to unproductive segments, and empire-building models, such as Lamont (1997) that suggest that wealth generated by positive shocks is dispersed throughout the firm.

To test their model Maksimovic and Phillips (2002) run the following regression on a sample of 270 thousand segment years over the period 1977–1992.

$$\begin{aligned}\text{GROWTH} = {} & \alpha + \beta(\text{Industry shock}) + \gamma(\text{Segment TFP}) \\ & + \delta(\text{Industry shock}) \times (\text{Segment TFP}) \\ & + \phi(\text{Other segments' TFP}) \\ & + \theta(\text{Relative demand}) \times (\text{Other segments' TFP}) + \text{controls}.\end{aligned}$$

MP use TFP as measure of each segment's productivity. The TFP takes the actual amount of output produced for a given amount of inputs and compares it to a predicted amount of output. The measure is computed at the plant level and aggregated up to segment level. "Predicted output" is what a plant should have produced, given the amount of inputs it used. A plant that produces more than the predicted amount of output has a greater-than-average TFP. This measure is more flexible than a cash flow measure, and does not impose the restrictions of constant returns to scale and constant elasticity of scale that a "dollar in, dollar out" cash flow measure requires. Demand shocks are measured by changes in the industry real shipments.[37]

Consistent with the model, MP find that productive segments grow faster ($\gamma > 0$), especially in industries which have experienced a positive demand shock ($\delta > 0$). Most importantly, a segment's growth rate is lower if the firm has more productive operations in other industries ($\phi < 0$). The segment's growth is further reduced if these more productive operations are in industries which have received a positive demand shock ($\theta < 0$). The last two finding are consistent with the cross-segment predictions of MP's neoclassical model but difficult to reconcile with an agency model in which the firm invests inefficiently.

As a robustness check MP identify a subsample of "failed conglomerates" (diversified firms which restructure by decreasing the number of segments by at least a quarter)

[37] MP show that their results also hold for several other measures of productivity and demand shocks.

and a control subsample of "regular" conglomerates that do not reduce the number of segments so substantially. They run their regression separately on the two subsamples. For the failed conglomerates the coefficients ϕ and θ are not significantly different from zero for the period prior to restructuring. The subsample of "regular" conglomerates these coefficients are negative and significant, as predicted by the model. Thus, MP find evidence that there is subset of "failed" conglomerates that grow inefficiently, and are subsequently broken up. However, even for these failed conglomerates MP do not find a positive significant relation the segments' growth rates and other segments productivity. Thus, they find no evidence that even these failed conglomerates systematically grow their unproductive segments at the expense of productive segments.[38]

MP also find that a segment's relative size in the firm does affect its growth, even controlling for productivity. Main segments of firms (i.e., segments that produce at least a quarter of its value added) grow faster in response to positive demand shocks than peripheral segments. In part this is because main segments are on average more productive. However, a substantial growth differential remains even after controlling for productivity.

The growth differential is especially pronounced in recessions. Rather than being cushioned in recessions as predicted by models that stress bargaining within the firm, peripheral segments of conglomerates are cut sharply in response to negative demand shocks. These cuts are greater than predicted by MP's simple neoclassical model. They suggest that a more complex mechanism is at work. Thus, negative demand shocks may cause diversified firms to reassess the prospects of their peripheral segments and to shift resources into more promising ventures, as modeled by Stein (1997).

The decline in peripheral divisions is also reflected in aggregate Census data. In the beginning of the 1980s main divisions of diversified firms produced about half of the value added by U.S. manufacturing and this share was maintained through the end of the 1990ies. By contrast, the share of peripheral segments of diversified firms fell from 27.5% to 23.5% over that period.

In sum, Maksimovic and Phillips (2002) find that a simple profit maximizing neoclassical model of firm growth across segments is consistent with plant-level data and that there is little evidence of systematic resource misallocation by diversified firms. There is some evidence that failed conglomerates that are subsequently broken up do not allocate resources model efficiently. However, even these firms do not systematically grow unproductive segments at the expense of productive segments. Instead, there is evidence that smaller, less productive units of conglomerates grow more slowly than their main divisions or similarly productive stand alone firms.

[38] MP perform robustness tests using several alternative measures of productivity and investment. Their model predicts, for example, predicts that segment size is a proxy for segment productivity. The results using segments size yield the qualitative results.

4.6. Mergers and acquisitions, divestitures and spinoffs

4.6.1. Diversified firms and the market for assets

The early theoretical literature on internal capital markets, such as Stein (1997), explicitly recognizes the importance of the size of the internal market for its efficiency. Thus, while the importance setting the firm's boundaries for the quality of the internal capital market was recognized early, much of the literature takes a partial equilibrium approach and assumes that the firm's boundaries as given. This is potentially important since many of the hypothesized conflicts within the firm can be solved or mitigated by selling assets that do not fit well with the firm's total portfolio. Thus, if the market for firms' assets is efficient, the magnitude of the investment distortions that can be created by conflicts within the firm is likely to be tightly bounded. Of course, there may still be conflicts of interest between top management and shareholders. However, top managers have clear incentives to maximize firm value.[39]

An objection to this might be that the market for corporate assets is insufficiently liquid so that firms which attempt to readjust their portfolio by selling segments face a capital loss. This is unlikely. Tables 2A and 2B, from Maksimovic and Phillips (2001), shows that there exists a large, procyclical market for segments and individual plants.

Using Census, data Maksimovic and Phillips (2001) show that in the period 1974–1992, 1.94% of all manufacturing plants change ownership annually in partial-firm transactions.[40] This is comparable to the total rate at which manufacturing plants change ownership in all-firm mergers and takeovers over this period, 1.95% annually. Similar rates of partial firm sales occur in both growing and declining industries. The market for divisions and plants is a market dominated by conglomerates. MP report that the sellers operate in an average of 10 4-digit SIC industries and the buyers in an average of 8 such industries.

MP test whether diversified firm's decision to sell a manufacturing plant can be explained by their neoclassical model. They run a probit regression on a panel of plants 1979–1992 from the LRD, where the dependent variable, PLANT SALE, takes on the value of 1 if the plant is sold and the value of 0 if the plant is not sold in a given year.

$$\begin{aligned}\text{PLANT SALE} = {} & \alpha + \beta(\text{Industry shock}) + \gamma(\text{Segment TFP}) \\ & + \delta(\text{Industry shock}) \times (\text{Segment TFP}) \\ & + \phi(\text{Other segments' TFP}) \\ & + \theta(\text{Relative demand}) \times (\text{Other segments' TFP}) + \text{controls}.\end{aligned}$$

Consistent with the profit maximizing model, MP find that plants in productive segments are less likely to be sold ($\gamma < 0$), especially in industries which have experienced

[39] For a contrary view, see Aggarwal and Samwick (2003).

[40] See Maksimovic and Phillips (2001) for a detailed description of the sample. See also Schlingemann, Stulz and Walking (2002) for a discussion of liquidity in the market for assets on the rate of sales.

Table 2A

	Total	Mergers and acquisitions	Asset sales	
			Full segment	Partial segment
Reallocation rates across and within industries Full period: 1974–1992				
Number of plants reallocated	35,291	17,720	8,556	9,015
Average annual % of plants reallocated	3.89%	1.95%	0.95%	0.99%
% Plants sold to buyer inside industry				
Same three-digit SIC code	56.8%	54.1%	55.5%	63.1%
Same four-digit SIC code	47.7%	44.9%	47.9%	53.0%
Average plant size (Real $ in thousands, value of shipments)	$30,332	$28,435	$30,916	$33,506
Average industry plant size (Real $ in thousands, value of shipments)	$33,790	$34,569	$36,440	$37,574

a positive demand shock ($\delta > 0$). Most importantly, a plant's probability of being sold is higher if the firm has more productive operations in other industries ($\phi > 0$). The probability of being sold further increased if these more productive operations are in industries which have received a positive demand shock ($\theta < 0$). The last two finding are consistent with the simple neoclassical model but and do not suggest an agency model in which the firm retains and subsidizes inefficient plants using resources generated by more successful divisions.

MP also find that there is negative relation between the probability that a plant is sold and the share of the firm's output produced by the segment to which the plant belongs. The finding is consistent with the notion that diversified firms divest from their smallest and least productive divisions and redeploy their assets.

MP also examine who purchases plants and firms and find that the probability of a purchase goes up with the buyer's productivity. When they examine the productivity of the plants after the purchase, MP find that the change in productivity increases with difference between the buyer's productivity and purchased plant's productivity. In sum, the evidence is consistent with transfers of assets going from less to more productive firms—especially when industries receive positive demand shocks.

More recently, Maksimovic, Phillips and Prabhala (2006) show that acquirers sell about 40% of the target's plants in the four years after the acquisition. The sold plants tend to be those in the target's peripheral divisions. The plants that are kept increase in productivity after the acquisition, the plants that are sold do not. This pattern is consistent with the hypothesis that acquirers keep the assets which they can exploit efficiently and that they economize on managerial attention by selling or closing the assets that they cannot exploit efficiently.

Taken together, plant-level evidence suggests that the direction and timing of sales of corporate assets is consistent with an efficient allocation of resources within the firm.

Table 2B

	Sample of firms			
	Total	Mergers and takeovers	Asset sales	
			Full division	Partial division
Transactions by aggregate economy conditions				
Recession years (1981, 1982, 1991)				
Average % reallocated (total number)	3.57% (5,148)	2.16% (3,112)	0.70% (1,003)	0.72% (1,033)
Expansion years (1986, 1987, 1988)				
Average % reallocated (total number)	6.19% (8,989)	2.69% (3,904)	1.73% (2,509)	1.77% (2,576)
Indeterminate years	3.21%	1.73%	0.70%	0.78%
Transactions by industry capacity utilization				
Low industry capacity utilization (bottom quartile)				
Average % reallocated (total number)	3.86% (8,618)	1.90% (4,244)	0.99% (2,210)	0.97% (2,164)
High industry capacity utilization (top quartile)				
Average % reallocated (total number)	3.69% (8,413)	1.92% (4,375)	0.87% (1,977)	0.90% (2,061)
Transactions by long-run industry growth/decline				
Quartile 1: Declining industry growth				
Average % reallocated (total number)	4.01% (6,290)	1.95% (3,058)	1.09% (1,707)	0.97% (1,525)
Quartile 2				
Average % reallocated (total number)	3.86% (5,250)	1.96% (2,666)	1.05% (1,425)	0.85% (1,160)
Quartile 3				
Average % reallocated (total number)	3.52% (10,008)	1.80% (5,131)	0.88% (2,505)	0.83% (2,372)
Quartile 4: High industry growth				
Average % reallocated (total number)	4.03% (15,746)	2.01% (7,870)	0.87% (3,405)	1.14% (4,471)

Source: Maksimovic and Phillips (2001), Journal of Finance.

On average, the good assets are kept and the assets that cannot be exploited efficiently are sold. When the opportunity cost of retaining marginal assets is higher because other segments are more productive and growing faster, the rate at which marginal assets are disposed off is higher.

Schoar (2002) also used the LRD plant-level data to examine productivity of conglomerate firms and changes in productivity following plant acquisitions. Schoar (2002) establishes that market valuations of single-segment and conglomerate firms track estimates of productivity derived from LRD data. The tracking is equally strong for single-segment and conglomerate firms. This suggests that the conglomerate discount, if it exists, is unlikely to be caused by investors' inability to evaluate diversified firms' operations as efficiently as those of single-segment firms.

Schoar also finds no evidence that conglomerates' plants are less efficient than those of single-segment firms. Specifically, using plant-level data she runs the following regression

$$\text{TFP} = a + b * \text{DIV} + c * (\text{plant size}) + d * (\text{plant age}),$$

where TFP is total factor productivity and DIV is a dummy that takes on a value of 1 if the plant belongs to a diversified firm and zero otherwise. The coefficient of DIV is positive and significant and remains so when the equation is augmented by segment-level control variables.

Like Maksimovic and Phillips (2001), Schoar finds that acquired plants on average increase in productivity while the acquirer's own plants decline in productivity. She calls this the "new toy" effect, and argues that post-acquisition productivity of the acquirer is on balance negative. However, as Schoar points out this time-series effect does not cancel out the cross-sectional finding that diversified firms' plants have a higher TFP.

An intriguing possibility raised by Schoar's work is that a diversification discount may arise because conglomerates pay out a higher proportion of their revenues in salaries and benefits than standalone firms. She finds that diversified firms pay higher hourly wage rates than similar standalone firms. Assuming that these differences do not reflect differences in the educational level or quality of their respective workforces, the wage difference is enough to explain a 2–3% discount for diversified firms.

4.6.2. Spinoffs

Several studies, including Gertner, Powers and Scharfstein (2002), Dittmar and Shivasani (2003), Burch and Nanda (2003), Anh and Denis (2004), and Colak and Whited (2005), examine spinoff and divestiture decisions that reduce the number of divisions that a conglomerate firm operates. These papers examine the investment efficiency of firms before and after the refocusing decision. This approach has potential advantages over studies that examine a sample of firms, some of which refocus and some which do not. If it can be assumed that the severity of measurement error does not change over time, measurement error bias that in the comparison of before and after refocusing performance, is mitigated. These papers further argue that they have reduced omitted variables bias by focusing on changes in value and efficiency in a single sample of firms.

Gertner, Powers and Scharfstein (2002) examine sensitivity of segment investment to the median Tobin's q of the single-segment firms in that segment's industry.

The sensitivity of Tobin's q captures the idea that the more efficient a firm is, the more it should respond to changes in investment opportunities by altering its investment policy. In order to get around the problem that the median industry Tobin's q is an imperfectly measure of investment opportunities for an individual firm, Gertner, Powers and Scharfstein (2002) paper examines the same firm's sensitivity of investment to Tobin's q before and after the spinoff. They find that segment sensitivity to industry Tobin's q increases after the segment spinoff and that changes are related to the stock market's reaction to the spinoff decision.

Dittmar and Shivasani (2003) find that the announcement returns for divestitures are significantly correlated with the change in the diversification discount. Larger decreases in diversification are associated with higher announcement returns. Dittmar and Shivdasani also find that RSZ measures of the efficiency of segment investment increase substantially following the divestiture and that this improvement is associated with a decrease in the diversification discount. One can interpret this evidence in several ways. The evidence is consistent with the firm divesting divisions will now be run more efficiently. Alternatively, the evidence is also consistent with changes in investment opportunities for the divesting firm or its divisions and thus the market responds positively as firms change their investment.

Burch and Nanda (2003) examine whether changes in value following spinoffs are related to measures of investment diversity by reconstructing the diversified firm after the spinoff. They construct changes in value using both industry multiples and also using firm-specific measures. To avoid the measurement error problem of assessing opportunities using industry measures, they also use an ex post, direct measure of excess value based on the post-spinoff market-to-book values of the divested division(s) and remaining parent firm. As they note, using ex-post data implicitly assumes that diversity in post-spinoff investment opportunities is a reasonable proxy for the diversity prior to the spinoff. Using these measures, they find that improvements in aggregate excess value (changes in the implicit discount less the actual pre-spinoff discount) depends significantly on direct measures of diversity and changes in measures of diversity based on industry proxies.

Anh and Denis (2004) also examine the changes in measure of investment efficiency from RSZ pre- and post-spinoff. They find that post-spinoff, measures of investment efficiency increase for the hypothetical combined firm—combining the post-spinoff divisions with the parent in order to examine the total impact of the spinoff decision. They also find that the measures of investment efficiency increase the most for firms with the highest dispersion in the segment Tobin's qs from single-segment firms. They do note two caveats to their analysis. First, they note that by focusing just on firms that choose to spinoff divisions, they may be focusing on the set of firms with more severe investment inefficiencies. Second, they note that other changes in the investment opportunity set may be driving firms to spinoff and also contributing to the observed changes in investment efficiency.

Colak and Whited (2005) show the caveats noted in these papers are important. Their results challenge the view that these spinoffs and divestitures provide evidence that firms

were misallocating resources prior to the spinoff. Using three-different approaches to control for endogeneity they show that refocusing decisions does not necessarily cause improvements in efficiency. In particular, firms that choose to spin-off and divest divisions are larger, more diversified, and subject to more serious problems of asymmetric information. Further, the spun-off segments tend to be in fast growing industries with a great deal of IPO and corporate control activity. Finally, they appear to have experienced recent unanticipated shocks to profit. They find that although spin-offs and divestitures may be associated with improvements in investment efficiency, they do not cause these improvements. When they control for measurement error, they also show that the sensitivity of investment to both industry Tobin's q does not significantly change following the refocusing decision.

5. Conclusions: What have we learned?

There have been a substantial number of careful empirical papers on internal financial markets in the last few years. Any summary of what has been learned is bound to be subjective and reflect the interests of the authors. With that caveat in mind, we can summarize the existing evidence about internal capital markets.

- The early work established clearly that, using single-segment firms as benchmarks, there exists a conglomerate discount.
- Initial attempts to explanation the discount focused on agency conflicts and conflicts among divisions that led to overinvestment in divisions with poor prospects and underinvestment in divisions with high qs.
- Conclusions drawn from econometric studies of segment capital expenditures, which use the Tobin's qs of single-segment firms to proxy for segment investment opportunities, are subject to measurement error and may not be valid.
- Diversified firms rely more on acquisitions than single-segment firms. Thus, studies that focus on capital expenditures may miss important components of investment by diversified firms.
- A conglomerate discount is not, by itself, evidence of agency or inefficiency—it may be due to the fact that single segment and diversified firms operate on different regions of the production function.
- A simple neoclassical model that recognizes that the decision to diversify is endogenous and that firms grow fastest in industries where they have a comparative advantage in response to positive demand shocks in those industries is consistent with the growth patterns of diversified firms.
- The sales of plants by firms are also consistent with a simple neoclassical profit-maximizing model.
- Much of conglomerate discount can be explained by sample selection. Firms that choose to diversify, or to stay diversified or to be acquired by diversifiers inherently differ from single-segment firms.

- On balance, industry case studies and econometric analyses of firm growth suggest that internal capital markets are efficient in reallocating resources.
- Even controlling for productivity, main and peripheral segments of diversified firms are treated differently. Main divisions grow faster, are less likely to be cut back in recessions, and less likely to be sold.

In our review of the evidence and econometric results, we have come to the conclusion that diversified firms predominantly behave like value maximizers given their productivity and internal capital markets facilitate the efficient transfer of resources. The evidence is broadly consistent with firms making endogenous value-maximizing choice of organizational form and allocating resources across industries consistent with a neoclassical model of resource allocation.

However, there is a large part of the literature that reaches different a conclusion, that conglomerate firms usually misallocate resources. Given the latest evidence, we are unable to reach this conclusion *for the majority* of conglomerate firms. However, there is some evidence that conglomerate firms that are busted up had investment patterns that varied from the neoclassical model. In addition, other puzzles do remain. In particular, the differences in growth patterns of main and peripheral divisions of diversified firms still have to be explained.

The conclusion that internal capital markets do not, on average, promote resource misallocation does not imply that firms are not subject to agency problems. Managers may allocate resources efficiently, but then expropriate the shareholder value created using those resources. Similarly, diversified firms may overpay for acquisitions that increase the firm's total value added from manufacturing activities.

More generally, the empirical literature on internal capital markets is an excellent case study of the importance of specifying the underlying benchmark model, paying attention to strengths and weaknesses of alternative data sources, and addressing econometric issues such as sample selection and measurement error. Seemingly reasonable choices at any of these steps are fully capable of leading to different results. As a result, the area remains of active interest to researchers.

Appendix A. Neoclassical model of resource allocation across industries

In this appendix we illustrate how demand shocks affect the relative resource allocation and output of efficient and inefficient producers in an industry and also efficient and inefficient segments within a multi-industry setting. The exposition is based on the working paper version of MP (2002) and complements the discussion in Section 3.5.

We begin by analyzing how firms change capacity in response to demand shocks in a single industry and then generalize the model to multiple industries. We also discuss how these predictions differ from those of agency models in the literature.

A.1. Shocks and growth in a single industry

We first analyze the relative growth rates and the flow of assets between differing productivity over the business cycle in a single industry. Accordingly, in this subsection we

assume that all firms in the industry are single-segment firms that produce only in one industry.

We start by simplifying the firm's profit function given in equation (2) in the text to the one industry case

$$pd^j k^j - rk^j - \beta\left(k^j\right)^2,$$

where, for simplicity, we have abstracted from labor costs (so that $\alpha = 0$ in equation (2) in the text). The subscript j refers to firm j. Recall that r is the market price of a unit of capacity and β is the standard neoclassical diseconomy of scale. To reduce notation, we further assume without loss of generality that d^j can take one of only two values. Let high productivity, or H firms, produce one unit of that industry's output per unit of capacity so that for those firms $d^j = d^{\mathrm{H}} = 1$. Let low productivity, or L firms, produce only $d^j = d < 1$ units of output per unit of capacity. Thus, the profit functions specialize to $pk^{\mathrm{H}} - rk^{\mathrm{H}} - \beta(k^{\mathrm{H}})^2$ for H firms and $pdk^{\mathrm{L}} - rk^{\mathrm{L}} - \beta(k^{\mathrm{L}})^2$ for L firms, after adjusting the notation to reflect the fact that all the H (L) firms are identical, and where and the number of capacity units operated by H and L firms is k^{H} and k^{L}, respectively. Assume that total amount of capacity available to the industry is $K = \sigma + \rho r$, $\sigma, \rho > 0$. Thus, we assume that the supply of capacity is not perfectly elastic, reflecting the addition of new capacity (for high levels of r) and sales for scrap (for low levels of r).

Assume that there is an exogenously determined number, n, of entrepreneurs and that the proportion of entrepreneurs that can operate H firms is λ. To avoid discussion of firm entry and exit, which would require more notation, also assume that the opportunity cost of capacity outside the industry is sufficiently low so that it is optimal for all high- and low-quality firms to operate at the level of demand we are considering.

The time sequence is as follows. There is one period and two dates: $t = 1, 2$. At time $t = 1$, the entrepreneurs learn the actual realization of the next period's level of demand in the industry. A market for capacity opens in which firms can purchase capacity units at a price r. The price of capacity, r, adjusts so that supply equals demand for capacity. At time $t = 2$, the firms realize the cash flows. For simplicity, we assume that capacity has no salvage value at $t = 2$.

To make explicit the role of demand shocks and the distribution of capacity units on firm growth, we describe the equilibrium in the market for output. The market price that the customers pay in industry for the output is determined as $p = a - bn(\lambda k^{\mathrm{H}} + (1 - \lambda)k^{\mathrm{L}})$, where $n(\lambda k^{\mathrm{H}} + (1-\lambda)k^{\mathrm{L}})$ is the aggregate output and a, b are positive constants.

Remark 1. A positive demand shock causes, productive profit maximizing firms increase in size relative to less productive profit maximizing firms.

Proof of Remark 1.

We obtain the output of type H firms by maximizing the firm's operating profit, $pk^{\mathrm{H}} - rk^{\mathrm{H}} - \beta(k^{\mathrm{H}})^2$. Solving for k^{H}, we obtain $\frac{p-r}{2\beta}$ as the optimal capacity that type H firms operate at the given opportunity cost, r. The capacity at which the low-quality firms

operate is similarly obtained as $k^{\mathrm{L}} = \frac{pd-r}{2\beta}$. Notice that $k^{\mathrm{H}} > k^{\mathrm{L}}$, so that a type H firm uses more capacity than the low-quality firm at every price level.

If both H and L firms are active in the industry and the price of capacity exceeds its salvage value, the market price of the output is $p = a - bn(\lambda k^{\mathrm{H}} + d(1-\lambda)k^{\mathrm{L}})$. We determine the price of capacity by equating the demand for capacity by each type of firm to the total number of capacity units available, either on the secondary market or as supplied by manufacturers, so that

$$\sigma + \rho r = \lambda n \frac{p-r}{2\beta} + (1-\lambda)n\frac{pd-r}{2\beta}, \tag{A.1}$$

where the total amount of capacity employed by the industry is $K = \sigma + \rho r$. The first term on the right hand side of the equation is the demand for capacity by the λn high-quality firms. The second term is the demand for capacity by the $(1-\lambda)n$ low-quality firms. Solving equation (1) for the opportunity cost of capacity yields

$$r = \frac{p(\lambda + d(1-\lambda))}{n + 2\beta\rho} - \frac{2\beta\sigma}{n+2\beta\rho}. \tag{A.2}$$

Substituting the expression for the rental cost of capital (A.2) into the expressions for the desired capacity by high- and low-quality firms, we obtain

$$k^{\mathrm{H}} = \frac{\sigma}{n+2\beta\rho} + \frac{(1-d)(1-\lambda)n + 2\beta\rho}{2w(n+2\beta\rho)}p,$$
$$k^{\mathrm{L}} = \frac{\sigma}{n+\beta\rho} - \frac{(1-d)\lambda n - 2\beta\rho d}{2w(n+2\beta\rho)}p.$$

The derivative of the ratio $(k^{\mathrm{H}}/k^{\mathrm{L}})$ with respect to the output price, p, is

$$\frac{2(1-d)(n+2\rho)\beta K}{(2w\sigma + (2\beta d\rho - (1-d)\lambda n)p)^2} > 0.$$

The last expression shows that a positive price shock (increase in p) increases the ratio $k^{\mathrm{H}}/k^{\mathrm{L}}$. Thus, positive price shocks are associated with higher growth of high-quality firms relative to low-quality firms. Since positive demand shocks to a at time $t = 1$ translate into increases in p, it is straightforward, but messy, to show that the same relation obtains for the ratio $k^{\mathrm{H}}/k^{\mathrm{L}}$ and a.[41] □

Remark 2. Consider a multiperiod generalization of the above industry equilibrium in which the model is repeated over a sequence of dates, with the demand intercept a changing over time. Positive (negative) innovations in a will cause more productive firms to engage in purchases of new capacity and purchases from other firms (divest) and less productive firms to divest (acquire) capacity.

[41] The analysis presented here assumes an interior equilibrium. A full analysis would take into account the exit and entry of entrepreneurs.

In a multi-period setting firms don't need to acquire all their capacity in each period. After the first period, they have an endowment of capacity form the previous period. Thus, they need only make marginal adjustments to capacity in response to changes in a. Firms can choose to use all their capacity to produce, to sell some capacity and use the remainder to produce, or to buy more capacity and produce. Capacity may be purchased from and sold to other firms operating in the same industry, or from sources outside the industry. The net capacity adjustments they make follow from Remark 1.

A.2. Cross-segment effects and the growth of conglomerates

As discussed above, when a positive demand shock occurs in industry 1 more productive producers increase their market share. When the productive producer is a conglomerate which operates both in industry 1 and industry 2 this increase in production in industry 1 creates a negative externality for this producer in industry 2. Thus, the conglomerate producer becomes a relatively less aggressive competitor in industry 2. By contrast, producers in industry 1 that are sufficiently less productive reduce capacity in industry 1 by selling capacity to the more productive firms.[42] This reduction in capacity reduces their control costs and creates a positive externality for the producers in industry 2. As a result, the less productive producers in industry 1 that also operate in industry 2 become more aggressive competitors in industry 2 and grow faster than they otherwise would in that industry. Thus, we can observe that:

Remark 3. Given a distribution of managerial talent, a positive price shock in industry 1 provides incentives for: (a) Conglomerates that are more productive producers in industry 1 relative to industry competitors to reduce their focus on industry 2 and increase their focus on industry 1 (b) Conglomerates that are marginally productive producers in industry 1 to reduce their focus on industry 1 and increase their focus on industry 2.

We illustrate case (b). This is easiest to show if we assume that there exist some firms in each industry which are single-segment. We use the suffix ss to indicate that the firm is single-segment. For simplicity, all single-segment firms in both industries have the same technology.

We assume that of the total number of firms n a fraction, λ_c, are conglomerates and operate in both industries. Assume that all conglomerates have identical abilities d_1^c and d_2^c. An equal number of single-segment firms operates in both industries, so that the fraction of the n firms operating in each industry as single-segment firms is λ_{ss},

[42] Note that "sufficiently" depends on the elasticity of supply of capacity into the industry. If supply is fixed ($\beta = 0$), then it is sufficient that $d < 1$. In a more general model it would not be necessary for the sale of capacity to occur in industry 1 in order for the less productive firms to become more aggressive competitors in industry 2. It would be sufficient for the less productive producers to grow more slowly in industry 1 than the more productive producers following a positive price shock.

where $\lambda_{ss} = (1 - \lambda_c)/2$. We assume that the capacity in each industry is fixed at K_i for $i = 1, 2$.

The profit function of a single-segment firm that operates only in industry i is, as before

$$p_i k_i^{ss} - r_i k^{ss} - \beta_i \left(k_i^{ss}\right)^2.$$

Maximizing profits yield an expression for optimal output analogous to that in the single industry case above, so that $k_i^{ss} = \frac{p_i - r_i}{2\beta}$.

A conglomerate's profit function is given in equation (2) in the text. For the special case discussed here it can be rewritten as

$$d_1^c p_1 k_1^c + d_2^c p_2 k_2^c - r_1 k_1^c - r_2 k_2^c - \beta \left(k_1^c + k_2^c\right)^2.$$

We want to show that following a positive price shock in industry 2, conglomerate segments that are less efficient than the competing single segment firms in industry 1 become smaller relative to the single segment firms in industry 1, so that the ratio (k_1^c / k_1^{ss}) declines with increases in p_2. We thus assume that $d_1^c < 1$ and, without loss of generality, $d_2^c = 1$.

By solving for k_i^c and k_i^{ss} and substituting into the industry equilibrium conditions $\sigma + \rho r_i = (\lambda_c k_i^c + \lambda_{ss} k_i^{ss}) n$ where $i = 1, 2$, we can solve for the price of capital in each industry r_1 and r_2. Substituting r_1 and r_2 back into the expressions for k_i^c and k_i^{ss}, we obtain

$$\frac{\delta(k_2^c / k_1^{ss})}{\delta p_1} = -A \left(\frac{n\lambda_{ss}}{n\lambda_{ss} + 2\beta(v + w_j)} - d_1^c \right).$$

It can be shown that A is positive for feasible λ_{ss} ($\lambda_{ss} < 0.5$). Thus, for all sufficiently low d_1^c ($d_1^c < \frac{n\lambda_{ss}}{n\lambda_{ss} + 2\beta\rho}$) the result follows. Note that if the supply of capacity is fixed in each industry so that $\rho = 0$, it is sufficient that $d_1^c < 1$.

Case (a) can be shown similarly. We can also show that:

Remark 4. The greater the productivity of a conglomerate's operations in an industry, the greater the effect of price shocks in that industry on the optimal size of operations of the conglomerate in other industries.

Thus, we would expect that shocks in a conglomerate's main segment (which, all else being equal, has a higher relative productivity) would produce greater effects on the industries in which it has its peripheral segments than if the opposite were true.

Note that we do not predict this pattern of growth across conglomerates business units because the conglomerate firms have an internal capital markets that are superior to those of single-industry firms. Rather, they result from the comparative advantage of conglomerates and single-segment firms over different ranges of demand. Moreover, the predictions of model differ from the agency or empire building models in the literature. The agency and empire building models predict that if a conglomerate receives

a positive shock in industry 1 it grows faster in industry 2. By contrast, by Remark 3 the model here predicts that if a conglomerate receives a positive shock in industry 1 and is very productive in industry 1 it grows more slowly in industry 2. Only when a conglomerate that receives a positive shock in industry 1 and is relatively unproductive in industry 1 does it grow faster in industry 2. Thus these predictions differ from agency and empire building models.

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Chapter 9

VENTURE CAPITAL*

PAUL GOMPERS

Graduate School of Business, Harvard University, Morgan 483, Soldiers Field, Boston, MA 02163, USA
e-mail: pgompers@hbs.edu

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Abstract

Venture capital has emerged as an important intermediary in financial markets, providing capital to young high-technology firms that might have otherwise gone unfunded. Venture capitalists have developed a variety of mechanisms to overcome the problems that emerge at each stage of the investment process. At the same time, the venture capital process is also subject to various pathologies from time to time, which can create problems for investors or entrepreneurs. This handbook chapter reviews the recent empirical literature on these organizations and points out area where further research is needed.

Keywords

venture capital, agency costs, optimal contracting, capital constraints monitoring

1. Introduction

Venture capital has attracted increasing attention in both the popular press and academic literature. It is alternately described as the engine fueling innovation in the US economy and as the industry that fueled the boom and bust of the Internet era. The recent dramatic growth and subsequent decline in the venture capital industry during the past decade has been accompanied by new academic research that explores its form and function. This research has increasingly shown that far from being a destabilizing factor in the economy, the venture capital industry, while relatively small compared to the public markets, has had a disproportionately positive impact on the economic landscape. There are several critical research questions, however, that still need to be addressed. This includes the extent to which the US venture capital model will be transferred outside of the US and measuring risk and return in the venture capital sector. Thus, this chapter has a two-fold role: to summarize and synthesize what is known about the nature of venture capital investing from recent research and to raise several areas that have yet to be fully answered.

The current view from the existing research is that venture capital has developed as an important intermediary in financial markets, providing capital to firms that might otherwise have difficulty attracting financing. These young firms are plagued by high levels of uncertainty and large differences in what entrepreneurs and investors know, possess few tangible assets, and operate in markets that can and do change very rapidly. The venture capital process can be seen as having evolved useful mechanisms to overcome potential conflicts of interest at each stage of the investment process. At the same time, the venture capital process is also subject to various pathologies from time to time. Various researchers have documented periods of time and settings in which these imbalances have created problems for investors or entrepreneurs.

A natural first question is what constitutes venture capital. Venture capital is often interpreted as many different kinds of investors. Many start-up firms require substantial capital. A firm's founder may not have sufficient funds to finance these projects alone and therefore must seek outside financing. Entrepreneurial firms that are characterized by significant intangible assets, expect years of negative earnings, and have uncertain prospects are unlikely to receive bank loans or other debt financing. Venture capital organizations finance these high-risk, potentially high-reward projects, purchasing equity or equity-linked stakes while the firms are still privately held. At the same time, not everyone who finances these types of firms is a venture capitalist. Banks, individual investors (or "angels"), and corporations are among the other providers of capital for these firms. Venture capital is defined as independent and professionally managed, dedicated pools of capital that focus on equity or equity-linked investments in privately held, high growth companies.

The primary focus of this chapter is on reviewing the empirical academic research on venture capital and highlighting the critical role that venture capital has played in filling an important financing gap. Our empirical understanding of venture capital has grown dramatically over the past decade as large scale databases on venture investing

have become widely available to researchers. The theoretical literature on venture capital has likewise exploded during the past decade. The improvement in efficiency might be due to the active monitoring and advice that is provided (Cornelli and Yosha, 1997; Marx, 1994; Hellmann, 1998), the screening mechanisms employed (Amit, Glosten, and Muller, 1990a, 1990b; Chan, 1983), the incentives to exit (Berglöf, 1994), the proper syndication of the investment (Admati and Pfleiderer, 1994), or the staging of the investment (Bergmann and Hege, 1998). This work has improved our understanding of the factors that affect the relationship between venture capitalists and entrepreneurs.

2. The development of the venture capital industry

The venture capital industry was a predominantly American phenomenon in its initial decades. It had its origins in the family offices that managed the wealth of high net worth individuals in the last decades of the nineteenth century and the first decades of this century. Wealthy families such as the Phippes, Rockefellers, Vanderbilts, and Whitneys invested in and advised a variety of business enterprises, including the predecessor entities to AT&T, Eastern Airlines, and McDonald-Douglas. Gradually, these families began involving outside professional managers to select and oversee these investments.

The first venture capital firm satisfying the criteria delineated above, however, was not established until after World War II. MIT President Karl Compton, Harvard Business School Professor Georges F. Doriot, and local Boston business leaders formed American Research and Development (ARD) in 1946. This small group of venture capitalists made high-risk investments into emerging companies that were based on technology developed for World War II. The success of the investments ranged widely: almost half of ARD's profits during its 26-year existence as an independent entity came from its $70,000 investment in Digital Equipment Company (DEC) in 1957, which grew in value to $355 million. Because institutional investors were reluctant to invest, ARD was structured as a publicly traded closed-end fund and marketed mostly to individuals (Liles, 1977). The few other venture organizations begun in the decade after ARD's formation were also structured as closed-end funds.

The closed-end fund structure employed by these funds had some significant advantages that made them more suited to venture capital investing than the more familiar open-end mutual funds. While the funds raised their initial capital by selling shares to the public, the funds did not need to repay investors if they wished to no longer hold the fund. Instead, the investors simply sold the shares on a public exchange to other investors. This provision allowed the fund to invest in illiquid assets, secure in the knowledge that they would not need to return investors' capital in an uncertain time frame. Most importantly, because it was a liquid investment that could be freely bought or sold, Security and Exchange Commission regulations did not preclude any class of investors from holding the shares.

The publicly traded structure, however, was soon found to have some significant drawbacks as well. In a number of cases, brokers sold the funds to inappropriate in-

vestors: i.e., elderly investors who had a need for high current income rather than long-term capital gains. When the immediate profits promised by unscrupulous brokers did not materialize, these investors vented their frustration at the venture capitalists themselves. For instance, much of General Doriot's time during the mid-1950s was spent addressing investors who had lost substantial sums on their shares of American Research and Development.

The first venture capital limited partnership, Draper, Gaither, and Anderson, was formed in 1958. Unlike the closed-end funds, partnerships were exempt from securities regulations, including the exacting disclosure requirements of the Investment Company Act of 1940. The set of the investors from which the funds could raise capital, however, was much more restricted. The interests in a given partnership could only be held by a limited number of institutions and high net-worth individual investors.

The Draper partnership and its followers applied the template of other limited partnerships: e.g., to develop real estate projects and explore oil fields. The partnerships had pre-determined, finite lifetimes (usually ten years, though extensions were often allowed). Thus, unlike closed-end funds, which often had indefinite lives, the partnerships were required to return the assets to investors within a set period. From the days of the first limited partnerships, these distributions were typically made in stock. Rather than selling successful investments after they went public and returning cash to their investors, the venture capitalists would simply give them their allocation of shares in the company in which the venture firm had invested. In this way, the investors could choose when to realize the capital gains associated with the investment. This feature was particular important for individuals and corporate investors, as they could arrange the sales in a manner that would minimize their capital gains tax obligation.

While imitators soon followed, limited partnerships accounted for a minority of the venture pool during the 1960s and 1970s. Most venture organizations raised money either through closed-end funds or small business investment companies (SBICs), federally guaranteed risk capital pools that proliferated during the 1960s. While the market for SBICs in the late 1960s and early 1970s was strong, the sector ultimately collapsed in the 1970s. The combination of federal guarantees and limited scrutiny of applicants led to scenario that foreshadowed the savings and loan crisis of the 1980s. Unscrupulous and naïve operators were frequently granted SBIC licenses. Frequently, their investments proved to be either in firms with poor prospects or in outright fraudulent enterprises.

Activity in the venture industry increased dramatically in late 1970s and early 1980s. Tables 1A, 1B and Figure 1 provide an overview of fundraising by venture partnerships, highlighting the changing volume of investments over the years, as well as the shifting mixture of investors. Industry observers attributed much of the shift to the U.S. Department of Labor's clarification of the "prudent man" rule in 1979. Prior to this year, the Employee Retirement Income Security Act (ERISA) limited pension funds from investing substantial amounts of money into venture capital or other high-risk asset classes. The Department of Labor's clarification of the rule explicitly allowed pension managers to invest in high-risk assets, including venture capital. In 1978, when $424 million was

Table 1A
Summary statistics for venture capital fund-raising by independent venture partnerships. All dollar figures are in millions of 2004 dollars

	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
First closing of funds													
Number of funds	23	27	57	81	98	147	150	99	86	112	78	88	50
Size (millions of 1992)	414	469	1,208	1,661	2,026	5,289	4,694	4,065	4,295	5,217	3,606	3,354	2,431
Sources of funds													
Private pension funds	15%	31%	30%	23%	33%	26%	25%	23%	39%	27%	27%	22%	31%
Public pension funds	[a]	[a]	[a]	[a]	[a]	5%	9%	10%	12%	12%	20%	14%	22%
Corporations	10%	17%	19%	17%	12%	12%	14%	12%	11%	10%	12%	20%	7%
Individuals	32%	23%	16%	23%	21%	21%	15%	13%	12%	12%	8%	6%	11%
Endowments	9%	10%	14%	12%	7%	8%	6%	8%	6%	10%	11%	12%	13%
Insurance companies/banks	16%	4%	13%	15%	14%	12%	13%	11%	10%	15%	9%	13%	9%
Foreign investors/other	18%	15%	8%	10%	13%	16%	18%	23%	11%	14%	13%	13%	7%
Independent venture partnerships as a share of the total venture pool[b]			40%	44%	58%	68%	72%	73%	75%	78%	80%	79%	80%

Source: Compiled from the unpublished Venture Economics funds database and various issues of the *Venture Capital Journal*. The numbers differ slightly from Lerner and Gompers (1996) due to continuing emendations to the funds database.

[a]Public pension funds are included with private pension funds in these years.

[b]This series is defined differently in different years. In some years, the *Venture Capital Journal* states that non-bank SBICs and publicly traded venture funds are included with independent venture partnerships. In other years, these funds are counted in other categories. It is not available after 1994.

Table 1B
Summary statistics for venture capital fund-raising by independent venture partnerships. All dollar figures are in millions of 1992 dollars

	1991	1992	1993	1994	1995	1996	1997	1998	1999
First closing of funds									
Number of funds	34	31	46	80	84	80	103	161	186
Size (millions of 1992 $)	1,483	1,950	2,480	3,582	4,045	6,805	8,060	16,933	31,299
Sources of funds									
Private pension funds	25%	22%	59%	47%	38%	43%	40%	37%	9%
Public pension funds	17%	20%	[a]	[a]	[a]	[a]	[a]	10%	9%
Corporations	4%	3%	8%	9%	2%	13%	30%	18%	16%
Individuals	12%	11%	7%	12%	17%	9%	13%	11%	19%
Endowments	24%	18%	11%	21%	22%	21%	9%	8%	15%
Insurance companies/banks	6%	14%	11%	9%	18%	5%	1%	3%	11%
Foreign investors/other	12%	11%	4%	2%	3%	8%	7%	13%	22%
Independent venture partnerships as a share of the total venture pool[b]									
	80%	81%	78%	78%					

Source: Compiled from the unpublished Venture Economics funds database and various issues of the *Venture Capital Journal*. The numbers differ slightly from Lerner and Gompers (1996) due to continuing emendations to the funds database.

[a]Public pension funds are included with private pension funds in these years.

[b]This series is defined differently in different years. In some years, the *Venture Capital Journal* states that non-bank SBICs and publicly traded venture funds are included with independent venture partnerships. In other years, these funds are counted in other categories. It is not available after 1994.

invested in new venture capital funds, individuals accounted for the largest share (32 percent). Pension funds supplied just 15 percent. Eight years later, when more than $4 billion was invested, pension funds accounted for more than half of all contributions.[1]

The subsequent years saw both very good and very trying times for venture capitalists. On the one hand, venture capitalists backed many of the most successful high-technology companies during the 1980s and 1990s, including Apple Computer, Cisco Systems, Genentech, Microsoft, Netscape, and Sun Microsystems. A substantial number of service firms (including Staples, Starbucks, and TCBY) also received venture financing.

At the same time, commitments to the venture capital industry were very uneven. As Figure 1 and Tables 1A, 1B depict, the annual flow of money into venture funds increased by a factor of ten during the early 1980s, peaking at around six billion (in 2004 dollars). From 1987 through 1991, however, fundraising steadily declined. This

[1] The annual commitments represent pledges of capital to venture funds raised in a given year. This money is typically invested over three to five years starting in the year the fund is formed.

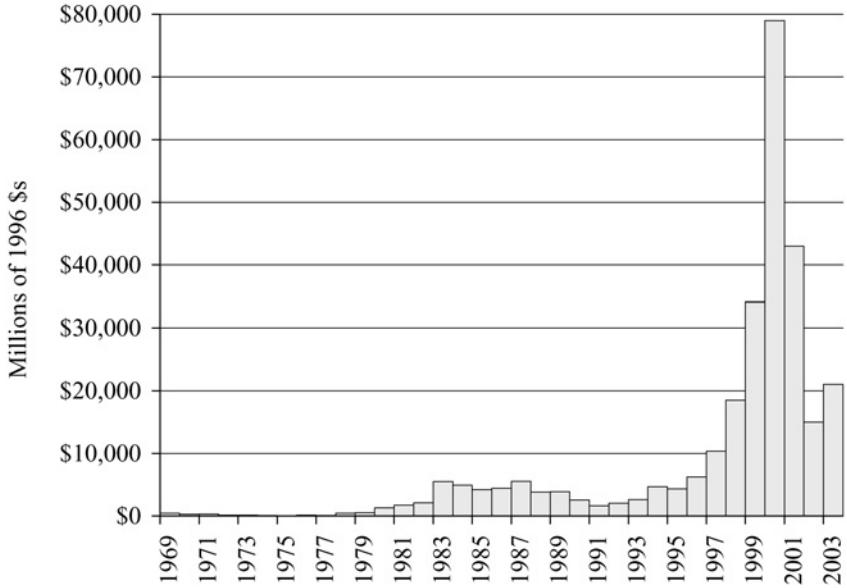

Fig. 1. Commitments to the venture capital industry. Commitments are defined as the amount of money that is pledged to venture capital funds in that year. Amounts are in millions of 1996 dollars. Source: Venture Economics and Asset Alternatives.

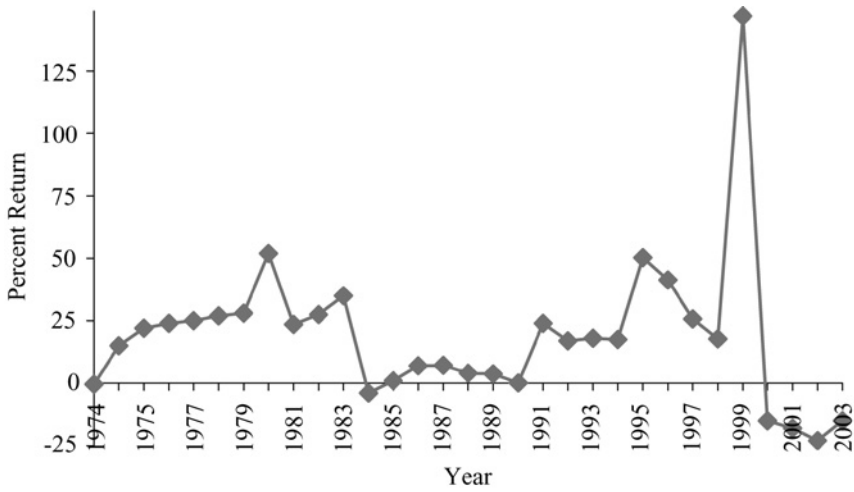

Fig. 2. Return on venture capital. The average annual internal rate of return on venture capital funds, net of fees and profit-sharing, is plotted by year. Source: Compiled from Venture Economics data.

fall-back reflected the disappointment that many investors encountered with their investments. As Figure 2 shows, returns on venture capital funds declined in the mid-1980s, apparently because of overinvestment in various industries and the entry of inexperienced venture capitalists. As investors became disappointed with returns, they committed less capital to the industry.

This pattern reversed dramatically in the 1990s, which saw rapid growth in venture fundraising. The explosion of activity in the IPO market and the exit of many inexperienced venture capitalists led to increasing venture capital returns. New capital commitments rose in response, increasing by more than twenty times between 1991 and 2000. While previous investment surges have been associated with falling venture capital returns, this expansion in fundraising saw a rise in the returns to venture funds. Much of the growth in fundraising was fueled by public pension funds, many of which entered venture investing for the first time in a significant way.

The explosion in venture capital investing was also driven by two other classes of investors: corporations and individuals. While the late 1960s and mid 1980s had seen extensive corporate experimentation with venture funds, the late 1990s saw an unprecedented surge of activity. The determinants of this increase were various. Some were similar to those in earlier waves of corporate venturing activity. For instance, the high degree of publicity associated with the successful venture investments of the period, such as Amazon.com, eBay, and Yahoo! triggered the interest of many CEOs, who sought to harness some of the same energy in their organization

This rapid rise in venture capital investing, however, gave way to just as rapid a deflation in venture capital investment activity. The causes of the decline are myriad. Some have commented on the overshooting of the venture industry and how the level of investment activity in 1999 and 2000 was driven up by irrational sentiment towards technology stocks. This sentiment fueled the rise in public equity values and the IPO market. When the business model for many of the startup companies, especially Internet-related firms, failed to deliver profits, investors began to realize that valuation levels assigned to these companies did not make rational sense.

In addition, corporations which had fueled much of the purchasing of new technology suddenly found themselves with excess capacity and slow end user demand. Technology spending by these companies quickly dried up and startups no longer had markets for their products. This decline in spending was protracted and many venture capital-backed startups could not recover.

Finally, the venture capital industry itself contributed to the overshooting and subsequent decline. Many venture capital firms played "follow the leader" strategies and invested in companies that were too similar to one another. This meant that even in attractive markets, product prices were driven down to unprofitable levels. Good ideas and good companies failed because the size of the markets addressed could not support the level of investment activity that took place in 1999 and 2000.

These factors led to a rise in venture capital-backed company failures and a rapid write-down in investment values. As fund portfolio values declined, interim internal rates of return became negative and investment levels declined. In the aftermath of the

Table 2
Number and dollar amount of venture capital disbursements in the U.S. in the first three quarters of 1999, by VentureOne industry classification. All dollar figures are in millions of current dollars

Industry	Number of transactions	Total $ invested
Communications and networking	255	$4,498
Electronics and computer hardware	59	$423
Information services	296	$3,053
Semiconductors and components	58	$518
Software	489	$4,233
Total of information technology	1157	$12,726
Healthcare services	47	$411
Medical compounds	84	$649
Medical devices and equipment	114	$827
Medical information systems	44	$336
Total of life sciences	289	$2,233
Retail and consumer products	30	$227
Other companies	454	$5,580
Total of non-technology or other	484	$5,807
Grand total	1979	$20,957

Source: Compiled from unpublished VentureOne databases.

retrenchment, many venture capital firms decided to reduce the amount of capital that they had raised, essentially foregoing commitments that their investors had made to their funds. As the investment pace slowed, the level of fundraising declined even more dramatically. While fundraising in the past few years has begun to recover, how far it rises and whether it reaches the speculative levels of 1999 and 2000 is an open question.

3. The venture capital investment process

Venture capitalists typically invest the money in young firms that may be little more than in the head of a talented engineer or scientist. Most of the firms that venture capitalists finance have few other sources of cash and many are subject to severe credit rationing. In order to overcome this capital rationing, however, the control and monitoring aspects of venture capitalists' investment process are paramount. Researchers have explored how the types of contracts utilized, the timing of investment, and the active involvement of the venture capital investor play important roles in improving the likelihood of success for the startup company

Tables 2–4 present historical information on the mixture of investments. Table 2 provides a detailed summary of investments in 1998; Table 3 presents a more aggregated summary of investments (in manufacturing firms only) over the past three decades; and

Table 4 provides a summary of investments in the ten states with the most venture capital activity over the past three decades.

Before considering the mechanisms employed by venture capitalists, it is worth highlighting that a lengthy literature has discussed the financing of young firms. Uncertainty and informational asymmetries often characterize young firms, particularly in high-technology industries. These information problems make it difficult to assess these firms, and permit opportunistic behavior by entrepreneurs after financing is received. This literature has also highlighted the role of financial intermediaries in alleviating these information problems.

To briefly review the types of conflicts that can emerge in these settings, Jensen and Meckling (1976) demonstrate that conflicts between managers and investors ("agency problems") can affect the willingness of both debt and equity holders to provide capital. If the firm raises equity from outside investors, the manager has an incentive to engage in wasteful expenditures (e.g., lavish offices) because he may benefit disproportionately from these but does not bear their entire cost. Similarly, if the firm raises debt, the manager may increase risk to undesirable levels. Because providers of capital recognize these problems, outside investors demand a higher rate of return than would be the case if the funds were internally generated.

More generally, the inability to verify outcomes makes it difficult to write contracts that are contingent upon particular events. This inability makes external financing costly. Many of the models of ownership (e.g., Grossman and Hart, 1986, and Hart and Moore, 1990) and financing choice (e.g., Hart and Moore, 1998) depend on the inability of investors to verify that certain actions have been taken or certain outcomes have occurred. While actions or outcomes might be observable, meaning that investors know what the entrepreneur did, they are assumed not to be verifiable: i.e., investors could not convince a court of the action or outcome. Start-up firms are likely to face exactly these types of problems, making external financing costly or difficult to obtain.

If the information asymmetries could be eliminated, financing constraints would disappear. Financial economists argue that specialized financial intermediaries, such as venture capital organizations, can address these problems. By intensively scrutinizing firms before providing capital and then monitoring them afterwards, they can alleviate some of the information gaps and reduce capital constraints. Thus, it is important to understand the tools employed by venture investors discussed below as responses to this difficult environment, which enable firms to ultimately receive the financing that they cannot raise from other sources. It is the nonmonetary aspects of venture capital that are critical to its success.

One of the most common features of venture capital is the meting out of financing in discrete stages over time. Sahlman (1990) notes that staged capital infusion is the most potent control mechanism a venture capitalist can employ. Prospects for the firm are periodically reevaluated. The shorter the duration of an individual round of financing, the more frequently the venture capitalist monitors the entrepreneur's progress and the greater the need to gather information. Staged capital infusion keeps the owner/manager

Table 3
Number and dollar amount of venture capital disbursements for U.S. manufacturing industries, by industry and five-year period. The count of venture capital investments in each five-year period is the sum of the number of firms receiving investments in each year. All dollar figures are in millions of 1992 dollars

#	Industry	1965–69	1970–74	1975–79	1980–84	1985–89	1990–96
Panel A: Venture capital investments (#s)							
1	Food and kindred	1	9	6	23	80	93
2	Textile and apparel	4	12	9	19	27	70
3	Lumber and furniture	2	8	6	24	62	37
4	Paper	2	2	2	2	12	14
5	Industrial chemicals	1	1	1	6	18	23
6	Drugs	1	12	34	245	554	746
7	Other chemicals	1	7	8	10	52	46
8	Petroleum refining and extraction	3	3	26	92	27	14
9	Rubber products	1	5	6	19	11	7
10	Stone, clay and glass products	0	1	3	14	48	31
11	Primary metals	0	3	5	20	44	33
12	Fabricated metal products	0	0	0	2	1	2
13	Office and computing machines	39	84	108	744	641	442
14	Other non-electrical machinery	12	12	32	254	280	162
15	Communication and electronic	23	65	60	497	736	709
16	Other electrical equipment	0	6	16	36	52	50
17	Transportation equipment	1	7	5	6	24	25
18	Aircraft and missiles	0	0	0	12	20	4
19	Professional and scientific instruments	13	37	70	383	549	544
20	Other machinery	7	14	16	62	89	98
	Total	111	288	413	2,470	3,327	3,150
Panel B: Venture capital disbursements (millions of 1992 $s)							
1	Food and kindred	4	19	7	25	212	258
2	Textile and apparel	6	15	14	27	45	186
3	Lumber and furniture	4	17	9	26	200	354
4	Paper	1	8	3	3	22	46
5	Industrial chemicals	0	1	1	41	34	33
6	Drugs	0	15	136	623	1,869	3,017
7	Other chemicals	1	40	4	9	155	87
8	Petroleum refining and extraction	12	6	92	359	110	29
9	Rubber products	1	3	15	28	8	18
10	Stone, clay and glass products	0	1	5	34	99	45
11	Primary metals	0	8	11	25	67	166
12	Fabricated metal products	0	0	0	1	0	1
13	Office and computing machines	67	404	288	3,253	2,491	1,426
14	Other non-electrical machinery	64	17	37	677	669	323
15	Communication and electronic	44	189	82	1,746	2,646	2,627
16	Other electrical equipment	0	8	53	78	107	104
17	Transportation equipment	0	10	4	9	47	96
18	Aircraft and missiles	0	0	0	19	19	8
19	Professional and scientific instruments	13	86	114	811	1,449	1,509
20	Other machinery	7	28	22	113	176	350
	Total	$225	$874	$895	$7,907	$10,423	$10,685

Source: Based on Kortum and Lerner (1999) and supplemented with tabulations of unpublished Venture Economics databases.

Table 4
Number and dollar amount of venture capital disbursements for all industries in the ten states with the most venture capital activity, by state and five-year period. The count of venture capital investments in each five-year period is the sum of the number of firms receiving investments in each year. All dollar figures are in millions of 1992 dollars

State	1965–69	1970–74	1975–79	1980–84	1985–89	1990–96
Panel A: Venture capital investments (#s)						
California	65	179	310	1,863	2,645	3,380
Massachusetts	45	93	155	708	1,014	1,028
Texas	18	71	84	373	584	489
New York	28	90	73	311	324	276
New Jersey	15	35	47	171	291	336
Colorado	5	22	31	194	258	298
Pennsylvania	8	21	32	120	290	311
Illinois	16	29	31	133	214	312
Minnesota	12	34	42	170	186	194
Connecticut	3	20	37	136	217	210
Total, all states	302	847	1,253	5,365	8,154	9,406
Panel B: Venture capital disbursements (millions of 1992 $s)						
California	218	546	691	6,711	9,670	13,603
Massachusetts	61	155	197	1,943	2,829	3,386
Texas	37	140	148	1,161	2,171	2,010
New York	32	154	162	688	1,404	1,394
New Jersey	33	82	77	370	1,214	1,711
Colorado	12	50	46	493	805	951
Pennsylvania	18	41	116	370	1,530	1,109
Illinois	59	134	117	287	1,208	1,413
Minnesota	6	90	44	270	406	522
Connecticut	1	32	85	319	1,463	724
Total, all states	$687	$1,935	$2,259	$15,261	$30,742	$37,162

Source: Based on tabulations of unpublished Venture Economics databases.

on a "tight leash" and reduces potential losses from bad decisions.[2] Venture capitalists

[2] Two related types of agency costs exist in entrepreneurial firms. Both agency costs result from the large information asymmetries that affect young, growth companies in need of financing. First, entrepreneurs might invest in strategies, research, or projects that have high personal returns but low expected monetary payoffs to shareholders. For example, a biotechnology company founder may choose to invest in a certain type of research that brings him/her great recognition in the scientific community but provides little return for the venture capitalist. Similarly, entrepreneurs may receive initial results from market trials indicating little demand for a new product, but may want to keep the company going because they receive significant private benefits from managing their own firm. Second, because entrepreneurs' equity stakes are essentially call options, they have incentives to pursue highly volatile strategies, such as rushing a product to market when further testing may be warranted.

should weigh potential agency and monitoring costs when determining how frequently they should reevaluate projects and supply capital. The duration of funding should decline and the frequency of reevaluation should increase when the venture capitalist expects conflicts with the entrepreneur are more likely.

If monitoring and information gathering are important, venture capitalists should invest in firms in which asymmetric information is likely to be a problem. The value of oversight will be greater for these firms. The capital constraints faced by these companies will be very large and the information gathered will help alleviate the constraint. Early-stage companies have short or no histories to examine and are difficult to evaluate. Similarly, high-technology companies are likely to require close monitoring. A significant fraction of venture investment should therefore be directed towards early-stage and high-technology companies.

In practice, venture capitalists incur costs when they monitor and infuse capital. Monitoring costs include the opportunity cost of generating reports for both the venture capitalist and entrepreneur. If venture capitalists need to "kick the tires" of the plant, read reports, and take time away from other activities, these costs can be substantial. Contracting costs (e.g., legal fees) and the lost time and resources of the entrepreneur must be imputed as well. These costs lead to funding being provided in discrete stages.

The nature of the firm's assets also has important implications for expected agency costs and the structure of staged venture capital investments. Intangible assets should be associated with greater agency problems. As assets become more tangible, venture capitalists can recover more of their investment in liquidation. This reduces the need to monitor tightly and should increase the time between refinancings. Industries with high levels of R&D should also have more frequent agency problems, and venture capitalists should shorten funding duration. Finally, a substantial finance literature (e.g., Myers, 1977) argues that firms with high market-to-book ratios are more susceptible to these agency costs, thus venture capitalists should increase the intensity of monitoring of these firms.

Gompers (1995) tests these predictions using a random sample of 794 venture capital-financed companies. The results confirm the predictions of agency theory. Venture capitalists concentrate investments in early stage companies and high technology industries where informational asymmetries are significant and monitoring is valuable. Venture capitalists monitor the firm's progress. If they learn negative information about future returns, the project is cut off from new financing. Firms that go public (these firms yield the highest return for venture capitalists on average) receive more total financing and a greater number of rounds than other firms (which may go bankrupt, be acquired, or remain private). Gompers also finds that early stage firms receive significantly less money per round. Increases in asset tangibility increase financing duration and reduce monitoring intensity. As the role of future investment opportunities in firm value increases (higher market-to-book ratios or R&D intensities), firms are refinanced more frequently. These results suggest the important monitoring and information generating roles played by venture capitalists.

Consistent evidence regarding the strength of contractual terms in these agreements is found in Kaplan and Stromberg's (2003) analysis of 130 venture partnership agreements. The overall use of contracts to control potential adverse behavior on the part of entrepreneurs has been modeled in a in a number of settings. Kaplan and Stromberg test a variety of these theories to determine whether factors like information asymmetries are critical to the types of contracts that are signed between venture capitalists and entrepreneurs. They find that venture contracts are effective at separating cash flow ownership from board rights, liquidation rights, voting rights and other control rights. Similarly, future financing and allocation of ownership in the firm is often based on reaching contingent milestones. The results support the contracting view of Aghion and Bolton (1992) and Dewatripont and Tirole (1994).

In addition to the staged capital infusions, venture capitalists will usually make investments with other investors. One venture firm will originate the deal and look to bring in other venture capital firms. This syndication serves multiple purposes. First, it allows the venture capital firm to diversify. If the venture capitalist had to invest alone into all the companies in his portfolio, then he could make many fewer investments. By syndicating investments, the venture capitalist can invest in more projects and largely diversify away firm-specific risk.

A second potential explanation for syndication patterns is that involving other venture firms provides as a second opinion on the investment opportunity. There is usually no clear-cut answer as to whether any of the investments that a venture organization undertakes will yield attractive returns. Having other investors approve the deal limits the danger that bad deals will get funded. This is particularly true when the company is early-stage or technology-based.

Lerner (1994a) tests this "second opinion" hypothesis in a sample of biotechnology venture capital investments. In a sample of 271 firms, Lerner finds that in the early rounds of investing, experienced venture capitalists tend to syndicate only with venture capital firms that have similar experience. Lerner argues that if a venture capitalist were looking for a second opinion, then he would want to get a second opinion from someone of similar or better ability, certainly not from someone of lesser ability.

A related topic is explored by Hochberg, Ljungqvist, and Lu (2006) who examine the relationship among various venture capital investors in syndicate networks and the performance of the companies in which they invest. Hochberg et al. create a measure of centrality based on syndicate patterns in the network. This measure, the Bonacich (1987) measure, controls for how central a venture capital firm is to the entire industry. Firms with greater Bonacich measures are more central to the industry based upon their syndicate patters. Hochberg et al. find that this measure is a strong predictor of performance for the underlying portfolio companies. Portfolio companies that receive an investment by a venture firm that is more central to the industry are more likely to be successful (as measured by the probability of exiting through an IPO or acquisition). In addition, they are more likely to survive to a subsequent financing round than are similar firms financed by venture capitalists that are less central based on their syndication patterns. These patterns support the results found by Lerner in his earlier work.

The advice and support provided by venture capitalists is often embodied by their role on the firm's board of directors. Lerner (1995) examines the decision of venture capitalists to provide this oversight. He examines whether venture capitalists' representation on the boards of the private firms in their portfolios is greater when the need for oversight is larger. This approach is suggested by Fama and Jensen (1983) and Williamson (1983), who hypothesize that the composition of the board should be shaped by the need for oversight. These authors argue that the board will bear greater responsibility for oversight—and consequently that outsiders should have greater representation—when the danger of managerial deviations from value maximization is high. If venture capitalists are especially important providers of managerial oversight, their representation on boards should be more extensive at times when the need for oversight is greater.

Lerner examines changes in board membership around the time that a firm's chief executive officer (CEO) is replaced, an approach suggested by Hermalin and Weisbach's (1988) study of outside directors of public firms. The replacement of the top manager at an entrepreneurial firm is likely to coincide with an organizational crisis and to heighten the need for monitoring. He finds that an average of 1.75 venture capitalists are added to the board between financing rounds when the firm's CEO is replaced in the interval; between other rounds, 0.24 venture directors are added. No differences are found in the addition of other outside directors. This oversight of new firms involves substantial costs. The transaction costs associated with frequent visits and intensive involvement are likely to be reduced if the venture capitalist is proximate to the firms in his portfolio. Consistent with these suggestions, he find that geographic proximity is an important determinant of venture board membership: organizations with offices within five miles of the firm's headquarters are twice as likely to be board members as those more than 500 miles distant. Over half the firms in the sample have a venture director with an office within sixty miles of their headquarters.

The role that venture capitalists play in shaping the overall board of directors at the time of the IPO is also explored in Baker and Gompers (2004a). In particular, they examine the determinants of board structures and the effects that these board structures play in determining the success of the firm. With data from 1,116 IPO prospectuses, they describe board size and composition for a set of firms with a median age of less than six years and a median equity capitalization of $42 million. This analysis gives insights on the role that venture capitalists play—beyond providing money—and the bargaining process between the CEO and outside shareholders.

The venture capital-backed board has fewer insiders and quasi-outsiders and more independent outside directors. These results hold when we control for ownership structure and the endogeneity of venture financing, suggesting a causal relationship where venture capitalists, in addition to monitoring management and providing capital, give advice and value-added services that otherwise might be performed by instrumental board members. The evidence is consistent with the Hermalin and Weisbach (1988) notion that board structure is the outcome of a bargain between the CEO and the outside investors. First, the fraction of outsiders on the board of directors falls with CEO tenure and voting control. Venture capitalists appear to be a counterweight to CEO

control. Venture capitalists not only reduce inside representation indirectly by reducing the control of the CEO with their concentrated outside ownership stakes, but also reputable venture firms are directly associated with greater outsider representation on the board. Second, a possible interpretation of the venture reputation effect is that reputable venture firms gain power by having access to adequate replacements for the founder. Consistent with this notion, the probability that a founder remains on as CEO at the time of the IPO falls with venture firm reputation. Baker and Gompers also explore the performance implications of better boards and find that the better board structure of venture capital backing improves long-term firm outcomes.

Hellmann and Puri (2002) examine the value that is added by venture capitalists, i.e., the role that they play in the professionalization of start-up companies. They examine a sample of 170 Silicon Valley start-ups and find that venture capitalists play a role at the top of the organization, in terms of replacing the original founders with an outside CEO. Moreover, they seem to influence developments further down the organization, in terms of playing a role for the introduction of stock option plans, the hiring of a VP of sales and marketing, and the formulation of human resource policies.

There are several specific questions that Hellmann and Puri address. First, they explore whether venture capitalists provide support in building up the internal organization. They look at several measures including the recruitment processes, the overall human resource policies, the adoption of stock option plans, and the hiring of a vice president of marketing and sales. When they compare similar companies that did and did not receive venture capital financing, they find that companies that obtain venture capital are more likely and are faster to professionalize along these various dimensions.

In work similar to Baker and Gompers (2004a, 2004b), Hellmann and Puri look at the position of the CEO and ask whether a founder is more likely to be replaced by an outsider as CEO when a venture capitalist invests in the firm. Not surprisingly, venture capitalists are more likely to replace a founder as CEO. To attract a new CEO, venture capital is particularly important for early stage companies that do not have any signs of success, still important for companies with a product on the market, and no longer important by the time companies have gone public.

Another mechanism utilized by venture capitalists to avoid conflicts is the widespread use of stock grants and stock options. Managers and critical employees within a firm receive a substantial fraction of their compensation in the form of equity or options. This tends to align the incentives of managers and investors. Baker and Gompers (2004b) examine the role that venture capitalists play in setting compensation and incentives of entrepreneurs. They find that venture capitalists increases the sensitivity of management's compensation to the firm's performance relative to similar nonventure capital-financed companies. Fixed salaries are lower and the size of the equity stake held is higher for venture capital-backed CEOs.

The venture capitalist also employs additional controls on compensation to reduce potential gaming by the entrepreneur. First, venture capitalists usually require vesting of the stock or options over a multi-year period. In this way, the entrepreneur cannot leave the firm and take his shares. Similarly, the venture capitalist can significantly dilute the

entrepreneur's stake in subsequent financings if the firm fails to realize its targets. This provides additional incentives for the entrepreneur. In order to maintain his stake, the entrepreneur will need to meet his stated targets.

Until this point, this section has highlighted the ways in which venture capitalists can successfully address agency problems in portfolio firms. The argument is often made by venture capital practitioners, however, that the industry has gone through periods of disequilibrium. During periods when the amount of money flowing into the industry has dramatically grown, they argue, the valuations at which investments are made or the likelihood that certain transactions get funded can shift dramatically. If there are only a certain number of worthy projects to finance, then a substantial increase in the amount of venture fundraising may increase the prices that are paid to invest in these companies. These higher prices may ultimately affect the returns on investment in the industry.

Sahlman and Stevenson (1987) chronicle the exploits of venture capitalists in the Winchester disk drive industry during the early 1980s. Sahlman and Stevenson believe that a type of "market myopia" affected venture capital investing in the industry. During the late 1970s and early 1980s, nineteen disk drive companies received venture capital financing. Two-thirds of these investments came between 1982 and 1984, the period of rapid expansion of the venture industry. Many disk drive companies also went public during this period. While industry growth was rapid during this period of time (sales increased from $27 million in 1978 to $1.3 billion in 1983), Sahlman and Stevenson question whether the scale of investment was rational given any reasonable expectations of industry growth and future economic trends.[3] Similar stories are often told concerning investments in software, biotechnology, and the Internet. The phrase "too much money chasing too few deals" is a common refrain in the venture capital market during periods of rapid growth.

Gompers and Lerner (2000) examine these claims through a dataset of over 4000 venture investments between 1987 and 1995 developed by the consulting firm VentureOne. They construct a hedonic price index that controls for various firm attributes that might affect firm valuation, including firm age, stage of development, and industry, as well as macroeconomic variables such as inflow of funds into the venture capital industry. In addition, they control for public market valuations through indexes of public market values for firms in the same industries and average book-to-market and earnings-to-price ratios.

The results support contentions that a strong relation exists between the valuation of venture capital investments and capital inflows. While other variables also have significant explanatory power—for instance, the marginal impact of a doubling in public market values was between a 15% and 35% increase in the valuation of private equity

[3] Lerner (1997) suggests, however, that these firms may have displayed behavior consistent with strategic models of "technology races" in the economics literature. Because firms had the option to exit the competition to develop a new disk drive, it may have indeed been rational for venture capitalists to fund a substantial number of disk drive manufacturers.

transactions—the inflows variable is significantly positive. A doubling of inflows into venture funds leads to between a 7% and 21% increase in valuation levels.

While prices rose somewhat in 1987, they declined and remained quite flat through the 1990s. Starting in 1994, however, prices steadily increased. This increase coincided with the recent rise in venture fundraising. The regression results show that this rise in fundraising is an important source of the increase in prices. The results are particularly strong for specific types of funds and funds in particular regions. Because funds have become larger in real dollar terms, with more capital per partner, many venture capital organizations have invested larger amounts of money in each portfolio company. Firms have attempted to do this in two ways. First, there has been a movement to finance later-stage companies that can accept larger blocks of financing. Second, venture firms are syndicating less. This leads to greater competition for making later-stage investments. Similarly, because the majority of money is raised in California and Massachusetts, competition for deals in these regions should be particularly intense and venture capital inflows may have a more dramatic effect on prices in those regions. The results support these contentions. The effect of venture capital inflows is significantly more dramatic on later-stage investments and investments in California and Massachusetts.

3.1. Exiting venture capital investments

In order to make money on their investments, venture capitalists need to turn illiquid stakes in private companies into realized return. Typically, as was discussed above, the most profitable exit opportunity is an initial public offering (IPO). In an IPO, the venture capitalist assists the company in issuing shares to the public for the first time. Table 5 summarizes the exiting of venture capital investments through initial public offerings as well as comparable data on non-venture capital offerings.

Initial empirical research into the role of venture capitalists in exiting investments focused on the structure of IPOs. Barry et al. (1990) focus on establishing a broad array of facts about the role of venture capitalists in IPOs, using a sample of 433 venture-backed and 1123 non-venture IPOs between 1978 and 1987.

Barry et al. (1990) document that venture capitalists hold significant equity stakes in the firms they take public (on average, the lead venture capitalist holds a 19% stake immediately prior to the IPO, and all venture investors hold 34%), and hold about one-third of the board seats. They continue to hold their equity positions in the year after the IPO. Finally, venture-backed IPOs have less of a positive return on their first trading day. The authors suggest that this implies that investors need less of a discount in order to purchase these shares (i.e., the offerings are less "underpriced"), because the venture capitalist has monitored the quality of the offering.

Megginson and Weiss (1991) argue that because venture capitalists repeatedly bring firms to the public market, they can credibly stake their reputation. Put another way, they can certify to investors that the firms they bring to market are not overvalued. Certification requires that venture capitalists possess reputational capital, that the acquisition

Table 5
The distribution of venture-backed and non-venture IPOs for the period 1978–1999. This table compares the distribution of IPOs in this sample versus all IPOs recorded over this period of time. All dollar figures are in millions of 1992 dollars

Year	Number of venture-backed IPOs	Amount raised in venture-backed IPOs	Total number of IPOs	Total amount raised in all IPOs	Venture-backed IPOs as percent of all IPOs (number)	Venture-backed IPOs as percent of all IPOs (amount)
1978	6	$134	42	$485	12.50%	21.59%
1979	4	$62	103	$777	3.74%	7.34%
1980	24	$670	259	$2,327	8.48%	22.35%
1981	50	$783	438	$4,848	10.25%	13.91%
1982	21	$738	198	$1,901	9.59%	27.97%
1983	101	$3,451	848	$17,999	10.64%	16.09%
1984	44	$731	516	$5,179	7.86%	12.37%
1985	35	$819	507	$13,307	6.46%	5.80%
1986	79	$2,003	953	$23,902	7.66%	7.73%
1987	69	$1,602	630	$19,721	9.87%	7.52%
1988	36	$915	435	$6,679	8.28%	13.70%
1989	39	$1,110	371	$6,763	10.51%	16.41%
1990	43	$1,269	276	$4,828	15.58%	16.29%
1991	119	$3,835	367	$16,872	32.43%	22.73%
1992	157	$4,317	509	$23,990	30.84%	17.99%
1993	193	$4,905	707	$40,456	27.30%	12.12%
1994	159	$3,408	564	$27,786	28.19%	12.26%
1995	205	$6,251	566	$36,219	36.22%	17.26%
1996	284	$10,976	845	$38,245	33.61%	28.70%
1997	138	$4,419	628	$40,278	21.34%	10.60%
1998	78	$3,388	319	$31,075	24.45%	10.90%
1999	271	$20,757	485	$56,952	55.87%	36.45%

Sources: Barry et al. (1990), Ritter (2006), and various issues of the *Going Public: The IPO Reporter* and the *Venture Capital Journal*.

of such a reputation is costly, and that the present value of lost reputational capital by cheating is greater than the one-time gain from behaving in a duplicitous manner.

Megginson and Weiss test these ideas using a matched set of 640 venture-backed and non-venture IPOs between 1983 and 1987. First, they examine the quality of the underwriters who bring firms to market. They show that the underwriters of venture-backed firms are significantly more experienced than the underwriters of comparable non-venture offerings. Megginson and Weiss also find that institutional holdings of venture-backed firms after the IPO are larger than comparable non-venture companies. Third, Megginson and Weiss gather evidence on expenses associated with going public. Venture-backed IPOs have significantly lower fees than non-venture IPOs. Fourth, Megginson and Weiss demonstrate that venture capitalists retain a majority of their equity after the IPO. Megginson and Weiss argue that this is a commitment device. Finally,

Megginson and Weiss present evidence that the underpricing of venture capital-backed IPOs is significantly less than the underpricing of non-venture IPOs.

More recent research has examined the timing of the decision to take firms public and to liquidate the venture capitalists' holdings (which frequently occurs well after the IPO). Several potential factors affect when venture capitalists choose to bring firms public. One of these is the relative valuation level of publicly traded securities. Lerner (1994b) examines when venture capitalists choose to finance a sample of biotechnology companies in another private round versus taking the firm public in. Using a sample of 350 privately held venture-backed firms, he shows take firms public at market peaks, relying on private financings when valuations are lower. Seasoned venture capitalists appear more proficient at timing IPOs. The results are robust to the use of alternative criteria to separate firms and controls for firms' quality. The results are not caused by differences in the speed of executing the IPOs, or in the willingness to withdraw the proposed IPOs.

Another consideration may be the reputation of the venture capital firm. Gompers (1996) argues that young venture capital firms have incentives to "grandstand": i.e., they take actions that signal their ability to potential investors. Specifically, young venture capital firms bring companies public earlier than older venture capital firms in an effort to establish a reputation and successfully raise capital for new funds. He examines a sample of 433 venture-backed initial public offerings (IPOs) between 1978 and 1987, as well as a second sample consisting of the first IPOs brought to market by 62 venture capital funds. The results support predictions of the grandstanding hypothesis. For example, the effect of recent performance in the IPO market on the amount of capital raised is stronger for young venture capital firms, providing them with a greater incentive to bring companies public earlier. Young venture capital firms have been on the IPO company's board of directors 14 months less and hold smaller percentage equity stakes at the time of IPO than the more established venture firms. The IPO companies that they finance are nearly two years younger and more underpriced when they go public than companies backed by older venture capital firms. Much of the difference in underpricing and the venture capitalists' percentage equity stake is associated with a shorter duration of board representation, indicating that rushing companies to the IPO market imposes costs on the venture firm. The results suggest that the relation between performance and capital raising affects the incentives and actions of venture capitalists.

The typical venture capital firm, however, does not sell their equity at the time of the IPO. The negative signal that would be sent to the market by an insider "cashing out" would prevent a successful offering. In additional, most investment banks require that all insiders, including the venture capitalists, do not sell any of their equity after the offering for a pre-specified period (usually six months) as noted in Brav and Gompers (2003). Once that lock-up period is over, however, venture capitalists can return money to investors in one of two ways. They can liquidate their position in a portfolio company by selling shares on the open market after it has gone public and then paying those proceeds to investors in cash. More frequently, however, venture capitalists make distributions of shares to investors in the venture capital fund. Many institutional investors

have received a flood of these distributions during the past several years and have grown increasingly concerned about the incentives of the venture capitalists when they declare these transfers.

Gompers and Lerner (1998a) examine how investors might be affected by distributions. These distributions have several features that make them an interesting testing ground for an examination of the impact of transactions by informed insiders on securities prices. Because they are not considered to be "sales", the distributions are exempt from the anti-fraud and anti-manipulation provisions of the securities laws. The legality of distributions provides an important advantage. Comprehensive records of these transactions are compiled by the institutional investors and the intermediaries who invest in venture funds, addressing concerns about sample selection bias. Like trades by corporate insiders, transactions are not revealed at the time of the transaction. Venture capitalists can immediately declare a distribution, send investors their shares, and need not register with the SEC or file a report under Rule 16(a). Rather, the occurrence of such distributions can only be discovered from corporate filings with a lag, and even then the distribution date cannot be precisely identified. To identify the time of these transactions, one needs to rely on the records of the partners in the fund. They characterize the features of the venture funds making the distributions, the firms whose shares are being distributed, and the changes associated with the transactions in a way that can discriminate between the various alternative explanations for these patterns.

From the records of four institutions, Gompers and Lerner construct a representative set of over 700 transactions by 135 funds over a decade-long period. The results are consistent with venture capitalists possessing inside information and of the (partial) adjustment of the market to that information. After significant increases in stock prices prior to distribution, abnormal returns around the distribution are a negative and significant -2.0 percent, comparable to the market reaction to publicly announced secondary stock sales. The sign and significance of the cumulative excess returns for the twelve months following the distribution appear to be negative in most specifications, but are sensitive to the benchmark used.

Significant differences appear in the returns for some sub-samples. Distributions that occur in settings where information asymmetries may be greatest—especially where the firm has been taken public by a lower-tier underwriter and the distribution is soon after the IPO—have larger immediate price declines. Post-distribution price performance is related to factors that predict event window returns.

Finally, Brav and Gompers (1997) explore the long-run performance implications of venture capital backing after they perform an IPO. In particular, they examine whether the pre-IPO performance differences noted by Hellmann and Puri (2002) or Gompers and Lerner (1998b) carry over to when the companies go public, long after they received venture financing. Brav and Gompers find that venture capital-backed companies do indeed outperform comparable nonventure-capital-backed companies, with venture capital backed companies earning 40% more over five years after the IPO.

4. Venture investing and innovation

In this section, I explore the issue of venture capital impact on innovation. I begin by reviewing the evidence regarding the overall impact of venture capital on innovation. I then turn to exploring the impact of the historic boom-and bust pattern on these shifts. I highlight that while the overall relationship between venture capital and innovation is positive, the relationships across the cycles of venture activity may be quite different.

A lengthy theoretical literature has been developed in recent years, as financial economists have sought to understand the mechanisms employed by venture capitalists. These works suggest that these financial intermediaries are particularly well suited for nurturing innovative new firms.

It might be thought that it would be not difficult to address the question of the impact of venture capital on innovation. For instance, one could look in regressions across industries and time whether, controlling for R&D spending, venture capital funding has an impact on various measures of innovation. But even a simple model of the relationship between venture capital, R&D, and innovation suggests that this approach is likely to give misleading estimates.

Both venture funding and innovation could be positively related to a third unobserved factor, the arrival of technological opportunities. Thus, there could be more innovation at times that there was more venture capital, not because the venture capital caused the innovation, but rather because the venture capitalists reacted to some fundamental technological shock which was sure to lead to more innovation. To date, only two papers have attempted to address these challenging issues.

The first of these papers, Hellmann and Puri (2000), examines a sample of 170 recently formed firms in Silicon Valley, including both venture-backed and non-venture firms. Using questionnaire responses, they find empirical evidence that venture capital financing is related to product market strategies and outcomes of startups. They find that firms that are pursuing what they term an innovator strategy (a classification based on the content analysis of survey responses) are significantly more likely and faster to obtain venture capital. The presence of a venture capitalist is also associated with a significant reduction in the time taken to bring a product to market, especially for innovators. Furthermore, firms are more likely to list obtaining venture capital as a significant milestone in the lifecycle of the company as compared to other financing events.

The results suggest significant interrelations between investor type and product market dimensions, and a role of venture capital in encouraging innovative companies. Given the small size of the sample and the limited data, they can only modestly address concerns about causality. Unfortunately, the possibility remains that more innovative firms select venture capital for financing, rather than venture capital causing firms to be more innovative.

Kortum and Lerner (2000), by way of contrast, examine these patterns can be discerned on an aggregate industry level, rather than on the firm level. They address concerns about causality in two ways. First, they exploit the major discontinuity in the

recent history of the venture capital industry: as discussed above, in the late 1970s, the U.S. Department of Labor clarified the Employee Retirement Income Security Act, a policy shift that freed pensions to invest in venture capital. This shift led to a sharp increase in the funds committed to venture capital. This type of exogenous change should identify the role of venture capital, because it is unlikely to be related to the arrival of entrepreneurial opportunities. They exploit this shift in instrumental variable regressions. Second, they use R&D expenditures to control for the arrival of technological opportunities that are anticipated by economic actors at the time, but that are unobserved to econometricians. In the framework of a simple model, they show that the causality problem disappears if they estimate the impact of venture capital on the patent–R&D ratio, rather than on patenting itself.

Even after addressing these causality concerns, the results suggest that venture funding does have a strong positive impact on innovation. The estimated coefficients vary according to the techniques employed, but on average a dollar of venture capital appears to be three to four times more potent in stimulating patenting than a dollar of traditional corporate R&D. The estimates therefore suggest that venture capital, even though it averaged less than three percent of corporate R&D from 1983 to 1992, is responsible for a much greater share—perhaps ten percent—of U.S. industrial innovations in this decade.

The evidence that venture capital has a powerful impact on innovation might lead us to be especially worried about market downturns. A dramatic fall in venture capital financing, it is natural to conclude, would lead to a sharp decline in innovation.

But this reasoning, while initially plausible, is somewhat misleading. For the impact of venture capital on innovation does not appear to be uniform. Rather, during periods when the intensity of investment is greatest, the impact of venture financing appears to decline. The uneven impact of venture on innovation can be illustrated by examining the experience during two "boom" periods in the industry.

One example was the peak period of biotechnology investing in the early 1990s. While the potential of biotechnology to address human disease was doubtless substantial, the extent and nature of financing seemed to many observers at the time hard to justify. In some cases, dozens of firms pursuing similar approaches to the same disease target were funded. Moreover, the valuations of these firms often were exorbitant: for instance, between May and December 1992, the average valuation of the privately held biotechnology firms financed by venture capitalists was $70 million. These doubts were validated when biotechnology valuations fell precipitously in early 1993: by December 1993, only 42 of 262 publicly traded biotechnology firms had a valuation over $70 million.

Most of the biotechnology firms financed during this period ultimately yielded very disappointing returns for their venture financiers and modest gains for society as a whole. In many cases, the firms were liquidated after further financing could not be arranged. In others, the firms shifted their efforts into other, less competitive areas, largely abandoning the initial research efforts. In yet others, the companies remained mired with their peers for years in costly patent litigation.

The boom of 1998–2000 provides many additional illustrations. Funding during these years was concentrated in two areas: Internet and telecommunication investments, which, for instance, accounted for 39% and 17% of all venture disbursements in 1999. Once again, considerable sums were devoted to supporting highly similar firms—e.g., the nine dueling Internet pet food suppliers—or else efforts that seemed fundamentally uneconomical and doomed to failure, such as companies which undertook the extremely capital-intensive process of building a second cable network in residential communities. Meanwhile, many apparently promising areas—e.g., advanced materials, energy technologies, and micro manufacturing—languished unfunded as venture capitalists raced to focus on the most visible and popular investment areas. It is difficult to believe that the impact of a dollar of venture financing was as powerful in spurring innovation during these periods as in others.

5. What we don't know about venture capital

While financial economists know much more about venture capital than they did a decade ago, there are many unresolved issues that would reward future research. In this final section, I highlight three areas for further research that I consider particularly promising.

5.1. Understanding risk and return

One critical, but unanswered area, is the assessment of venture capital as a financial asset. Many institutions, primarily public and private pension funds, have increased their allocation to venture capital and private equity in the belief that the returns of these funds are largely uncorrelated with the public markets.

It is natural to see how they come to this conclusion. Firms receiving capital from private equity funds very often remain privately held for a number of years after the initial investment. These firms have no observable market price. In order to present a conservative assessment of the portfolio valuation, private equity managers often refrain from marking portfolio firm values to market, preferring to maintain the investments at book value.

But as discussed throughout this analysis, there appear to be many linkages between the public and private equity market values. Thus, the stated returns of private equity funds may not accurately reflect the true evolution of value, and the correlations reported by Venture Economics (1997) and other industry observers may be deceptively low. To ignore the true correlation is fraught with potential dangers.[4]

[4] In a preliminary analysis using data from one venture group, Gompers and Lerner (1997) find that the correlation between venture capital and public market prices increases substantially when the underlying venture portfolio is "marked-to-market". An alternative approach is to examine the relatively modest number of publicly traded venture capital funds, as is done by Martin and Petty (1983).

Recent work by Kaplan and Schoar (2004) and Cochrane (2004) has attempted to deal with this stale price problem. Kaplan and Schoar use the change in the level of the S&P 500 as a benchmark from the time of investment while Cochrane uses econometric corrections for stale prices and selection biases in the data. While the results of each are somewhat contradictory, they are important first steps in addressing a problem that is clearly central to the asset allocation decision of many investors.

5.2. The internationalization of venture capital

The rapid growth in the U.S. venture capital market has led institutional investors to look increasingly at venture capital alternatives abroad. Until very recently, outside of the United Kingdom (where performance of funds has been quite poor) and Israel, there has been little venture capital activity abroad.[5] (Table 6 provides an international comparison of venture capital activity.) Black and Gilson (1998) argue that the key source of the U.S. competitive advantage in venture capital is the existence of a robust IPO market. Venture capitalists can commit to transfer control back to the entrepreneur when a public equity market for new issues exists. This commitment device is unavailable in economies dominated by banks, such as Germany and Japan.

These arguments, however, have less credibility in light of the events of the past twelve months. There has been a surge in venture capital investment, particularly relating to the Internet, in a wide variety of nations across Asia, Europe, and Latin America. While local groups (many recently established) have made some of these investments, much of the activities have been driven by U.S.-based organizations.

In a pioneering study, Jeng and Wells (1999) examine the factors that influence venture capital fundraising in 21 countries. They find that the strength of the IPO market is an important factor in the determinant of venture capital commitments, echoing the conclusions of Black and Gilson. Jeng and Wells find, however, that the IPO market does not seem to influence commitments to early-stage funds as much as later-stage ones. While this work represents an important initial step, much more remains to be explored regarding the internationalization of venture capital.

One provocative finding from the Jeng and Wells analysis is that government policy can have a dramatic impact on the current and long-term viability of the venture capital sector. In many countries, especially those in Continental Europe, policymakers face a dilemma. The relatively few entrepreneurs active in these markets face numerous daunting regulatory restrictions, a paucity of venture funds focusing on investing in high-growth firms, and illiquid markets where investors do not welcome IPOs by

[5] One potential source of confusion is that the term venture capital is used differently different in Europe and Asia. Abroad, venture capital often refers to all private equity, including buyout, late stage, and mezzanine financing (which represent the vast majority of the private equity pool in most overseas markets). In the U.S., these are separate classes. I confine our discussion of international trends—as the rest of the paper—to venture capital using the restrictive, U.S. definition.

Table 6
The size of the venture capital pool in 21 nations in 1995. I use Jeng and Wells' figures for early-stage funds in each country outside the U.S. because I believe it to be most comparable to venture capital funds as defined in the U.S. Figures for Australia and New Zealand are 1994 estimated levels; figures for Israel are a 1995 estimate; and figures for Portugal are the actual level in 1994. All dollar figures are in millions of current U.S. dollars

Country	Total venture capital under management
Australia	54
Austria	0.4
Belgium	8
Canada	182
Denmark	4
Finland	1
France	35
Germany	116
Ireland	1
Israel	550
Italy	60
Japan	11
Netherlands	100
New Zealand	1
Norway	7
Portugal	9
Spain	24
Sweden	9
Switzerland	1
United Kingdom	36
United States	3,651

Source: Compiled from Jeng and Wells (1999), as slightly amended by the author.

young firms without long histories of positive earnings. It is often unclear where to being the process of duplicating the success of the United States. Only very recently have researchers begun to examine the ways in which policymakers can catalyze the growth of venture capital and the companies in which they invest. (Three recent exceptions are Irwin and Klenow (1996), Lerner (1999), and Wallsten (1996).) Given the size of recent initiatives undertaken both in the United States and abroad (summarized in Lerner, 1999, and Gompers and Lerner, 1999a), much more needs to be done in this arena.

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