Handbooks in Finance: Empirical Corporate Finance

Chapter III.4: IPO Underpricing * †

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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).¹ 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.

¹ Underpricing averages are based on data available on Jay Ritter's website (http://bear.cba.ufl.edu/ritter/ipodata.htm).

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 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 very positive development. As we will see, it has one 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.²

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 There is surprisingly little literature on IPO auctions, especially regarding the potential costs and benefits of moving from bookbuilding to auctions for pricing IPOs. Sherman (2002) 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 (2003) 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.

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 through 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 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 planned IPO which unusually for a U.S. IPO, will be 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.





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.



Figure 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.



Figure 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.³ This requires that conditional expected returns are non-negative so that the

³ 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

uninformed at least break even.⁴ 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.

Testable implications and evidence

Adjusted for rationing, uninformed investors earn zero initial returns. Informed investors' conditional returns just cover their costs of 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

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.

⁴ 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.

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, Ljungqvist, Wilhelm, and Yu (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.⁵ This clearly

⁵ 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.

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 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 (2003), 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 (2003) 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. Investor 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.

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.⁶

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.⁷

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 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

⁶ 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.

⁷ We will discuss price support more fully in Section 4.2.

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, Ljungqvist, Wilhelm, and Yu (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.⁸ 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'.

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

⁸ 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 (2000) develop a model in which one firm's IPO provides information about industry prospects, thus causing many similar companies to go public soon after.

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.

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 he 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. Pricelimited 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 the 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 co-operative 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-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 (2004), 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 (2004) 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 (2003) – 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, an activity that Credit Suisse First Boston was fined \$100 million for in 2002.⁹ 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).

⁹ Source: NASD Regulation, Inc. news release dated January 22, 2002.

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.¹⁰ 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.

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

¹⁰ 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.

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.

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 assumptions 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 inadept 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 (2003)), 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)).

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.¹¹ 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).

¹¹ For a survey of seasoned equity offers more generally, see the chapter by Eckbo, Masulis, and Nørli in this Volume.

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.

Usually, companies announcing seasoned equity offerings experience negative announcementdate 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.

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 period (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 marketindex 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 valid¹² or strong¹³ identifying variables statistically. Loughran and Ritter (2002) found a positive relation between lagged index returns and underpricing, but there is no reason 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.¹⁴

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

¹² 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 their Table 5, p. 329).

¹³ 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.

¹⁴ 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.

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 an important 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 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 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.¹⁵ 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.

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

¹⁵ 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.

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, 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 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.

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.¹⁶

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.

¹⁶ 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.

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 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.

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 Shaw (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 Shaw).

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 (2003) 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 allocated pro rata. Stoughton and Zechner, on the other hand, model a bookbuilding regime with discretionary allocations. In a prorata 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.¹⁷

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 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

¹⁷ For a survey of behavioral corporate finance more generally, see the chapter by Baker, Ruback, and Wurgler in this Volume.

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).¹⁸

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.

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.

¹⁸ 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'.

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 a national distribution. Thus the choice of underwriter is not random, implying that simple OLS estimates 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). Assume 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.

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 (2003) 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.

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.

Using German data on IPO trading by 5,000 retail customers of an online broker, Dorn (2003) 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 *increases* 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.

Testable implications and evidence

Ljungqvist and Wilhelm (2004) 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-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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