IPOs with Buy- and Sell-Side Information Production: The Dark Side of Open Sales

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The proposed model, by incorporating both (1) banker screening of new issues and (2) costly evaluation by investors, is the first to admit endogenous double-sided information production. It demonstrates a nontrivial link between these two sides: the banker wishes to structure a sale conducive to investor research because selling to an uninformed pool would result in his own shirking. One application of this paradigm indicates that, contrary to the findings of most IPO models, larger investor pools are not always better. This result resolves the "participation restriction puzzle" of why bankers do not open sales to all bidders even when doing so would maximize competition and reduce underpricing.

Why would a profit-maximizing banker limit investor participation, thereby choking off price competition?[1] Models of initial public offerings have not adequately answered this question. For example, in bookbuilding models,[2] underpricing arises because informed investors have the ability to withhold or misrepresent information (although they are honest in equilibrium). However, as the number of investors rises, these information rents are driven away. The intuition is simple: if underpricing arises due to the difficulty of extracting information, then banks should increase the number of investors to make lies more detectable.

Other models also fail to explain participation restrictions. Milgrom (1979) shows that price converges to true value in a first-price auction as the number of investors goes to infinity, and Milgrom (1981) shows this result holds for a $(k+1)$th price auction for k objects. Back and Zender (2001) provide an analogous result for a uniform price-divisible goods auction when the seller chooses the quantity, which is a reasonable model for IPOs. It seems a fairly general result that, whatever the sale type, the seller optimally invites a large number of bidders.

I am grateful for comments from Kerry Back, Maureen O'Hara (editor), Jeroen Swinkels, Jos van Bommel, Jaime Zender, and an anonymous referee, as well as seminar participants at the University of Utah, Washington University, and the University of Colorado. Address correspondence to: Chris Yung, Leeds School of Business, University of Colorado at Boulder, or e-mail: chris.yung@colorado.edu.

[1] Arguments that investment bankers *do* limit competition are frequent; see e.g., Wall Street Journal (2000).

[2] Bookbuilding describes a sale in which the issue is marketed to investors before the price is set. Alternative mechanisms include fixed-price sales in which investors are not consulted, or formal auctions in which investor bids mechanically determine the sale outcome.

The Review of Financial Studies Vol. 18, No. 1
doi:10.1093/rfs/hhi004 Advance Access publication August 25, 2004

The notion that participation restrictions increase underpricing also seems to have empirical support [see Jenkinson and Ljungqvist (2001) for a survey]. Auction sales are typically open to all bidders, and prices are determined by bids rather than by special invitation or by individual standing with the investment banker. Even though more empirical research is warranted, it is reasonable to suggest that the stark differences in underpricing are due less to the specific price-clearing mechanism — which in the literature include discriminatory auctions, uniform-price auctions, and a variety of mixed procedures — than to the presence or absence of participation restrictions.

This paper departs from much of the IPO literature by incorporating a role for the banker in screening out low quality firms via costly evaluation. The average quality of the firms taken public is, therefore, endogenous and may depend on the size of the investor pool. Investors, too, play an economic role by evaluating the firm before purchasing, which again departs from most models to date.

The assumption of double-sided information production is new to the literature; indeed, a link between buy- and sell-side information is the theme of this article. When investor information production is low, the banker will sell to an essentially uninformed pool. The sale outcome will then be uncorrelated with true value, which gives the banker no reason to screen out bad firms in the first place because doing so will be costly. This reasoning implies that the banker wishes to structure a sale that induces investors to conduct research. Otherwise, his own moral hazard problem prevents a good sale outcome. In addition, it should be noted that the main intuition developed — the link between the two sides of information production — is not limited to the bookbuilding paradigm. Rather, it will exist in any sale for which the expected sale price is increasing with the quality of investor signals.

This link between the two sides of information production is the first contribution of this article. However, an interesting implication of the link constitutes a second contribution: larger investor pools may not always be better. As the investor pool grows, each investor does less evaluation because each views the aggregate research as a partial substitute for personal investigation since it makes prices more accurately reflect true value and reduces risk in the offering. Nevertheless, although individual research may decrease, the aggregate informativeness of the investor pool may go either up or down. It is even possible for aggregate informativeness to be driven to zero as the number of investors goes to infinity. In this case, the banker would not want an open sale (i.e., a large number of investors) since the equilibrium price would reflect a total lack of screening. Thus, whether or not open sales are optimal is clearly assumption specific. Indeed, this model provides examples within the bookbuilding framework for which open sales are optimal and other examples for which they are not. The optimal number of investors may be large or small, but most important, it is not necessarily infinite.

While underpricing obtains in this model, it is not the model's focus. It is not a new insight to point out that stock might be sold at a discount to compensate investors for costly information production.[3] Underpricing in this model may be large or small: investors may earn significant informational rents or only be fairly compensated. Both types of equilibria exist, but the two main insights — the link between the two sides of information production and the possibility that open sales fail — exist independent of the size of investor rents.

Double-sided information production may be a relevant imperfection for many economic problems. Some of these applications are discussed in the appendix. However, IPOs form a particularly natural instrument around which to frame the results because (1) in recent years, discussion about the openness of the bidding process has been extensive, (2) uncertainty about value is high for new equity issues, and (3) moral hazard on the part of investment banks is widely suspected.

1. Related Literature

One bookbuilding model in which the size of the investor pool plays a central role is that of Maksimovic and Pichler (1999). Their model distinguishes between atomistic retail investors and large institutional investors, each with different information. To induce information revelation, the optimal mechanism gives strict allocational preference to institutional investors reporting good information. They also assume that each investor demands a positive fixed return, which they suggest could stem from costly information. However, given their failure to check that investors actually choose to acquire costly information, this interpretation is incomplete. Rather, as suggested here, the assumptions that each investor makes such a choice or that the amount of information acquired is constant may become more inappropriate as the pool size increases. Moreover, Maksimovic and Pichler's work does not capture the important link between buy- and sell-side information production because the banker's behavior is not modeled.

Modeling of the information acquisition of investment banks was done as early as 1980 [Campbell and Kracaw (1980)]. Chemmanur and Fulghieri (1994) study this acquisition when access to information technology differs between banks. However, in these articles, investors are

[3] Compensation for information production arises in Sherman (1992), Chemmanur (1993), van Bommel (2002), and Sherman and Titman (2002).

homogeneous and uninformed, and the question of optimal number of investors is absent.

More recently, buy-side information acquisition has attracted greater attention. Sherman (2000) points out that information acquisition makes prices more informative, thereby reducing the severity of the winner's curse and raising expected prices. Chemmanur (1993) and Chemmanur and Liu (2001) argue that greater price accuracy permits higher prices for secondary offerings; hence, issuers may induce buy-side information at the time of the IPO. Van Bommel (2002) shows that information acquisition adds value when post-IPO investment is sensitive to the secondary market price. Sherman and Titman (2002) share my assumption that investors acquire information. They also conclude that, because of a free-rider problem, the optimal number of investors is finite. In their model, inducing information production lowers expected offer price since the issuer indirectly pays for information. Although information production increases offer price variance — the sale price with no information would be constant — it also increases the likelihood of the price being correct. The issuer prefers to induce information when, as Sherman and Titman assume, issuers directly value price accuracy.[4] In the model proposed here, banks also value price accuracy, but this result is obtained endogenously. Price accuracy is valuable because it mitigates intermediary moral hazard.

The finding that the optimal number of buyers is finite is echoed by Matthews (1984), who shows that revenue can monotonically decrease with the number of bidders. He argues, "When [bidders] can acquire private information before an auction, excessive information is purchased ... both the seller and society will profit, therefore, if private information can be prohibited." However, my model shows that if seller information production is allowed, the outcome can be reversed: the seller wants to structure a sale that naturally encourages buyer information production. The key difference is that here the quality of the object for sale is endogenous and depends on the sale mechanism.

2. The Model

A pool of firms seeks funding. Good firms are assigned the value 1; bad firms, the value $\lambda < 1$. The proportion of good firms in the pool is α. There are infinitely many risk-neutral investors with neither wealth constraints nor direct access to the firms. Ex ante, all participants are uninformed about firm quality (including the firm itself).

[4] Their assumption that issuers directly value the accuracy of prices can be motivated by assuming that post-IPO investment is sensitive to prices [as in van Bommel (2002)] or that prices are used in post-IPO management compensation schemes. Sherman and Titman's analysis is reduced-form; the precise source of value behind price accuracy is suppressed.

An investment bank has access to the pool of firms and the technology to learn about the firms therein (albeit imperfectly) at a cost. If the bank exerts screening effort ω, it is able to identify the quality of (and thus remove from the pool) some proportion $r(\omega)$ of bad firms. The cost of ω units of screening effort is taken to be C_ω. From the residual pool, the bank selects one firm to take public.[5] By Baye's rule, the probability that this firm is good is $P_G = \frac{\alpha}{\alpha+(1-r)(1-\alpha)}$. I assume that $r' > 0$, $r'' < 0$, and $\lim_{\omega\to 0} r'(\omega) = \infty$; it follows that $P'_G > 0$, $P''_G < 0$, and $\lim_{\omega\to 0} P'_G(\omega) = \infty$.

The bank then maximizes expected revenue from the IPO, net of any costs of the offering. Maximizing the joint surplus of the bank and issuing firm abstracts from a potentially important conflict of interest. However, the basic intuition of the model requires only that the banker's utility increase in offer price, which would be satisfied in a variety of models that include imperfectly controlled conflict of interest between the banker and the issuing firm.

Investors can evaluate the banker's offering. Each receives one of two signals, $s = G$ or $s = B$, that are independent across investors (conditional on the true value of the firm) and satisfy

$$\Pr(s = B \mid \text{Firm is Bad}) = Q(\theta),$$

$$\Pr(s = G \mid \text{Firm is Good}) = 1,$$

where Q is a function of θ, the amount of costly evaluation done by the investor. It is assumed that $Q' > 0$, $Q'' < 0$, and (unless stated otherwise) $\lim_{\theta\to 0} Q'(\theta) = \infty$. The cost of θ units of evaluation is taken to be $K\theta$.

Note that investor signals only admit type II errors. By Baye's rule, given a bad signal, the firm is bad with probability 1; given a good signal, the firm may be good or bad. The conditional probability of these events depends on the equilibrium choices ω and θ.

The typical assumption in IPO articles is one of ex-ante private information among investors. The motivation for this assumption has been that without any private information among investors, the method of IPO sale is irrelevant (the issue may as well be sold to one investor at expected value) and there is no underpricing. Underpricing has been shown to arise from either the difficulty of extracting information from investors [Benveniste and Spindt (1989)] or from adverse selection in the buyer's market [Rock (1986)], neither of which is a problem if buyers are uninformed.

In the present model, ex-ante private investor information corresponds to the assumption $Q(0) > 0$. Interestingly, the outcome depends heavily on whether this assumption is made or not. As the models shows, if there *is*

[5] The assumption that the bank is short-lived and so can only take one firm public is relaxed in Section 4.

ex-ante private information, then open sales can be optimal. Thus, the intuition of the previous literature, that larger investor pools are better, carries over to the environment in which both sides can produce information. In contrast, if there is no ex-ante private information, the optimal number of investors can be relatively small.

The model's timing is as follows. The banker screens (i.e., chooses an ω) and picks a firm to offer. The subsequent offering procedure occurs precisely as in other bookbuilding models. That is, it is assumed that the banker wishes to extract information from investors and does so by presenting them with a menu of prices and allocations that depend upon reported signals. Thus, the menu must be designed so that (1) honest investor revelation is optimal, (2) investor "orders" (the price and allocation that result from a given set of information) are nonbinding, and (3) the outcome price is the same for all investors. These last two requirements are imposed by the U.S. legal system. All three conditions are standard in bookbuilding models.

The model is subject to two restrictions. First, I limit attention to symmetric pure strategy equilibria (although the strategic variables are continuous). Second, I assume a result from the bookbuilding literature that it is optimal to give allocation preference to those who reveal good signals.[6] These two restrictions maintain tractability by limiting the number of signals. It is dubious whether asymmetric allocation rules or giving preference to investors who report bad signals would somehow signal higher screening effort. Indeed, once the intuition of the model is developed, it should be clear that such schemes would promote banker shirking by making the sale outcome less correlated with true value.

These two restrictions imply a unique allocation rule: the issue is divided equally among all those who give good signals. If none give good signals, the issue is divided equally among all participants. This is the same rule derived in Benveniste and Spindt (1989) as well as in Maksimovic and Pichler (1999).

My model also shares a monotonicity result with other bookbuilding models. The greater the allocation received, the worse the investor view of quality, because the investor assumes — and it is borne out by equilibrium — that large allocations occur when other investors have unfavorable information. In this analysis, monotonicity takes a particularly simple form because the premarketing phase either reveals that the firm is bad or it does not. This fact follows because an investor allocated more than $\frac{1}{N}$ of the issue (where N is the number of investors) knows that

[6] See Benveniste and Spindt (1989) for a derivation of this result. The intuition is that, all else equal, investors do not want to reveal good information that would raise the price. This incentive is counteracted by excluding from the offer those who reveal bad information.

another investor must have reported a bad signal. Thus, the firm value is λ. If the price is higher than λ, because bookbuilding orders are nonbinding, the investor will withdraw from the issue. On the other hand, since λ is the lowest value any stock can take, a reservation value of λ is assumed for the banker. This scenario implies that the price is λ when there is any bad signal. The question is what price the banker will set in the case that all investors report good signals. I denote this price $\bar{P}$.

In this game, perfect Bayesian equilibria (PBE) consist of

1. A set of beliefs for investors: For each $\bar{P}$, a conjectured firm quality $\widehat{P_G}(\bar{P})$ and research done by other investors $\hat{\theta}(\bar{P})$.
2. Actions for the investors: For each $\bar{P}$, a level of research $\theta(\bar{P})$ and a revelation for each realized signal type.
3. Actions for the banker: Choices ω and $\bar{P}$.

The PBE concept requires that the investor's actions be optimal given beliefs. Moreover, these beliefs must be correct on the equilibrium path, which here includes one event: Observing $\bar{P}$.

Theorem 1. *Fixing the number N of investors, the triple* $\{\bar{P}, \omega^*, \theta^*\}$ *is an outcome of a perfect Bayesian equilibrium if and only if the following system*[7] *is satisfied*:

$$P'_G = \frac{C}{[1-(1-Q)^N](\bar{P}-\lambda)}, \tag{1}$$

$$Q' = \frac{NK}{[1-Q]^{N-1}(1-P_G)(\bar{P}-\lambda)}, \tag{2}$$

$$0 \leq (\bar{P}-\lambda) \leq \frac{(1-\lambda)P_G - NK\theta}{[P_G + (1-Q)^N(1-P_G)]}. \tag{3}$$

In any PBE, the banker's screening effort is strictly below first best, and the expected price is strictly less than expected value.

Proof. See Appendix.

As is common in signaling games, there is an uncountable number of PBEs.[8] However, in any one of the PBEs, a critical link exists between the behavior of investors and the banker. Thus, these results are general,

[7] It should be noted that $Q = Q(\theta^*)$ and $P_G = P_G(\omega^*)$; arguments in the system of Equations (1)–(3) are suppressed.

[8] This can be illustrated by picking a $\bar{P}$ and substituting it into the system of Equations (1), (2) to find screening ω^* and research θ^*. It yields a PBE if Equation (3) is satisfied at these best responses. However, if $\bar{P}$ is perturbed even slightly, it yields a different PBE.

holding not only for a particular PBE — which would necessitate further equilibrium selection — but rather for all the equilibria.

Equation (1) is the first-order condition for the banker. This condition indicates that if investors do not have any information ($Q=0$), then the banker will not screen. This link between the investors' evaluations and the banker's evaluation is the article's central finding.

Equation (2) is the first-order condition for investors. It illustrates the free-rider effect. To the extent that other investors evaluate the firm ($Q>0$) or that there are many investors (N large), there is a disincentive for private evaluation.

Equation (3) is a participation constraint that establishes a limit on how high expected prices can be. $\bar{P}$ must be discounted sufficiently to cover (in expectation) investors' research costs. Equation (3) indicates that there are equilibria in which investors break even and others for which they earn significant rents. However, the key intuitions — that investors free-ride on each other's research and that the banker will not screen unless investors obtain some information — are invariant to the particular PBE examined and so to the level of investor rents.

Although details of the proof are given in the appendix, a few key points merit discussion here. First, truthful investor revelations[9] are optimal in this model for the same reasons as in other bookbuilding models. An investor having a *good* signal but reporting a *bad* one gets no allocation of a stock expected to be underpriced. On the other hand, an investor receiving a *bad* signal does not wish to report a *good* signal, because such action would result in an issue that is overpriced in expectation. Second, the outcome exhibits positive banker screening effort, even though this screening is costly and unobserved. Costly screening obtains because investors' information results in a correlation between the true value of the firm and the sale outcome. In other words, the banker's unobservable screening increases the chance that the firm is actually good, which increases the likelihood that investors receive *good* signals, which in turn increases the chance that the proceeds are $\bar{P}$ rather than λ. Even though no conflict of interest between the banker and the firm is included in the current model (in which the banker maximizes expected price net of screening costs, which is joint surplus), the basic intuition holds as long as the banker's payoffs are increasing in realized price. Moreover, any contract not having this property would result in zero screening effort.

[9] Investors reveal their signals not their level of research. While able to calculate level of research just as I do, using the first order condition, the banker cannot know the signal realization — which is important information for valuing the firm — unless the mechanism induces this revelation. Similarly, there is no point in a model in which investors ask the banker ω^*.

3. Varying the Pool Size

The solution to the system of Equations (1)–(3) depends on the number of investors N, left fixed until now. To reflect this dependence, the investor and banker choices are denoted θ_N and ω_N.

Lemma 1. *In any sequence of perfect Bayesian equilibria, $N\theta_N$ is bounded. Each investor's research goes to zero at least as fast as $\frac{1}{N}$. Thus, if there is no endowed information* $[Q(0) = 0]$, *in the limit each investor has no information.*

Proof. By Equation (3),

$$0 \leq (\overline{P_N} - \lambda)[P_G + (1-Q)^N P_B] \leq (1-\lambda)P_G - NK\theta_N \tag{4}$$

holds for each N (arguments for Q and P_G are suppressed). Thus, $N\theta_N \leq \frac{1-\lambda P_G}{K} \leq \frac{1-\lambda}{K}$. ■

The free-riding effect is particularly dramatic as the number of investors grows. Larger investor pools increase the incentive to free-ride directly by making each signal less likely to be marginal precisely at the same time that the slice of the pie left for any one investor shrinks, so that it becomes more difficult to compensate investors. Lemma 1 deals with only the latter fact: For any given level of research, it is possible to find a number of investors sufficiently large to make this level unsustainable.

It follows that in a sale to an infinite number of investors, $\theta = 0$ for each investor. No information is produced since each investor's position is zero. If there is no private information, the sale is to uninformed investors. The banker's response is therefore to choose $\omega = 0$.

However, while it may never make sense to literally invite an infinite number of investors, it may be that no finite optimum N exists. In other words, a larger number of investors may always be better.[10] Lemma 1 demonstrates that the research of each investor goes to zero, but it does not show that the aggregate information goes to zero. Deducing that $1-(1-Q)^N \to 0$, which does imply open sale failure, requires the additional assumption of bounded returns to investor research.

Theorem 2. *Assuming $Q'(0) < \infty$, there exists an N^* such that $\forall N \geq N^*$ the amount of research done by each investor is zero.*

(*a*) **(Open sale optimality):** *If there is ex-ante private information* [*i.e.*, $Q(0) \neq 0$] *and Equation* (3) *holds with equality, the limit of the banker's screening is first best as the number of investors goes to infinity.*

(*b*) **(Open sale failure):** *If there is no ex-ante private information* [*i.e.*, $Q(0) = 0$], *then the banker does no screening for all $N \geq N^*$.*

[10] Note that the outcome of an open auction (i.e., with infinitely many investors) may not be the same as the limit of the outcomes of large auctions.

Proof. See Appendix.

Theorem 2(a) illustrates cases that retain the standard result that open sales are better. However, it is important to note that what is driving the optimality here is that aggregative investor informativeness become perfect, even as investors do zero aggregate costly research.

Theorem 2(b), a main result, is a counterexample to the conventional wisdom. When N is sufficiently high, each investor optimally chooses to do no evaluation. This choice implies that the banker sells to an uninformed pool. In turn, by condition (a), the banker does not screen. Thus, open sales *maximize* the severity of the bank's moral hazard problem.

The limiting results depend on whether information is produced or endowed. Not surprisingly, admitting the standard assumption that information is endowed gives results in line with conventional wisdom. The new insight is that, to the degree that information is *produced* rather than *endowed*, this conventional wisdom does not always hold.

Moreover, although boundedness of Q' is a sufficient condition for open sale failure, it is not a necessary condition. When $\lim_{\omega \to 0} Q'(\omega) = \infty$, there are examples for which open sales are optimal and others for which participation restrictions are optimal. Details of these numerical examples are available from the author upon request.

4. Reputation

This article identifies a key benefit of investor information production. Making the offer price sensitive to the issue's true quality mitigates the banker's moral hazard problem in screening new issues. An alternative view is that this immediate financial consequence — lower prices for worse issues — may not be important if long-run reputations are considered. Taking low-quality firms public risks future profits. Moreover, if reputation resolves this moral hazard problem, such a solution may be preferable to that suggested in this article, since it does not involve investor duplication of the bank's information. I show here that reputations are generally insufficient, however. The short-run financial incentive provided by informative IPO prices is often necessary.

The modifications to the base model are that the investment banker is now long lived, takes one firm public each period, and maximizes expected profits over an infinite horizon using discount factor δ. The number of investors N is fixed in this section because the focus is now on the first of the article's main points — the link between the banker's information production and the investor's information production — and how this interacts with reputation. The optimal pool size (the second main issue) is still finite if investors produce information.

To aid tractability, I replace the game player's continuous strategic choices, screening effort ω and research θ, with binary choices. If the banker screens, the probability that the firm is good is $P_G(1)$; otherwise, it is $P_G(0)$. Likewise, the investor's choice leads to $Q(1)$ or $Q(0)$. Assuming $Q(0)=0$, there is no private information and banker screening is efficient whether or not investors evaluate the firm; that is,

$$(1-\lambda)[P_G(1)-P_G(0)] > C + NK. \tag{5}$$

Thus, an outcome in which the banker screens is an efficient one. However, as will be addressed later in this section, the question still remains of whether reputation alone is a sufficiently powerful incentive.

Finally, I assume that banker behavior is ex post observable to investors, with some noise. Partially revealing histories mitigate moral hazard; reputation acquisition occurs (agents "behave") because bankers know that their actions now affect future profits.[11] Specifically, I assume that the banker's action at time $T=t$ is revealed at time $T=t+1$ with probability ψ. I assume that if investors learn that the banker has shirked, they will not purchase from the banker again. This particularly harsh punishment scheme is chosen for computational simplicity. Finite punishment would give reputation less power to control intermediary moral hazard and would increase the importance of investor learning.

I compare three differing environments for the long-run game: (1) With information production only, (2) with reputation only, and (3) with both information production and reputation. The first case (with information production only) is simply a sequence of one-shot games similar to that of the base model. The long-run profits of this game are computed and will be compared with those of the other cases. Next, I solve the case in which investors cannot evaluate the firm but where reputation is an issue.[12] Finally, I allow both investor learning and long-run reputation, providing a specific sense of when these two disciplinary devices together can strictly improve the outcome so that investor learning complements investment bank reputation.

***Theorem 3* (Long-run equilibria with only investor learning)**. *Defining*

$$\bar{P}-\lambda = \frac{(1-\lambda)P_G(1)-NK}{P_G(1)+(1-Q(1))^N P_B(1)}, \tag{6}$$

[11] Precisely the same approach to reputation acquisition is taken by Klein and Leffler (1981) and by Shapiro (1983). Tirole (1997) presents an overview of these models, arguing that reputation "*may* offer incentives to supply quality, not that it necessarily will" and that this incentive increases with the patience of the agent and decreases with the lag of information revelation. These are my conclusions also. My intent is not to create a novel model of reputation acquisition but merely to investigate how reputation acquisition (a long-term dynamic) interacts with investor evaluation.

[12] Equivalently, I could structure the sale such that even if investors are endowed with the technology to evaluate firms, they find it optimal not to. For example, I could make information very costly or, as in the base model, impose an open sale.

an efficient equilibrium exists if

$$(\bar{P}-\lambda)[P_G(1)-P_G(0)][1-(1-Q(1))^N]\geq C, \tag{7}$$

$$(\bar{P}-\lambda)(1-Q(1))^{N-1}Q(1)P_B(1)\geq NK. \tag{8}$$

If conditions (7) *and* (8) *hold, the banker's long-run profit is*

$$V_1=\frac{\lambda+(1-\lambda)P_G(1)-NK}{1-\delta}. \tag{9}$$

Proof. See Appendix.

One change to the base model is the assumption that the participation constraint (6) holds with equality for computational convenience.[13] It should be noted that an efficient equilibrium cannot exist in the absence of investor learning [i.e., where Equation (8) fails], because if $Q=Q(0)$ rather than $Q=Q(1)$, the analog of Equation (7) would fail. If the price were insensitive to true quality, shirking would be optimal.

The next result demonstrates what happens to the game when reputations are considered so that an additional cost of banker shirking is a probabilistic loss of future profits.

***Theorem 4* (Long-run game with information production and reputation).** *Defining*

$$\bar{P}-\lambda=\frac{(1-\lambda)P_G(1)-NK}{P_G(1)+(1-Q(1))^N P_B(1)}, \tag{10}$$

an efficient equilibrium exists if

$$(\bar{P}-\lambda)[P_G(1)-P_G(0)][1-(1-Q(1))^N]\geq C-\psi V_1\delta, \tag{11}$$

$$(\bar{P}-\lambda)(1-Q(1))^{N}Q(1)P_B(1)\geq NK. \tag{12}$$

The banker's long-run profit is

$$V_1=\frac{\lambda+(1-\lambda)P_G(1)-NK}{1-\delta}. \tag{13}$$

Proof. See Appendix.

The outcome here is the same as in Theorem 3 except condition (11), which reflects an additional cost of shirking: Besides a lower expected

[13] The inequality in the base model's Equation (3) shows that even though there are PBEs in which the investors just break even and others where they earn large profits, all yield the same intuition. The same is true of the current model. Having made that point, for concreteness, I characterize here only the case in which the banker keeps all the surplus.

price this period, the banker risks losing a future stream of business. Because condition (7) implies condition (11), reputation extends the range of parameters over which efficient equilibria occur. Banker profit in both cases is unchanged since the compensation to investors is the same as in Theorem 3.

Thus, reputation does improve the outcome. As to the question of whether reputation alone induces efficient equilibria — which would negate any reason to induce investors to learn — as the theorem demonstrates, the answer is "sometimes."

***Theorem 5* (Long-run game with reputation only)**. *Defining the banker's long run profit as* V_2, *then*

$$V_2 = \frac{\lambda + (1-\lambda)P_G(1)}{1-\delta}. \tag{14}$$

There exists an efficient equilibrium if

$$\psi V_2 \delta \geq C. \tag{15}$$

In the efficient equilibrium, the banker's long-run profit satisfies $V_2 > V_1$.

Proof. See Appendix.

This inequality in Equation (15) stems from the fact that, if screening is an equilibrium outcome, short-run effort savings must be smaller than the expected cost of losing a perpetuity worth V_2 next period, with probability ψ.

I now offer the following global comparison. In general, the banker prefers efficient outcomes supported by reputation alone. However, the existence of efficient equilibria is not guaranteed. Indeed, when the banker's discount factor is low and the aftermarket is noisy, reputation is insufficient.

Theorem 6. *Define*

$$C_1 = \frac{(1-\lambda)P_G(1) - NK}{P_G(1) + (1-Q(1))^N P_B(1)} \times [P_G(1) - P_G(0)][1-(1-Q(1))^N] + \psi V_1 \delta, \tag{16}$$

and

$$C_2 = \psi V_2 \delta. \tag{17}$$

Case 1: $C_1 \leq C_2$

If $C \in [0, C_2]$, *then efficient equilibria supported by reputation alone exist and dominate other types.*

If $C \in (C_2, \infty)$, *then efficient equilibria do not exist.*

Case 2. $C_1 > C_2$

If $C \in [0, C_2]$, *then efficient equilibria supported by reputation alone exist and dominate other types.*

If $C \in (C_2, C_1]$, *then efficient equilibria cannot be supported by reputation alone, but can be supported by both reputation and investor learning.*

If $C \in (C_1, \infty)$, *then efficient equilibria do not exist.*

Proof. See Appendix.

The case $C \in (C_2, C_1]$ is the condition under which reputations and investor learning are complementary mechanisms for resolving investment bank moral hazard. By inspection, this scenario occurs under precisely the circumstances suggested earlier: If investment bankers are impatient (low δ) and if actions are slowly revealed to the public (low ψ).

5. Implications

5.1 International choice of IPO method

This article provides an endogenous motivation for limiting participation in IPOs. Perhaps the most straightforward application of this result is the observed internation migration away from competitive open auctions toward institutional investor-dominated bookbuilding [Sherman (2002)], a shift which has puzzled researchers since auctions are simpler and offer less underpricing [Jenkinson and Ljungqvist (2001)].

To the degree some firms still opt for open auctions, the doubled-sided moral hazard problem considered here implies that firms in greater need of quality certification will prefer less competitive offering procedures. For example, in the French IPO market, both open auctions and U.S.-style bookbuilding are observed. As the model predicts, the less competitive procedure (bookbuilding) appears to be chosen by firms with greater certification needs. Auctioned IPOs are more than twice as large as book-built IPOs [Derrien and Womack (2003)]. Moreover, all issuers on the Nouveau Marche, a small exchange designed for high-growth technology firms, choose bookbuilding despite the absence of any institutional requirement to do so.

Also relevant is an interesting Japan IPO market experiment. Prior to 1989, prices and allocations were determined by investment bankers, as in the United States. In 1989, following a political scandal in which hot IPO shares were allocated to government officials, the finance ministry dictated that all IPOs were to be conducted as open auctions. Kaneko and Pettway (1996) find that this change reduced underpricing from 62.1 to 12.0%. In 1997, the finance ministry reversed its decision and once again allowed investment banks full discretion of pricing and allocations. One of the reasons cited for this reversal was the apparent success of the

U.S. bookbuilding procedure in allowing small, risky firms access to capital [Kutsuna and Smith (2003)]. Consistent with the earlier results, underpricing increased after the restrictions were lifted. Post-1997, IPOs have all utilized bookbuilding and average underpricing has been 48.0% [Kaneko and Pettway (2003)].

A comparison of long-run returns following the two procedures would provide the most direct test of the model. For a given amount of uncertainty, less information is produced in open auctions. Prices in the immediate aftermarket are then less informative, meaning that uncertainty is resolved only in the aftermarket. Controlling for ex-ante risk measures, auctions should therefore lead to more volatility in long-run returns. Corollaries to this hypothesis are that bid-ask spreads should be larger and price reactions to earnings announcements more volatile following auctions.

Evidence on the comparative long-run returns is limited, but univariate results in Derrien and Womack (2003) tentatively support the hypothesis. The standard deviation of long-run returns is very similar for the two procedures. For 24-month holding periods, the standard deviations of returns are 82.8% (bookbuilding) and 82.1% (auctions). Yet, auctions are chosen by firms that appear much less risky. This difference in firm type suggests that, controlling for observable risk characteristics, auctions are associated with more long-run return volatility.[14]

5.2 Penalty bids and flipping

The model also has a bearing on policy discussions regarding price stabilization and penalty bids designed to discourage "flipping." Conventional wisdom is that these penalty bids are primarily targeted at retail stock flippers rather than institutional investors [Wall Street Journal (2000)]. Yet, this assumption is difficult to reconcile with adverse selection models, as it makes the winner's curse for uninformed retail investors *more* severe. Benveniste, Busaba, and Wilhelm (1996) argue that, in a bookbuilding framework, making informed investors the beneficiaries of this differential flipping policy reduces the rents of uninformed investors (thus reducing total rents). An analogous argument in the model proposed here takes on particular importance given the allocative role played by costly information. If the banker can shift the benefits of underpricing to institutional investors who produce information, from retail investors who do not, then the incentives to produce information may be maintained even when retail investors are included in the offering.

[14] The model has predictions regarding volatility of long-run returns but not regarding *level* of long-run returns. Moreover, the long-run underperformance anomaly is not limited to IPOs but holds for non-IPO stocks of similar size and book-to-market [Brav and Gompers (1997)]. This deviation from efficient markets is not well-understood and the literature currently emphasizes behavioral explanations [Ritter and Welch (2003)].

One policy implication is that securities legislation cracking down on differential flipping prohibitions may not be wise. This legislation could act like a tax on traditional offerings, where the recipients are retail investors. This tax would constitute a friction in the market, interfering with bankers' issue selection incentives and choice of IPO mechanisms. It may well discourage investment bankers from including retail investors in the process, since their free-riding would increase. The effect on underpricing is unclear: There would be more underpricing on traditional issues (the removal of institutional investors ex-post insurance would lead them to demand larger ex-ante profit), although a shift might also occur toward open sales (which may have less underpricing). Finally, the market for risky IPOs might shrink considerably, which would discourage entrepreneurship. In addition, this shrinkage might drive a substitution from public equity to private equity, which is less regulated.

5.3 Extensions

This model introduces a paradigm — the interaction of buy- and sell-side information production and moral hazard — that can be applied to a variety of IPO institutional arrangements. For example, to the extent that IPO lockups serve as a signal of firm quality, do these lockups complement or substitute for intermediary evaluation? How does the breakdown of fees between underwriting syndicate members affect information acquisition incentives? How does the optimal syndicate size vary in the severity of intermediary moral hazard? How does the addition of warrants to stock offerings (i.e., unit offerings) affect the profits and risk on both the buy and sell side, and therefore the incentive to acquire information? How does the Greenshoe provision interact with the banker's moral hazard problem? How does the stabilizing bid compare with the syndicate short position as a method of price support? Presumably, the answers to several of these questions would require a more complete characterization of the banker as intermediary between issuers and investors than in my model, where the bank is assumed to act in the interest of issuers.

Finally, the dual-sided information production approach could be applied to topics outside of initial public offerings, such as labor markets, banking competition, and mergers and acquisitions. For example, in a divestiture, both seller and buyer acquire information about the value of the asset being sold. The amount of such information acquisition depends on the structure of the sale and the competitiveness of the buy-side market. Likewise, a large body of literature exists on banking competition, some of which includes information acquisition on the buy side [Hauswald and Marquez (2003)]. To the extent that sellers invest in information (which may be useful in deciding how to signal their quality, how to price their offerings, or whether to make offerings at all) the interaction between buy- and sell-side information acquisition may enrich these models.

Appendix

Proof of Theorem 1. The statement to prove is

$$\exists \text{ a PBE with} \{\bar{P}, \omega^*, \theta^*\} \text{ as an outcome} \Longleftrightarrow \{\bar{P}, \omega^*, \theta^*\} \text{ satisfy Equations (1)–(3)}$$

$\Longrightarrow$: Assuming a perfect Bayesian equilibrium that has outcome $\{\bar{P}, \omega^*, \theta^*\}$, I show that Equations (1)–(3) must be satisfied, denoting

$\hat{\omega}$, $\hat{\theta}$: Investors' forecast of other agents' actions upon seeing $\bar{P}$.
$\widehat{P_G} = P_G(\hat{\omega}), \hat{Q} = Q(\hat{\theta})$.
$\widehat{P_B} = 1 - \widehat{P_G}$.

Given the signal structure and allocation rule, investors know the following. First, as long as someone else declares good, each investor gets an allocation only by also declaring good. Second, if any other investor reports a bad signal, price and value are λ. These two facts imply that investor profit only comes when one declares high and all others do likewise. In this case, allocation is $\frac{1}{N}$, and the probability of this event is $\pi = \widehat{P_G} + (1-\hat{Q})^{N-1}(1-Q)\widehat{P_B}$, which depends not only on the investor's actual choice of θ, but on the forecasts of others' choices of θ. The investor solves

$$\max_{\theta} \frac{1}{N}\left[\lambda + \frac{(1-\lambda)\widehat{P_G}}{\pi} - \bar{P}\right]\pi - K\theta. \tag{18}$$

The bracketed term is the expected value of the stock conditional on $N-1$ good signals (of equilibrium precision) and on the precision of the investor's own signal (which is a choice variable), minus the price. The former is computed by Baye's rule. The problem gives first-order condition (FOC)

$$-(\bar{P}-\lambda)\frac{\partial \pi}{\partial \theta} = NK, \tag{19}$$

which is

$$Q' = \frac{NK}{[1-\hat{Q}]^{N-1}\widehat{P_B}(\bar{P}-\lambda)}. \tag{20}$$

In perfect Bayesian equilibria, the investor's forecast of the behavior of the other investors and of the banker must be correct. Substituting in $\widehat{P_G} = P_G$ and $\hat{Q} = Q$, the above equation becomes Equation (2).

Derivation of Equation (1) uses the same approach. Taking the behavior of the investors as fixed (again denoted $\hat{Q}$),

$$\max_{\omega} \pi\bar{P} + (1-\pi)\lambda - c\omega, \tag{21}$$

where $\pi(\omega) = P_G(\omega) + (1-\hat{Q})^N P_B(\omega)$ is the probability of N good signals. This problem is the same as

$$\max_{\omega}(\bar{P}-\lambda)\pi - C\omega \Rightarrow \text{FOC: } (\bar{P}-\lambda)\frac{\partial \pi}{\partial \omega} = C, \tag{22}$$

but $\frac{\partial \pi}{\partial \omega} = P'_G[1-(1-\hat{Q})^N]$, so the FOC is

$$P'_G = \frac{C}{[1-(1-\hat{Q})^N](\bar{P}-\lambda)}. \tag{23}$$

Now, again in a perfect Bayesian equilibrium, the forecasted actions of the other participants is accurate, so that $\hat{Q} = Q$ and Equation (23) turns into Equation (1). In both problems, the second order conditions follow from concavity.

Derivation of Equation (3) follows from the fact that, in equilibrium, incentive compatibility constraints (that investors honestly reveal signals) and participation constraints (that investors do not earn negative profits) must hold. For short, investors with bad signals are designated as low types and investors with good signals as high types.

(*Incentive compatibility*) Letting V denote the expected value of the stock given N high types,

$$V = \lambda + \frac{P_G(1-\lambda)}{P_G + (1-Q)^N P_B}. \tag{24}$$

I argue that any price $\bar{P} \in [\lambda, V]$ is incentive compatible. Low types do not want to declare high: Such a declaration yields an allocation of overpriced stock. Likewise, high types do not want to declare low: Such a declaration only results in allocation when all other players are low types. However, if all other players are low types, the stock has been revealed as bad, and is fairly priced. Thus, a low declaration results in zero expected profit, but a high declaration results in allocation of a stock that is underpriced in expectation. Thus, incentive compatibility gives the restriction that

$$0 \leq (\bar{P} - \lambda) \leq \frac{(1-\lambda)P_G(\omega)}{[P_G(\omega) + (1-Q(\theta))^N P_B(\omega)]}. \tag{25}$$

(*Participation constraint*) It should be noted that if $\theta > 0$, then investors will earn negative profits if the right hand side of Equation (25) holds with equality. $\bar{P}$ must be sufficiently low to allow investors to earn zero profits given their best response θ. Total underpricing on these issues must be at least $\frac{NK\theta}{P_G + (1-Q)^N P_B}$ (ensuring that underpricing is $NK\theta$), which yields the following constraint

$$\bar{P} - \lambda \leq \frac{(1-\lambda)P_G(\omega) - NK\theta}{[P_G(\omega) + (1-Q(\theta))^N P_B(\omega)]}. \tag{26}$$

Now Equation (3) is derived by combining Equations (25) and (26).

$\Longleftarrow$: Assuming the existence of a $\{\bar{P}, \omega^*, \theta^*\}$ that satisfies Equations (1)–(3), a set of beliefs must be constructed that yield optimal behavior consistent with these response functions. The task in this existence proof is not to find the most reasonable beliefs but merely any belief that gives us this outcome as a PBE. Therefore, investors are assigned the belief that $\widehat{P_G} = P_G(\omega^*)$ [where ω^* is part of the solution to Equations (1)–(3)] when they see $\bar{P}^*$ but that the firm is definitely bad otherwise. Likewise, the banker forecasts $\hat{\theta} = \theta^*$ [i.e., that investors behave as suggested by the solution to Equations (1)–(3)].

These beliefs must be shown to be consistent with optimizing behavior. Therefore, for now it is assumed (but later checked) that honest revelation of signals is optimal and that, given investor behavior, the banker is better off following the equilibrium strategy than any other. ω^* is optimal given that $\bar{P}^*$ is chosen; this is the banker's first-order condition for screening. The only argument needed is that it is suboptimal to set some price other than $\bar{P}^*$. If the banker sets some other price, by assumption investors believe the issue is bad. Banker proceeds are then no higher than λ. This scenario is dominated by the setting of $\bar{P}^*$ and $\omega = 0$ (which sometimes yields an offer price higher than λ), which is dominated in turn by setting $\bar{P}^*$ and the ω^* that solves Equation (1). Therefore, the equilibrium strategy provides a better outcome than that of any pricing deviation. As before, similar arguments demonstrate incentive compatibility and participation constraint satisfaction when Equations (25) and (26) hold, so that investor behavior is also the best response. ■

Proof of Theorem 2. The investor's problem is

$$\max_{\theta} \frac{1}{N}[V - \bar{P}]\pi - K\theta, \tag{27}$$

where V is the value of the stock given N good reports, and π is the probability of this event. Increasing investor research raises V, lowers π, and raises investor private costs. Expanding this gives the problem

$$\max_{\theta} \frac{1}{N}(\bar{P}-\lambda)Q(\theta)(1-\hat{Q})^{N-1}(1-P_G)-K\theta, \tag{28}$$

where $\hat{Q}$ is the result of research done by the *other* investors (hence the superscript $N-1$). If Q' is bounded, the derivative of the objective function in Equation (28) is negative for sufficiently large N. Thus, for a sufficiently large number of investors, the marginal costs of research are always greater than the marginal benefits, so no research is done.

Proof of (a). Generally, the banker screens less than first best because

$$P_G'[1-(1-Q)^N](\bar{P}-\lambda) = C, \tag{29}$$

whereas first best has

$$P_G'(1-\lambda) = C. \tag{30}$$

Here, however, $\lim_{N\to\infty}(1-Q)^N = 0$ because there is private information. Moreover, that $\lim_{N\to\infty}\bar{P}-\lambda = 1-\lambda$ can be checked [since research is identically zero and Equation (3) assumed to hold with equality]. The limit of Equation (29) is Equation (30).

Proof of (b): If $Q(0)=0$, then $(1-Q)^N = 1$ for sufficiently high N, since no research is done. Now Equation (1) implies $\omega = 0$. ■

Proof of Theorem 3. $\Longrightarrow$: Assuming that an efficient equilibrium exists (i.e., the banker screens), Equations (7), (8), and (6) must hold.

This proof takes precisely the same form as that of Theorem 1 (in fact, it is just a discretized version of Theorem 1). I first solve the problem of an investor who assumes (1) that the banker screened, so that the relevant probability is $P_G(1)$ and (2) that *other* investors have some equilibrium behavior $\hat{Q}$. It will be helpful to write the probability of N good signals as

$$\pi_{\text{YES}} = P_G(1) + (1-\hat{Q}^{N-1})(1-Q(1))P_B(1), \tag{31}$$

if the investor screens and

$$\pi_{\text{NO}} = P_G(1) + (1-\hat{Q}^{N-1})P_B(1), \tag{32}$$

if the investor does not (recalling that the signal structure gives the investor a good signal if the investor does not evaluate the firm, but that this signal is meaningless). Not evaluating reduces the probability that bad firms are detected.

Recalling also that, provided other investors are following equilibrium strategies, the investor profits only on declaring "good." This constraint occurs because, if an investor declares bad (even after, e.g., receiving a good signal), that investor only receives allocation when *all other* investors also declare bad. However, in this case, the stock actually is bad and is thus fairly priced at λ. In other words, the investor actually profits only when all investors declare good. Thus, profits occurs with some probability π_{YES} or π_{NO}, and in this event the allocation is $\frac{1}{N}$.

Expected profit from evaluating the firm is

$$\frac{1}{N}\left[\lambda + \frac{(1-\lambda)P_G(1)}{\pi_{\text{YES}}} - \bar{P}\right]\pi_{\text{YES}} - K, \tag{33}$$

while expected profit from not evaluating is

$$\frac{1}{N}\left[\lambda + \frac{(1-\lambda)P_G(1)}{\pi_{\text{NO}}} - \bar{P}\right]\pi_{\text{NO}}. \tag{34}$$

The bracketed term is the profit expected in the event that the investor receives a good signal and purchases the stock (and all others do likewise). Evaluating the firm reduces the probability of purchase, raises the expected value given purchase, and imposes a cost. Comparing Equation (33) with Equation (34) yields Equation (7). The condition for the banker is similarly derived. Incentive compatibility (proof that honest revelation is optimal) and participation constraints exactly mimic those of Theorem 1.

As in the proof of Theorem 1, fixing banker screening and investor evaluation, Equation (6) holds if and only if incentive compatibility and participation constraints hold.

$\Longleftarrow$: Assuming Equations (6), (7), and (8), a set of beliefs must be found that support an efficient PBE (i.e., one in which the banker screens). The proof is identical to that of the analogous statement from Theorem 1. Optimality of screening and of investor evaluation follow from Equations (7) and (8); that is how these conditions were derived. Incentive compatibility (i.e., that investors honestly report their signals) and participation constraints are both implied by Equation (6). ■

Proof of Theorem 4. This theorem repeats the techniques of the proofs for Theorem 3 and 5. ■

Proof of Theorem 5. Assuming investors do not evaluate the firm, if banker screening is an equilibrium response, the highest price at which the banker can sell the firm is expected value, $\lambda + (1-\lambda)P_G(1)$. Further, if it is a best response for the banker to screen each period, then the banker's business provides a perpetuity worth $V_2 = \frac{\lambda+(1-\lambda)P_G(1)}{1-\delta}$.

By shirking (this period only), the banker saves C but risks losing the perpetuity with probability ψ. This loss, if it occurs, will happen next period, so the banker will shirk if

$$\psi V_2 \delta < C. \tag{35}$$

■

Proof of Theorem 6. By Theorem 5, C_2 is the highest cost for which screening would occur when reputation alone is considered, while, as follows from substituting Equation (6) into Equation (7), C_1 is the highest cost of screening that can be supported if both investor learning and reputation are admitted. All claims of the theorem immediately follow from these two interpretations. ■

References

Back, K., and J. Zender, 2001, "Auctions of Divisible Goods with Endogenous Supply," *Economics Letters*, 73, 29–34.

Benveniste, L., W. Busaba, and W. Wilhelm, 1996, "Price Stabilization as a Bonding Mechanism in New Equity Issues," *Journal of Financial Economics*, 42, 223–255.

Benveniste, L., and P. Spindt, 1989, "How Investment Bankers Determine the Price and Allocation of New Issues," *Journal of Financial Economics*, 24, 343–361.

Brav, A., and P. Gompers, 1997, "Myth or Reality? The Long-Run Underperformance of Initial Public Offerings: Evidence from Venture and Nonventure Capital-Backed Companies," *Journal of Finance*, 52, 1791–1821.

Campbell, T., and W. Kracaw, 1980, "Information Production, Market Signalling, and the Theory of Financial Intermediation," *Journal of Finance*, 35, 863–882.

Chemmanur, T., 1993, "The Pricing of Initial Public Offerings: A Dynamic Model with Information Production," *Journal of Finance*, 48, 285–304.

Chemmanur, T., and P. Fulghieri, 1994, "Investment Bank Reputation, Information Production, and Financial Intermediation," *Journal of Finance*, 49, 57–79.

Chemmanur, T., and H. Liu, 2001, "How Should a Firm Go Public? A Dynamic Model of the Choice Between Fixed-price Offerings and Auctions in IPOS and Privatizations," working paper, Boston College, Boston, MA.

Derrien, F., and K. Womack, 2003, "Auctions vs. Bookbuilding and Control of Underpricing in Hot Issue Markets," *Review of Financial Studies*, 16, 31–61.

Hauswald, R., and R. Marquez, 2003, "Information Technology and Financial Services Competition," *Review of Financial Studies*, 16, 921–948.

Jenkinson, T., and A. Ljungqvist, 2001, *Going Public: The Theory and Evidence on How Companies Raise Equity Finance,* Clarendon Press, Oxford.

Kaneko, T., and R. Pettway, 1996, "The Effects of Earlier Market Sales and Auctions upon Short-Term IPO Returns: The Case of Japanese IPOs," *Pacific Basin Finance Journal*, 4, 241–258.

Kaneko, T., and R. Pettway, 2003, "Auctions Versus Bookbuilding of Japanese IPOs," *Pacific Basin Journal*, 11, 439–462.

Klein, B., and K. Leffler, 1981, "The Role of Market Forces in Assuring Contractual Performance," *Journal of Political Economy*, 81, 615–641.

Kutsuna, K., and R. Smith, 2004, "Why Does Book Building Drive Out Auction Methods of IPO Issuance? Evidence from Japan," *Review of Financial Studies*, 17, 1129–1166.

Maksimovic, V., and P. Pichler, 1999, "Private v. Public Offerings: Optimal Selling Mechanisms," working paper, University of Maryland.

Matthews, S., 1984, "Information Acquisition in Discriminatory Auctions," in M. Boyer and R. E. Kihlstrom (eds.), *Bayesian Models in Economic Theory,* North Holland, New York.

Milgrom, P., 1979, "Ratinal expectations, Information Acquistition and Competitive Bidding," *Econometrica*, 49, 921–943.

Ritter, J., and I. Welch, 2003, "A Review of IPO Activity, Pricing and Allocations," working paper, University of Florida.

Rock, K., 1986, "Why New Issues Are Underpriced," *Journal of Financial Economics*, 15, 187–212.

Shapiro, C., 1983, "Premiums for High Quality Products as Rents to Reputation," *Quarterly Journal of Economics*, 98, 659–680.

Sherman, A., 1992, "The Pricing of Best Efforts New Issues," *Journal of Finance*, 47, 781–790.

Sherman, A., 2000, "IPOs and Long Term Relationships: An Advantage of Book-building," *Review of Financial Studies*, 13, 697–714.

Sherman, A., 2002, "Global Trends in IPO Methods: Book Building vs. Auctions," working paper, University of Notre Dame.

Sherman, A., and S. Titman, 2002, "Building the IPO Order Book: Underpricing and Participation Restrictions with Costly Information," *Journal of Financial Economics*, 65, 3–29.

Tirole, J., 1997, *The Theory of Industrial Organization,* MIT Press, Cambridge, MA.

van Bommel, J., 2002, "Messages from Market to Management: The Case of IPOs," *Journal of Corporate Finance*, 8, 123–138.

Wall Street Journal, 2000, "SEC Targets IPO Process with Probes," December 19, 2000, Page C1.