

Investment Bank Reputation, Information Production, and Financial Intermediation

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ABSTRACT

We model reputation acquisition by investment banks in the equity market. Entrepreneurs sell shares in an asymmetrically informed equity market, either directly, or using an investment bank. Investment banks, who interact repeatedly with the equity market, evaluate entrepreneurs' projects and report to investors, in return for a fee. Setting strict evaluation standards (unobservable to investors) is costly for investment banks, inducing moral hazard. Investment banks' credibility therefore depends on their equity-marketing history. Investment banks' evaluation standards, their reputations, underwriter compensation, the market value of equity sold, and entrepreneurs' choice between underwritten and nonunderwritten equity issues emerge endogenously.

THE ROLE OF FINANCIAL intermediaries as information producers has been of considerable interest in finance (see, e.g., Leland and Pyle (1977) and Campbell and Keracaw (1980)). An important issue that arises here is that of the credibility of the intermediary. For instance, an investment bank marketing equity in a firm has an incentive to represent the firm's projects as worthy of investment, even if it has expended limited resources in investigating these projects. The problem is further complicated by the fact that even stringent evaluation procedures are subject to error, and intermediaries can make "honest" mistakes, making it difficult to distinguish between intermediaries acting in good faith and those acting in their own interest to the detriment of investors. In this paper, we argue that reputation acquisition by intermediaries can mitigate this credibility problem. We model the role of reputation acquisition in enabling an intermediary to act as a producer of credible information, and we derive implications for the valuation of financial securities sold by the intermediary.

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We develop our model in the context of an investment bank underwriting a stock issue. There are three kinds of agents in our economy: entrepreneurs, investment banks, and ordinary investors. Entrepreneurs approach the equity market to raise capital for their projects, entering the market only once and marketing equity either directly to investors or through an investment bank (underwriter). Investment banks are information producers that interact repeatedly with the equity market. They produce noisy evaluations of entrepreneurs' projects, which they report to investors when marketing equity in return for a fee from the entrepreneur. Ordinary investors determine the market value of the equity. Because investors do not observe the amount of resources investment banks devote to evaluating entrepreneurs' projects, they do not know how strict investment banks' standards are when they recommend investment in a firm. Investors therefore use the investment banks' past performance, as measured by the quality of firms in which they have previously sold equity, to assess credibility, valuing the equity they market accordingly.

Investment banks therefore face a dynamic trade-off; setting strict standards in evaluating firms is costly in the short run but beneficial in the long run, since it reduces the probability of their marketing lemons and damaging their reputation. A lower reputation leads to lower market values for equity sold in the future, and in turn, to lower future fees. The evaluation standard set by investment banks, their reputations, valuation of firms by investors, investment banking fees, and entrepreneurs' choice between underwritten and direct sales of equity emerge endogenously in the equilibrium of this dynamic game.

Even though we develop our model in the setting of a private firm issuing equity in an initial public offering (IPO), it is equally applicable to the case of seasoned equity issues, and we develop implications for these as well.¹ The model is also applicable (in a slightly modified form) to other situations where intermediaries act as information producers helping to reduce the adverse impact of information asymmetry in the financial market; examples include investment banks producing information about target firms in corporate takeovers, investment banks assisting issuing firms in calling convertible debt (in an asymmetrically informed debt market), and rating agencies producing information about firms issuing bonds. In each of these situations, the ability of the financial intermediary to acquire a reputation for veracity mitigates the moral hazard problem in information production.

Our analysis is particularly relevant in light of the extensive empirical literature relating the reputation of investment banks and the values of the securities they market. Logue (1973), Beatty and Ritter (1986), Carter and Manaster (1990), Tinic (1988), and Johnson and Miller (1988) relate invest-

¹ Our objective in this paper is not to explain the "underpricing" of IPOs, and we will not model the institutional details specific to the new issues market. However, we will relate an investment bank's reputation to its effectiveness in reducing the impact of asymmetric information between firm insiders and outsiders, and indirectly, to the extent of underpricing of the IPOs it underwrites.

ment bank reputation to the various characteristics of IPOs of equity; Schadler and Manuel (1989) study the role of underwriter reputation in the market for seasoned equity issues. The following are the empirical implications of our model: (i) The greater the reputation of an investment bank, the more effective it is in reducing the impact of information asymmetry in the equity market. This implies that the extent of IPO underpricing and the size of the negative stock price reaction around seasoned equity issues are decreasing functions of the reputation of the underwriters involved. (ii) More prestigious investment banks engage in underwriting contracts with less risky client firms. (iii) The greater the underwriter's reputation, the larger the amount of fees charged. (iv) The proceeds to a firm selling equity, net of underwriter fees, increase with underwriter reputation. (v) Investment banks that overprice equity subsequently lose market share. (vi) In equity markets characterized by asymmetric information, all firms prefer to market equity using an investment bank; only firms that do not face a significant degree of adverse selection, or firms unable to obtain the services of an investment bank, engage in a nonunderwritten equity offering.

Our research is related to the product market literature (see, e.g., Allen (1984), and Shapiro (1983)), which argues that the fear of ruining reputation may prevent manufacturers of "experience" goods (i.e., goods whose quality can be verified only after purchase) from lowering product quality in order to increase short-run profits. In a similar vein, the considerations of reputation building in our model play an important role in shaping the interactions between the investment bank and investors. Unlike a manufacturer in the product market, however, the investment bank is a *middleman* in the equity market. As such, while the investment bank may obtain more accurate information than ordinary investors about the true value of the firm selling equity, typically it does not have as much information as the entrepreneur. We therefore assume that it is the entrepreneur who has private information about firm value, so that the entrepreneur's choice between underwritten or nonunderwritten equity offerings, and the reputation of the underwriter he uses to market equity, conveys information to investors. Further, unlike in the product market literature, we allow even an investment bank following the most stringent evaluation procedure possible to make mistakes, so that even if it sells overpriced equity once, its reputation in the equity market is not damaged permanently. In addition to being realistic, it is this feature of our model that results in investment banks of different reputations obtaining different market prices for the equity they sell. Thus, we model equity issues as a three-party game among entrepreneurs, investment banks, and ordinary investors, explicitly incorporating the incentives of all parties.

Our research is also related to the extensive literature on reputation effects in dynamic games with incomplete information, both in finite horizon settings (see, e.g., Kreps and Wilson (1982a) and Milgrom and Roberts (1982)) and in infinite horizon settings (see, e.g., Holmström (1982)). Much of this literature develops models in an industrial organization context. In the finance context, there are the papers of Diamond (1989), John and Nachman

(1985), and Maksimovic and Titman (1991). Our approach to modeling reputation is closest to that of Kreps and Wilson (1982a). Though Kreps and Wilson assume that actions are observable, in our model the investment bank's choice of evaluation standard is unobservable and (as discussed above) the investment bank may make honest mistakes. Were such mistakes not possible, investors could immediately identify an investment bank setting low standards if a single firm whose equity it markets turns out to be bad. This would allow regulatory agencies and courts to impose large enough penalties to deter investment banks from setting low standards, making reputation acquisition somewhat irrelevant.

Other approaches have also been suggested to ensure information reliability. Following Leland and Pyle (1977), Campbell and Kracaw (1980) argue that an intermediary can mitigate the moral hazard problem in information production by investing enough of its own wealth in the firms being evaluated, thus making cheating suboptimal. This requires intermediaries to invest large amounts of wealth in such firms, however, which is not generally observed in practice. In a debt market setting, Diamond (1984) shows that diversification within an intermediary can reduce the cost of providing incentives for delegated monitoring; Ramakrishnan and Thakor (1984) show that information reliability can be improved if information producers form coalitions.

The role of underwriters in equity issues has also been discussed. Heinkel and Schwartz (1986), Bower (1989), and De and Nabar (1990) develop models of the choice between rights and underwritten equity offerings; Titman and Trueman (1986) develop a signaling model of the firms' choice of intermediary (auditor or underwriter). However, these are single period models that assume away the moral hazard faced by the intermediary, eliminating any role for reputation acquisition. Gilson and Kraakman (1984) and Booth and Smith (1986) argue that underwriters can certify project quality and suggest that the underwriter's "reputational capital" may act as a bond to indicate that the issue price reflects available inside information. In their empirical study of the effect of underwriter reputation on the underpricing of IPOs, Beatty and Ritter (1986) argue that an investment bank's reputation may serve to enforce the "underpricing equilibrium" in the new issues market. Simon's (1990) empirical study draws on Shapiro's (1983) product market model to argue that underwriter reputation may be significantly related to IPO underpricing. However, reputation acquisition by investment banks and its impact on the valuation of financial securities have not been formally analyzed. Our objective here is to provide such an analysis.

The rest of the paper is organized as follows. In Section I we describe the essential features of the model. In Section II we characterize the equilibrium and develop results. In Section III we generalize the model, allowing investment banks to use a more general evaluation technology and enlarging the set of equity marketing choices available to entrepreneurs. In Section IV we discuss the empirical implications of the model, relating them to the existing evidence. In Section V we conclude. The proofs of all propositions are in the Appendix.

I. The Model

The model has two dates (time 0 and time 1). There are three kinds of agents, who are all risk neutral: entrepreneurs, investment banks, and ordinary investors. The riskless rate is zero. At time 0, entrepreneurs take their private firms public by selling their equity in these firms to outsiders in an IPO. Each entrepreneur chooses to market equity either directly to investors or using the services of an investment bank. At time 1, a new round of entrepreneurs enters the equity market, at which time the events at time 0 are repeated. This concludes the game.

Each entrepreneur (firm) has a single project, which can be of two types, “good” ($f = G$) or “bad” ($f = B$). For simplicity, we assume that the expectation of future cash flows from firms with good projects is 1, and from those with bad projects is 0. The market for new issues is characterized by asymmetric information. While entrepreneurs know the type of their own firms, ordinary investors cannot tell good firms from bad ones. The proportion of good firms is the same at each date, and is denoted by θ , which is common knowledge. At time 1, before the second round of entrepreneurs enters the equity market, the true types of all firms in which equity was sold at time 0 become known.

Investment banks, like ordinary investors, cannot a priori distinguish between good and bad firms; however, they conduct an evaluation of each firm approaching them. These evaluations have only two possible outcomes, denoted by e : “good” ($e = G$) or “bad” ($e = B$). Before evaluating firms at each date, each investment bank decides on the stringency of its evaluation procedure. In other words, it chooses an “evaluation standard.” The investment bank can set a different evaluation standard at each date. We will assume that the investment bank always obtains good evaluations for truly good projects (we relax this assumption in Section III). However, depending on how strict its evaluation standard is, it may also assign (incorrectly) a good evaluation to a bad firm with a probability r , $r \in [p, 1]$, $p > 0$. Hence,

$$\text{Prob}(e = G | f = G) = 1; \quad \text{Prob}(e = G | f = B) = r. \quad (1)$$

A higher r corresponds to a less-stringent evaluation procedure (since r is the probability of making an incorrect evaluation). If the investment bank sets $r = 1$, it gives a good evaluation to all firms approaching it. The other extreme, $r = p$, corresponds to the most stringent evaluation procedure available; since $p > 0$, mistakes are possible even in this case. Only the investment bank observes its evaluation standard; ordinary investors know only the evaluation reported.

Each investment bank brings only one firm to the equity market at each date.² An investment bank chooses the firm whose equity it markets at a given date based on its evaluation of firms approaching it at that date.

² This assumption, made to avoid computational complexity, is not crucial; all our results will go through even if an investment bank can bring $N > 1$ firms to the equity market at each date, with the difference that investors will now have N informational events based on which they update the investment bank’s reputation.

Though investment banks inform each entrepreneur of the outcome of the evaluation of his firm, the evaluation is conveyed to the equity market only if they agree to market equity in the firm. Thus, an entrepreneur can refuse to make use of an investment bank after learning the evaluation that the investment bank will report. We assume that each entrepreneur's firm is evaluated by only one investment bank. If this investment bank does not agree to market the equity, or the entrepreneur chooses not to use the investment bank, he has no choice but to market the equity directly to investors (we relax this assumption also in Section III). Further, each investment bank has access to a large enough pool of firms that it can always find a firm that obtains a good evaluation, however stringent its evaluation standard.

Investment banks are of two types, indexed by I ; while most have to incur a cost to evaluate firms ("high-cost" investment banks, $I = H$), there is a small proportion that can evaluate firms costlessly ("no-cost" investment banks, $I = N$). Investment banks know their own type; however, entrepreneurs and ordinary investors observe only a probability distribution over investment bank types. At time 0, entrepreneurs and investors have a prior probability assessment α_0 , $\alpha_0 \in (0, 1)$, of each investment bank being of the no-cost type. At time 1, they update this probability based on additional information obtained about the investment bank's performance at time 0.³

The evaluation cost of the high-cost investment bank depends upon the stringency of its evaluation standard. Denote by $C(r)$ the expected evaluation cost to be incurred *at each date*. We assume that the evaluation cost function is continuously differentiable in r over the interval $[p, 1]$. Further, the higher the probability of making an incorrect evaluation (r), the lower the expected value of the evaluation cost incurred at each date; i.e., $C_r < 0$.⁴ Finally, we assume that $C(1) = 0$; i.e., the evaluation cost is zero if the investment bank does not produce any information, and instead gives a good evaluation to all

³ If an investment bank is identified as a high-cost type with certainty, investors infer that it will always set $r = 1$ in the last period. This implies that it has no benefit from acquiring a reputation for veracity, so that it sets $r = 1$ at time 0 as well. To avoid this "unraveling problem," we assume (following Kreps and Wilson (1982a) and Milgrom and Roberts (1982)) incomplete information about the investment bank's evaluation cost, which provides a role for reputation building in this finite horizon model. Other approaches to modeling reputation acquisition require assuming that the investment bank assigns a positive probability of a continuation of the game beyond time 1, or alternatively, the assumption of an infinite horizon for the investment bank.

⁴ In practice, such a cost function can arise in several ways. For instance, if the investment bank takes only firms with good evaluations public (which is the case in equilibrium), the number of firms that it needs to evaluate and turn away before finding one that obtains a good evaluation follows a geometric distribution and is increasing in r . The expected cost per date will then satisfy the properties specified above (if the cost of conducting each additional evaluation is either a constant or decreasing in r). Another possibility is that the skill level, and hence the salary, of the employees needed to implement an evaluation standard may increase with its stringency.

firms.⁵ Since standards are unobservable, the high-cost type is subject to moral hazard; it has an incentive to lower its evaluation standard in order to reduce the evaluation cost.⁶ The no-cost type, however, has no such incentive, since it can evaluate firms costlessly.⁷

Investment banks obtain a fee only from firms whose equity they market. We assume that the fee charged by the investment is a fraction k , $k \in (0, 1)$, of the “surplus value” generated by it for the firm. This surplus value is the difference between the value of equity when the investment bank markets it and the value when the entrepreneur approaches the equity market directly. We assume that k is the same for all investment banks at both dates and is common knowledge.⁸ Since the surplus value is determined endogenously, the amount of the investment bank’s fee is also determined endogenously.

Ordinary investors value firms taken public by an investment bank based on its evaluation, the confidence they have that this evaluation is correct, and the other variables that are common knowledge. The credibility of an investment bank’s evaluation with investors depends on their beliefs about the strictness of its evaluation standards. While neither ordinary investors nor entrepreneurs can observe an investment bank’s evaluation standards, they know that the no-cost type has a stronger incentive to set strict standards. Thus, the investors’ probability assessments of an investment bank being of the no-cost type are a measure of the confidence they attach to its evaluation. In this sense, this probability reflects the investment bank’s “reputation.”

A. Firm Valuation

We derive the investors’ valuation rule for equity sold by investment banks at each date. We discuss here only the case of firms marketed with good evaluations, since we show later that, in equilibrium, no investment bank chooses to market the equity of firms with bad evaluations. The value, V_0 , of equity marketed at time 0 depends on the confidence investors have in the

⁵ Assuming that investment banks have to incur a fixed cost at each date in addition to these information production costs will not alter our results.

⁶ It is never optimal for an investment bank to evaluate a firm according to a strict evaluation standard and then lie about the outcome to the equity market. Since investors do not observe the standard of evaluation, the investment bank will simply set $r = 1$ if its objective is to deceive the equity market.

⁷ For our results to go through, the total evaluation cost of no-cost type investment banks need not be zero. For instance, the evaluation cost incurred by investment banks may have a fixed component observable by investors, and an unobservable (variable) component which increases with the desired precision of the evaluation (for high-cost investment banks). In that case, we can think of no-cost investment banks as those which have a special expertise in evaluating firms such that they can obtain the most precise evaluation possible by incurring only the fixed evaluation cost, and consequently, have no incentive to relax their evaluation standards at time 1.

⁸ This compensation rule is an extremely simplified form of fee schedules observed in practice. It is adopted to model, in the simplest way possible, the dependency of the investment bank’s fee on the incremental value it generates. The fraction k can be thought of as the outcome of bargaining, exogenous to the model, between the investment bank and the entrepreneur.

investment bank's evaluation standard, as captured by its reputation α_0 . Since all agents are risk neutral, the true value of good firms is 1 and that of bad firms is 0. Consequently, using Bayes' rule to evaluate the various conditional probabilities, and using r_0^H and r_0^N to denote the investors' conjectures about the time 0 evaluation standard set by the high-cost and the no-cost type respectively, we obtain

$$V_0(\alpha_0) = \theta \left\{ \frac{\alpha_0}{\theta + r_0^N(1 - \theta)} + \frac{(1 - \alpha_0)}{\theta + r_0^H(1 - \theta)} \right\}. \quad (2)$$

At time 1, investors come to know the true type of firms marketed by investment banks at time 0, and update the investment bank's reputation using Bayes' rule. Denoting this updated reputation value by α_1^s , $s \in \{G, B\}$ corresponding to the firm marketed at time 0 being revealed as good ($s = G$) or bad ($s = B$),

$$\begin{aligned} \alpha_1^G &= \frac{[\theta + (1 - \theta)r_0^H] \alpha_0}{\theta + (1 - \theta)[\alpha_0 r_0^H + (1 - \alpha_0)r_0^N]}, \\ \alpha_1^B &= \frac{r_0^N \alpha_0 [\theta + r_0^H(1 - \theta)]}{\theta [r_0^N \alpha_0 + r_0^H(1 - \alpha_0)] + r_0^N r_0^H(1 - \theta)}. \end{aligned} \quad (3)$$

From (3), we can verify that the investors' updated beliefs about the type of the investment bank depend on their conjectures about the evaluation standard chosen by each type, which determines the probability of these evaluations being incorrect. If investors conjecture that the no-cost type sets stricter evaluation standards than the high-cost type in equilibrium, the investment bank's reputation goes down if it is revealed that the equity marketed by it at time 0 was that of a bad firm and goes up if the equity was that of a good firm (i.e., $\alpha_1^G > \alpha_0 > \alpha_1^B$). There will be no such change in reputation, however, if investors believe that both types set the same evaluation standard in equilibrium (i.e., $\alpha_1^G = \alpha_0 = \alpha_1^B$).

Investors use the updated reputation value, α_1^s , to compute the value, V_1^s , $s \in \{G, B\}$, of equity marketed by each investment bank at time 1, giving

$$V_1^s(\alpha_1^s) = \theta \left\{ \frac{\alpha_1^s}{\theta + r_1^N(1 - \theta)} + \frac{(1 - \alpha_1^s)}{\theta + r_1^H(1 - \theta)} \right\}, \quad (4)$$

where r_1^H and r_1^N denote the conjectured time 1 evaluation standard set by the high-cost and the no-cost type, respectively. The stricter the evaluation standard chosen by an investment bank at time 0, the lower the chance that it will incorrectly market a bad firm as a good one. The standard chosen at time 0 thus affects the investment bank's time 1 reputation, and, in turn, the value of any firm it markets at time 1.

B. The Investment Bank's Objective

At each date, the objective of an investment bank is to maximize the expected value of its future profits (total fee minus total evaluation cost). Thus, each investment bank works backward from time 1, choosing the evaluation standard at each date that is optimal for the remainder of the game. For simplicity, we assume that if the value of the objective is the same for two different evaluation standards, either type of investment bank chooses the stricter standard. Denote by u_t the investors' valuation of a firm whose equity is marketed by the entrepreneur directly to investors at date t ($t = 0, 1$).

At time 1, each investment bank chooses its evaluation standard r_1^I , $I \in \{H, N\}$, to maximize the expected profit from marketing equity at that date, denoted by π_1^I , $I \in \{H, N\}$. The high-cost type maximizes

$$\pi_1^H = k(V_1^s - u_1) - C(r_1^H). \quad (5)$$

Here V_1^s is given by (4), so that $k(V_1^s - u_1)$ gives the fee obtained by the investment bank from the entrepreneur. The no-cost type's objective, π_1^N , is similar to (5), with the difference that its evaluation cost is zero. In either case, the investment bank's time 1 expected profit depends, through V_1^s , on the information that has been revealed about the true value of the firm marketed at time 0.

At time 0, each investment bank chooses its evaluation standard r_0^I , $I \in \{H, N\}$, to maximize the expected value of the sum of profits over time 0 and time 1, denoted by π_0^I , $I \in \{H, N\}$. The high-cost type maximizes

$$\pi_0^H = k(V_0 - u_0) - C(r_0^H) + E_0[\pi_1^H],$$

where

$$E_0[\pi_1^H] \equiv \frac{k}{\theta + (1 - \theta)r_0^H} [\theta V_1^G + (1 - \theta)r_0^H V_1^B] - ku_1 - C(r_1^H). \quad (6)$$

Here $E_0[\pi_1^H]$ gives the high-cost investment bank's expectation (at time 0) of its time 1 profit, V_1^G and V_1^B denote the value of V_1^s corresponding to $s = G$ and $s = B$ respectively, and $k(V_0 - u_0)$ gives the investment bank's time 0 fee. The no-cost type's time 0 objective π_0^N is similar to (6), with the difference that its evaluation cost is zero. In either case, π_0^I depends, through V_0 and V_1^s , on the investors' conjectures about the time 0 evaluation standard chosen by the investment bank.

C. The Entrepreneur's Objective

Each entrepreneur maximizes the proceeds from the sale of equity, net of any fee paid to the investment bank. An entrepreneur obtains $\{V_t - k(V_t - u_t)\}$ if he uses an investment bank at date t ($t = 0, 1$); otherwise, he obtains the entire proceeds from the sale of equity, which is u_t . Denote by m_t^f the choice of an entrepreneur of type f entering the equity market at date t ;

$m_t^f \in \{U, R\}$ corresponding to the entrepreneur using an investment bank to market equity (i.e., an underwritten issue) or marketing equity directly to investors. After observing the evaluation given by the investment bank, each entrepreneur chooses the method of marketing stock that maximizes his objective.⁹ For simplicity, we assume that an entrepreneur prefers to market equity directly if he does not obtain higher net proceeds by using an investment bank. Thus $m_t^f = U$ if $V_t - k(V_t - u_t) > u_t$, and $m_t^f = R$ if $V_t - k(V_t - u_t) \leq u_t$.

II. Equilibrium

The equilibrium concept we use is based on the “sequential equilibrium” of Kreps and Wilson (1982b). An equilibrium consists of choices by each investment bank of an evaluation standard and of the firm to take public, an equity-marketing choice by entrepreneurs, and a system of beliefs formed by ordinary investors that satisfy the following conditions: (i) Choices made by investment banks and entrepreneurs maximize their respective objectives at each date, given the equilibrium choices of the other players and the set of equilibrium beliefs formed by investors in response to these choices. (ii) Beliefs of investors are rational, given the equilibrium choices made by investment banks and entrepreneurs, and are formed using Bayes’ rule (along the equilibrium path). Any deviation from equilibrium, by any player, is met by investor beliefs that yield a lower expected payoff compared to that obtained in equilibrium. (In the following, we will use an asterisk to denote equilibrium values.)

In equilibrium, the no-cost-type investment bank always sets the strictest possible evaluation standard at each date ($r_0^{N^*} = r_1^{N^*} = p$), since it can evaluate firms costlessly.¹⁰ The high-cost type behaves differently. Since evaluating firms is costly, and there are no reputation effects to consider at time 1, it minimizes the evaluation cost by setting $r_1^{H^*} = 1$. However, at time 0, the high-cost type faces a tradeoff; setting a lower evaluation standard reduces evaluation costs, but increases the probability of marketing a bad firm with a good evaluation, thereby damaging reputation and lowering time 1 profit. The time 0 evaluation standard of the high-cost type emerges from this tradeoff.

Since the two types of investment banks behave differently in equilibrium, the revelation of firm type at time 1 conveys to investors information that they use to update their probability assessment of the investment bank type. If the firm taken public by an investment bank at time 0 is revealed as a bad

⁹ We will show that, in equilibrium, all entrepreneurs prefer to obtain an evaluation of their firm from an investment bank.

¹⁰ The no-cost type obtains the same expected payoff for a continuum of time 1 evaluation standards, $p \leq r_1^N \leq 1$; reputation effects arise as long as $p \leq r_1^N < 1$ in equilibrium. By assuming that the investment bank sets the strictest evaluation standard corresponding to a given expected payoff, we focus on the equilibrium with $r_1^{N^*} = p$, where reputation effects are the strongest.

firm, the investment bank's reputation decreases to α_1^B ; if it turns out to be a good firm, its reputation increases to α_1^G . In equilibrium, investment banks market equity only in firms that obtain good evaluations. Further, since a good firm is guaranteed a good evaluation, it is always in the interest of entrepreneurs with good firms to use investment banks to reduce the extent of their pooling with bad firms. Given this incentive, investors infer that any firm whose equity is marketed directly by the entrepreneur is a bad firm and therefore price the equity of such firms at the true value of a bad firm; i.e., $u_0^* = u_1^* = 0$. This, in turn, implies that even an entrepreneur with a bad firm will approach an investment bank in equilibrium to undergo evaluation, since there is a positive probability that the investment bank will incorrectly assign his firm a good evaluation and market its equity. Thus, only entrepreneurs whose firms receive bad evaluations market equity directly. Consistent with this equilibrium behavior, V_0^* is given by setting $r_0^H = r_0^{H^*}$ and $p_0^N = p$ in (2); V_1^* is given by substituting $r_1^H = 1$ and $r_1^N = p$ in (4).

We characterize the equilibrium formally in Proposition 1.

PROPOSITION 1: *The following strategy-belief combination constitutes an equilibrium.*

Investment bank choices: $r_0^{N^*} = r_1^{N^*} = p$; $r_0^{H^*} > p$; $r_1^{H^*} = 1$. Both high-cost and no-cost investment banks market only the equity of firms that obtain good evaluations by the above evaluation standard.

Entrepreneur choices: $m_0^{G^*} = m_0^{B^*} = m_1^{G^*} = m_1^{B^*} = U$ if $e = G$; $m_0^{B^*} = m_1^{B^*} = R$ if $e = B$.

Investor beliefs along the equilibrium path:

At time 0: $\text{Prob}(I = N) = \alpha_0$;
 $\text{Prob}(f = G | e = G, m_0^f = U)$ is given by (2), for $f = G, B$;
 $\text{Prob}(f = G | m_0^f = R) = 0$, for $f = G, B$.
At time 1: $\text{Prob}(I = N | s = G) = \alpha_1^G$, and $\text{Prob}(I = N | s = B) = \alpha_1^B$, are given by (3);
 $\text{Prob}(f = G | e = G, m_1^f = U)$ is given by (4), for $f = G, B$;
 $\text{Prob}(f = G | m_1^f = R) = 0$, for $f = G, B$.

Investor beliefs off the equilibrium path: At either date, investors set $\text{Prob}(I = N) = 0$ in response to out-of-equilibrium choices by investment banks. They set $\text{Prob}(f = G) = 0$ in response to out-of-equilibrium choices by entrepreneurs.

The equilibrium evaluation standard set by the high-cost type may be a corner value ($r_0^{H^*} = 1$), or an interior value ($1 > r_0^{H^*} > p$), depending on the marginal cost of setting a stricter standard. In either case, the evaluation standard is less strict than that of the no-cost type ($r_0^{H^*} > p$). This is because, if both types set the same standard in equilibrium, there is no information content in the time 1 revelation about the type of firm marketed by the investment bank at time 0, and consequently, no benefit to the high-cost type from incurring the cost involved in setting a stricter standard.

Investment banks have no incentive to market a firm with a bad evaluation, since they generate no incremental value for the entrepreneur by doing so, and consequently obtain zero fees. For the same reason, no entrepreneur will agree to such marketing. Further, given the out-of-equilibrium beliefs specified, if investors observe an investment bank marketing equity in a firm with a bad evaluation, they infer, with probability 1, that it is of the high-cost type and that the equity being marketed is that of a bad firm (ensuring that no investment bank or entrepreneur engages in such out-of-equilibrium behavior).

The equilibrium is a partial pooling equilibrium, in terms of investment bank type as well as entrepreneur type. Since there is a positive probability of even a bad firm getting a good evaluation and therefore being marketed by an investment bank, it is not possible for investors to infer firm type with probability 1 by observing an entrepreneur's equilibrium equity marketing strategy. Investment banks' evaluations thus allow only partial differentiation between good and bad firms. Investors also cannot infer investment bank type with probability 1 (as long as it implements its equilibrium strategy), since even the no-cost type can make incorrect evaluations with a positive probability.¹¹

It is useful to contrast the above equilibrium behavior with that in a single-period game where investment banks are concerned only with time 0 profits. In a one-period game, there are no reputation effects, and the high-cost type is concerned only with minimizing its evaluation costs, achieved by setting $r_0^{H^*} = 1$. In such a setting, the information content of a good evaluation from an investment bank is almost zero. On the other hand, in a setting with reputation acquisition, even high-cost investment banks are induced to set strict evaluation standards (i.e., $r_0^{H^*} < 1$) in an interior equilibrium, mitigating the moral hazard problem in information production, thereby allowing investment banks to act as credible information producers. This reduces the level of pooling in the equity market, giving higher proceeds to entrepreneurs with good firms and lower (expected) proceeds to those with bad firms.

PROPOSITION 2: *The equilibrium evaluation standard set by the high-cost type, $r_0^{H^*}$, represents a unique, interior solution ($1 > r_0^{H^*} > p$) if the magnitude of the marginal cost of changing the evaluation standard, $|C_r|$, is a constant c that satisfies the parametric restriction*

$$c < \frac{k\theta^2(1-\theta)^2(1-p)^2\alpha_0(1-\alpha_0)}{[\theta\{\alpha_0 p + (1-\alpha_0)\} + (1-\theta)p][\theta + (1-\theta)\{\alpha_0 + (1-\alpha_0)p\}]} \quad (7)$$

Condition (7) ensures that the marginal cost to the high-cost investment bank of setting a stricter evaluation standard is lower than its marginal

¹¹ There are no separating equilibria in our model that can be supported by "reasonable" investor beliefs. Under such beliefs the requisite incentive compatibility conditions for a separating equilibrium are not satisfied.

benefit from doing so at $r_0^{H^*} = 1$, ensuring an interior equilibrium. In an interior equilibrium with constant marginal cost c , the high-cost investment bank's evaluation standard is characterized by the condition

$$c = k \frac{(1 - \theta)\theta(V_1^G - V_1^B)}{[\theta + (1 - \theta)r_0^H]^2} \equiv \frac{k\theta^2(1 - \theta)^2(1 - p)\alpha_0(1 - \alpha_0)(r_0^H - p)}{B(r_0^H)}, \quad (8)$$

where

$$B(r_0^H) \equiv [\theta + (1 - \theta)r_0^H][\theta(\alpha_0 p + (1 - \alpha_0)r_0^H) + (1 - \theta)pr_0^H] \times [\theta + (1 - \theta)(\alpha_0 r_0^H + (1 - \alpha_0)p)]. \quad (9)$$

Condition (8) characterizes the value of r_0^H that maximizes the high-cost type's objective, π_0^H , for given values of V_1^G and V_1^B ; consistent with this, these values of V_1^G and V_1^B are precisely those that correspond to this equilibrium value of r_0^H , the equilibrium choice $r_0^{N^*} = p$ of the no-cost type, and the equilibrium beliefs of investors. In the rest of the paper, we assume that the evaluation cost function satisfies (7), and use (8) to develop the comparative statics of the unique interior equilibrium guaranteed by this assumption.¹² As a first step, we examine the impact of reputation on standard selection.

PROPOSITION 3 (effect of a change in reputation): (i) *For low reputation values (i.e., α_0 small), the high-cost investment bank's evaluation standard is stricter as its reputation is greater ($r_0^{H^*}$ is decreasing in α_0).* (ii) *For α_0 tending to 1, the high-cost investment bank's evaluation standard becomes less strict as its reputation is greater ($r_0^{H^*}$ is increasing in α_0).*

The informativeness of an investment bank's equity marketing record is greater when there is more to learn about the type of the investment bank. Depending on the value of θ , there is a certain value of α_0 at which this informativeness is greatest. The high-cost type will set the strictest standard if its reputation equals this value, since at this value of α_0 its loss from incorrectly marketing a bad firm as good is greatest. As α_0 approaches this point from below, the marginal benefit from setting a stricter evaluation standard becomes larger, while the marginal cost of setting a stricter standard is a constant. Consequently, for a small α_0 , the equilibrium evaluation standard set by the high-cost type is stricter as the investment bank's current reputation is greater (as in (i)). Conversely, for α_0 close to 1, a greater reputation means that α_0 is moving away from this point of maximum

¹² If the marginal cost of changing the evaluation standard does not satisfy the parametric restriction (6), there are two possibilities. When c is very large, there is a unique corner equilibrium ($r_0^{H^*} = 1$). This case is both unrealistic and uninteresting, since it occurs only when conducting any kind of evaluation is extremely expensive for the high-cost investment bank. For lower values of c , there may be multiple equilibria: a corner equilibrium, as well as two interior equilibria. The comparative statics developed below apply also in this latter case, to the interior equilibrium with the lower value of $r_0^{H^*}$.

informativeness, so that the loss in reputation arising from a mistake in evaluating firms decreases with α_0 . Therefore, in this range of reputation values, the more prestigious the investment bank is, the smaller its marginal benefit from setting a stricter standard (while the marginal cost of a stricter standard is constant). As a result, the equilibrium evaluation standard becomes less strict as reputation increases (as in (ii)).¹³ Figure 1 illustrates this behavior.

Proposition 3 (i) has several implications. Since investors value equity according to their beliefs about the strictness of the investment bank's evaluation standard, and $r_0^{N^*}$ always remains at p , a stricter equilibrium standard set by the high-cost type gives a higher market value for equity sold by the investment bank. This means that, for a small α_0 , the market value of equity sold by an investment bank is increasing in its current reputation. Further, the investment bank's fees, and the net proceeds to the firms selling equity are also increasing in the investment bank's reputation (since the entrepreneur and the investment bank share the surplus value generated by reputation).

PROPOSITION 4 (comparative statics): (i) *The high-cost investment bank's time 0 evaluation standard (a) is stricter as the fraction, k , of the surplus value charged as a fee increases; (b) is less strict as the marginal cost, c , of setting a stricter standard increases. (ii) For low reputation values (i.e., α_0 small), and $\theta > 1/2$, the variance (denoted by σ_V^2) of the true value of firms marketed by the high-cost type at time 0 is decreasing in its reputation.*

As the investment bank's share of the surplus value it generates goes up, the benefit from establishing a better reputation increases, while the marginal evaluation cost is unaffected. This leads the high-cost investment bank to set a stricter time 0 evaluation standard. On the other hand, if the marginal cost of evaluation goes up while the marginal benefit from setting a stricter standard remains the same, the equilibrium value of this standard becomes less strict. Finally, the equilibrium evaluation standard set by the high-cost type is stricter if its reputation is greater, reducing the variance in the true value of firms marketed by it.

III. Equilibrium in a Generalized Setting

We now generalize the model presented above ("the basic model" from now on) in two directions. First, we modify the investment banks' evaluation technology to allow for two-sided errors, assuming that investment banks

¹³ Proposition 3(ii) shows that the popular notion that more prestigious investment banks set stricter standards for firms they take public is not true for values of α_0 close to 1. It should be emphasized that this incentive to "milk" reputation is *not* an artifact of the two-period structure of our model. Milking effects may arise even in an infinite horizon model (with discounted future cash flows) for α_0 close to 1. However, in most real world settings, it seems reasonable to assume that α_0 is small, so that proposition 3(i) applies.

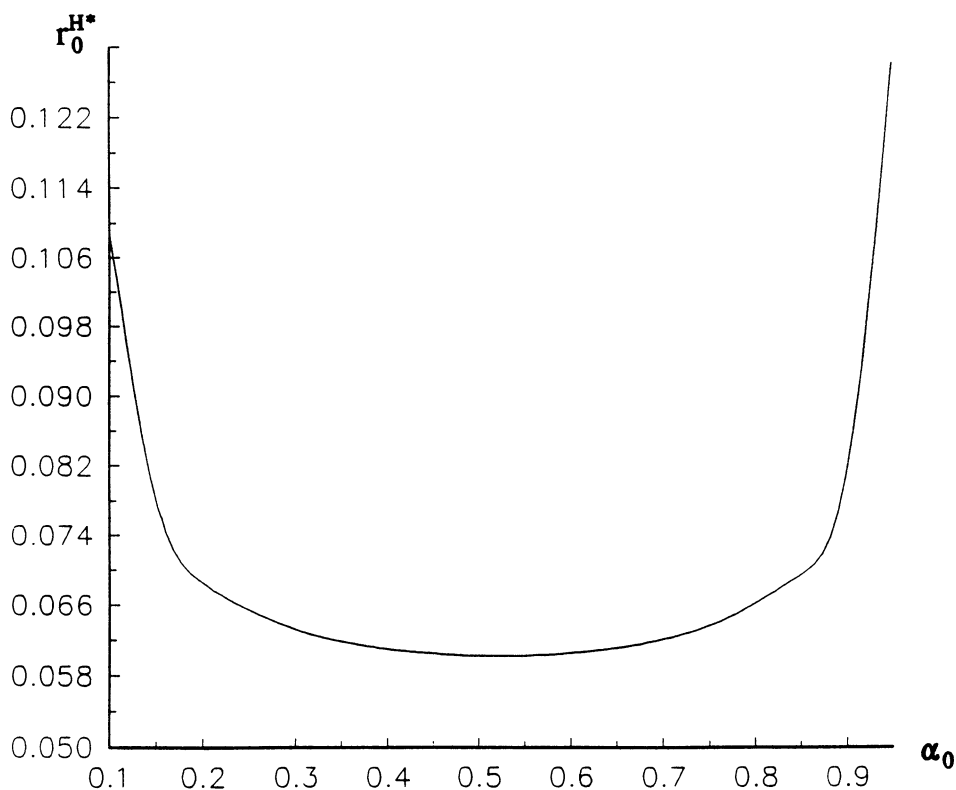


Figure 1. Variation of the high-cost investment bank's evaluation standard (i.e., the probability of an incorrect evaluation), r_0^{H*} , with its prior reputation, α_0 . The case illustrated is for the following parameter values: θ , the proportion of good firms in the economy, is 0.3; p , the probability of incorrectly giving a good evaluation to a bad firm corresponding to the strictest evaluation standard available to the investment bank, is 0.05; k/c is 20, where k is the fraction of the surplus value generated by the investment bank which is paid to it as fee, and c is the marginal cost of setting a stricter evaluation standard. For a small α_0 , the evaluation standard becomes stricter (r_0^{H*} decreases) as α_0 increases. For values of α_0 close to 1, the reverse is true.

may incorrectly evaluate a good firm as bad with a positive probability q . Thus,

$$\begin{aligned} \text{Prob}(e = G | f = G) &= 1 - q, & \text{Prob}(e = G | f = B) &= r - q; \\ \text{Prob}(e = B | f = G) &= q, & \text{Prob}(e = B | f = B) &= 1 - r + q. \end{aligned} \quad (10)$$

Here the evaluation standard $r \in [p, 1]$, with $0 < q < p$. (The evaluation technology (1) in the basic model is simply the limiting case of this generalized technology as q approaches zero.) For simplicity we assume that the error probability q does not depend on the evaluation standard r chosen by

the investment bank.¹⁴ Second, we assume that at each date t , entrepreneurs choose between investment banks with n different reputation levels, $\alpha_{t,1} > \alpha_{t,2} > \dots > \alpha_{t,n}$ (the second subscript denotes an investment bank's "reputation rank"). Further, if they are rejected by one investment bank, entrepreneurs can approach another to market equity.¹⁵

In this setting, in equilibrium, each entrepreneur entering the equity market (at each date) first approaches the investment bank with the greatest reputation and uses it to market equity (if he obtains a good evaluation). If he obtains a bad evaluation, he approaches the investment bank at the next reputation level, and so on. An entrepreneur markets equity directly to investors only if he cannot induce any investment bank to do so. This is because, in equilibrium, investors pay a higher price for equity, in a firm marketed by a more reputable investment bank. Further, the price of equity, even in a firm marketed by the investment bank with the lowest reputation level, is higher than that of equity marketed directly. Thus, the nature of the equilibrium remains essentially the same as in the basic model, with the difference that the proportion of good firms in the pool of entrepreneurs approaching each investment bank is itself determined in equilibrium by the investment bank's reputation.

We now derive the equilibrium market value of equity as a function of the reputation of the investment bank marketing the equity. Denote by θ_i the probability assessment of outsiders that a firm approaching an investment bank of reputation rank i is good. Since all entrepreneurs approach the investment bank with the highest reputation level, $\theta_1 = \theta$. However, only firms rejected as bad by an investment bank of a greater reputation level go on to the investment bank at the next reputation level. Consequently, θ_2 is the probability of a firm being good conditional on its being evaluated as bad by the investment bank of reputation $\alpha_{i,1}$; θ_3, θ_4 , etc., can be computed in a similar manner. Thus $\theta_2, \theta_3, \dots, \theta_n$ are generated recursively from (11):

$$\theta_i = \frac{q\theta_{i-1}\alpha_{0,i}}{q\theta_{i-1} + (1 - r_{0,i}^N + q)(1 - \theta_{i-1})} + \frac{q\theta_{i-1}(1 - \alpha_{0,i})}{q\theta_{i-1} + (1 - r_{0,i}^H + q)(1 - \theta_{i-1})} \quad \text{for } i > 1. \quad (11)$$

The equity value of a firm marketed at time 0 by an investment bank of

¹⁴ Allowing the error probability q to depend upon the evaluation standard, r , increases computational complexity without significantly altering the nature of our results.

¹⁵ We assume that, at each date, investment banks can be ranked in the order of their reputation and that there are no two investment banks with exactly the same level of reputation.

reputation $\alpha_{0,i}$ is then given by

$$V_0(\alpha_{0,i}) = (1-q)\theta_i \left[\frac{\alpha_{0,i}}{(1-q)\theta_i + (r_{0,i}^N - q)(1-\theta_i)} + \frac{1-\alpha_{0,i}}{(1-q)\theta_i + (r_{0,i}^H - q)(1-\theta_i)} \right], \quad (12)$$

where $r_{0,i}^H$ and $r_{0,i}^N$ represent the investors' conjectures about the equilibrium time 0 evaluation standard set by the high-cost and the no-cost investment bank, respectively.

As in the basic model, investors use Bayes' rule to update the investment bank's reputation at time 1, once the true quality of the firm marketed at time 0 is revealed, giving

$$\alpha_1^G = \frac{(1-q)\theta_i + (r_{0,i}^H - q)(1-\theta_i)}{(1-q)\theta_i + [\alpha_{0,i}r_{0,i}^H + (1-\alpha_{0,i})r_{0,i}^N - q](1-\theta_i)} \alpha_{0,i}, \quad (13)$$

$$\alpha_1^B = \frac{[(1-q)\theta_i + (r_{0,i}^H - q)(1-\theta_i)](r_{0,i}^N - q)}{(1-q)[\alpha_{0,i}r_{0,i}^N + (1-\alpha_{0,i})r_{0,i}^H - q]\theta_i + (r_{0,i}^H - q)(r_{0,i}^N - q)(1-\theta_i)} \alpha_{0,i}. \quad (14)$$

However, the value of equity marketed by the investment bank at time 1 depends not only on this updated reputation, but also on the investment bank's reputation rank at time 1, denoted by j . The proportion of good firms θ_j in the set of the investment bank's potential clients at time 1 is determined (as at time 0) by this reputation rank and can therefore be computed from an expression similar to (11). The value of equity marketed by the investment bank at time 1 is then given by

$$V_1(\alpha_{1,j}^s) = (1-q)\theta_j \left[\frac{\alpha_{1,j}^s}{(1-q)\theta_j + (r_{1,j}^N - q)(1-\theta_j)} + \frac{1-\alpha_{1,j}^s}{(1-q)\theta_j + (r_{1,j}^H - q)(1-\theta_j)} \right]. \quad (15)$$

The equilibrium time 0 evaluation standard, r_0^{H*} , set by the high-cost-type investment bank is that which maximizes the present value of its future profits, given by

$$\pi_{0,i}^H = k(V_0 - u_0) - C(r_{0,i}^H) + \frac{k[(1-q)\theta_i \hat{V}_1^G + (r_{0,i}^H - q)(1-\theta_i) \hat{V}_1^B]}{(1-q)\theta_i + (r_{0,i}^H - q)(1-\theta_i)} - ku_1 - C(r_{1,j}^H), \quad (16)$$

where \hat{V}_1^G and \hat{V}_1^B denote the investment bank's time 0 expectation of V_1^G and V_1^B , respectively (which depend, through θ_i , on its reputation rank at

time 1). The equilibrium evaluation standard set by the high-cost type at time 1 is $r_{1,j}^{H*} = 1$, since there are no reputation effects to consider at this date. On the other hand, the no-cost type's equilibrium evaluation standard at both time 0 and time 1 is independent of its reputation level and is the most stringent standard possible, i.e., $r_{0,i}^{N*} = r_{1,j}^{N*} = p$, since it evaluates firms costlessly.

Finally, the equilibrium market value of a firm whose equity is marketed directly by the entrepreneur is given by θ_{n+1} , obtained by setting $i = (n + 1)$ in (11), since investors infer that if the firm's equity is marketed directly, it has been evaluated as bad by even the investment bank at the lowest reputation level. $\theta_{n+1} > 0$, since there is a small probability that even a firm which has been evaluated as bad by all investment banks is, in fact, good.

IV. Empirical Implications

We now summarize the empirical implications of our model and discuss how they relate to the existing evidence.¹⁶

Implication 1 (Investment Banks and Information Asymmetry): Investment banks with greater reputation capital are more effective in reducing the impact of information asymmetry in the equity market. This has implications for IPOs as well as for seasoned equity issues. Several authors argue that the underpricing of IPOs is a consequence of the information asymmetry between firm insiders and outside investors (see, e.g., Chemmanur (1993), Allen and Faulhaber (1989), Grinblatt and Hwang (1989), and Welch (1989)). In these models, the extent of underpricing is decreasing in the degree of information asymmetry between firm insiders and outsiders. Therefore, an indirect prediction of our model is that the extent of underpricing is a decreasing function of the reputation of the investment bank underwriting the IPO. Logue (1973), Tinic (1988), and Carter and Manaster (1990) present evidence that is consistent with this prediction.¹⁷ Similarly, several authors argue that the negative stock price reaction around seasoned equity issues is due to asymmetric information (see, e.g., Myers and Majluf (1984)). If this is the case, the negative price reaction around a seasoned stock issue will be lower if the investment bank involved in the issue is more prestigious.¹⁸

¹⁶ Implications 1 to 5 are developed under the assumption that investment banks' reputations (as captured by α_0) are not too large, so that proposition 3(i) holds.

¹⁷ However, James and Wier (1990) do not find a significant relationship between IPO underpricing and underwriter reputation. The authors point out that this may be due to the high degree of correlation between the measures of investment bank reputation and of ex ante uncertainty (about firm value) used in their regression (see also Implication 2).

¹⁸ Since the adverse selection problem can be expected to be more severe in the case of new issues relative to seasoned equity issues, we expect the role of the investment bank as an information producer to be much more significant in the context of IPOs. Consequently, empirical results relating investment bank reputation to the different features of equity issues will be much more pronounced in this setting.

Implication 2 (Reputation and Equity Value Uncertainty): The greater the reputation of the investment bank, the lower is the variance of possible firm values (i.e., uncertainty about true value) of the firms it markets. Evidence supporting this implication is provided by Carter and Manaster (1990) and Johnson and Miller (1988) in the context of IPOs. Schadler and Manuel (1989) document this relationship between underwriter prestige and firm riskiness in the context of seasoned equity offerings.¹⁹

Implication 3 (Reputation and Underwriter Compensation): Underwriters with greater reputation capital charge larger fees and therefore have higher gross incomes than their less prestigious rivals. Preliminary evidence consistent with this is provided by Carter and Manaster (1988) in the context of IPOs.

Implication 4 (Reputation and Equity Offer Proceeds): Other things constant, the proceeds, net of underwriting fees, accruing to issuing firms are increasing in underwriter reputation (in either an IPO or a seasoned offering). Preliminary evidence consistent with this is provided by Johnson and Miller (1988) and Carter and Manaster (1988) in the context of IPOs.

Implication 5 (Reputation and Underwriter Choice): Firms prefer to use the services of the most prestigious investment bank that agrees to market their equity, even when the amount charged as fees is larger for more prestigious investment banks. Since, in our model, investment banks that overprice equity lose reputation, this implies that they will lose market share as well. This is documented for IPOs by Beatty and Ritter (1986), who find that underwriters whose offerings have average initial returns not commensurate with their ex ante uncertainty subsequently lose market share.

Implication 6 (Underwritten vs. Nonunderwritten Offerings): Firms that face an asymmetrically informed equity market prefer to make underwritten equity offerings rather than market the equity directly (for instance, in a rights issue). We therefore expect nonunderwritten issues to be made only by firms in one of two categories: those not facing a significant degree of information asymmetry in the equity market (for example, firms with a long track record) and those unable to procure the services of a credible investment bank.²⁰ Consistent with this, Smith (1977) documents that 90 percent of seasoned equity issues involve underwriters, despite the significantly lower

¹⁹ Carter and Manaster (1988 and 1990) use the average age of firms marketed by an underwriter as a proxy for the variance of (or uncertainty about) the true firm values. Schadler and Manuel (1989) use firm size, interest coverage ratio, and industry concentration ratio as proxies for firm riskiness. Carter and Manaster use the ranking of an investment banking firm in "tombstone advertisements" as a proxy for underwriter reputation, arguing that the hierarchy in the investment banking industry is reflected in these advertisements.

²⁰ Rights issues of closely-held firms fall into the first category if there is no information asymmetry between firm insiders (managers) and other equity holders. However, problems of asymmetric information arise even in this case if existing equity holders want to sell their rights to new investors. Shelf offerings constitute another class of nonunderwritten offerings.

costs of rights issues. Hansen (1988) documents that rights issues have been virtually nonexistent in the United States during the 1980s.

V. Conclusion

This paper develops a model of reputation acquisition by investment banks in an asymmetrically informed financial market. We show that the ability of financial intermediaries to acquire a reputation for veracity mitigates the moral hazard problem in information production. Consequently, reputation acquisition plays a crucial role in enabling intermediaries such as investment banks to act as credible information producers. In the context of an investment bank underwriting a stock issue, we develop results relating the investment bank's reputation to the standards it sets in evaluating firms, the value of the equity it markets, its fee from the investment banking activity, the net proceeds to issuing firms, and the equilibrium equity marketing choice of firms between underwritten and nonunderwritten offerings. Our results are consistent with much of the empirical evidence relating underwriter reputation to the various features of IPOs as well as seasoned equity offerings.

Appendix

Proof of Proposition 1: Investment Banks. Solving backward, consider the last period. For $I = N$, π_1^N is independent from r_1^N , and $r_1^{N*} = p$ is weakly optimal. Type H will minimize costs by setting $r_1^{H*} = 1$. At $t = 0$, the marginal gain for $I = N$ from relaxing its standards is

$$\frac{\partial \pi_0^N}{\partial r_0^N} = -k \frac{(1 - \theta)\theta(V_1^G - V_1^B)}{[\theta + (1 - \theta)r_0^N]^2}, \quad (\text{A1})$$

which is negative if $V_1^{G*} > V_1^{B*}$ (this will be shown to be the case later). Hence $r_0^{N*} = p$. Similarly, for $I = H$, from (6) the Kuhn-Tucker necessary condition for an optimum at $r_0^H = p$ requires that

$$\frac{\partial \pi_0^H}{\partial r_0^H} = -C'(p) - k \frac{(1 - \theta)\theta(V_1^G - V_1^B)}{[\theta + (1 - \theta)p]^2} \leq 0. \quad (\text{A2})$$

From (4), we have

$$\begin{aligned} V_1^G - V_1^B &= \frac{\theta(1 - \theta)(1 - p)}{\theta + (1 - \theta)p} \\ &\times \frac{\alpha_0(1 - \alpha_0)(\theta + (1 - \theta)r_0^H)(\theta + (1 - \theta)p)(r_0^H - p)}{[\theta(\alpha_0 p + (1 - \alpha_0)r_0^H) + (1 - \theta)pr_0^H][\theta + (1 - \theta)(\alpha_0 r_0^H + (1 - \alpha_0)p)]} \end{aligned} \quad (\text{A3})$$

From (A3), $r_0^{H*} = p$ implies that $V_1^{G*} - V_1^{B*} = 0$, contradicting (A2). Hence $r_0^{H*} > p$, which, from (4), implies also that $V_1^{G*} > V_1^{B*}$. Finally, given the investors' out-of-equilibrium beliefs, it is never optimal for an investment bank to deviate from equilibrium choices.

Entrepreneurs. If $e = G$, an entrepreneur sets $m_t^f = U$, collecting $V_t^* - k(V_t^* - u_t^*)$, $t = 0, 1$, rather than $m_t^f = R$, collecting $u_t^* = 0$. If $e = B$, he has no choice other than $m_t^f = R$.

Investors' Beliefs. Given equilibrium behavior, investors update reputations using Bayes' rule, giving (3). All good firms obtain $e = G$ and use investment banks, so that direct sale reveals $f = B$. Q.E.D.

Proof of Proposition 2: The Kuhn-Tucker necessary condition for an optimum at $r_0^H = 1$ requires

$$\frac{\partial \pi_0^H}{\partial r_0^H} = -C'(1) - k\theta(1 - \theta)(V_1^G(1) - V_1^B(1)) \geq 0, \quad (\text{A4})$$

which is violated by condition (7). This, with Proposition 1, implies that $p < r_0^{H*} < 1$. Further, with constant marginal cost c , an interior equilibrium r_0^{H*} must satisfy

$$c = k \frac{(1 - \theta)\theta(V_1^G - V_1^B)}{[\theta + (1 - \theta)r_0^H]^2} \equiv \psi\phi(r_0^H), \quad (\text{A5})$$

where $\psi \equiv k\theta^2(1 - \theta)^2(1 - p)\alpha_0(1 - \alpha_0)$, $\phi \equiv (r_0^H - p)/B(r_0^H)$, and $B(r_0^H)$ is given in (9). We now show that the RHS and LHS of (A5) intersect only once, and hence that (A5) has a unique solution. Denote by S the slope of the RHS of (A5), given by

$$S \equiv \psi \frac{\partial \phi(r_0^H)}{\partial r_0^H} = \frac{\psi}{[B(r_0^H)]^2} (B(r_0^H) - (r_0^H - p)B'(r_0^H)). \quad (\text{A6})$$

Using the equilibrium condition (A5) in (A6), the value of S at any equilibrium point is

$$S^* = \psi \frac{r_0^{H*} - p}{[B(r_0^{H*})]^2} \left(\frac{\psi}{c} - B'(r_0^{H*}) \right). \quad (\text{A7})$$

Using the fact that $B''(r_0^H) > 0$, we can show that, as r_0^{H*} increases, S^* changes sign at most once, from positive to negative. However, $\phi(p) = 0$, and, using (7), $\phi(1) > c$. This implies that the LHS and RHS of (A5) can intersect only once, and the intersection occurs in the increasing section of the RHS (i.e., $S^* > 0$). Thus, there is only one stationary point, which must be the unique interior maximum. Q.E.D.

Proof of Proposition 3: An equilibrium with interior optimum is characterized by

$$J(r_0^H, \alpha_0, \theta, k, c, p) \equiv \psi\phi - c \equiv \lambda \frac{\alpha_0(1 - \alpha_0)}{\gamma} - c = 0, \quad (\text{A8})$$

where $\lambda \equiv k\theta^2(1 - \theta)^2(1 - p)(r_0^H - p)/(\theta + (1 - \theta)r_0^H)$ and $\gamma \equiv B(r_0^H)/(\theta + (1 - \theta)r_0^H)$. By implicit differentiation, we obtain $\partial r_0^{H*}/\partial \alpha_0 = -(\partial J/\partial \alpha_0)/(\partial J/\partial r_0^H)$. Comparing (A6) and (A8), we can see that $\partial J/\partial r_0^H = S$. This gives that $\partial J/\partial r_0^H > 0$ at r_0^{H*} , since $S^* > 0$. Finally, $\partial J/\partial \alpha_0 = \lambda((1 - 2\alpha_0)\gamma - \alpha_0(1 - \alpha_0)\gamma')/\gamma^2 > 0$, for $\alpha_0 \rightarrow 0$, and similarly $\partial J/\partial \alpha_0 < 0$, for $\alpha_0 \rightarrow 1$, giving the desired results. Q.E.D.

Proof of Proposition 4: (i) From (A8), we can check that $\partial J/\partial k > 0$ and $\partial J/\partial c < 0$. Working as in the proof of Proposition 3, and using $S^* > 0$, gives $\partial r_0^{H*}/\partial k < 0$ and $\partial r_0^{H*}/\partial c > 0$.

(ii) A firm marketed by a high-cost investment bank is of the good type ($f = G$) with probability $\theta/(\theta + r_0^{H*}(1 - \theta))$. Hence, the variance of the true value of firms marketed at time 0 is $\sigma_v^2 = \theta(1 - \theta)r_0^{H*}/(\theta + r_0^{H*}(1 - \theta))$. Differentiating, we obtain

$$\frac{\partial \sigma_v^2}{\partial \alpha_0} = \theta(1 - \theta) \left[\theta^2 - r_0^{H*2}(1 - \theta)^2 \right] \frac{\partial r_0^{H*}}{\partial \alpha_0}. \quad (\text{A9})$$

From Proposition 3, $\partial r_0^{H*}/\partial \alpha_0 < 0$ for a small α_0 , and (A9) is negative for $\theta > 1/2$. Q.E.D.

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