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Underwritten Equity Offerings under Two-sided Asymmetric Information

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Abstract

A model of refined sequential equilibrium is presented in which a firm's optimal choice of underwriting contract is derived. Assuming two-sided asymmetric information between issuing firms and investment bankers, the model offers justification for many firms using an apparently more costly negotiated method rather than a less costly competitive bidding procedure for making underwritten equity offerings. The number of new shares and other terms of the offering in the underwriting contracts arise endogenously as a part of the equilibrium. Testable economic implications are also derived from the resulting equilibrium in the issuance game.

1 Introduction

This paper examines a firm's optimal choice of method and terms of the underwriting contract under two-sided asymmetric information when it must issue new shares to the public in order to undertake a valuable project. In particular we address the predominant use of a seemingly costly method for making underwritten equity offerings.

In a general cash offer, a firm can sell its new shares to the highest bidding underwriter on a competitive offer basis, or it can obtain underwriters' services through negotiation with an investment banker. The relevant cost advantage of these alternative methods has been the major focus of numerous studies. Most empirical studies show that underwriting contracts with competitive bidding involve significantly lower costs (Logue and Jarrow[1978], Bhagat and Frost[1986]). For example, a study by Bhagat and Frost[1986] of 552 utility stock issues between 1973 and 1980 found average spreads of 3.9 percent for negotiated offerings and 3.1 percent for competitive ones.[1] Several studies of new issues of corporate bonds also show that negotiated sales offer higher yields on average. (Dyl and Joehnk[1976], Ederington[1976], Sorensen[1979], and Booth and Smith[1986]).[2] The evidence, however, indicates that new issues of debt and equity are overwhelmingly done on a negotiated offer basis when the choice between competitive bidding and negotiated contract rests with the issuing firm as opposed to regulatory authorities.[3] This raises the question of why many firms choose to use a negotiated method, in spite of its apparent cost disadvantage.

Several explanations have been offered for the dominant use of negotiated offerings. Logue and Jarrow[1978] have claimed that selling and stabilization efforts would be greater for negotiated than for competitive offerings from the perspective of investment bankers. Bhagat and Frost[1986], on the other hand, have argued that conflicts in interest between managers and shareholders can explain this behavior since managers might benefit by choosing negotiated offerings at the cost of shareholders. Bhagat[1986] supports the agency costs explanation by

[1]The average cost advantage of competitive method is 1.29% of gross proceeds after adjusting for the risk of the offering, the size of the offering, and information costs.

[2]Dyl and Joehnk[1976] and Booth and Smith[1986] also find that underwriters' spread is lower for competitive sealed bid than for negotiated underwriting. Ederington[1976], however, reports no consistent spread differential.

[3]Bhagat and Frost[1986] examine utilities' 552 underwritten equity offerings in the U.S. over the period 1973–1980; in which 479 are negotiated underwritings and 73 are competitive underwritings. Similarly Logue and Jarrow[1978], Booth and Smith[1986] and Smith[1987] report the predominant use of negotiated underwritten equity offerings in the U.S.

indicating the negative abnormal returns on the announcement of the suspension of Rule 50 and the positive abnormal returns on the announcement of the termination of suspension of Rule 50. Rule 50 requires certain utility companies to use the competitive method based on the Public Utility Holding Company Act of 1935 unless the firm obtains an exemption from the SEC. Smith[1986] conjectures that firms will employ a negotiated underwriting since the level of monitoring activity tends to be higher for negotiated than for competitive issue under the informational asymmetry between insiders and outside investors. In this spirit, Booth and Smith[1986] develop a certification hypothesis to explain the role of the underwriter and the frequent use of negotiated firm-commitment underwriting.[4] In their model, however, the information asymmetry between the issuing firm and the underwriter is exogenously resolved.

Our principle objective is to provide an alternative explanation for the stylized facts, focusing on the role of asymmetric information prevailing in the capital markets. This paper differs from others by assuming two-sided asymmetric information: Issuing firms are better informed regarding their intrinsic value than investors, whereas investment bankers know more than issuing firms about the true state of the capital markets. This paper also provides a method for characterizing an equilibrium based on an application of recent developments regarding *refinements* of the sequential equilibrium concept. In this study we are primarily interested not in the separating equilibria themselves, but in the pooling equilibria properties which will result if refinements are made. This issue has received little attention in other studies.

The model considers a firm that has access to valuable investment projects that require it to raise external financing in the capital markets. New capital is raised solely in the equity market via firm-commitment contracts. We will demonstrate that the behavior of privately informed issuing firms, together with that of investment bankers, can explain some of the empirical observations mentioned above as well as suggest some new testable implications.

Unlike observable explicit costs such as issue expenses, implicit costs arise from the market's misperception that transfers wealth from undervalued firms to overvalued firms. The firm whose stock is undervalued, realizing there are implicit costs to the competitive method, selects the negotiated method, unless the explicit costs of using the negotiated underwriting are too high relative to those of using the competitive underwriting. In addition to its treatment of multi-feature information asymmetry, this paper differs from other recent *signalling* models in its development of *pooling* equilibrium properties. Irrespective of the firm's type, a negotiated

[4]Bower[1989] also applied the certification role of underwriters to the choice between a firm-commitment and a best-efforts offering.

offering will be preferred when its costs are lower than or only slightly higher than the costs of using the competitive bidding process.

The comparative statics show that as the market conditions are more uncertain, as the informational asymmetry regarding the quality of the firm becomes greater, or as the required amount of external funds relative to firm value increases, many firms deviate from the less costly competitive underwriting method and pay higher issuance costs. Other things equal, the issue size represented by the fraction of new shares or net proceeds to the firm is shown to be greater for a competitive issue than for a negotiated one. Also the impact of the suspension of Rule 50 on stock prices is negative reflecting the ex-ante loss in value due to the ex-post deadweight costs of signaling.

Working with the sequential equilibrium concept, we are left with multiple equilibria even after adopting the Cho-Kreps'[1987] *intuitive criterion* because the equilibrium outcomes are sensitive to the beliefs on the strategies that are not dominated for both types. The notion of *universal divinity* developed by Banks and Sobel[1987] is also shown to be insufficient for uniqueness although it narrows down the number of sequential equilibria. The notion of *Pareto-optimality* or Grossman and Perry[1986]'s *perfect sequential equilibrium* concept is capable of eliminating some universally divine equilibria. In this model, however, some equilibria which are not universally divine cannot be eliminated by applying the Pareto-optimality concept alone.

The paper is organized as follows. In the model presented in section 2, firms choose a method of underwriting and associated terms of the offering to maximize the expected post-issue payoffs to the current shareholders. The strategies under each method are identified to set up an equilibrium concept with two-sided information asymmetry. In section 3, we derive the intuitive sequential equilibria which give an explanation for the choice between the competitive and negotiated methods. Section 4 introduces stronger refinement concepts to obtain a unique equilibrium that depends upon the cost differential and dispersion of private value. Section 5 contains all major results arising from the two-sided asymmetric information as well as associated comparative static exercises for empirical implications. The results of this paper are summarized in section 6 and highlight the economic effects of Rule 50 on market efficiency when the firm value is not fully revealed to the markets.

2 The Model

2.1 Framework

Consider a firm that has access to valuable investment projects. The projects require the firm to raise at least I amount of external funds in the capital market so that it cannot undertake a fraction of the project.[5] To abstract from problems related to the important issue of the security type, we assume that new capital is raised solely in the equity market via firm-commitment contracts.

Before going out for external equity financing, the firm realizes its attribute; either high-quality type, denoted by type H, with probability of θ, or low-quality type, denoted by type L, with probability $1-\theta$. The market-determined equity value under full information is represented by βV^i, provided that the firm raises an amount I which is just enough to finance the capital spending. The expected final equity value is given by V^i, indexed by $i \in \{H, L\}$, where $V^H > V^L$ by construction of attribute i. The multiplicative term β represents the state of the capital market at the issue date by which future expected values are transformed to present values.[6] For simplicity, β is assumed to be distributed with the expected value of 1 and with the support over $[1-\gamma, 1+\gamma]$, where $\gamma \in (0,1)$.

The crucial assumption in our model is the two-sided asymmetric information between issuing firms and capital markets. The issuing firm has its own information about the investment-contingent expected value of the equity V^i. Investment bankers and investors, on the other hand, do not know the true quality of the issuing firm. The market, in a collective sense, is presumed to know the realized value of β representing an integration of individual investors' valuations at the time of the new issue. In contrast, the issuing firm cannot establish a direct communication channel to the public to figure out the market's general condition.[7] To complete the information structure, we assume that investment bankers are better informed about the capital markets than is the issuing firm. This information asymmetry may arise because the investment banker can obtain private information about the demand for the new issue through its preselling activities with potential purchasers. All others aspects of the subsequent problems are assumed to be common knowledge.

[5]This is partly because of substantial fixed issuance costs or delay costs associated with external financing.

[6]Thus, β incorporates not only the business cycle but also the investors' attitude towards these general economic conditions.

[7]This is possibly because it is too costly for the issuer to survey the potential investor's attitude and information.

After the firm decides on the type of security to issue, it must choose the method to market it. In a firm-commitment underwriting, the form of the equity contract is given by (α, P, P_o): The firm issues α share, where α is the fraction of new shares to old shares, and an underwriter purchases the new shares from the firm at αP and resells them to investors at αP_o.[8] Investment bankers and issuing firms are assumed to be risk-neutral. If the offer succeed, $\alpha P_o - \alpha P$ represents the compensation received by the investment bankers. Upon making a timely firm-commitment underwriting contract where the proceeds to the issuing firm, αP, are greater than the intended amount for the investment, I, the value of type i to current shareholders at the final offer date will be

$$\frac{1}{1+\alpha}(\beta V^i + \alpha P - I) \tag{1}$$

If the capital market believes that the probability of being a high-quality type is $t \in [0,1]$, then it reflects the belief to its value of shareholding as

$$V^t = tV^H + (1-t)V^L \tag{2}$$

Consequently, we create a continuum of type $t \in [0,1]$, where $t = \theta$ in a complete pooling case. In most cases, however, we will continually use type H for $t = 1$, and type L for $t = 0$. Given beliefs on the firm type, t, homogeneous investors will accept the offer only if the offer price is less than the post-issue value of the equity holding such that

$$\frac{\alpha}{1+\alpha}(\beta V^t + \alpha P - I) \geq \alpha P_o \tag{3}$$

Myers and Majluf[1984] focus on the situation in which the high-quality firm optimally refrains from a new issue in the existing shareholders' interest when the uncertainty about the value of assets in place is higher relative to the investment opportunity's expected NPV. In contrast, this paper considers the situation in which both types are better off by issuing new shares and by being assured of the full amount even when the markets' beliefs and states are unfavorable to shed light on the optimal choice of the issuance procedure.[9]

[8]Since α is defined as the fraction of new shares to old shares, the offer price per share and the net proceeds per new share to the issuing firm are computed from dividing P_o and P by the number of current shares outstanding, respectively.

[9]If the sign of the *NPV* of the new issue is contingent upon the investors' beliefs and market conditions, then the issuing firm can reserve the option to withdraw the new issue during a bargaining process with an investment banker. This might be an explanation for the predominant use of negotiated underwriting in some cases. We can also possibly incorporate the tradeoff between shortfall costs and dilution costs from undervaluation in the

The contractual terms, (α, P, P_o), can be obtained through either a negotiated or a competitive bid contract. In the next subsection we are mainly concerned with the behavior of the investment banker and its effect on the issuing firm's behavior.[10] Our analysis centers on how to choose the optimal contract that maximizes the expected current shareholder's wealth. The sequence of events regarding external equity financing is depicted in Figure 1.

2.2 Competitive Underwritten Equity Offerings

In the competitive bidding process, underwriting syndicates bid on the net proceeds to the issuing firm after the firm announces the number of new shares and its intent to use the competitive method. A syndicate which bids the highest net proceeds, αP, will underwrite and purchase all the shares offered at this price. The underwriting syndicate then resells the new shares immediately at αP_o which provides the maximum gross proceeds the syndicate can receive from the sale subject to selling all shares. Hence, each syndicate determines the net proceeds due to the issuing firm from a new issue, whereas the issuer can control directly only the number of new shares and not the dollar amount of funds.

The issuing firm of type i, that is perceived to be of type t, selects the fraction of new share α, to maximize the expected value of investment-contingent current shareholders' wealth (1) expressed as

$$\max_{\alpha} \mathrm{E}\left[\frac{1}{1+\alpha}(\beta V^i + \alpha P - I)\right] \tag{4}$$

$$\text{s.t.} \quad \alpha P \geq I \quad \forall \ \beta \in [1-\gamma, 1+\gamma] \tag{5}$$

$$P = P(\alpha; \beta, t) \tag{6}$$

where E[·] denotes the mathematical expectation operator over β and P. The first constraint represents the condition to make the firm finance the entire project under all circumstances of market conditions. The proceeds function in (6) shows that the net receipts due to the firm

relevant range. The optimal fraction of new shares, in a competitive bidding, then depends on the probability density function of β and the degree of undervaluation. However, this would bring further complications to the subsequent analysis.

[10]Since the efficient contracting mechanism design for new issue is beyond the scope of this paper, we will employ a mechanism prevailing in the new issue market.

depend on the syndicates' bidding strategy, $P(\alpha, \beta; t)$, given market conditions, β, and investors' perception on the firm's quality, t. Since the market condition is not known to the issuing firm, net proceeds are uncertain when it makes a decision on the fraction of new shares.[11]

Let K_c be the total costs to underwriters which would include selling expenses and various fees. Assuming Q potential bidders who are identical in every aspect, all bidders submit the same proceeds αP and the winner is picked by a random drawing. Provided that the offer succeeds with gross proceeds αP_o, the expected profits to a bidder are then given by

$$(\alpha P_o - \alpha P - K_c)/Q \tag{7}$$

Bertrand competition among the bidders will then yield the highest αP which makes zero profits, conditional upon the investors' competitive rationality condition (3). The investment bankers' optimal offer price and bidding function are then

$$P_o = P + (K_c/\alpha) \tag{8}$$

$$P(\alpha; \beta, t) = \beta V^t - I - \frac{1+\alpha}{\alpha} K_c \tag{9}$$

By substituting (9) into (4) and (5) and utilizing the fact that $E(\beta) = 1$, the optimization problem of the issuing firm becomes

$$\max_{\alpha} \; U^i(\alpha; t) = V^i - I - K_c - \frac{\alpha}{1+\alpha}(V^i - V^t) \tag{10}$$

subject to the investment-feasibility condition

$$\alpha \geq \frac{I + K_c}{(1-\gamma)V^t - I - K_c} \equiv \alpha(\gamma; t) \tag{11}$$

$\alpha(\gamma; t)$ is the minimum fraction of new shares to ensure the investment. Figure 2 shows the relationship between the number of new shares and the current shareholders' expected welfare under various market perceptions on the firm's intrinsic value. From (10), if the firm is fairly valued ($t = i$), the current shareholders' welfare is independent of α and α is unbounded as long as (11) holds, which is a property derived in a full information case. On the other hand, if it is undervalued ($t < i$), the optimal choice of the firm is $\alpha(\gamma; t)$ and the resulting payoffs are

$$U^i(\alpha(\gamma; t); t) = V^i - \left(\frac{1}{1-\gamma}\right)\left(\frac{V^i - \gamma V^t}{V^t}\right)(I + K_c) < V^i - I - K_c \tag{12}$$

[11]Although the issuing firm is free to ask advice from another investment banker to infer the market condition, β may change when actual bidding occurs after announcing α.

$\forall\ \gamma \in (0,1)$. The welfare loss to the undervalued firm becomes greater as the uncertainty on market conditions, measured by the value of γ, increases. The reason is that as γ increases the undervalued firm must sell a larger number of new shares at a discounted price in order to be assured of the full amount.

2.3 Negotiated Underwritten Equity Offerings

To avoid the complicated issue of bargaining procedure, the form of the negotiation is exogenously imposed. In the negotiated method, the issuing firm quotes terms of the contract (α, P) to an investment banker. The banker accepts the offer and becomes an underwriter if the terms (α, P) jointly satisfy the condition

$$\mathrm{E}[\alpha P_o(\alpha, P; \beta, t) - \alpha P] \geq K_n \tag{13}$$

where K_n is defined as the expenses and fees plus the minimum compensation guranteed to the underwriter in a negotiated process.[12] Including an economic quasi-rent, the value of K_n indicates the effectiveness of the competition in the investment banking industry. After investigating the value of β, the underwriter decides the offer price that maximizes the spread $\alpha(P_o - P)$ subject to the contractual agreement, $\alpha P \geq I$, and investors' competitive rationality condition (3).

$$P_o(\alpha, P; \beta, t) = \frac{1}{1+\alpha}(\beta V^t + \alpha P - I) \tag{14}$$

When the firm of type i is perceived of type t, the issuer wishes to choose the contract term (α, P) to maximize the expected current shareholders' welfare (1). Since $E(\beta) = 1$, the issuer's problem is expressed as

$$\max_{(\alpha,P)} U^i(\alpha, P) = \frac{1}{1+\alpha}(V^i + \alpha P - I)$$

subject to the contract- and investment-feasibility conditions

$$P \leq V^t - I - \frac{1+\alpha}{\alpha} K_n \equiv \overline{P}(\alpha; t) \tag{15}$$

$$P \geq I/\alpha \equiv \underline{P}(\alpha) \tag{16}$$

[12]The offer price function $P_o(\alpha, P; \beta, t)$ is not known with certainty when (α, P) is set because the underwriter does not set P_o until the offering date due to changing market conditions during the registration period.

Constraint (15) is obtained by substituting (14) into (13). $\overline{P}(\alpha;t)$ and $\underline{P}(\alpha)$ together restrict the feasible net proceeds; one is imposed by the underwriter and the other is by the issuing firm. Because $U^i(\alpha,P)$ is monotonically increasing with respect to P for every α, the above problem can be rewritten as

$$\max_{\alpha} \; V^i - I - K_n - \frac{\alpha}{1+\alpha}(V^i - V^t)$$
$$\text{s.t.} \quad \alpha \geq \frac{I+K_n}{V^t - I - K_n} \equiv \alpha(t)$$

The maximand of the fairly valued firm ($t=i$) is independent of α. If the firm is undervalued ($t<i$), its optimal strategies are (α_t^i, P_t^i) and the resulting payoff to the current shareholders are given by

$$\alpha_t^i = \alpha(t), \qquad P_t^i = V^t - I - \frac{V^t}{I+K_n}K_n$$
$$U^i(\alpha_t^i, P_t^i) = V^i - \frac{V^i}{V^t}(I+K_n) \tag{17}$$

The optimal terms of the offering no longer depend on the true quality of the firm but on the market's perception. The decrease in the market's perception on the final expected value of the firm would decrease the welfare of the current shareholders. Note that, when $K_n = K_c$, the payoffs in the negotiated procedure, (17), is greater than that in the competitive bidding process in (12) as long as $\gamma > 0$.[13]

3 Intuitive Sequential Equilibrium in the Issuance Game

3.1 Equilibrium Concept and Cho-Kreps Criterion

The firm's decision and investment bankers' reaction problem with investors' beliefs surrounding the new issue can be interpreted as follows. The firm of type i selects the method, either negotiated or competitive, and reaches agreement on the terms of the contract, (α, P), with an underwriter to maximize the current shareholders' wealth. Investment bankers, on the other hand, respond to the firm's offer to maximize the expected profits from the sale of the new issue which in turn depends on the market conditions and investors' beliefs. The investors, upon observing the method and terms of the offering denoted by x, the vector of the issuing

[13] We can derive similar results with an alternative auction mechanism in which the issuer announces the intended amount of funds instead of the number of new shares.

firm's strategy, construct beliefs on the type of the firm $t(x)$, which is equivalent to a conditional probability distribution over the high-quality type.

A full specification of this sequence of possible actions, of the information available at each point, and of the resultant payoffs would yield a game of incomplete information in extensive form. For mathematical convenience in the subsequent analysis, we define $W^i(x;t(x))$ as a maximand of actual type i that is perceived to be of type t when investors observe the issuing firm's action x. x represents α if the firm selects a competitive offering and a pair (α, P) if a negotiated one. Then $W^i(x;t(x))$ is formally described as follow. If $x = \alpha$ and it satisfies the contract-feasibility condition (11), then $W^i(x;t(x))$ is represented by $U^i(\alpha;t(\alpha))$ in (10). If $x = (\alpha, P)$ and it satisfies the contract-deasibility condition (15) and the investment-feasibility condition (16), then $W^i(x;t(x))$ is represented by $U^i(\alpha, P)$ in (2.3). We can assign any arbitrary low value to $W^i(x;t(x))$ if x does not satisfy any feasibility condition so that the issuing firm cannot pass up the valuable investment opportunity. We also define $U^i(t)$ as an indirect payoff function of type i when it is always perceived to be of type t.

We will employ the *sequential equilibrium* concept introduced by Kreps and Wilson[1982] and its *refinements* to impose restrictions on the market's out of equilibrium beliefs. To make this paper self-contained, we will describe the related definitions in our context. We will consider only *pure strategies* to focus on *complete pooling* or *perfectly separating* cases in investors' beliefs.

Definition 1 *A refined sequential equilibrium of the issuance game is defined as a system of market beliefs, $t(x)$, and the issuing firm's strategy in each type, x^i for $i \in \{H, L\}$, such that*

1. *The firm's strategies are sequentially rational in that*

$$x^i = arg \max_{x \in \{\alpha, (\alpha, P)\}} W^i(x;t(x))$$

2. *Investors' beliefs are consistent in that on the equilibrium path, $x = x^i$ for some $i \in \{H, L\}$, they are given by Bayes' rule.*

3. *When there exists a consistent out of equilibrium belief on the probability that the firm is a high-quality one, μ, for any method and terms of the offering that are not selected by any type, then $t(x) = \mu$.*

Subsequent investment bankers' equilibrium strategies and investors' competitive rationality conditions, given the consistent beliefs, $t(x)$, are represented by the system of equations and inequalities (2), (3), (8), (9), (14), and (15) when the investment-feasibility condition (11) or (16) holds.[14]

Our refinements deal with the investors' *consistent out of equilibrium belief*, μ; the reasonable beliefs borne by investors for the method and terms of the offering which are not played by any type in an equilibrium. The first restriction, which is adapted from Cho and Kreps[1987], involves the elimination of sequential equilibria which are not rational for investors in response to the method and terms of the offering.

Definition 2 *Consider any sequential equilibrium outcome $\{x^i, t(x^i)\}$ and corresponding equilibrium response of investment bankers and investors. The sequential equilibrium is said to fail the intuitive criterion if for some*

$$x' \in \{x | W^L(x^L; t(x^L)) \geq W^L(x; H)\}$$

which is dominated by the equilibrium value for the low-quality type, the high-quality type would be better-off by employing x' and convincing the market of its true type. That is,

$$W^H(x'; H) > W^H(x^H; t(x^H))$$

3.2 Separating Equilibria

In the previous section, we show that there should be a welfare loss to the undervalued firm. If the firm can convince the market by disclosing the information about its quality, it might be better off. Since the gain from the new information will be captured by the high-quality type, it has an incentive to separate itself from the low-quality type.

Lemma 1 *The firm of high-quality type cannot separate itself by selecting a competitive underwritten equity offering.*

Proof see Appendix A.

[14]A sequential equilibrium will be categorized as a separating equilibrium if $x^H \neq x^L$ and a pooling equilibrium if $x^H = x^L$.

Lemma 2 *There exists a separating equilibrium in which the firm of high-quality type chooses a negotiated underwritten equity offering if and only if* $K^s(\gamma) > K_n > K_c$ *where*

$$K^s(\gamma) = K_c + \left(\frac{1}{1-\gamma}\right)\left(\frac{V^H - V^L}{V^L}\right)(I + K_c) \tag{18}$$

Proof see Appendix A.

Armed with Lemma 1 and Lemma 2, we are now able to derive a costly fully revealing signalling equilibrium by the elimination of type-strategy pairs. As a tie-breaking rule, we assume that if the issuers are indifferent among the number of new shares they issue with the competitive bidding process, they choose the smaller number of new shares.

Proposition 1 *There exists an intuitive separating equilibrium if and only if* $K^s(\gamma) > K_n > K_c$*. In an intuitive separating equilibrium, if one exists, the low-quality type chooses a competitive method with the number of new shares per old share* $\alpha_L = \alpha(\gamma; L)$*. The high-quality type chooses a negotiated method with terms of the contract,* (α_H, P_H) *such that*

If $K^s(\gamma) > K_n \geq K^s(0)$,

$$\alpha_H = \frac{I + K_n}{V^H - I - K_n}, \qquad P_H = V^H - I - \frac{V^H}{I + K_n}K_n$$

If $K^s(0) > K_n > K_c$,

$$\alpha_H = \frac{I + K_c}{V^L - I - K_c}, \qquad P_H = V^L - I - \frac{V^L}{I + K_c}K_c$$

where the function $K^s(\gamma)$ *is defined as (18).*

Proof see Appendix A.

The crucial mechanism for the existence of a signalling equilibrium is that the costs of using a negotiated method for the high-quality type are relatively smaller than those for the low-quality type. Conversely, the implicit costs of using a competitive method becomes greater for the high-quality type with the increase in the uncertainty on market conditions. Figure 3 illustrates this formally. The indifference curve, $U^H(L) = U^H(\alpha, P)$ and $U^L(L) = U^L(\alpha, P)$, and the feasibility set of terms of the offerings, represented by $\overline{P}(\alpha; t) \geq P > \underline{P}(\alpha)$ are drawn for a different range of cost differentials. The slope $\partial P/\partial \alpha$ for the high-quality type must be greater than that for the low-quality type.

In Figure 3.a, we can see that the costs of using a negotiated method are too high relative to those of using a competitive method, so all issues are pooled together and use the cheaper contract. Thus the incentive compatibility condition of the high- quality type is violated for any (α, P) which satisfies the contract-feasibility condition. In Figure 3.b and 3.c, if the high-quality type sets (α_H, P_H), it is too costly for the low-quality type to imitate by falsifying the signal. In Figure 3.b, the proceeds to the issuing firm lie on the boundary of the feasible contract region. In Figure 3.c, we have a situation in which the high-quality type provides higher compensation to the investment banker than is normally required in the symmetric information case. Figure 3.d shows the pooling situation where both types choose the cheaper method since the low-quality type can easily mimic the high-quality type.

Signalling is costly to the high-quality type in that it has to use a more expensive method of underwriting and provide higher compensation to the investment banker voluntarily in some cases. As shown in Figure 3.c, the issuing firm allows an excess spread by discounting the new issue if the cost differential is small.

We will define the *misinformation costs* of type i as the difference between type i's payoffs in a full information case and those in an asymmetric information case with the equilibrium outcome $\{x^i, t(x^i)\}$ for $i \in \{H, L\}$. Formally describe this as

Definition 3

$$MIC^i = U^i(i) - W^i(x^i; t(x^i))$$

It is readily shown that $\text{MIC}^H \geq 0$ and $\text{MIC}^L \leq 0$. If $\text{MIC}^H = 0$ then the high-quality type can distinguish itself without incurring any costs and asymmetric information is naturally resolved.

Corollary 1 *There does not exist a costless separating equilibrium and*

$$\begin{aligned} MIC^H &= \begin{cases} K_n - K_c & \text{if } K^s(\gamma) > K_n \geq K^s(0) \\ \frac{V^H - V^L}{V^L}(I + K_c) & \text{if } K^s(0) > K_n > K_c \end{cases} \\ MIC^L &= 0 \end{aligned}$$

Proof Immediate from the definition of MIC^i.

The deadweight loss of the high-quality type is at least $[(V^H - V^L)/V^L](I + K_c)$ and increases as K_n increases from $K^s(0)$ to $K^s(\gamma)$.

3.3 Pooling Equilibria with Negotiated Offerings

In this section we will develop pooling equilibrium properties. Here, the low-quality type selects the same method of underwriting and employs the same contractual terms as the high-quality type. The following lemma is useful to formulate the pooling equilibrium with negotiated underwriting.

Lemma 3 *A pooling equilibrium in which the equilibrium strategy of both types is (α_n, P_n) is intuitive if and only if the investment-feasibility condition is binding, that is, $\alpha_n P_n = I$.*

Proof see Appendix A.

This lemma states that at any pooling equilibrium with negotiated underwriting which is intuitive, the issuing firm does not issue more than the amount required for the proposed investment. We are now ready to state our second proposition.

Proposition 2 *There exists an intuitive pooling equilibrium with negotiated underwriting if and only if $K_n(\theta) > K_n$ where*

$$K^n(\theta) = K_c + \frac{V^\theta - V^L}{V^L}(I + K_c) \tag{19}$$

and any pooling equilibrium strategy (α_n, P_n) must satisfy

$$\frac{I + \min\{K_c, K_n\}}{V^L - I - \min\{K_c, K_n\}} \geq \alpha_n \geq \frac{I + K_n}{V^\theta - I - K_n} = \alpha_n^* \tag{20}$$

$$\alpha_n P_n = I \tag{21}$$

Proof see Appendix A.

If capital markets do not have a symmetric information on the firm's quality, the terms of the offering in underwriting contracts no longer depend on the quality of the firm per se but will be determined by the market perceptions. If investors think that a competitive method is more likely associated with the low-quality type, it would pay both types to choose the negotiated procedure if the cost differential lies on the region of (19).

Notice that for $K_n(\theta) > K_n > K_c$, there exist both separating and pooling equilibria with negotiated underwriting. Suppose that investors' beliefs are the same as those constructed in the separating equilibrium but replacing the belief for (α_n, P_n) which satisfies both (20) and (21), $t(\alpha_n, P_n)$, by θ. Recall that the beliefs and the conditions in Proposition 2 are constructed so that a pooling equilibrium with negotiated underwriting, if one exists, is intuitive. Now it can be shown that the conditions imply that (α_n, P_n) is an equilibrium strategy given the above investors' beliefs. The interesting feature of (19) is that although the costs of using a negotiated method are greater than the costs of using a competitive method, both types choose negotiated one. With a negotiated offering, the high-quality type can reduce the dilution by transferring the risks of adverse market conditions to the underwriter. If the costs of using a negotiated method are not too high relative to those of using a competitive method, the low- quality type will mimic the high-quality type. Our next corollary regarding the misinformation costs bases on the Pareto-superior equilibrium among the pooling equilibria with an equilibrium strategy of negotiated underwriting.

Corollary 2 *If $K^n(\theta) > K_n$ and the equilibrium strategies of both types are $\alpha_n = \alpha_n^*$ and $P_n = I/\alpha_n^*$, then*

$$MIC^H = \begin{cases} \frac{V^H}{V^\theta}(I+K_n) - (I+K_c) & \text{if } K^n(\theta) > K_n > K_c \\ \frac{V^H - V^\theta}{V^\theta}(I+K_n) & \text{if } K_c \geq K_n \end{cases}$$

$$MIC^L = \begin{cases} \frac{V^L}{V^\theta}(I+K_n) - (I+K_c) & \text{if } K^n(\theta) > K_n > K_c \\ \frac{V^L - V^\theta}{V^\theta}(I+K_n) & \text{if } K_c \geq K_n \end{cases}$$

The proofs follow immediately from the definition 3.

3.4 Pooling Equilibria with Competitive Offerings

For some ranges of the cost differential, there also exists a pooling equilibrium in which both types use a competitive method. The following proposition is about this case.

Proposition 3 *If a pooling equilibrium, in which the equilibrium strategy of both types is a competitive method with α_c, passes the intuitive criterion, then $K_n \geq K^c(\theta,\gamma)$ where*

$$K^c(\theta,\gamma) = K_c + \left(\frac{1}{1-\gamma}\right)\left(\frac{V^H - V^\theta}{V^\theta}\right)(I + K_c) \tag{22}$$

There exists an intuitive pooling equilibrium, in which the equilibrium strategy of both types is a competitive method with $\alpha_c = \alpha(\gamma;\theta)$, if and only if $K_n \geq K^c(\theta,\gamma)$ where $\alpha(\gamma;\theta)$ is defined in (11).

Proof see Appendix A.

Of course we can construct another pooling equilibrium with an equilibrium strategy $\alpha_c > \alpha(\gamma;\theta)$ if $K_n \geq K^c(\theta,\gamma)$. This is because for the strategies which are not dominated for both types we can arbitrarily assign beliefs so that a proposed equilibrium holds. The intuitive criterion does impose a weak restriction as long as $K_n \geq K^c(\theta,\gamma)$. In section 4, however, we will show that any pooling equilibrium with $\alpha_c > \alpha(\gamma;\theta)$ fails to be a ***universally divine equilibrium*** whose notion is introduced by Banks and Sobel[1987]. The misinformation costs for each type are directly obtained from the univerrsally divine equilibrium outcome.

Corollary 3 *If $K_n > K^c(\theta,\gamma)$ and the equilibrium strategy of both types is $\alpha_c = \alpha(\gamma;\theta)$ then*

$$MIC^H = \left(\frac{1}{1-\gamma}\right)\left(\frac{V^H - V^\theta}{V^\theta}\right)(I + K_c)$$

$$MIC^L = \left(\frac{1}{1-\gamma}\right)\left(\frac{V^L - V^\theta}{V^\theta}\right)(I + K_c)$$

The proofs are immediate from the definition 3.

4 Unique Refined Sequential Equlibrium

In this section a unique equilibrium and its properties are derived in order to develop some testable economic implications in the capital acquisition process. As shown in the previous section, the problem of having multiple equilibria is not resolved by the application of equilibrium dominancy. The reason is that the existence of a sequential equilibrium critically depends on the investors' beliefs on the type of the firm. That is, how investors form their expectations and what they infer from the behavior of issuing firm's out of equilibrium strategies which are not dominated for both types.

4.1 Universally Divine Sequential Equilibria

Which particular equilibrium would be more likely prevailing in the economy? To obtain some insight into this question, we adopt the notion of *universal divinity* due to Banks and Sobel[1987]. Consider any proposed equilibrium outcome. The universal divinity criterion requires that the out of equilibrium beliefs must not raise the prior probability that it is the low-quality type if, whenever the low-quality type wishes to defect, the high-quality type strictly wishes to defect.

Definition 4 *A proposed intuitive equilibrium outcome $x^i, t(x^i)$, for $i \in \{H, L\}$, fails to be a universally divine equilibrium if there exists a number of new shares issued per old share α with a competitive bidding process such that*

$$t_o^L(\alpha) \neq \{\phi\} \qquad \textit{and} \tag{23}$$

$$\min\{t_o^L(\alpha), \theta\} \geq t^H(\alpha) \tag{24}$$

(with inequality strict if $t_o^H(\alpha) \neq \{\phi\}$) where

$$t^i(x) = \inf\{t | W^i(x;t) > W^i(x^i; t(x^i)), t \in [0,1]\}$$

$$t_o^i(x) = \min\{t | W^i(x;t) = W^i(x^i; t(x^i)), t \in [0,1]\}$$

A modified definition is used since we are working with a reduced-form payoff function, $W^i(x;t)$, which is non-decreasing with respect to the belief t. Notice that *universal divinity* subsumes *equilibrium dominancy*. Thus our attention is given to the out of equilibrium strategy beliefs that are not governed by the intuitive criterion.

The high-quality type does not have a greater incentive to defect to any strategy with negotiated offer (α, P) which is not chosen to play in an intuitive equilibrium: The cut-off belief to defect for both types is either empty or given by the contract-feasibility condition.[15] For an out of equilibrium strategy α in a competitive offer, it is easy to show that $t_o^L(\alpha) = \{\phi\}$ implies $t^H(\alpha)$ $[= t_o^H(\alpha)$ if $t_o^H(\alpha) \neq \{\phi\}] \geq t^L(\alpha)$.[16] Thus there always exists a belief that supports these out of equilibrium strategies, for example the low-quality type, with probability one; the proposed equilibrium is universally divine.

If there exists α such that $t_o^L(\alpha) \geq (>) t^H(\alpha)$ and $t_o^H(\alpha) = (\neq)\{\phi\}$, then the out of equilibrium strategy α must be supported by a belief $t(\alpha) \geq \theta$. Consequently the high-quality type will defect voluntarily if the condition $\theta \geq (>) t^H(\alpha)$ satisfies

$$W^H(\alpha; t(\alpha) \geq \theta) \geq (>) W^H(\alpha; t^H(\alpha)) > (\geq) W^H(x^H; t(x^H))$$

This will break the proposed equilibrium. The intuitive equilibrium is said to be universally divine if there does not exist α that satisfies both (23) and (24). This is because then there always exists a belief that supports any out of equilibrium strategy.

Proposition 4 *Any sequential equilibrium in which both types use a competitive method with the fraction of share $\alpha > \alpha(\gamma; \theta)$ is not a universally divine equilibrium. Any other intuitive sequential equilibrium is universally divine.*

Proof see Appendix A.

The first part of Proposition 4 can be interpreted as follows. The undervalued firm would like to minimize the dilution while the overvalued firm prefers to issue larger fraction of new shares. Upon seeing a smaller fraction of new shares than that in proposed one, investors must update

[15] Recall that $W^i(\alpha, P; t)$ can be decomposed into three parts: The unconstrained maximand, $U^i(\alpha, P)$, and investment-feasibility condition, $\alpha P \leq I$, do not depend on market's perception while the contract-feasibility condition, $P \leq P(\alpha; t)$, does.

[16] Recall that $W^i(\alpha; t)$ is decomposed into two parts: the unconstrained maximand, $U^i(\alpha; t)$, and investment-feasibility condition, $\alpha \geq \alpha(\gamma; t)$. Since $U^i(\alpha; t)$ is continuous with respect to $t \in [0, 1]$, $t_o^L(\alpha) = \{\phi\}$ implies $U^L(\alpha; t^L(\alpha)) > U^L(x^L; t(x^L))$ and $\alpha = \alpha(\gamma; t^L(\alpha))$. Then it must be that $t^H(\alpha) = t^L(\alpha)$ if $t_o^H(\alpha) = \{\phi\}$ and $t^H(\alpha) = t_o^H(\alpha) > t^L(\alpha)$ if $t_o^H(\alpha) \neq \{\phi\}$. That is, the high-quality type does not have greater incentive to defect.

their beliefs to believe that the defection more likely came from the high-quality type rather than the low-quality type since the high-quality type has a greater incentive to play that action. Thus a reasonable equilibrium must consist of the smallest fraction of new share $\alpha(\gamma;\theta)$ as a pooling equilibrium outcome with competitive bidding, if one exists, compelled by the high-quality type.

4.2 Pareto-Optimal Equilibrium

As shown by the second part of Proposition 4, the universal divinity alone cannot prune some other apparently unreasonable equilibria; for example, a Pareto-dominated equilibrium in which both types use a negotiated offering with $\alpha_n > \alpha_n^*$ as shown in Proposition 2.[17] We need to make welfare comparisons of equilibria to obtain a unique equilibrium. Before, we define the Pareto-optimality condition. Appendix B describes that *perfect sequential equilibrium* concept leads to the same result when there are two types choosing only pure strategies.

Definition 5 *An equilibrium outcome $\{x^i, t(x^i)\}$ is said to be pareto-optimal if there does not exist another equilibrium outcome $\{x^{i'}, t'(x^{i'})\}$ such that*

$$W^i(x^{i'}; t'(x^{i'})) \geq W^i(x^i; t(x^i)) \qquad \text{for } i \in \{H, L\}$$

with one inequality strict.

Lemma 4 *Any intuitive pooling equilibrium, in which the equilibrium strategy of both types is a negotiated method with $\alpha_n > \alpha_n^*$ and $P_n = I/\alpha_n$, is not pareto-optimal.*

Proof see Appendix A.

From proposition 1–4 and Lemma 4, we have at most three equilibria to be concerned as candidates given a cost differential, $K_n - K_c$.

1. a pooling equilibrium with competitive underwriting $[x^H = x^L = \alpha(\gamma;\theta)]$,

2. a pooling equilibrium with negotiated underwriting $[x^H = x^L = (\alpha_n^*, I/\alpha_n^*)]$,

[17]By replacing $t_o^L(\alpha)$ for $\min\{t_o^L(\alpha), \theta\}$ in (24), we can construct Cho-Kreps' *D1 criterion* which is stronger than the notion of universal divinity. However, this does not help since we can show that the second part of Proposition 4 holds without relying on the condition $\theta \geq t^H(\alpha)$.

3. a separating equilibrium in which the high-quality type uses a negotiated method $[x^H = (\alpha_H, P_H)]$ and the low-quality type uses a competitive method $[x^L = \alpha(\gamma; L)]$.

Let us therefore directly compare the Pareto-optimality of these equilibria in Proposition 5.

Proposition 5 *Consider the universally divine equilibria. If there exist both a separating and a pooling equilibrium, then the separating equilibrium is not pareto-optimal. If there exist both a pooling equilibrium with competitive offerings and a pooling equilibrium with negotiated ones, then that with negotiated ones is not pareto- optimal.*

Proof see Appendix A.

We apply the notion of universal divinity and Pareto-optimality to obtain a unique equilibrium for any given cost differential. Notice that some intuitive equilibria are eliminated by the notion of universal divinity, some by Pareto-optimality.[18]

4.3 Type of Equilibrium given Cost Differential and Dispersion of Private Value

Simple calculations show that a refined separating equilibrium exists for some $K^s(\gamma) > K_n \geq K_c$ if and only if[19]

$$0 \leq \theta < \frac{\sqrt{(\gamma V^L)^2 + 4(1-\gamma)V^H V^L} - (2-\gamma)V^L}{2(1-\gamma)(V^H - V^L)} = \overline{\theta}$$

Also there exists a refined separating equilibrium in which the high-quality type does not allow a discretional discounting for some $K^s(\gamma) > K_n > K^s(0)$ if and only if

$$0 \leq \theta < \frac{\gamma V^L}{(1-\gamma)V^H + \gamma V^L} = \underline{\theta}$$

[18]See Appendix B for the general illustration of obtaining a unique equilibrium from a set of intuitive equilibria when there are two types choosing only pure strategies.

[19]Here, a refined separating equilibrium means the unique separating equilibrium that survives from our screening process.

Figure 4 summarizes the type of equilibrium prevailing under various cost differentials and density of each type. Both types select a negotiated underwriting if $K_n \leq \min\{K^n(\theta), K^c(\theta,\gamma)\}$. This is denoted as Region I in Figure 4. In the area to the right of $K_c(\theta,\gamma)$, denoted as Region IV, both types select a competitive method because the costs of using a negotiated method are far exceeds the benefits of avoiding the excess dilution. Consider the area in $K_n(\theta) < K_n < K^c(\theta,\gamma)$ where the high-quality type will use a costly negotiated offering and the low-quality type chooses a competitive bidding process. The market will have a separating equilibrium with normal spread in Region III, whereas the high-quality type must endure the higher compensation in Region II so that the low-quality type cannot profitably mimic the spread chosen by the high-quality type. Region I is particularly interesting because we observe that both types select a negotiated method in spite of its apparent cost disadvantage.

5 Testable Economic Implications

5.1 Equilibrium Properties

Having established the unique equilibrium, we will focus our attention on the equilibrium properties and its implications. It shows that a separating equilibrium is viable when the proportion of good firms is low. This implies that in any signaling equilibrium we must observe that more firms use competitive bidding than negotiation. Thus signaling outcomes are not persuasive enough to explain the anomaly we described earlier in this paper that firms use negotiation almost exclusively, unless forced to use a competitive method.

This result and other observations are summarized in the following conjecture without a formal proof.

Conjecture 1 *When most issues are made by negotiation, pooling equilibria with negotiation are prevailing in the market and information asymmetry is remained to be resolved. Negotiated underwritten equity offerings are not a bad signal to the market relative to competitive offerings. Given the required amount of external funds, the issue size tends to be greater for competitive issue.*

The fraction of new shares and expected total net proceeds to the firm are greater for competitive issues than for negotiated issues. This is not only because of the tendency of being a low-quality type with a competitive offer but because of the investment-feasibility condition of (11).

Next, we will examine the effect of increasing uncertainty of market conditions on the equilibrium properties. Consider a probability distribution with the support over $[1-\gamma', 1+\gamma']$ where $\gamma' > \gamma$. This new probability density function is generated by a mean-preserving spread and thus second-order stochastically dominated by the original distribution. The effect of the mean-preserving spread is shown in Figure 5.

When γ increases, Region I, II, and III expand to the right, meaning that a pooling equilibrium with competitive underwriting occurs less frequently. Conversely, when γ approaches zero, Region IV expands to fill the entire area where $K_n > K_c$, meaning that the cost comparison is a sole determinant of choosing an optimal method of underwriting contracts. The degree of uncertainty on market conditions provides interesting implications on the behavior of the firm. During periods of generally unstable market conditions, the negotiated offerings would be used more frequently.[20] The basic intuition behind this argument is that as the uncertainty on market conditions increases, the implicit costs of using competitive offerings to the high-quality type becomes greater because the dilution becomes greater.

Another comparative static readily shows that negotiated underwritten equity offerings are more likely observable if the dispersion on the quality of the firm, denoted by V^H/V^L, becomes greater or the required amount of external funds, I, relative to firm value increases. (See Figure 6 and 7). Our findings are summarized in the following proposition. This proposition provides a testable implication.

Proposition 6 *Negotiated offering methods would be used more frequently if the uncertainty on market conditions increases, the informational asymmetry on the firm's quality becomes greater, or the required amount of external funds relative to firm value increases.*

Proof see Appendix A.

Utilities are allowed to earn common equity returns equal to their market costs regulated by state and federal government. As a result, in the utility industry we expect that the adverse selection problem is not significant, and thus the relatively low value of V^H/V^L. In that case some firms would use the competitive offerings even when they are not required to do so by regulation. This result is consistent with the data referenced by Smith [1987].[21]

[20]Tallman, Rush, and Melicher[1974] and Fabozzi, Moran, and Ma[1988] find supporting evidence from the debt issues of regulated industries.

[21]Smith[1987, Table 1, p. 706] reports that negotiated offerings were used by almost all firms that have a choice:

5.2 Impact on Stock Prices of the Suspension and Termination of Suspension of Rule 50

On April 8, 1941, the SEC adopted Rule 50 making competitive bidding a mandatory procedure for new securities offering of all registered utility holding companies and their subsidiaries.

> On July 19, 1974, the SEC publicly announced the temporary suspension of Rule 50 for the first time with respect to the issuance of common stock of registered utility companies... On November 7, 1974, the SEC announced that the suspension would remain in effect until March 31, 1975. (Bhagat[1986], pp.182–183)

When the competitive offerings are the only available method for a firm, its equilibrium strategy would be $\alpha_c = \alpha(\gamma;\theta)$ as shown in Lemma 1 and Proposition 3 irrespective of its quality. In short, there does not exist a separating equilibrium since for all $\alpha \geq \alpha(\gamma; H)$, $U^L(\alpha; H) > U^L(\alpha; L)$. In this pooling situation capital markets may well treat the firm's quality identically. Suppose that capital markets price the value of equity prior to the realization of its quality by taking the expected value of current share holding after a new issue.[22] Then from (12), the ex-ante equity value is priced as $V^\theta - I - K_c$, the equity value of the firm of type θ under full information. This can be confirmed by showing that the expected misinformation costs are zero from Corollary3. Directly computing the expected misinformation costs from Corollaries 1–3, we can examine the effect on stock price of the unanticipated announcement of the suspension of Rule 50. Defining the expected misinformation costs as MIC, we have

$$\text{MIC} = \begin{cases} K_n - K_c & \text{if } \min\{K^c(\theta,\gamma), K^n(\theta)\} > K_n > K_c \\ \theta\left(\frac{V^H - V^L}{V^L}\right)(I + K_c) & \text{if } \overline{\theta} \geq \theta > \underline{\theta} \text{ and } K^c(\theta,\gamma) \geq K_n > K^n(\theta) \text{ or} \\ & \underline{\theta} \geq \theta \geq 0 \text{ and } K^s(0) \geq K_n > K^n(\theta) \\ \theta(K_n - K_c) & \text{if } \underline{\theta} \geq \theta \geq 0 \text{ and } K^c(\theta,\gamma) \geq K_n \geq K^s(0) \\ 0 & \text{otherwise} \end{cases}$$

Since MIC is non-negative in any case, the effect on the stock price of the suspension of Rule 50 is non-positive. Applying the same argument, it is shown that the effect on the stock price of

Over the period 1977–1985, competitive offerings were used occasionally for electric and gas utility issues (7.3% for all utilities and 5.4% for the unregulated utilities.) and used rarely for other industries (0.1%). In our context, it seems that the pooling equilibrium with negotiated offerings, represented by Region I in Figure 4, prevails in the new issue market.

[22]Here the underwritten offerings are presumed to be anticipated by the market.

the termination of suspension of Rule 50 is non-negative. Our result is robust with respect to the valuation assumption as long as the current stock price responds positively to the expected value of holding a share. This result is formally stated as Proposition 7.

Proposition 7 *The unanticipated announcement of the suspension of Rule 50 has a non-positive effect on the stock price. The unanticipated announcement of the termination of suspension has a non-negative effect on the stock price.*

This is interpreted as the reduction in the market value of firms engendered by the firm's incentive to signal because bonding activities have not been allowed. This cost is borne by the shareholders. The reason is that the capital markets are characterized by rational expectation so that investors will be aware of the firm's ex-post incentive. In other words, the capital market prices the stock incorporating the effect of these incentives on the ex-post real decisions of the firm, thereby choosing a costly method of financing.

6 Concluding Remarks

In this paper we have put forth a general cash offer model that preserves the maximization of existing shareholder's wealth. It permits us to identify the optimal contract under two-sided asymmetric information. The terms of offering are determined in an environment where investment bankers have private information concerning the market conditions while issuing firms have superior information regarding their intrinsic value.

This model also offers justification for many firms using an apparently more costly negotiated underwriting contract when they are not facing a regulatory constraint. In so doing, we apply the refined sequential equilibrium concept to derive a unique equilibrium in which most issuing firm selects a negotiated offering under some conditions. The model is based on the idea that the undervalued firm is faced with a dilution problem which could be severe with competitive bidding. Since investment bankers cannot provide a complete insurance function via competitive bidding process for making an underwriting contract, issuing firms must issue enough new shares incurring a loss if the firm is undervalued.[23] Overvalued firms also prefer a negotiated offering

[23] Although issuers' reputation may have an important role under informational asymmetry, the fact that firms do not raise external funds frequently prevents this resolution.

when the costs of the negotiated offering are within a certain range of those of the competitive bidding.

In our analysis, Rule 50 is beneficial to the shareholders ex-ante. However, it is shown to be inefficient for the undervalued firm in an ex-post sense because the high-quality type is forced to use competitive offerings. Furthermore, we can construct a situation where Rule 50 is not beneficial to the current shareholders even before the informational asymmetry on the quality type arises. Suppose the parameter value lies on Region I, II, or III in Figure 4 but the regulatory authorities do not allow the undervalued firm to use the negotiated method. Then in some cases the high-quality type is better off by abandoning the project rather than enduring severe dilution by choosing the competitive offering. If the project is worthwhile to undertake by reducing the dilution with negotiated procedure, the forgone positive NPV project due to the regulation becomes deadweight costs to the current shareholders even before the firm type is realized. Thus this raises a question of the economic efficiency of Rule 50 when informational asymmetry prevails in the capital markets.

APPENDIX

A Proof of Lemmas and Propositions

Definition A.1

$$K = \min\{K_c, K_n\}$$

Proof of Lemma 1

There exists a separating equilibrium in which the high-quality type selects a competitive method if and only if there exists α such that

$$V^L + \frac{\alpha}{1+\alpha}(V^H - V^L) - I - K_c \leq V^L - I - K = U^L(L) \tag{A.1}$$

$$V^H - I - K_c > U^H(L) \tag{A.2}$$

$$\alpha \geq \frac{I + K_c}{(1-\gamma)V^H - I - K_c} = \alpha(\gamma; H) \tag{A.3}$$

(A.1) and (A.2) are the necessary incentive compatibility conditions to ensure the separation. Inequality (A.3) is the investment-feasibility condition of the high-quality type that ensures the firm to finance the entire projects.

From (A.1), a positive fraction α exists if and only if $K_c > K = K_n$. Then $U^H(L) = V^H - (V^H/V^L)(I + K_n)$ from (12) and (17) and (A.2) can be restated as

$$K_c > K_n > K_c - \frac{V^H - V^L}{V^H}(I + K_c) \tag{A.4}$$

Under this condition, the necessary and sufficient condition for the existence of a separating equilibrium in which the firm of high-quality type selects a competitive method is equivalent to say that there exists α such that

$$\frac{K_c - K_n}{(V^H - V^L) - (K_c - K_n)} \geq \alpha \geq \frac{I + K_c}{(1-\gamma)V^H - I - K_c}$$

$$\text{or} \qquad K_n \leq K_c - \left(\frac{1}{1-\gamma}\right)\left(\frac{V^H - V^L}{V^H}(I + K_c)\right)$$

from (A.1) and (A.3) which contradicts the necessary condition (A.4). □

Proof of Lemma 2

The firm of high-quality type can separate itself by choosing a negotiated method if and only if for some (α, P),

$$\frac{1}{1+\alpha}(V^L + \alpha P - I) \leq V^L - I - K = U^L(L) \tag{A.5}$$

$$\frac{1}{1+\alpha}(V^H + \alpha P - I) > U^H(L) \tag{A.6}$$

$$\underline{P}(\alpha) = \frac{I}{\alpha} \leq P \leq V^H - I - \frac{1+\alpha}{\alpha}K_n = \overline{P}(\alpha; H) \tag{A.7}$$

(A.5) and (A.6) are the necessary incentive compatibility conditions for the firm of low- and high-quality type, respectively, in a separating equilibrium. (A.7) says the equilibrium strategy of high-quality type, if it exists, must satisfy the investment- and contract-feasibility conditions. Rearranging (A.5) and (A.6) with respect to P, we have the equivalent condition

$$V^L - I - \frac{1+\alpha}{\alpha}K \geq P > \frac{1+\alpha}{\alpha}U^H(L) - \frac{1}{\alpha}V^H + \frac{1}{\alpha}I \tag{A.8}$$

There exists a pair (α, P) which satisfies (A.8), or (A.5) and (A.6) accordingly, if and only if

$$\alpha < \frac{(V^H - I - K) - U^H(L)}{U^H(L) - (V^L - I - K)} \tag{A.9}$$

Suppose $K_n \leq K_c$ and $K = K_n$. From (12) and (17), $U^H(L) = V^H(V^H/V^L)(I + K_n)$ and subsequently (A.9) can be rewritten as

$$\alpha < \frac{I + K_n}{V^L - I - K_n} \tag{A.10}$$

From the left-hand side of the inequalities (A.8),

$$\alpha P \leq \alpha(V^L - I - K_n) - K_n \tag{A.11}$$

Since the right-hand side of the inequality (A.11) is monotonically increasing with respect to α and α is bounded above from (A.10), the value of αP which satisfies both (A.5) and (A.6) is less than I which violates the investment-feasibility condition in the left-hand side of inequalities (A.7).

Next, suppose $K_n \geq K^*(\gamma)$. Then,

$$U^H(L) = V^H - \left(\frac{1}{1-\gamma}\right)\left(\frac{V^H - \gamma V^L}{V^L}\right)(I + K_c)$$

and the right-hand side of the inequalities (A.8) becomes

$$P > V^H - \left(\frac{1+\alpha}{\alpha}\right)\left(\frac{1}{1-\gamma}\right)\left(\frac{V^H - \gamma V^L}{V^L}\right)(I + K_c) + \frac{1}{\alpha}I \tag{A.12}$$

There exist (α, P) which satisfy both (A.12) and the contract-feasibility condition in the right-hand side of the inequalities (A.7) if and only if $K_n < K^s(\gamma)$ which is a contradiction. This proves the necessity part of the lemma.

For the sufficiency part, suppose that $K^s(\gamma) > K_n > K_c$. Now consider a pair (α', P') and $\varepsilon > 0$ such that the investment-feasibility condition holds.

$$\alpha' = \frac{V^H - U^H(L)}{U^H(L)}, \qquad P' = I/\alpha' + \varepsilon$$

α' is obtained by equating the right-hand side of the inequality (A.8) to the left-hand side of the inequalities (A.7). It can be shown that the pair (α', P') satisfies the incentive compatibility conditions, (A.5) and (A.6), and the contract-feasibility condition by taking an arbitrary small number for ε:

$$\begin{aligned}
U^L(\alpha', P') &= \frac{U^H(L)}{V^H}V^L + \varepsilon', \qquad \text{where } \varepsilon' = \tfrac{V^H - U^H(L)}{V^H}\varepsilon \\
&= V^L - I - \min\left\{K_n,\ K_c + \left(\frac{\gamma}{1-\gamma}\right)\left(\frac{V^H - V^L}{V^H}\right)(I + K_c)\right\} + \varepsilon' \\
&< V^L - I - K_c + \varepsilon' \qquad (\text{since } K_n > K_c) \\
&\longrightarrow U^L(L) \quad \text{as } \varepsilon \longrightarrow 0^+ \\
U^H(\alpha', P') &= U^H(L) + \varepsilon' > U^H(L) \qquad \text{and} \\
\overline{P}(\alpha'; H) &= V^H - I - \frac{V^H}{V^H - U^H(L)}K_n \\
&= P' + \frac{V^H}{V^H - U^H(L)}(V^H - U^H(L) - I - K_n) - \varepsilon \\
&= P' + \frac{V^H}{V^H - U^H(L)}\min\left\{K^s(\gamma) - K_n,\ \frac{V^H - V^L}{V^H}(I + K_n)\right\} - \varepsilon \\
&> P' - \varepsilon \qquad (\text{since } K^s(\gamma) > K_n) \\
&\longrightarrow P' \quad \text{as } \varepsilon \longrightarrow 0^+ \quad \square
\end{aligned}$$

Proof of Proposition 1

The necessity part of the first-half of the proposition directly follows from Lemma 2. Lemma 1 and 2 say that at any undominated separating equilibrium, the choice of the high-quality type (α_H, P_H) must be a solution to

$$\max_{(\alpha,P)} U^H(\alpha,P) = \frac{1}{1+\alpha}(V^H + \alpha P - I) \tag{A.13}$$

subject to

$$\frac{1}{1+\alpha}(V^L + \alpha P - I) \leq V^L - I - K_c \tag{A.14}$$

$$\alpha P \geq I \tag{A.15}$$

$$P \leq \overline{P}(\alpha; H) = V^H - I - \frac{1+\alpha}{\alpha}K_n \tag{A.16}$$

See Milgrom and Roberts[1986] for this part of proof. Notice that the intuitive criterion is equivalent to the dominancy criterion in a separating equilibrium with two-types. The constraint (A.14) is the incentive compatibility condition for the low-quality type: At any separating equilibrium, the low-quality type chooses an optimal strategy in a full information case and resulting payoff is $U^L(L) = V^L - I - K_c$ when $K = K_c$.

The condition (A.14) and (A.16) can be combined as

$$P \leq \min\left\{V^H - I - \frac{1+\alpha}{\alpha}K_n\,,\; V^L - I - \frac{1+\alpha}{\alpha}K_c\right\} = P^*(\alpha) \tag{A.17}$$

Since $U^H(\alpha, P)$ is monotonically increasing with respect to P for any value of α, the constraint (A.17) is binding and P_H must be a maximum feasible value for any optimal fraction of new issue α_H. Substituting the right-hand side of the inequality (A.17), $P^*(\alpha)$, for P in the maximand, we can see that $U^H(\alpha, P^*(\alpha))$ is monotonically decreasing with respect to α. Thus the constraint (A.15) must be binding and α_H must be a minimum feasible value for any optimal net proceed, P_H, in the contract. The choice of the high-quality type, (α_H, P_H), can then be found by solving the equations $\alpha_H P^*(\alpha_H) = I$ and $P_H = P^*(\alpha_H)$ simultaneously. These calculations result in the second-half of the proposition.

Conversely, it is easy to show that the conditions of cost differential ensure that α_H and P_H describe the equilibrium strategies when investors' beliefs are given by the following way. The beliefs are constructed such that investors assign zero probability of being a low(high)-quality type for the strategies dominated for the low(high)-quality type. Any probability can be assigned to the strategies which are dominated for both types. Finally, for all out of equilibrium strategies which are not dominated for any type, investors perceive the firm as low-quality one so that no type has an incentive to deviate from the equilibrium.

The cost differential condition, $K^s(\gamma) > K_n > K_c$, ensures that the equilibrium strategy of high-quality type, (α_H, P_H), provides more payoffs than those can be obtained in the worst belief, that is, when it is perceived to be the low-quality type, from Lemma 2 and the maximization problem (A.13)–(A.16). □

Proof of Lemma 3

Suppose that this is not true and $\alpha_n P_n > I$. Consider a pair (α', P') such that $\alpha' = \alpha_n - \varepsilon, P' = I/(\alpha_n - \varepsilon)$. The proposed pair is dominated by equilibrium value for the low-quality type if

$$\varepsilon \leq (1+\alpha_n)\left(\frac{\alpha_n P_n - I}{V^L + \alpha_n P_n - I}\right)$$

Especially consider $\varepsilon = (1+\alpha_n)\left(\frac{\alpha_n P_n - I}{V^\theta + \alpha_n P_n - I}\right)$. Then,

$$\alpha' = \frac{\alpha_n V^\theta - \alpha_n P_n + I}{V^\theta + \alpha_n P_n - I}, \qquad P' = \frac{(V^\theta + \alpha_n P_n - I)I}{\alpha_n V^\theta - \alpha_n P_n + I}$$

The high-quality type can improve its welfare by taking (α', P') and convincing its true type since

$$\begin{aligned}
\frac{1}{1+\alpha'}V^H &= \frac{1}{1+\alpha_n}\left(V^H + \frac{V^H}{V^\theta}(\alpha_n P_n - I)\right) \\
&> \frac{1}{1+\alpha_n}(V^H + \alpha_n P_n - I) \\
&= W^H(\alpha_n, P_n; \theta)
\end{aligned}$$

By definition, (α', P') satisfies the investment-feasibility condition. To check the contract-feasibility condition,

$$\begin{aligned}
\overline{P}(\alpha'; H) - P' &= \frac{(\alpha_n V^\theta - \alpha_n P_n + I)V^H - (1+\alpha_n)V^\theta(I+K_n)}{\alpha_n V^\theta - \alpha_n P_n + I} \\
&\geq \frac{(V^H - V^\theta)(1+\alpha_n)(I+K_n)}{\alpha_n V^\theta - \alpha_n P_n + I} > 0
\end{aligned}$$

The first inequality comes from the contract-feasibility condition of the suggested equilibrium strategy (α_n, P_n), that is, $P_n \le V^\theta - I - \frac{1+\alpha_n}{\alpha_n}K_n$. Therefore, for any proposed equilibrium (α_n, P_n), where $\alpha_n P_n > I$, there exists a pair (α', P') which breaks the original equilibrium by the intuitive criterion.

Now consider a pooling equilibrium strategy (α_n, P_n) such that $\alpha_n P_n = I$. The proposed equilibrium passes the intuitive criterion if and only if there does not exist another (α, P) such that

$$\frac{1}{1+\alpha}(V^L + \alpha P - I) \le \frac{1}{1+\alpha_n}V^L \tag{A.18}$$

$$\frac{1}{1+\alpha}(V^H + \alpha P - I) > \frac{1}{1+\alpha_n}V^H \tag{A.19}$$

$$\frac{I}{\alpha} \le P \le V^H - I - \frac{1+\alpha}{\alpha}K_n \tag{A.20}$$

or α such that

$$V^L + \frac{\alpha}{1+\alpha}(V^H - V^L) - I - K_c \le \frac{1}{1+\alpha_n}V^L \tag{A.21}$$

$$V^H - I - K_c > \frac{1}{1+\alpha_n}V^H \tag{A.22}$$

$$\alpha \ge \frac{I + K_c}{(1-\gamma)V^H - I - K_c} = \alpha(\gamma; H) \tag{A.23}$$

Both (A.18) and (A.19) can be restated as

$$\frac{\alpha - \alpha_n}{\alpha(1+\alpha_n)}V^L + \frac{I}{\alpha} \ge P > \frac{\alpha - \alpha_n}{\alpha(1+\alpha_n)}V^H + \frac{I}{\alpha}$$

Such P exists only when $\alpha < \alpha_n$. But then $\alpha P < I$ for all (α, P) which satisfies both (A.18) and (A.19). This violates the left-hand side of the inequality (A.20). Both (A.21) and (A.22) hold only for

$$\alpha \le \frac{I + K_c - \frac{\alpha_n}{1+\alpha_n}V^L}{(V^H - I - K_c) - \frac{1}{1+\alpha_n}V^L} \qquad \text{where} \quad \alpha_n > \frac{I + K_c}{V^H - I - K_c}$$

to make the proposed equilibrium satisfy the feasibility conditions. But then it violates (A.23). Therefore any pooling equilibrium consisting $\alpha_n P_n = I$ passes the intuitive criterion. □

Proof of Proposition 2

Equilibrium proceeds (21) is a restatement of Lemma 3. The feasibility conditions imply $\alpha_n \geq \alpha_n^*$. The incentive compatibility condition for the low-quality type holds if

$$\frac{1}{1+\alpha_n}V^L > V^L - I - K \qquad \text{or} \qquad \frac{I+K}{V^L - I - K} > \alpha_n$$

There exists α_n which satisfies (20) if and only if $K^n(\theta) > K_n$. This proves the necessity part of the proposition.

The converse also holds by constructing beliefs such that investors assign zero probability of that type for any strategies which are dominated for the type and very low probability of high-quality type for all out of equilibrium strategies which are not dominated for any type. From (19) and (21) the incentive compatibility condition for the high-quality type is then

$$\frac{1}{1+\alpha_n}V^H > V^H - \frac{V^H}{V^L}(I+K) = \begin{cases} U^H(\alpha_H, P_H) & \text{if } K^n(\theta) > K_n > K_c \\ U^H(L) & \text{if } K_c \geq K_n \end{cases}$$

which is true by the left-hand side of the inequalities (20) that also makes the incentive compatibility condition for the low-quality type hold. □

Proof of Proposition 3

If a pooling equilibrium, where the equilibrium strategy of both types is α_c, is intuitive, then there does not exist (α, P) such that

$$\frac{1}{1+\alpha}(V^L + \alpha P - I) \leq V^L + \frac{\alpha_c}{1+\alpha_c}(V^\theta - V^L) - I - K_c \tag{A.24}$$

$$\frac{1}{1+\alpha}(V^H + \alpha P - I) > V^H - \frac{\alpha_c}{1+\alpha_c}(V^H - V^\theta) - I - K_c \tag{A.25}$$

$$\frac{I}{\alpha} \leq P \leq V^H - I - \frac{1+\alpha}{\alpha}K_n \tag{A.26}$$

We can rewrite (A.24) and (A.25) in terms of P.

$$P \leq V^L + \left(\frac{1+\alpha}{\alpha}\right)\left(\frac{\alpha_c}{1+\alpha_c}\right)(V^\theta - V^L) - I - \frac{1+\alpha}{\alpha}K_c \tag{A.27}$$

$$P > V^H - \left(\frac{1+\alpha}{\alpha}\right)\left(\frac{\alpha_c}{1+\alpha_c}\right)(V^H - V^\theta) - I - \frac{1+\alpha}{\alpha}K_c \tag{A.28}$$

From (A.27) and (A.28), there exists a pair (α, P) which satisfies both (A.24) and (A.25) if and only if $\alpha < \alpha_c$.

Now consider a pair (α', P') such that $\alpha' = \alpha_c$, and $P' = V^\theta - I - \frac{1+\alpha_c}{\alpha_c}K_c$. This pair satisfies the investment-feasibility condition in a negotiated offering with strict inequality

$$\alpha' P' = \alpha_c(V^\theta - I - K_c) - K_c \geq \frac{V^\theta - I - K_c}{(1-\gamma)V^\theta - I - K_c}(I + K_c) - K_c > I$$

The first inequality comes from the investment-feasibility condition of the proposed pooling equilibrium with competitive underwriting, $\alpha_c \geq \alpha(\gamma;\theta)$, and the second strict inequality holds since $\gamma > 0$. Therefore, there always exists a set of (α, P) which satisfies (A.27), (A.28), and the investment-feasibility condition in a negotiated offering for any proposed pooling equilibrium strategy α_c such that

$$\alpha_c \geq \alpha(\gamma;\theta) = \frac{I + K_c}{(1-\gamma)V^\theta - I - K_c} \tag{A.29}$$

The lower bound of α_c is due to the investment-feasibilitycondition in a competitive offering defined in (11).

Hence the set of (α, P) must not be a feasible contract for the high-quality type to make the proposed pooling equilibrium pass the intuitive criterion. That is,

$$V^H - \left(\frac{1+\alpha}{\alpha}\right)\left(\frac{\alpha_c}{1+\alpha_c}\right)(V^H - V^\theta) - I - \frac{1+\alpha}{\alpha}K_c \geq V^H - I - \frac{1+\alpha}{\alpha}K_n \tag{A.30}$$

The left-hand side of the inequality (A.30) is the infimum of P which satisfies both (A.24) and (A.25) as shown by (A.28). Rearranging (A.30), we have the necessary condition for the pooling equilibrium strategy α that is intuitive.

$$K_n > K_c + \frac{\alpha_c}{1+\alpha_c}(V^H - V^\theta) \tag{A.31}$$

Since the right-hand side of the inequality (A.31) is strictly increasing with respect to α_c and α_c is bounded below by (A.29), we prove the lemma by substituting $\alpha(\gamma;\theta)$ for α_c in (A.31).

For the proof of second part of the proposition, we will show only the sufficiency since we already show the necessity. By constructing investors' beliefs such that investors assign zero probability of being a high-quality type for all strategies except the equilibrium strategy and those dominated for the low-quality type, α_c satisfies the incentive compatibility condition for the low-quality type

$$U^L(\alpha_c;\theta) = V^L - \left(\frac{1}{1-\gamma}\right)\left(\frac{V^L - \gamma V^\theta}{V^\theta}\right)(I + K_c) > V^L - I - K_c = U^L(L)$$

The incentive compatibility condition for the high-quality type given investors' credible beliefs for the dominated strategies is given by

$$U^H(\alpha_c:\theta) > \begin{cases} V^H - \left(\frac{1}{1-\gamma}\right)\left(\frac{V^H-\gamma V^L}{V^L}\right)(I+K_c) & \text{if } K_n \geq K^s(\gamma) \\ V^H - I - K_n & \text{if } K^s(\gamma) > K_n > K^c(\theta,\gamma) \geq K^s(0) \\ V^H - \frac{V^H}{V^L}(I+K_c) & \text{if } K^s(0) \geq K_n \geq K^c(\theta,\gamma) \end{cases}$$

where

$$U^H(\alpha_c;\theta) = V^H - \left(\frac{1}{1-\gamma}\right)\left(\frac{V^H-\gamma V^\theta}{V^\theta}\right)(I+K_c)$$

Obviously these conditions hold for all $K_n \geq K^c(\theta,\gamma)$.

Next, we will show that the proposed equilibrium passes the intuitive criterion. Since there does not exist (α, P) that breaks the proposed equilibrium as shown in the first part, we must show that there does not exist α such that

$$V^L + \frac{\alpha}{1+\alpha}(V^H - V^L) - I - K_c \leq V^L - \left(\frac{1}{1-\gamma}\right)\left(\frac{V^L-\gamma V^\theta}{V^\theta}\right)(I+K_c) \quad \text{(A.32)}$$

$$V^H - I - K_c > V^H - \left(\frac{1}{1+\gamma}\right)\left(\frac{V^H-\gamma V^\theta}{V^\theta}\right)(I+K_c) \quad \text{(A.33)}$$

$$\alpha \geq \frac{I+K_c}{(1-\gamma)V^H - I - K_c} = \alpha(\gamma;H) \quad \text{(A.34)}$$

Both (A.32) and (A.33) hold only for

$$\alpha \leq \frac{(V^\theta - V^L)(I+K_c)}{(1-\gamma)V^\theta(V^H-V^L) - (V^\theta - V^L)(I+K_c)}$$

But then it violates (A.34). Thus the proposed one passes the intuitive criterion. □

Proof of Proposition 4

For any intuitive equilibrium strategy $\alpha_c > \alpha(\gamma;\theta)$, consider an out of equilibrium strategy $\alpha(\gamma;\theta)$. Then, $t_o^H(\alpha) = \{\phi\}$ and

$$t^L(\alpha(\gamma;\theta)) = \left(\frac{1+\alpha(\gamma;\theta)}{\alpha(\gamma;\theta)}\right)\left(\frac{\alpha_c}{1+\alpha_c}\right)\theta > \theta = t^H(\alpha(\gamma;\theta))$$

Next, we will show that, at any other intuitive equilibrium, there does not exist α that satisfies (23) and (24).

1. Separating equilibrium
$\{x^H = (\alpha_H, P_H), x^L = \alpha_L, t(\alpha_H, P_H) = 1, t(\alpha_L) = 0\}$
$t^H(\alpha) \geq t^L(\alpha)$ with inequality strict if $t_o^L(\alpha) \neq \{\phi\}$. This is because the low-quality type always has an incentive to defect whenever the investment-feasibility condition holds.

2. Pooling equilibrium with negotiated issue
$\{\frac{I+K_c}{V^L-I-K_c} > \alpha_n \geq \frac{I+K_n}{V^\theta-I-K_n}, P_n = \frac{1}{\alpha_n}, t(\alpha_n, P_n) = \theta\}$
For $\alpha \geq \alpha_n$, if $t_o^L(\alpha) \neq \{\phi\}$,
$$\begin{aligned} t^H(\alpha) &= \frac{(\alpha-\alpha_n)V^H - \alpha(1+\alpha_n)V^L + (1+\alpha)(1+\alpha_n)(I+K_c)}{\alpha(1+\alpha_n)(V^H-V^L)} \\ &\geq \frac{-(1+\alpha)\alpha_n V^L + (1+\alpha)(1+\alpha_n)(I+K_c)}{\alpha(1+\alpha_n)(V^H-V^L)} = t^L(\alpha) \end{aligned}$$
and $t_o^H\alpha \neq \{\phi\}$.
For $\alpha < \alpha_n$, $t_o^L(\alpha) = \{\phi\}$.

3. Pooling equilibrium with competitive issue
$\{\alpha_c = \alpha(\gamma;\theta), t(\alpha(\gamma;\theta)) = \theta\}$
For $\alpha \geq \alpha_c$,
$$t^H(\alpha) = \frac{\alpha - \alpha_c + \alpha_c(1+\alpha)\theta}{\alpha(1+\alpha_c)} \geq \theta \geq \left(\frac{1+\alpha}{\alpha}\right)\left(\frac{\alpha_c}{1+\alpha_c}\right)\theta = t^L(\alpha)$$
and $t_o^H(\alpha) \neq \{\phi\}$
For $\alpha < \alpha_c$, $t_o^L(\alpha) = \{\phi\}$ and
$$\begin{aligned} t^H(\alpha) &= \frac{I+K_c - \alpha[(1-\gamma)V^L - I - K_c]}{\alpha(1-\gamma)(V^H-V^L)} \\ &> \frac{I+K_c-\alpha(\gamma;\theta)[(1-\gamma)V^L - I - K_c]}{\alpha(\gamma;\theta)(1-\gamma)(V^H-V^L)} = \theta \qquad \square \end{aligned}$$

Proof of Lemma 4

Consider a pooling equilibrium outcome (α_n, P_n) such that $\alpha_n > \alpha_n^*$ and $P_n = I/\alpha_n$. Now consider another intuitive pooling equilibrium outcome $\{(\alpha_n^*, I/\alpha_n^*), t(\alpha_n^*, I/\alpha_n^*) = \theta\}$. Then, for $i \in \{H, L\}$
$$U^i(\alpha_n^*, I/\alpha_n^*) = \frac{1}{1+\alpha_n^*}V^i > \frac{1}{1+\alpha_n}V^i = U^i(\alpha_n, P_n) \tag{A.35}$$

We can also show that any pooling equilibrium outcome (α_n, P_n), where $\alpha_n > \alpha_n^*$ and $P_n = I/\alpha_n$, fails to be a perfect sequential equilibrium. From (A.35), it must be that $t(\alpha_n^*, I/\alpha_n^*) = \theta$

by the definition of perfect sequential equilibrium. (See Appendix B) That is, the consistent beliefs for the out of equilibrium strategy $(\alpha_n^*, I/\alpha_n^*)$ must be the pooling in any equilibrium with the equilibrium strategy $\alpha_n > \alpha_n^*$. Then both types will defect voluntarily which will break the original equilibrium. □

Proof of Proposition 5

In any pooling equilibrium the strategies chosen by the high-quality type in the separating equilibrium is accorded by investors that the action came from the high-quality type by dominancy. Thus in the proposed separating equilibrium, upon observing a method and terms of the offering which is not in the equilibrium path of the separating equilibrium, but in the equilibrium path of the pooling equilibrium, the firm must be perceived as pooling compelled by both types. Then the proposed separating equilibrium is broken by both types directly from the incentive compatibility conditions for the pooling equilibrium.

Now consider the second part. From Proposition 2 and 3, both pooling equilibria exist if and only if

$$K^n(\theta) \geq K_n \geq K_c(\theta, \gamma) \tag{A.36}$$

Comparing the welfare under two equilibria,

$$U^H(\alpha_c;\theta) > U^H(\alpha_n^*, P_n^*;\theta) \longleftrightarrow K_n > K_c + \left(\frac{\gamma}{1-\gamma}\right)\left(\frac{V^H - V^\theta}{V^H}\right)(I + K_c)$$

$$U^L(\alpha_c;\theta) > U^L(\alpha_n^*, P_n^*;\theta) \longleftrightarrow K_n > K_c - \left(\frac{\gamma}{1-\gamma}\right)\left(\frac{V^\theta - V^L}{V^L}\right)(I + K_c)$$

The condition (A.36) implies that both types obtain higher welfare under a pooling equilibrium with the competitive underwriting strategy α_c. Thus in the pooling equilibrium with negotiated issue, when (A.36) holds, investors' consistent beliefs on the out of equilibrium strategy α_c must be a complete pooling. Then both types will defect voluntarily which breaks the proposed equilibrium with negotiated issue. □

Proof of Proposition 6

The boundaries of the equilibrium region are defined as $K_n = K^c(\theta, \gamma)$ for $\theta \in [0, 1]$ and $K_n = K^n(\theta)$ for $\theta \in [0, \bar{\theta}]$ from (19) and (22). The inverses of the functions are then respectively,

$$\theta = H^c(K_n;\cdot) = \frac{(V^H - V^L)(I + K_c) - V^L(1-\gamma)(K_n - K_c)}{(V^H - V^L)[(1-\gamma)(K_n - K_c) + (I + K_c)]}$$

Partially differentiating,

$$\frac{\partial H^c(\cdot)}{\partial \gamma} > 0, \qquad \frac{\partial H^n(\cdot)}{\partial \gamma} = 0 \quad \longrightarrow \quad \text{Expand Regions I, II, and III}$$

$$\left.\begin{array}{ll} \frac{\partial H^c(\cdot)}{\partial (V^H/V^L)} > 0, & \frac{\partial H^n(\cdot)}{\partial (V^H/V^L)} < 0 \\ \frac{\partial H^c(\cdot)}{\partial I} > 0, & \frac{\partial H^n(\cdot)}{\partial I} < 0 \end{array}\right\} \quad \longrightarrow \quad \text{Expand Region I and contract Region IV.} \quad \square$$

B Unique Equilibrium with Two Types Choosing Pure Strategies

The Pareto-optimality condition is nothing to do with the *stability* concept introduced by Kohlberg and Mertons[1986]. Since the equilibrium concepts we applied are sequential equilibria, we want to resolve the multiplicity of equilibria problem imposing further restriction on the out of equilibrium beliefs. Indeed any Pareto-dominated equilibrium fails to be a *perfect sequential equilibrium* whose notion is introduced by Grossman and Perry[1987].

Definition B.1 A proposed sequential equilibrium outcome $\{x^i, t(x^i)\}$ fails to be a perfect sequential equilibrium if there exists an out of equilibrium strategy x' such that

$$\begin{aligned} W^i(x';\mu) &> W^i(x^i;t(x^i)) \quad \text{for some } i \neq \{\phi\} \\ W^j(x';\mu) &< W^j(x^j;t(x^j)) \quad \text{for all } j \neq i \end{aligned}$$

where $\mu = 1$ if $i = \{H\}$ and θ if $i = \{H, L\}$.

Notice that with two types any equilibrium which fails to be a perfect sequential equilibrium also fails to be pareto-optimal. Also notice that both universal divinity and perfect sequential equilibrium concepts subsume the intuitive criterion.

Among the intuitive equilibria, an equilibrium which provides the highest payoffs to the high-quality type survives from our screening process by the notion of universal divinity and Pareto-optimality. This is true for any separating equilibrium. If there exists an intuitive pooling equilibrium, then clearly both types have an incentive to defect to the equilibrium strategy in the pooling equilibrium.

Next, fix an intuitive pooling equilibrium outcome, $\{x^i, \theta\}$. Suppose that there exists another intuitive pooling equilibrium, $\{x^{i'}, \theta\}$ in which the high-quality type is better off, that is, $W^H(x^{H'};\theta) > W^H(x^H;\theta)$. If the low-quality type is also better off with the alternative, $W^L(x^{L'};\theta) > W^L(x^L;\theta)$, then the proposed equilibrium is pareto-dominated. On the other hand, if the low-quality type prefers the proposed equilibrium outcome to the alternative, $W^L(x^L;\theta) > W^L(x^{L'};\theta)$, then the proposed equilibrium is not universally divine since the issuer's payoffs are not decreasing as the investors' posterior beliefs on the high- quality type increases, that is, $t^L(x') \geq \theta > t^H(x')$. This argument generally holds with two types and a monotonic response function with respect to beliefs on type.

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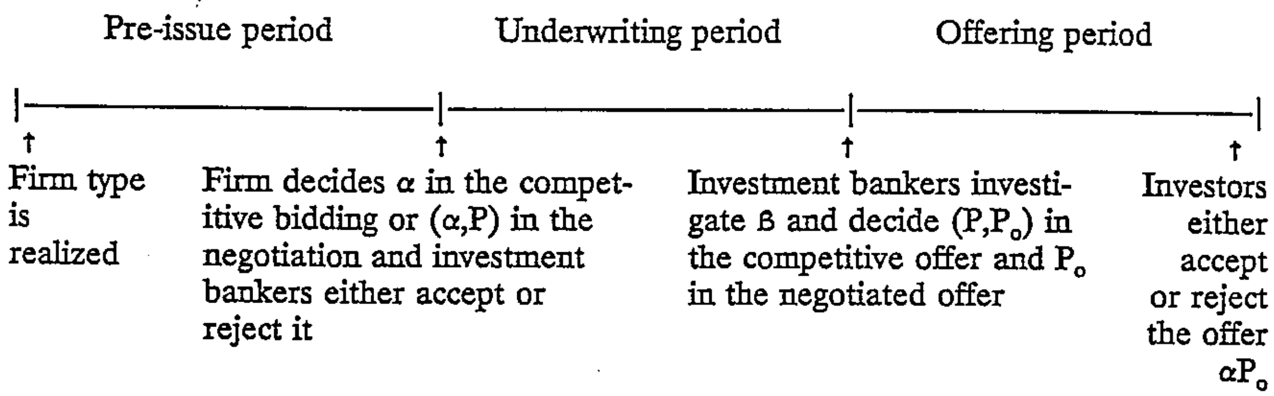
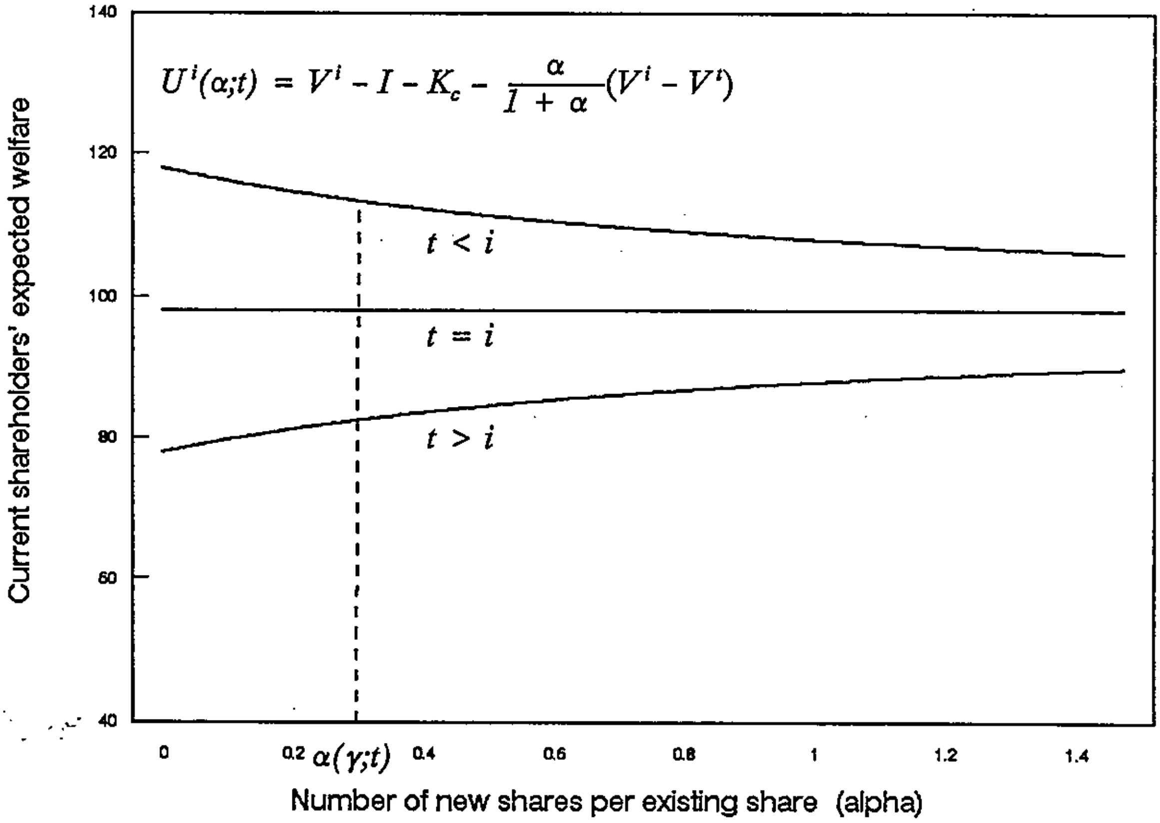


Figure 1. The sequence of events

Figure 2. A competitive offering under various market perceptions



When the firm is fairly valued, $U^i(\alpha;t=i)$ is independent of α. When the firm is undervalued, $U^i(\alpha;t<i)$ is increasingly decreasing and approaches to $U^t(\alpha;t) = V^t - I - K_c$ as α goes to infinity. In contrast, when the firm is overvalued, $U^i(\alpha;t>i)$ is decreasingly increasing and approaches to $U^t(\alpha;t)$ as α goes to infinity.

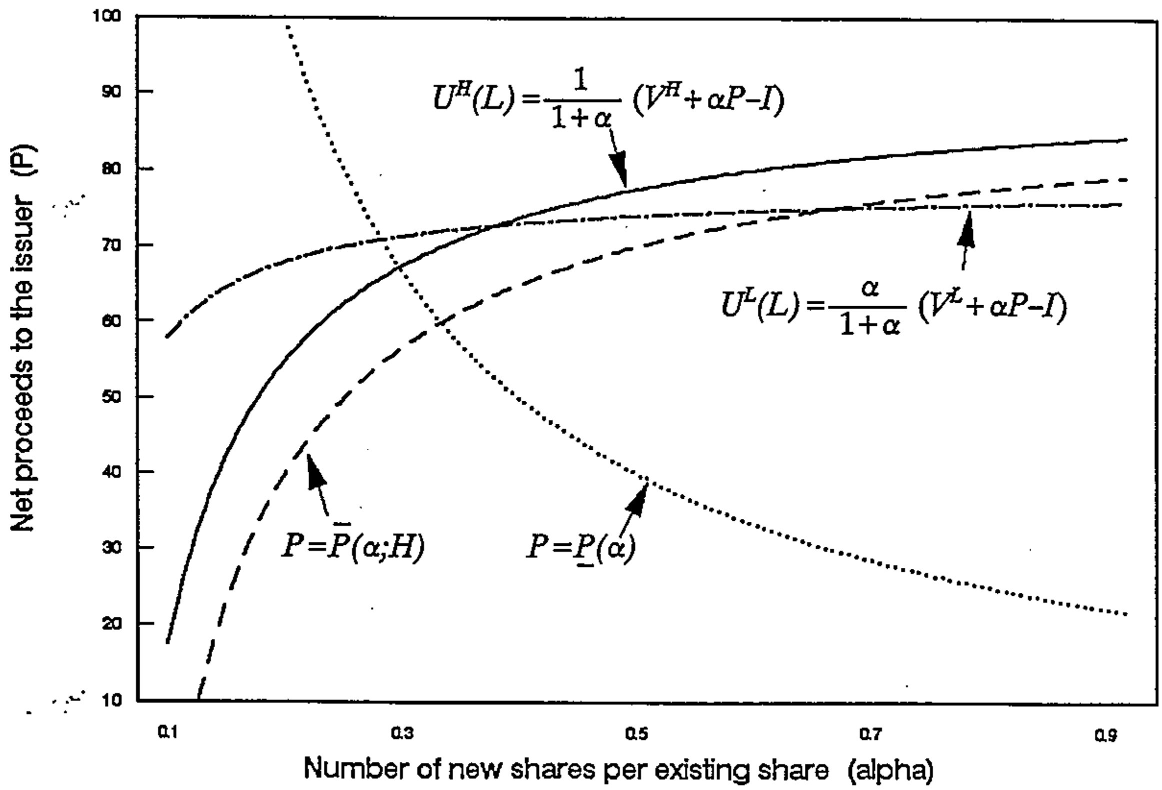
The case illustrated involves a market's perceived expected value of type t, V^t, of 120, required external funds, I, of 20, a cost of using competitive offers, K_c, of 2, and a parameter value representing the variability of market conditions, γ, of 0.2. Expected values of type i, V^i, are 100, 120, and 140, respectively.

Figure 3. The existence of a separating equilibrium

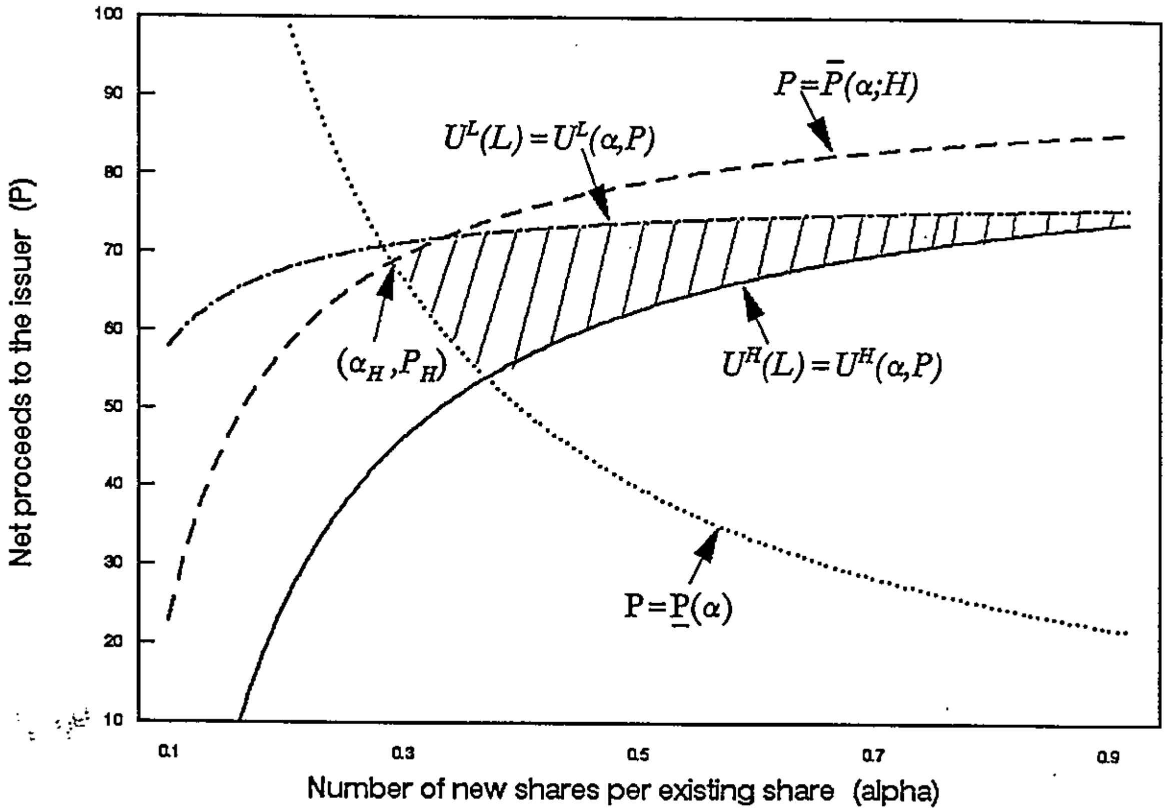
$P=\bar{P}(\alpha;H)$ and $P=\underline{P}(\alpha)$ respectively show the boundary of the contract-feasibility and investment-feasibility conditions. The indifference curves of the high-quality type, $U^H(L)$, and of the low-quality type, $U^L(L)$, are drawn for a different range of cost differentials. The slope $\partial P/\partial\alpha$ for the high-quality type is greater than that for the low-quality type.

The case illustrated involves an expected value of the high-quality type, V^H, of 120, and of the low-quality type, V^L, of 100, required external funds, I, of 20, a cost of using competitive offers, K_c, of 2, and a parameter value representing the variability of market conditions, γ, of 0.2. A cost of using negotiated offers, K_n, in each case is (a) 10, (b) 7, (c) 4 and (d) 1.

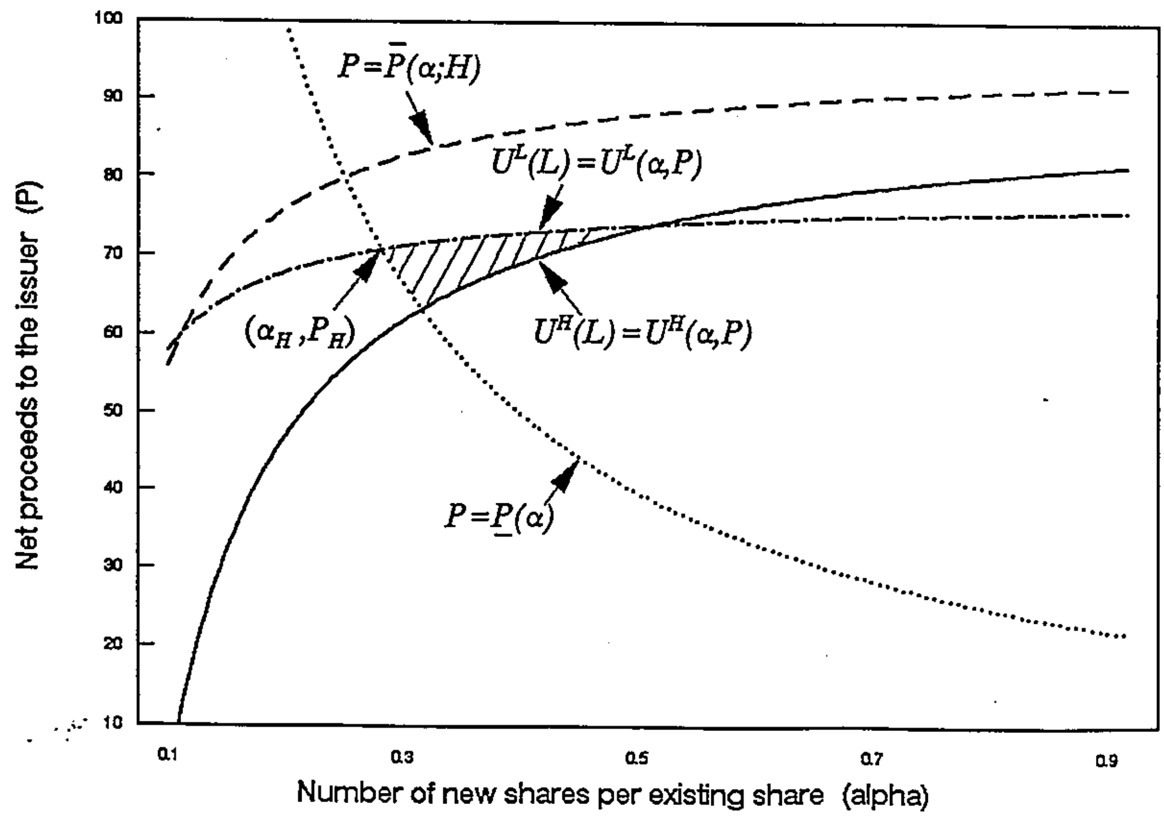
(a) No separating equilibrium exists



(b) A separating equilibrium without overcompensation exists



(c) A separating equilibrium with overcompensation exists



(d) No separating equilibrium exists

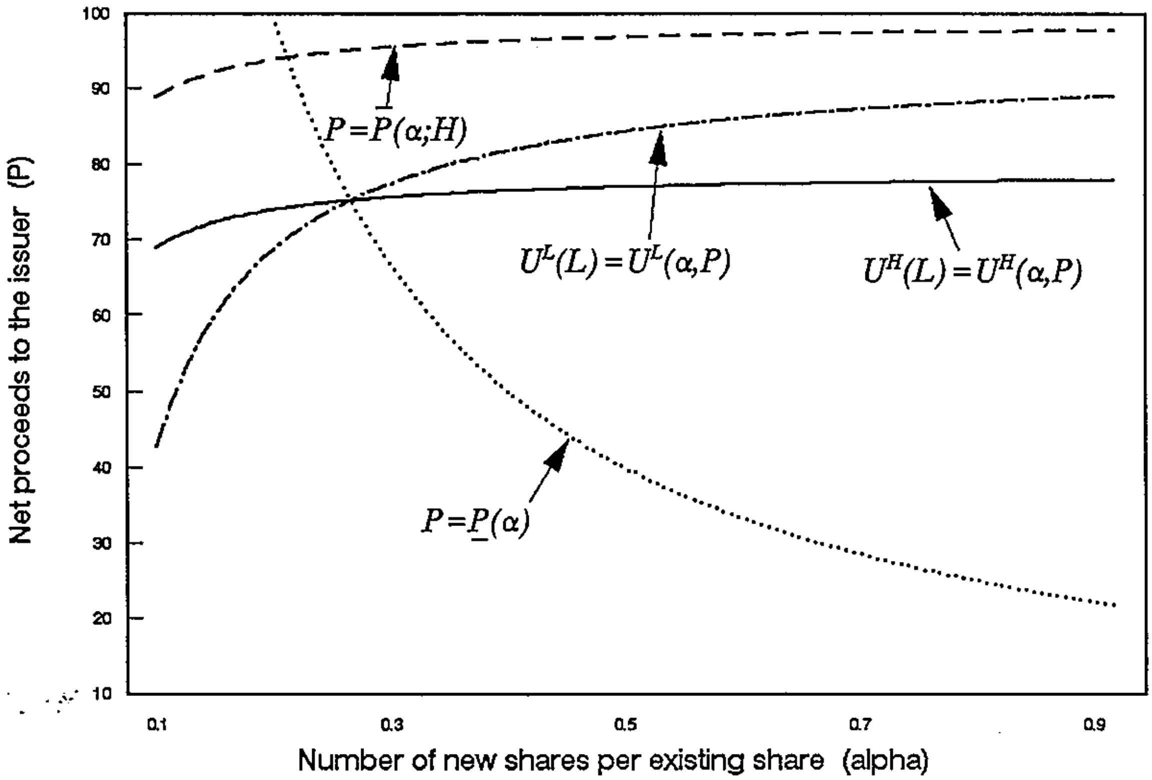
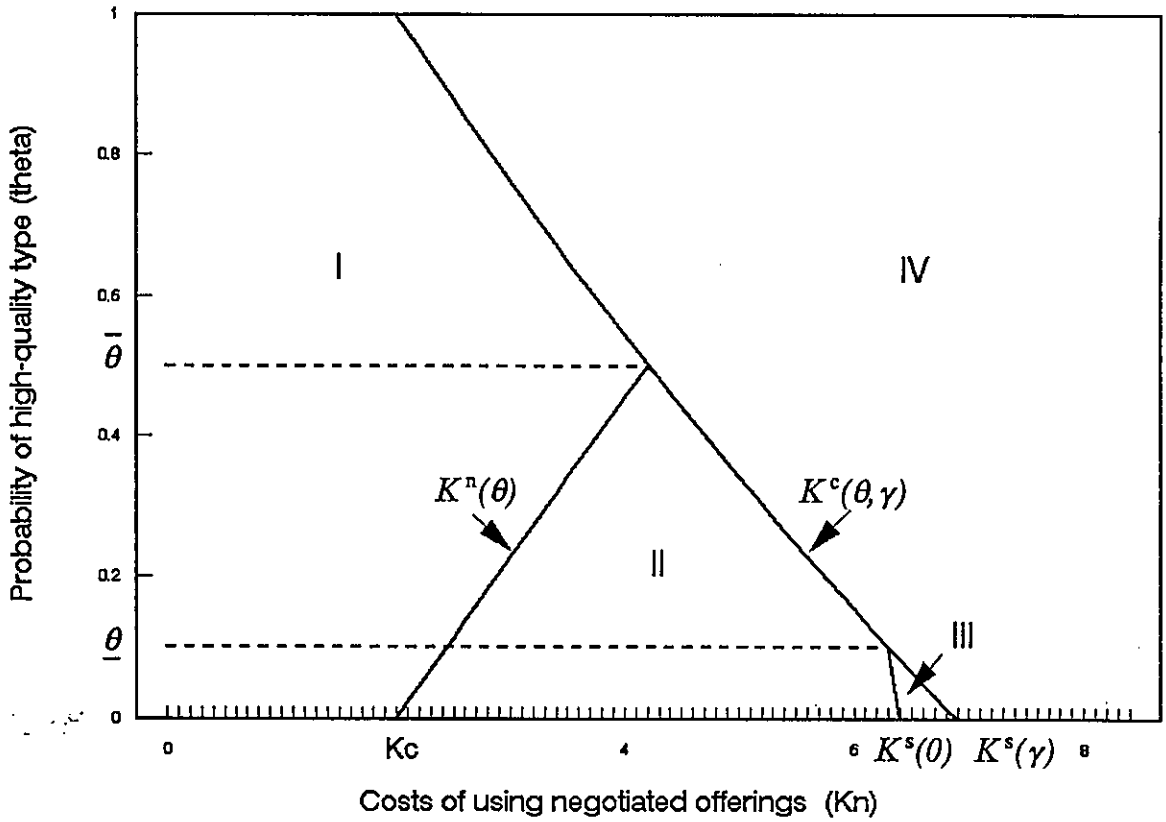


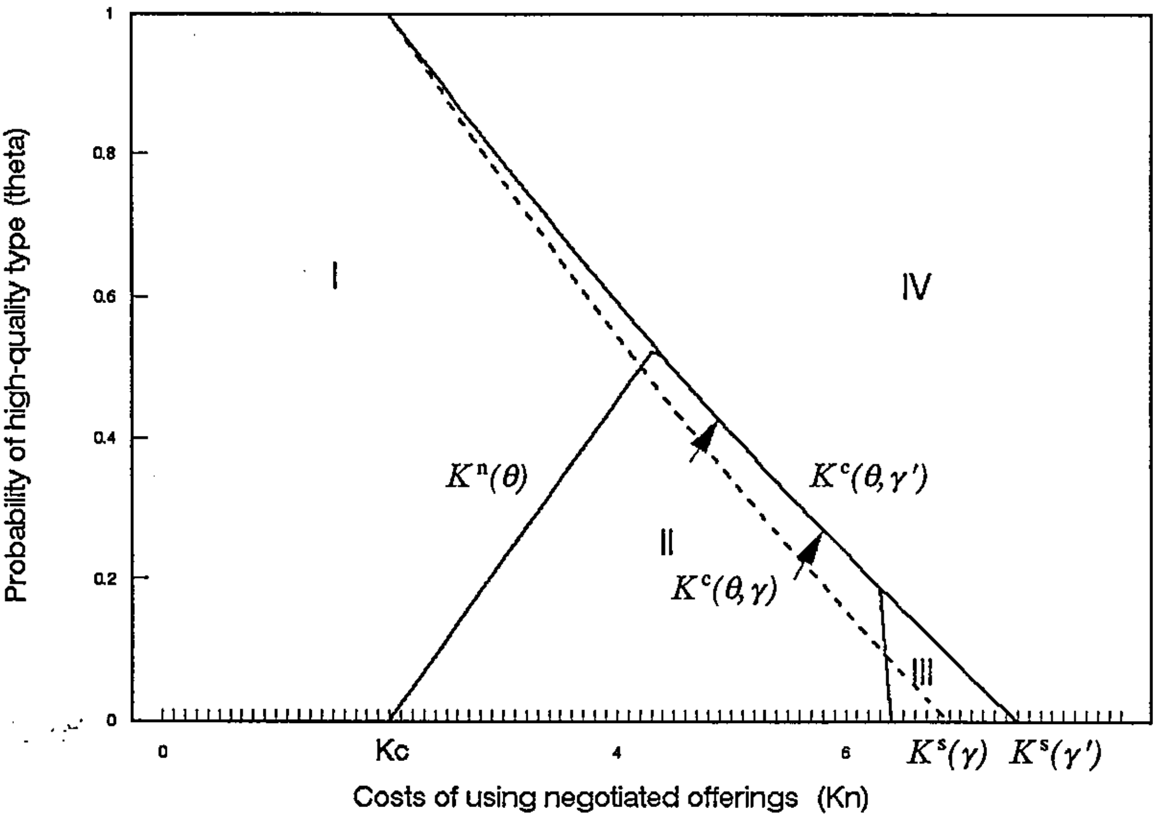
Figure 4. Refined sequential equilibria with the new issue



Region I	Pooling equilibria with negotiated underwriting
Region II	Separating equilibria with overcompensation
Region III	Separating equilibria without overcompensation
Region IV	Pooling equilibria with competitive underwriting

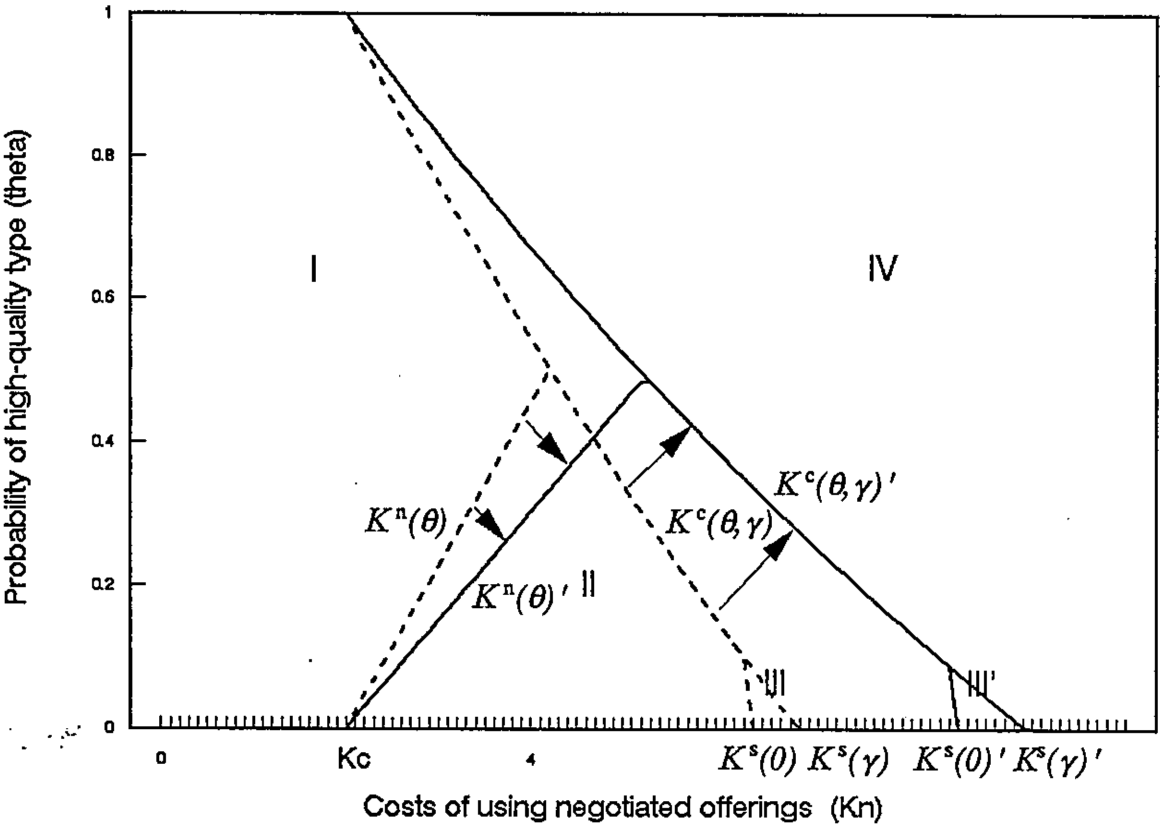
The case illustrated involves an expected value of the high-quality type, V^H, of 120, and of the low-quality type, V^L, of 100, required external funds, I, of 20, a cost of using competitive offerings, K_c, of 2, and a parameter value representing the variability of market conditions, γ, of 0.1.

Figure 5. The effect of higher market variability



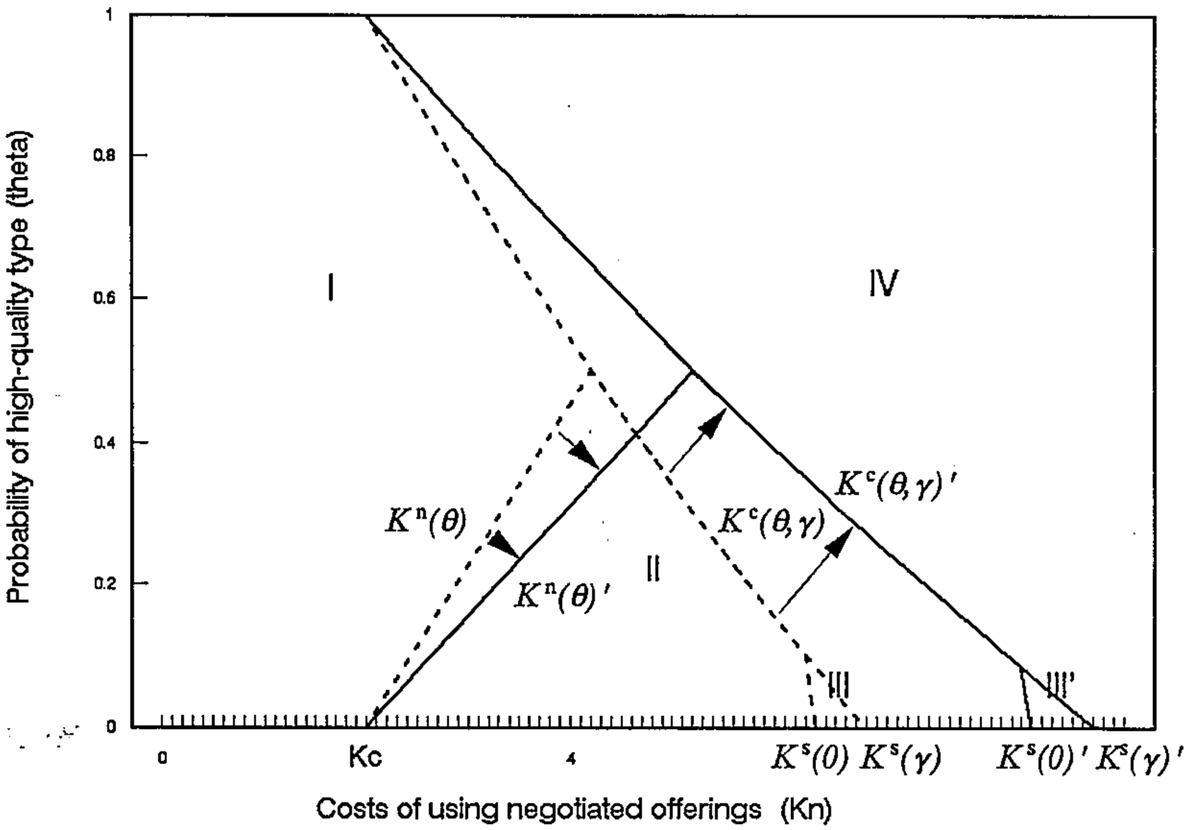
The case illustrated involves an increase in γ from 0.1 to 0.2. The increase in γ expands the region I, II, and III.

Figure 6. The effect of an increase in informational asymmetry



The case illustrated involves an increase in V^H from 120 to 130. The increase in V^H/V^L expands the region I and contracts the region IV.

Figure 7. The effect of an increase in required external funds



The case illustrated involves an increase in I from 20 to 30. The increase in I expands the region I and contracts the region IV.