



American Finance Association

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Author(s): David P. Baron

Source: *The Journal of Finance*, Vol. 37, No. 4 (Sep., 1982), pp. 955-976

Published by: Blackwell Publishing for the American Finance Association

Stable URL: <http://www.jstor.org/stable/2327760>

Accessed: 27/11/2009 08:20

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A Model of the Demand for Investment Banking Advising and Distribution Services for New Issues

DAVID P. BARON*

ABSTRACT

This paper presents a theory of the demand for investment banking advising and distribution services for the case in which the investment banker is better informed about the capital market than is the issuer, and the issuer cannot observe the distribution effort expended by the banker. The optimal contract under which the offer price decision is delegated to the better-informed banker in order to deal with the adverse selection and moral hazard problems resulting from the informational asymmetry and the observability problem is characterized. The model demonstrates a positive demand for investment banking advising and distribution services and provides an explanation of the underpricing of new issues.

AN INVESTMENT BANKER PERFORMS three functions which may be of value to an issuer of new securities: underwriting, advising, and distribution. This paper presents a theory of the demand for investment banking advising and distribution services based on an informational asymmetry between an issuer of new securities and an investment banker. Ultimately, a theory of the organization of the financial intermediary industry is required that would predict which firms would use which types of financial intermediaries for which purposes, and which firms would raise capital without engaging the services of a financial intermediary. Only a limited set of such predictions are developed here in the context of a model of a fixed-price offering under a negotiated contract in which the investment banker is better informed about the capital market than is the issuer of the securities.¹

Since the focus is on the advising and distribution functions, the demand for underwriting will be eliminated by assuming that both the issuer and the banker are risk neutral. The advising function may have value to the issuer if the banker has better information about the capital market than does the issuer, since the issuer can delegate the offer price decision to the banker so that he can utilize his

* Stanford University. This research has been supported by the National Science Foundation, Grant No. SOC 77-07251 A01. The author would like to thank Victor Liu for his assistance and Stuart Greenbaum, Bengt Holmstrom, and the participants in the Finance Workshop at Northwestern University and the Economics of Uncertainty Workshop at the University of Chicago for their helpful comments.

¹ A number of important issues are not considered here in order to simplify the analysis and to focus on the effect of the informational asymmetry. Two principal issues not addressed are competition among investment bankers, and the effect of the banker's advising and distribution decisions for the present contract on the banker's reputation and its impact on future contracts. Furthermore, other alternatives such as a rights offering, a private placement, bank borrowing, and an auction of the securities will not be considered here.

superior information.² Distribution by the banker may also have value to the issuer to the extent that the banker can generate demand for the issue. An investment banker may be able to do so either because of his ability to persuade customers to purchase the issue or because he may be able to “certify” the issue to the market by putting, for example, his reputation behind the issue. The term “delegation” will be used for the contract under which an issuer engages the services of an investment banker to both distribute the securities and to provide advice regarding the offer price to be set. The objective is to characterize endogenously the form of the delegation contract to be concluded between the issuer and the banker in the context of a negotiated, fixed-price offering.

Two special cases of a delegation contract are a “pure distribution” contract and a “direct sale.” In a pure distribution contract, the issuer makes the offer price decision based on his limited information and uses the investment banker only to distribute the issue.³ In a direct sale, the issuer determines the offer price based on his limited information and offers the securities to the market without using an investment banker for distribution. Since both of these alternatives are special cases of a delegation contract, the issuer weakly prefers to use the advising and distribution services of the investment banker. In the context of an example to be presented in Section II, strict preference is demonstrated, and the value of the advising and the distribution services is characterized.

In the example, the value to the issuer of delegating the offer price decision to the banker is shown to be an increasing function of the issuer’s uncertainty about the market demand for the securities. The optimal offer price is, however, a decreasing function of his uncertainty, which provides a prediction of the underpricing found empirically by Ibbotson [10]. For both delegation and pure distribution contracts, the value to the issuer of the banker’s distribution effort is an increasing function of the issuer’s uncertainty, so greater uncertainty increases the demand for the advising and distribution services of the banker. If an issuer of unseasoned securities is more uncertain about the market reaction to its issue than is an issuer of seasoned securities, issuers of unseasoned securities would be expected to have a greater demand for the advice of an investment banker, and their securities would be more underpriced.

In related models, Mandelker and Raviv [11], Baron [1], and Baron and Holmstrom [2] characterized the optimal contract between an issuer and an investment banker in the context of a negotiated sale. Mandelker and Raviv considered the risk sharing features of the contract for the case in which the issuer and the banker have symmetric information at the time of contracting. Baron also assumed symmetric information at the time of contracting in analyzing the offer price decision and the optimal contract to deal with the incentive problem resulting from the issuer’s inability to observe the distribution effort of the banker, and the banker’s incentive to underprice in order to reduce his

² The analysis presented here takes as given the institutional practice of setting a fixed offer price and attempting to sell the issue at that price until the issue is fully-subscribed or until no further sales can be made at that price. At that time stabilization is assumed to be terminated.

³ This type of contract differs from the conventional best-efforts contract because in a pure distribution contract the issuer does not necessarily bear all the risk involved with the sale and the banker does not necessarily receive a lump-sum payment.

distribution effort. Baron and Holmstrom assumed symmetric information at the time of contracting but recognized that during the registration period, investment bankers conduct preselling activities to gauge more accurately the demand for the issue. Since the information obtained by the banker through preselling is not directly available to the issuer, the issuer must design the contract so that the distribution effort and offer price decisions made by the banker, conditional on his private information, will serve the interests of the issuer.

The present paper does not assume that the issuer and the banker have symmetric information at the time of contracting but instead considers the case in which prior to contracting the banker has better information about the likely market demand than does the issuer. This might correspond to the situation in which the issuer and the banker do not finalize the contract until the end of the registration period, or in which the contract is finalized prior to the registration period with the provision that the banker is allowed to withdraw from the contract if his compensation given his private information is unsatisfactory. The model more appropriately, however, may be thought of as representing the case in which the banker has superior information at the time he begins his negotiations with the issuer.

Because in the model considered here the banker's decision to accept or reject the contract offered by the issuer is conditional on the banker's private information, the issuer's problem is more complex, and the resulting predictions are richer than in the three previous articles. For example, if the banker is risk neutral in the models considered in those articles, the first-best solution, a firm commitment contract under which the banker makes a lump-sum payment to the issuer and chooses the offer price and distribution effort without consulting the issuer, is attainable. The first-best solution is not attainable, however, when the banker has private information prior to contracting, since the banker may have an incentive to report false information to the issuer in order to receive greater compensation. The potential for such adverse selection requires the issuer to deviate from the first-best contract, and in doing so a moral hazard problem arises when the distribution effort is unobservable. The optimal contract will generally involve the sharing of risk between the issuer and the banker, with compensation paid to the banker for his advice about the offer price and for the distribution effort he exerts to sell the issue.

In the next section, a general model of a negotiated offering incorporating the banker's informational advantage and the advising and distribution functions is presented, and the optimal delegation contract is characterized. The value of the advising and distribution services is analyzed in the context of an example in Section II, and conclusions are offered in the final section.

I. The Model and the Optimal Delegation Contract

A. The Model

The issuer is assumed to have a demand for capital for investment in a project whose value is linear in the amount of capital invested at least over the relevant range. The issuer thus has preferences which are linear in the proceeds from the

security issue net of the compensation paid to the investment banker. The nature of the security issue is assumed to have been determined prior to contracting, so for an equity issue, for example, the number of shares to be issued is assumed to be fixed although in practice that number may be determined within the context of the contract. The only decisions to be made are thus the offer price and the terms of the contract to be concluded with the banker. The proceeds $x = x(p, e, \theta)$ from the sale of the issue are assumed to depend on the offer price p , the distribution effort e of the banker, and a state θ that represents a vector of parameters which index the demand for the issue. As a function of the offer price, the proceeds x may be linear in p for prices such that the issue is oversubscribed and may increase and then decrease for higher prices.⁴

The demand for the issue will depend on the distribution effort of the investment banker to the extent to which the banker can persuade investors to purchase the issue or can influence their expectations through the information it provides regarding the issue. For example, the banker may be able to increase the demand for one issue by promising to give a customer a greater ration of another issue that is oversubscribed. Similarly, for an unseasoned issue the banker may be able to provide certification of the potential returns on the securities that the issuer is unable to credibly provide.⁵ There are costs to the banker, however, of influencing demand through its distribution effort including the cost of the salesmen's time, any rebates granted, possible loss of customer goodwill, or a decrease in the effectiveness of future distribution efforts if the security is overpriced.

Conditional on a parameter δ , the banker and the issuer are assumed to have common knowledge about the state θ as represented by the conditional density function $h(\theta | \delta)$. The banker, however, is better informed about δ than is the issuer, and for the purposes of the analysis will be assumed to know δ prior to contracting while the issuer has only imperfect information represented by a density function $f(\delta)$ defined on the interval $[\underline{\delta}, \bar{\delta}]$ and positive and differentiable on $(\underline{\delta}, \bar{\delta})$. Although the banker knows δ , neither the banker nor the issuer knows which state θ will occur at the time that the securities are offered for sale. The private information δ of the banker may, for example, have been obtained during his contacts with customers made to gauge the demand for the issue or may, as another example, represent the banker's superior knowledge of the covariance between the return on the securities to be issued and the return on the market portfolio.⁶ Information will be parameterized so that higher values of δ represent less favorable information about the demand for the securities and hence smaller proceeds.

Instead of working directly with the probability distribution of the state θ , the formulation of Holmstrom [9] and Mirrlees [13] will be used to express the relationship between the proceeds and p , e , and δ by the density function $g(x | p,$

⁴ Investment banking practice involves "rebates" in the form of overtrading and soft-dollar designations, so the proceeds may nowhere be linear in p (see SEC[1979]).

⁵ The observation that some issues are undersubscribed and that stabilization efforts occasionally fail demonstrates, however, the limits to a banker's ability to influence demand.

⁶ It is, of course, also possible that the issuer has private information about, for example, its real return opportunities, but the case considered here is that in which the issuer has revealed such information to the banker, and the banker has verified it.

e, δ) induced on x by the probability distribution $h(\theta | \delta)$.⁷ The function g is assumed to be twice differentiable in p, e , and δ and to be nonzero on the largest open set contained in its support. The proceeds function $x(p, e, \theta)$ will be assumed to be strictly increasing in e , and hence the distribution function $G(x | p, e, \delta)$ is nonincreasing in e , indicating that greater effort results in a more favorable distribution of proceeds in the sense of first-degree stochastic dominance.⁸ Similarly, G is assumed to be nondecreasing in δ indicating that less favorable information results in (stochastically) smaller proceeds. These conditions imply that the expected proceeds $\bar{x}$ are nondecreasing in e and nonincreasing in δ . Three additional assumptions on $\bar{x}$ will be made for the purposes of analysis. First, the marginal proceeds from an increase in the distribution effort are assumed to be at least as great for a higher than for a lower offer price or $\bar{x}_{pe} \geq 0$, where the subscripts denote partial derivatives. Second, less favorable information (higher δ) is assumed to decrease the marginal expected proceeds from an increase in the offer price or $\bar{x}_{p\delta} < 0$. Third, to provide the needed second-order conditions, the expected proceeds will be assumed to be a concave function of e and p .

B. The Three Alternatives

Under a delegation contract, the issuer's objective is to choose a compensation function $\bar{S}$ for the banker that will induce the banker both to exert a greater sales effort than it would otherwise exert and to use its knowledge of the parameter δ in setting an offer price that is in the interests of the issuer. The offer price decision will be delegated to the banker by allowing him to choose from among a set of prices selected by the issuer. This will be accomplished by the issuer choosing an offer price function $p(\hat{\delta})$ and allowing the banker to report to the issuer a value $\hat{\delta} \in [\underline{\delta}, \bar{\delta}]$ for the parameter δ . If the issuer upon receiving the report $\hat{\delta}$ decides to issue the securities, the offer price will be $p = p(\hat{\delta})$. The issuer may prefer, however, to withdraw the securities if, for example, the anticipated market reception of the issue based on the report $\hat{\delta}$ is unsatisfactory. To represent this possibility, let $\pi(\hat{\delta})$ denote the probability that the issue will be offered when $\hat{\delta}$ is reported, so $(1 - \pi(\hat{\delta}))$ is the probability that the issue will be withdrawn. (In the optimal solution $\pi(\hat{\delta})$ will equal either zero or one.) The distribution effort exerted by the banker and its cost are reasonably assumed to be unobservable by the issuer as are the parameter δ and the state θ . The compensation function $\bar{S}(p, \hat{\delta}, x)$ can only be based on the three observable variables: the offer price p , the report $\hat{\delta}$, and the proceeds x . A delegation contract is thus the triple of functions $(p(\hat{\delta}), \bar{S}(p(\hat{\delta}), \hat{\delta}, x), \pi(\hat{\delta}))$.

An alternative to a delegation contract is to engage an investment banker solely to distribute the issue and not to use, and hence to pay for, his advice.

⁷ The support of the distribution of x is assumed to be independent of e and δ . If this is not the case, it may be possible to impose penalties and improve the solution as indicated in Mirrlees [13] and Holmstrom [9].

⁸ The proceeds function is constant in e and δ if the issue is oversubscribed at a fixed offer price, since a greater sales effort or a more favorable market valuation will not increase the proceeds. If, however, the offering involves give-ups, soft-dollar designation, or swaps, the proceeds need not be linearly related to e when the issue is oversubscribed.

Under such a pure distribution contract, the issuer determines the offer price based on his limited information, and the banker distributes the issue at that price. The issuer in this case does not ask for, and hence need not pay for, a report about δ , so no compensation based on $\hat{\delta}$ is paid. A pure distribution contract is thus a special case of a delegation contract in which $p(\hat{\delta}) = p^*$, $\pi(\hat{\delta}) = \pi^*$, and $\bar{S}(p, \hat{\delta}, x) = S^*(p, x)$ for all $\hat{\delta}$. The issuer weakly prefers a delegation contract to a pure distribution contract, and hence the optimal pure distribution contract will be explicitly characterized only for the example in Section II. One might expect that the gain from a delegation contract relative to a pure distribution contract would be greater the greater is the issuer's uncertainty about δ , but this issue is too complex to be investigated in general and will be considered only in the context of the example in Section II.

The third alternative is for the issuer to sell the issue directly in the market without using an investment banker. A direct sale contract is a special case of a pure distribution contract with $S^*(p, x) = 0$ for all p and x , so the issuer weakly prefers a pure distribution contract to a direct sale. The direct sale case will be considered in Section II in order to determine the benefit to the issuer of utilizing the advising and distribution functions of the banker.

C. The Optimal Delegation Contract

Given a policy $(p, \bar{S}, \pi)$, the banker will choose a report or response function $\hat{\delta}(\delta)$, based on the true value of δ known only to the banker. When $\hat{\delta} = \hat{\delta}(\delta)$ is reported, the offer price is set as $p(\hat{\delta})$, and thus the compensation $\bar{S}(p(\hat{\delta}), \hat{\delta}, x)$ can be expressed as a function $S(\hat{\delta}, x)$ defined by $S(\hat{\delta}, x) = \bar{S}(p(\hat{\delta}), \hat{\delta}, x)$. The banker is assumed to receive no compensation when the issue is withdrawn, so his income $R^*(\hat{\delta}, e, x)$ may be written as

$$R^*(\hat{\delta}, e, x) = (S(\hat{\delta}, x) - C(e))\pi(\hat{\delta}),$$

where $C(e)$ is the strictly increasing, strictly convex cost of the distribution effort e with $C(0) = 0$. The banker is assumed to be risk neutral and thus maximizes his expected net income $R(\hat{\delta}, \delta, e)$ given by

$$R(\hat{\delta}, \delta, e) = \int R^*(\hat{\delta}, e, x)g(x|p(\hat{\delta}), e, \delta) dx \quad (1)$$

The banker may behave in a risk neutral manner because of its ability to hedge its risks through positions taken in other securities or by risk sharing through syndicate formation.

The distribution effort chosen by the banker depends on his information δ and on his report $\hat{\delta}$ through the price $p(\hat{\delta})$. The optimal distribution effort response function $e(\hat{\delta}, \delta)$ is defined by

$$e(\hat{\delta}, \delta) = \operatorname{argmax}_e \left(R(\hat{\delta}, \delta, e) = \pi(\hat{\delta}) \int (S(\hat{\delta}, x) - C(e))g(x|p(\hat{\delta}), e, \delta) dx \right) \quad (2)$$

where argmax denotes the argument that maximizes the succeeding function. If $\pi(\hat{\delta}) > 0$, the effort response function satisfies the first-order condition

$$\int S(\hat{\delta}, x) g_e(x | p(\hat{\delta}), e(\hat{\delta}, \delta), \delta) dx - C'(e(\hat{\delta}, \delta)) = 0 \quad (3)$$

where the subscript denotes partial derivative. The response function $e(\hat{\delta}, \delta)$ will be assumed to be a differentiable function of $\hat{\delta}$ and δ for all $\hat{\delta}$ such that $\pi(\hat{\delta}) > 0$.

If the issuer chooses a policy (p^*, S^*, π^*) , the banker will choose an effort response function $e^*(\hat{\delta}, \delta)$ and a report function $\hat{\delta} = \delta^*(\delta)$. The same outcomes to the issuer and the banker can be achieved by another policy in which the banker reports its private information δ truthfully and the issuer uses the function $\delta^*(\delta)$ to calculate the same report $\hat{\delta}$ that the banker would have reported in response to (p^*, S^*, π^*) . If the issuer then implements the policy $(p^*(\delta^*(\delta)), S^*(\delta^*(\delta), x), \pi^*(\delta^*(\delta)))$, the price $p^*(\delta^*(\delta))$, the compensation $S^*(\delta^*(\delta), x)$, and the probability $\pi^*(\delta^*(\delta))$ will be the same as $(p^*(\hat{\delta}), S^*(\hat{\delta}, x), \pi^*(\hat{\delta}))$, so the banker will choose the same effort response function under both policies. Since $\delta^*(\delta)$ was optimal given the original policy, the banker has no incentive to report δ untruthfully against this new policy. Consequently, a policy $(p(\delta), S(\delta, x), \pi(\delta))$ defined by $(p(\delta) \equiv p^*(\delta^*(\delta)), S(\delta, x) \equiv S^*(\delta^*(\delta), x), \pi(\delta) \equiv \pi^*(\delta^*(\delta)))$ is equivalent to the original policy. An optimal policy thus will be found in the class of policies against which the banker has no incentive to report δ untruthfully. Such policies are said to be incentive compatible, and the optimality of an incentive compatible policy is a consequence of the "revelation principle" developed by Gibbard [5], Green and Laffont [6], Myerson [14], Harris and Townsend [8], and Dasgupta, Hammond, and Maskin [4]. The methodology that will be used to determine the optimal incentive compatible policy is based on the work of Myerson [15] and Baron and Myerson [3].

If the securities are issued, the expected net proceeds $N(\delta)$ of the issuer conditional on the reported information δ are

$$N(\delta) = \int (x - S(\delta, x)) g(x | p(\delta), e, \delta) dx \quad (4)$$

The issuer is assumed to be able to raise capital by other means, and his reservation level will be denoted by $\bar{N}(\delta)$, which represents the capital that can be raised from the best alternative source.⁹ The net proceeds $N^*(\delta)$ are thus

$$N^*(\delta) = N(\delta) - \bar{N}(\delta)$$

Since the issuer does not know δ when he determines the contract to offer to the banker, the issuer will choose a policy to maximize his expected net proceeds N given by

$$N = \int \pi(\delta)(N(\delta) - \bar{N}(\delta)) f(\delta) d\delta \quad (5)$$

The issuer's problem thus may be stated as¹⁰

⁹ The function $\bar{N}(\delta)$ is assumed to be exogenously determined and not to be used strategically by the issuer to influence the banker.

¹⁰ The program in Equations (6)–(10) is a game with private information in which the issuer moves first in choosing his strategy $(p(\cdot), S(\cdot), \pi(\cdot))$ and the banker moves second in choosing response functions $\hat{\delta}(\delta)$ and $e(\hat{\delta}, \delta)$. While the issuer does not know δ when he chooses his strategy, he does know perfectly the response functions the banker will choose as a result of his strategy.

$$\max_{p(\delta), S(\delta, x), \pi(\delta)} \int \left(\int (x - S)g(x|p(\delta), e(\delta, \delta), \delta) dx - \bar{N}(\delta) \right) \pi(\delta) f(\delta) d\delta \quad (6)$$

$$\text{s.t.} \quad R(\delta, \delta, e(\delta, \delta)) \geq R(\hat{\delta}, \delta, e(\hat{\delta}, \delta)) \quad \text{for all } \hat{\delta} \text{ and } \delta \quad (7)$$

$$e(\hat{\delta}, \delta) = \arg\max_e R(\hat{\delta}, \delta, e) \quad \text{for all } \hat{\delta} \text{ and } \delta \quad (8)$$

$$R(\delta, \delta, e(\delta, \delta)) \geq 0 \quad \text{for all } \delta \quad (9)$$

$$1 \geq \pi(\delta) \geq 0 \quad \text{for all } \delta. \quad (10)$$

The constraints in (7) define the class of incentive-compatible policies and ensure that if the banker's information is δ he will report δ truthfully rather than reporting any other value $\hat{\delta}$.¹¹ The constraints in (8) represent the banker's optimal choice of effort. The constraints in (9) are individual rationality conditions which state that the banker will not manage the issue unless his income $R(\delta, \delta, e(\delta, \delta))$ is at least as great as his reservation level which is taken to be zero. The constraints in (10) require $\pi(\delta)$ to be a probability. Since the issuer does not know δ , the constraints must be stated for all values of $\delta \in [\underline{\delta}, \bar{\delta}]$.

The optimal solution to the issuer's problem in Equations (6)–(10) is second-best in the sense that a better solution could be obtained if the issuer knew δ and were able to observe e . More formally, the first-best solution solves for each $\delta \in [\underline{\delta}, \bar{\delta}]$ the program

$$\begin{aligned} \max_{p, e, \pi, S} & \left(\int (x - S)g dx - C(e) - \bar{N}(\delta) \right) \pi \\ \text{S.T.} & \quad \int S(\delta, x)g dx - C(e) \geq 0 \end{aligned}$$

As the following proposition indicates, the first-best solution is attainable if δ is known even though e is unobservable, by using a firm commitment contract in which the banker receives the entire proceeds of the issue in exchange for a fixed payment $K(\delta)$. With such a contract, the banker finds it in his interest to choose the first-best levels of the offer price and the distribution effort.

Proposition 1: When the issuer knows δ but e is unobservable, the first-best solution is attainable through a firm commitment contract, and the optimal policy $(S^+(\delta, x), e^+(\delta, \delta), p^+(\delta), \pi^+(\delta))$ satisfies for each $\delta \in [\underline{\delta}, \bar{\delta}]$

$$\begin{aligned} S(\delta, x) &= x - K(\delta), \\ \bar{x}_p(p^+(\delta), e^+(\delta, \delta), \delta) &= 0 \\ \bar{x}_e(p^+(\delta), e^+(\delta, \delta), \delta) - C'(e^+(\delta, \delta)) &= 0 \\ \bar{x}_p(p^+(\delta), e^+(\delta, \delta), \delta) - K(\delta) - C(e^+(\delta, \delta)) &= 0 \\ \pi^+(\delta) &= \begin{cases} 1 & \text{if } K(\delta) \geq \bar{N}(\delta) \\ 0 & \text{if } K(\delta) < \bar{N}(\delta) \end{cases} \end{aligned}$$

¹¹ The constraints in (7) correspond to weak incentive compatibility. For the example in Section II the optimal policy will be shown to have the property of strong incentive compatibility.

The proof is immediate from standard agency theory for a risk neutral agent (see Harris and Raviv [7] and Holmstrom [8]).

The first-best solution is not attainable when the issuer does not know δ , however, because the issuer must choose a compensation function that provides the banker with an incentive, represented by Equation (7), to report his private information truthfully. That required compensation distorts both the offer price and the distribution effort decisions away from their first-best levels.

To develop the solution to Equations (6)–(10), the following interpretation is useful. The parameter δ may be viewed as a datum, the banker's choices $\hat{\delta}$ and $e(\hat{\delta}, \delta)$ as dependent variables, and the functions S , p , and π as the decision variables. As a first step in solving the program, the dependent variable $\hat{\delta}$ will be eliminated and an expression for R obtained that incorporates the incentive compatibility requirements in (7). To eliminate $\hat{\delta}$, consider the banker's reporting problem in (7). In an incentive-compatible policy, the banker's optimal report $\hat{\delta}$ equals δ and satisfies the following first-order condition, given a policy $(p(\hat{\delta}), S(\hat{\delta}), \pi(\hat{\delta}))$ and a response function $e(\hat{\delta}, \delta)$ that are differentiable almost everywhere,¹²

$$\begin{aligned} R_{\delta}(\hat{\delta}, \delta, e(\hat{\delta}, \delta)) \Big|_{\hat{\delta}=\delta} \\ = \left[\int S_{\delta}(\hat{\delta}, x) g \, dx + \int S(\hat{\delta}, x) g_p \, dx p'(\hat{\delta}) + \left(\int S(\hat{\delta}, x) g_e \, dx - C'(e) \right) \right. \\ \left. \cdot e_{\delta}(\hat{\delta}, \delta) \pi(\delta) + \left(\int S(\hat{\delta}, x) g \, dx - C(e(\hat{\delta}, \delta)) \right) \pi'(\hat{\delta}) \right] \Big|_{\hat{\delta}=\delta} = 0 \quad (11) \end{aligned}$$

To obtain an expression for the optimal income $R(\delta, \delta, e(\delta, \delta))$ of the banker, totally differentiate (1) with respect to δ to obtain

$$\begin{aligned} \frac{dR(\delta, \delta, e(\delta, \delta))}{d\delta} &= R_{\delta}(\delta, \delta, e(\delta, \delta)) + R_e(\delta, \delta, e(\delta, \delta)) \\ &= R_{\delta}(\delta, \delta, e(\delta, \delta)) \quad (\text{from (11)}) \\ &= \pi(\delta) \int S(\delta, x) g_{\delta} \, dx + \pi(\delta) \left(\int S(\delta, x) g_e \, dx \right. \\ &\quad \left. - C'(e(\delta, \delta)) \right) e_{\delta}(\delta, \delta) \\ &= \pi(\delta) \int S(\delta, x) g_{\delta} \, dx. \quad (\text{from (3)}) \quad (12) \end{aligned}$$

The function $S(\delta, x)$ will be assumed to be an increasing function of x , and since a decrease in δ results in a stochastically dominant distribution of x , the derivative in (12) is strictly negative when $\pi(\delta) > 0$, which establishes

¹² In the second-best solution $\pi(\delta)$ will equal zero or one, and at points of discontinuity the derivative does not exist. When $\pi(\delta) = 0$, R is zero under an incentive-compatible policy, and hence the functions $p(\delta)$, $e(\delta, \delta)$, and $S(\delta, x)$ are irrelevant.

Proposition 2: If $S(\delta, x)$ is an increasing function of x in an optimal solution, the income $R(\delta, \delta, e(\delta, \delta))$ of the banker is a strictly decreasing function of δ when $\pi(\delta) > 0$. In an incentive-compatible policy, the banker thus receives greater compensation the more favorable is the information he possesses about the market.¹³

An expression for the income of the banker can be obtained from the statement

$$\int_{\delta}^{\bar{\delta}} \frac{dR(\delta^+, \delta^+, e(\delta^+, \delta^+))}{d\delta} d\delta^+ = R(\bar{\delta}, \bar{\delta}, e(\bar{\delta}, \bar{\delta})) - R(\delta, \delta, e(\delta, \delta)) \quad \text{for all } \delta \in [\bar{\delta}, \bar{\delta}]$$

by evaluating the left-hand side using (12) and solving for $R(\delta, \delta, e(\delta, \delta))$ to obtain

$$R(\delta, \delta, e(\delta, \delta)) = - \int_{\delta}^{\bar{\delta}} \pi(\delta^+) \int S(\delta^+, x) g_{\delta} dx d\delta^+ + R(\bar{\delta}, \bar{\delta}, e(\bar{\delta}, \bar{\delta})) \quad (13)$$

The dependent variable $\hat{\delta}$ has now been eliminated, and an expression for the income of the banker that satisfies the incentive compatibility constraint has been obtained.

As the next step in solving the issuer's problem, the effort constraint in (8), expressed in the form of (3), will be incorporated into the issuer's objective function using a Lagrangian multiplier $\mu(\delta)$ which yields

$$N = \int \left[\int \left(x - S(\delta, x) \left(1 - \mu(\delta) \frac{g_e}{g} \right) \right) g dx - \mu(\delta) C'(e) - \bar{N}(\delta) \right] \pi(\delta) f(\delta) d\delta \quad (14)$$

From (1) the payment to the banker may be expressed as

$$\pi(\delta) \int S(\delta, x) g dx = R(\delta, \delta, e) + \pi(\delta) C(e)$$

Substituting this expression into (14) yields

$$N = \int \left[-\pi(\delta) C(e) - R(\delta, \delta, e) + \pi(\delta) \int \left(x + S(\delta, x) \mu(\delta) \frac{g_e}{g} \right) g dx - \pi(\delta) \mu(\delta) C'(e) - \pi(\delta) \bar{N}(\delta) \right] f(\delta) d\delta$$

Then, substituting for $R(\delta, \delta, e)$ from (13) yields

¹³ If R is not a nonincreasing function of δ , the banker may have an incentive to report its information untruthfully. Baron and Myerson [3] and Maskin and Riley [12] provide methods for guaranteeing that R is a nonincreasing function in somewhat different models.

$$\begin{aligned}
N = \int \left[-\pi(\delta)C(e) + \int_{\delta}^{\bar{\delta}} \pi(\delta^+) \int S(\delta^+, x) g_{\delta} dx d\delta^+ \right. \\
\left. + \pi(\delta) \int \left(x + S(\delta, x)\mu(\delta) \frac{g_e}{g} \right) g dx - \pi(\delta)\mu(\delta)C'(e) \right. \\
\left. - \pi(\delta)\bar{N}(\delta) \right] f(\delta) d\delta - R(\bar{\delta}, \bar{\delta}, e(\bar{\delta}, \bar{\delta}))
\end{aligned}$$

Integrating by parts yields

$$\begin{aligned}
N = \int \left[-C(e) + \int \left(x + S(\delta, x) \left(\mu(\delta) \frac{g_e}{g} + \frac{g_{\delta} F(\delta)}{g f(\delta)} \right) \right) g dx \right. \\
\left. - \mu(\delta) C'(e) - \bar{N}(\delta) \right] \pi(\delta) f(\delta) d\delta - R(\bar{\delta}, \bar{\delta}, e(\bar{\delta}, \bar{\delta})) \quad (15)
\end{aligned}$$

The issuer's problem is now¹⁴

$$\max_{p(\delta), S(\delta, x), e(\delta, \delta), \pi(\delta), R(\bar{\delta}, \bar{\delta}, e(\bar{\delta}, \bar{\delta}))} \bar{N} \quad (16)$$

$$\text{s.t.} \quad R(\delta, \delta, e(\delta, \delta)) \geq 0 \quad \text{for all } \delta \quad (9)$$

$$1 \geq \pi(\delta) \geq 0 \quad \text{for all } \delta \quad (10)$$

From (15) the issuer will choose $R(\bar{\delta}, \bar{\delta}, e(\bar{\delta}, \bar{\delta}))$ as small as possible, so from (9) $R(\bar{\delta}, \bar{\delta}, e(\bar{\delta}, \bar{\delta})) = 0$ is optimal. Consequently, the worst information $\delta = \bar{\delta}$ receives a payment from the issuer equal to the banker's distribution cost $C(e(\bar{\delta}, \bar{\delta}))$. When $S(\delta, x)$ is a nondecreasing function of x , the constraints in (9) are satisfied for all δ and can be ignored, since from Proposition 2 $R(\delta, \delta, e(\delta, \delta))$ is decreasing in δ when $\pi(\delta) > 0$ and otherwise is zero.

The issuer's problem, then, is to maximize N in (15) with respect to $p(\delta)$, $S(\delta, x)$, $e(\delta, \delta)$, and $\pi(\delta)$ subject to (10). To simplify the analysis, attention will be restricted to the class of compensation functions of the form¹⁵

$$S(\delta, x) = s(\delta) + tx, \quad t \in [0, 1] \quad (17)$$

While this specification is restrictive, it does include the two polar cases of a firm commitment contract ($t = 1$) in which the issuer receives a fixed payment independent of x and a best-efforts contract ($t = 0$) in which the banker receives a fixed payment for his services. Since the specification of S in (17) is nondecreasing in x , the constraints in (9) are satisfied for all δ . With this specification the terms $\int S g_e dx$ and $\int S g_{\delta} dx$ simplify to $t\bar{x}_e$ and $t\bar{x}_{\delta}$, respectively, so $s(\delta)$ does not appear in the expression for N in (15). The function $s(\delta)$ can be recovered from (13) and (1), however, and satisfies

$$\pi(\delta)(s(\delta) + t\bar{x} - C(e(\delta, \delta))) + t \int_{\delta}^{\bar{\delta}} \pi(\delta^+) \bar{x}_{\delta} d\delta^+ = 0 \quad (18)$$

¹⁴ Maximization with respect to $e(\delta, \delta)$ yields the adjoint equation for the multiplier $\mu(\delta)$.

¹⁵ This assumption is not meant to imply that a separable and linear compensation function is optimal.

Parameterized on t , the solution to the issuer's problem is a set of functions $(p(\delta), e(\delta, \delta), \mu(\delta), s(\delta), \pi(\delta))$ that satisfies (18) and

$$t\bar{x}_e - C'(e(\delta, \delta)) = 0 \quad (3a)$$

$$\bar{x}_p + t\mu(\delta)\bar{x}_{ep} + t(F(\delta)/f(\delta))\bar{x}_{\delta p} = 0 \quad (19)$$

$$-C'(e(\delta, \delta)) + \mu(\delta)[t\bar{x}_{ee} - C''(e(\delta, \delta))] + \bar{x}_e + t(F(\delta)/f(\delta))\bar{x}_{e\delta} = 0 \quad (20)$$

$$\pi(\delta) = \begin{cases} 1 & \text{if } \bar{x}(1-t) - s(\delta) \geq \bar{N}(\delta) \\ 0 & \text{if } \bar{x}(1-t) - s(\delta) < \bar{N}(\delta). \end{cases} \quad (21)$$

The optimal share t^+ is then determined from

$$t^+ = \operatorname{argmax}_t \int \pi(\delta)(N(\delta) - \bar{N}(\delta))f(\delta) d\delta \quad (22)$$

where $N(\delta)$ is evaluated at the optimal policy.¹⁶

The second term in (19) reflects the issuer's response to the distribution effort observability problem, and since $\bar{x}_{ep} \geq 0$ by assumption indicating that the marginal return to effort is an increasing function of the offer price, a positive multiplier $\mu(\delta)$ implies that the issuer prices higher than he would otherwise price in order to induce the banker to exert greater effort. The sign of $\bar{x}_p$ is ambiguous in this case, however, since the third term in (19) is negative. If $\mu(\delta)$ is negative, then $\bar{x}_p$ is negative, and the securities are offered at a price lower than that which maximizes the expected proceeds given the second-best pricing rule. The possibility of such "underpricing" will be further analyzed in the context of the example presented in the next section.

The sign of the multiplier $\mu(\delta)$ may be analyzed using the adjoint equation in (20) obtained by maximizing N with respect to $e(\delta, \delta)$. Substituting $C'(e) = t\bar{x}_e$ from (3a) yields

$$(1-t)\bar{x}_e + \mu(\delta)[t\bar{x}_{ee} - C''(e)] + t(F(\delta)/f(\delta))\bar{x}_{e\delta} = 0 \quad (23)$$

If $t < 1$, the first term in (23) is positive because an increase in effort results in a stochastically dominant distribution of x . If $\bar{x}_{e\delta} \geq 0$, the multiplier $\mu(\delta)$ is positive, since $(t\bar{x}_{ee} - C''(e))$ is negative by assumption. Consequently, if the marginal proceeds from an increase in the distribution effort are greater the less favorable is the banker's information, the multiplier $\mu(\delta)$ is positive. The multiplier may be interpreted as the increase in expected net proceeds to the issuer from an increase in the distribution effort by the banker, so in the optimal contract the issuer prefers that the banker exert greater sales effort when $\bar{x}_{e\delta} \geq 0$ and $t < 1$. If $\bar{x}_{e\delta} < 0$, a higher δ results in less effort expended for a given price, and the sign of the multiplier is ambiguous. With $\bar{x}_{e\delta}$ sufficiently negative, the issuer may prefer that the banker expend less effort in order to reduce the compensation that must be paid to the banker to cover the distribution cost $C(e(\delta, \delta))$. This analysis is summarized as

Proposition 3: If $t \leq (<)1$ and $\bar{x}_{e\delta} \geq 0$, then $\mu(\delta) \geq (>) 0$. If $\bar{x}_{e\delta} < 0$, the sign of $\mu(\delta)$ is ambiguous in general.

¹⁶ The existence of a solution satisfying these conditions is assumed here.

The optimal price function may be characterized from (19) which indicates the deviation from the first-best policy in Proposition 1 that is required to deal with the informational asymmetry and the distribution effort observability problem. To analyze (19), consider the third term which represents the issuer's response to the informational asymmetry. The term $\bar{x}_{\delta p}$ is negative, since by assumption less favorable information decreases the marginal return from an increase in the offer price. Consequently, if effort were fixed at the first-best level so that $\bar{x}_{ep} = 0$ in (19), the offer price is set such that $\bar{x}_p > 0$, which establishes

Proposition 4: If e is fixed at the first-best level, the optimal price $p(\delta)$ satisfying (19) is lower than the first-best price characterized in Proposition 1.

Consequently, because of the asymmetric information, the issuer lowers the offer price below that which would set in a first-best solution when the banker expends the first-best effort.

II. An Example

The example is based on the following specifications:

$$\begin{aligned} C(e) &= \frac{1}{2} b e^2, \quad b > 0 \\ \bar{x}(p, e, \delta) &= a(\bar{\delta} - \delta)e + d(\bar{\delta} - \delta)p + dp^0 - \frac{1}{2} m(p - p^0)^2, \\ a &> 0, \quad d > 0, \quad m > 0, \quad p^0 > 0 \\ f(\delta) &= \begin{cases} 1/\bar{\delta} & \text{if } \delta \in [0, \bar{\delta}] \\ 0 & \text{otherwise.} \end{cases} \end{aligned} \quad (24)$$

The proceeds function is separable in p and e which is restrictive, but it does permit the values of the advising and distribution services to be independently identified. The parameter p^0 may be thought of as an offer price at which the issue is expected to be fully subscribed. An offer price $p > p^0$ can result in greater net proceeds depending on the market parameter δ and the parameters d and m . To provide a needed second-order condition, it will be assumed that $2a^2m - bd^2 > 0$.

A. The Optimal Delegation Contract

From (3a) the effort response function given $S(\delta, x) = s(\delta) + tx$ is

$$e(\delta, \delta) = ta(\bar{\delta} - \delta)/b \quad (25)$$

which is decreasing in δ and is independent of p . From (19) the offer price function $p(\delta)$ is

$$p(\delta) = p^0 + d(\bar{\delta} - \delta(1 + t))/m \quad (26)$$

which is decreasing in δ . Solving (20) for $\mu(\delta)$ yields

$$\mu(\delta) = a(\bar{\delta}(1 - t) - \delta)/b \quad (27)$$

The expected proceeds $\bar{x}(\delta)$ are

$$\bar{x}(\delta) = a^2(\bar{\delta} - \delta)^2t/b + \frac{d^2((\bar{\delta} - \delta)^2 - t^2\delta^2)}{2m} + p^0 d(1 + \bar{\delta} - \delta) \quad (28)$$

From (13) the income $R(\delta, \delta, e(\delta, \delta))$ of the banker is

$$R(\delta, \delta, e(\delta, \delta)) = \frac{a^2 t^2 (\bar{\delta} - \delta)^2}{2b} + \frac{d^2 t ((\bar{\delta} - \delta)^2 - t(\bar{\delta}^2 - \delta^2))}{2m} + p^0 dt(\bar{\delta} - \delta) \quad (29)$$

which is strictly decreasing in δ if $p(\delta) > 0$, is strictly convex in δ , and satisfies $R(\bar{\delta}, \bar{\delta}, e(\bar{\delta}, \bar{\delta})) = 0$. The payment $s(\delta)$ obtained from (18) is given by

$$s(\delta) = \frac{d^2 t^2}{2m} (\delta^2(1+t) - \bar{\delta}^2) - t p^0 d. \quad (30)$$

which is strictly increasing and strictly convex in δ .

The optimal policy of the issuer may be interpreted as a self-selection mechanism in which for a fixed t the issuer offers the banker a set of contracts $\{s(\hat{\delta}), p(\hat{\delta}); \hat{\delta} \in [\underline{\delta}, \bar{\delta}]\}$, and the banker chooses among those contracts given his private information δ . The optimal set of contracts in Figure 1 is represented by the convex function $s^*(p)$ which is obtained from (26) and (30) and is given by¹⁷

$$s^*(p) = -t p^0 d + \frac{d^2 t^2}{2m} \left(\frac{\left(\bar{\delta} - (p - p^0) \frac{m}{d} \right)^2}{1+t} - \bar{\delta}^2 \right)$$

The slope of the banker's indifference curve in the (s, p) -plane is given by totally differentiating $R = s + t\bar{x} - C(e)$ to obtain¹⁸

$$\frac{ds}{dp} = -t\bar{x}_p = tm(p - p^0) - td(\bar{\delta} - \delta)$$

Indifference curves are shown in Figure 1 for the cases of high and low δ . If the banker knows that the market reception will be favorable (δ low), he will choose a contract with a high offer price and a low payment $s(\delta)$, while if δ is high, the banker will choose a lower offer price and a higher $s(\delta)$. The payment $s(\delta)$ is greater for high δ than for low δ because the banker has a greater incentive to misrepresent its information when δ is high than when it is low, and because when δ is high the compensation $t\bar{x}$ is low. Since the expected compensation of the banker is greater the more favorable is his information, the banker receives more of his compensation when δ is low in the form of his share $t\bar{x}$ of the expected proceeds and less in the form of the payment $s(\delta)$.

To verify that the optimal policy is incentive-compatible, consider an interval in $[\underline{\delta}, \bar{\delta}]$ such that $\pi(\delta) = 1$ for all δ in that interval. The revenue $R(\hat{\delta}, \delta, e(\hat{\delta}, \delta))$ is

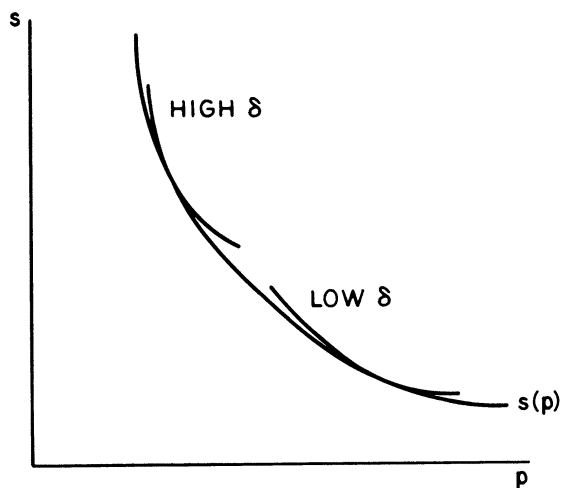
$$R(\hat{\delta}, \delta, e(\hat{\delta}, \delta)) = s(\hat{\delta}) + t\bar{x}(p(\hat{\delta}), e(\hat{\delta}, \delta), \delta) - C(e(\hat{\delta}, \delta))$$

and maximizing with respect to $\hat{\delta}$ yields the first-order condition

$$R_{\hat{\delta}}(\hat{\delta}, \delta, e(\hat{\delta}, \delta)) = \frac{d^2 t}{m} (1+t)(\delta - \hat{\delta}) = 0$$

¹⁷ The preferences of the banker for p and s in this example are independent of effort because of the separability of the expected proceeds function $\bar{x}$.

¹⁸ Substituting $p(\delta)$ from (26) indicates that the indifference curve is negatively sloped. The curvature (as measured by the second derivative) of the indifference curve is greater than the curvature of the contract function, as illustrated in Figure 1.

SELF-SELECTION BASED ON δ Figure 1. Self-selection based on δ

When $t > 0$, the second-order condition is satisfied for all $\hat{\delta}$, so it is globally optimal for the banker to report $\hat{\delta} = \delta$, and the optimal policy is strongly incentive-compatible.

The first-best distribution effort and offer price are

$$e^+(\delta) = a(\bar{\delta} - \delta)/b$$

$$p^+(\delta) = p^0 + \frac{d}{m} (\bar{\delta} - \delta)$$

Compared to the first-best solution, the second-best solution involves a lower distribution effort if $t \in (0, 1)$ and if $t \in (0, 1]$ a lower offer price. Furthermore, the income of the banker in the first-best solution is identically zero, while in the second-best solution the banker's income is strictly positive for $\delta < \bar{\delta}$. The issuer is thus strictly worse off and the banker strictly better off in the second-best solution for $\delta < \bar{\delta}$ than in the first-best solution. This results because of the asymmetry of information about δ and not because the distribution effort of the banker cannot be observed by the issuer.

The net expected proceeds $N(\delta)$ to the issuer in the second-best solution are

$$N(\delta) = \frac{a^2 t (\bar{\delta} - \delta)^2}{b} (1 - t) + p^0 d (1 + (1 - t)(\bar{\delta} - \delta)) + \frac{d^2}{2m} ((\bar{\delta} - \delta)^2 (1 - t) + t^2 (\bar{\delta}^2 - 2\delta^2)) \quad (31)$$

The reservation level $\bar{N}(\delta)$ will be assumed to be such that $N(\delta) > \bar{N}(\delta)$ for all $\delta \in [0, \bar{\delta}]$ at the optimal t , so $\pi(\delta) = 1$. Taking the expectation of $N(\delta)$ in (31) with

respect to δ yields

$$N = \frac{a^2 t(1-t)\bar{\delta}^2}{3b} + p^0 d(1 + (1-t)\bar{\delta}/2) + \frac{d^2 \bar{\delta}^2}{6m} (1-t+t^2) \quad (32)$$

The optimal share t^0 is obtained by maximizing N which yields

$$t^0 = \begin{cases} \max\left\{0, \frac{1}{2} - \frac{3p^0 m b d}{2y\bar{\delta}}\right\} & \text{if } y > 0 \\ 0 & \text{otherwise} \end{cases} \quad (33)$$

where $y \equiv 2a^2 m - d^2 b$ which has been assumed to be positive. If in (33) the term $(\frac{1}{2} - 3p^0 m b d / (2y\bar{\delta}))$ is negative, the optimal share t^0 is zero, and hence from (25) $e(\delta, \delta) = 0$ and from (30) $s(\delta) = 0$ for all δ . The banker thus receives no compensation but is as well off if he does or does not report δ truthfully. The program in (6)–(10) requires him to report δ truthfully in this case, but that is not realistic. To focus on the interesting case, attention will be restricted to those problems in which t^0 is positive.

When $y > 0$, the optimal share is bounded above by $\frac{1}{2}$, so the issuer never gives the banker more than half of the proceeds. In this case the optimal share t^0 is an increasing function of a indicating that the greater is the marginal effectiveness of the distribution effort the greater is the share of the proceeds given to the banker. The greater share reduces the offer price $p(\delta)$ from (26), so the issuer responds to a more effective sales effort by reducing the offer price and inducing a greater effort by giving the banker a greater share of the proceeds. Similarly, an increase in m reduces the marginal expected proceeds from an increase in the offer price, so the issuer increases the share allocated to the banker in order to increase his effort. An increase in the marginal cost b of effort or the marginal return (higher d) to a greater offer price decreases the share given to the banker.

From (27) when $t^0 > 0$ the multiplier $\mu(\delta)$ is positive for δ such that

$$\delta < \bar{\delta}/2 + 3p^0 m b d / (2(2a^2 m - d^2 b))$$

Consequently, at least for favorable information (δ low), the issuer prefers that the banker exert greater distribution effort. For unfavorable information, however, the issuer may prefer that the banker exert less distribution effort.

For the case in which $t^0 > 0$ the expected net proceeds N after substituting for t^0 are¹⁹

$$N = p^0 d + \frac{d^2 \bar{\delta}^2}{6m} + \frac{(\bar{\delta}y + 3p^0 m b d)^2}{24mby} \quad (34)$$

The objective is to compare N in this case with the expected proceeds from the other two alternatives available to the issuer, a pure distribution contract and a direct sale, in order to determine the value of the advising and distribution services of the investment banker. Before considering these two alternatives, the effect of the issuer's uncertainty about the private information δ of the banker will be analyzed.

¹⁹ The optimal contract with t^+ given in (33) is superior to a firm commitment contract ($t = 1$) by the amount represented by the last term in (34).

B. The Effect of the Issuer's Uncertainty About δ on the Demand for Delegation

In a delegation contract, the issuer benefits from both the distribution effort and the private information of the banker. If the issuer knew δ , there would obviously be no benefit from delegating the offer price decision and one might conjecture that the more uncertain the issuer is about δ the greater would be the value of delegating that decision. To examine this issue in the context of the example, consider the case in which the issuer's density function $f(\delta)$ is given by

$$f(\delta) = \begin{cases} \frac{1}{\bar{\delta} + \Delta - (\underline{\delta} - \Delta)} & \text{if } \underline{\delta} - \Delta \leq \delta \leq \bar{\delta} + \Delta \\ 0 & \text{otherwise} \end{cases}$$

where $\Delta > 0$. The mean of δ is independent of Δ , so an increase in Δ may be interpreted as representing greater uncertainty on the part of the issuer. In order that the marginal return be independent of Δ , the expected proceeds in (24) will be rewritten with $\bar{\delta}$ replaced by $\bar{\delta} + Z$ where Z is a positive constant such that $Z > \Delta$.

With this specification, the solution to (6)–(10) is given by

$$e_{\Delta}(\delta, \delta) = \frac{at(\bar{\delta} + Z - \delta)}{b} \quad (25a)$$

$$p_{\Delta}(\delta) = p^0 + \frac{d}{m} (\bar{\delta} + Z - \delta - t(\delta - (\underline{\delta} - \Delta))) \quad (26a)$$

$$\begin{aligned} \bar{x}_{\Delta}(\delta) = & \frac{a^2 t (\bar{\delta} + Z - \delta)^2}{b} + p^0 d (1 + \bar{\delta} + Z - \delta) \\ & + \frac{d^2}{2m} ((\bar{\delta} + Z - \delta)^2 - t^2 (\delta - (\underline{\delta} - \Delta))^2) \end{aligned} \quad (28a)$$

$$\begin{aligned} R_{\Delta}(\delta, \delta, e(\delta, \delta)) = & \frac{a^2 t^2 ((\bar{\delta} + Z - \delta)^2 - (Z - \Delta)^2)}{2b} \\ & + p^0 dt (\bar{\delta} + \Delta - \delta) + \frac{d^2 t}{2m} ((\bar{\delta} + Z - \delta)^2 \end{aligned} \quad (29a)$$

$$\begin{aligned} - t((\bar{\delta} + \Delta - (\underline{\delta} - \Delta))^2 - (\delta - (\underline{\delta} - \Delta))^2)) \\ N_{\Delta}(\delta) = & \frac{a^2 t (1 - t) (\bar{\delta} + Z - \delta)^2}{b} \\ & + p^0 d (1 + (1 - t) (\bar{\delta} + Z - \delta) + t(Z - \Delta)) \\ & + \frac{d^2}{2m} ((1 - t) (\bar{\delta} + Z - \delta)^2 \end{aligned} \quad (31a)$$

$$\begin{aligned} + t^2 ((\bar{\delta} + \Delta - (\underline{\delta} - \Delta))^2 - 2(\delta - (\underline{\delta} - \Delta))^2)) \\ + \frac{a^2 t^2}{2b} (Z - \Delta)^2 + \frac{d^2 t}{2m} (Z - \Delta)^2 \end{aligned}$$

$$\begin{aligned}
N_{\Delta} = & \frac{a^2 t (1-t) (\bar{\delta} + \Delta - (\underline{\delta} - \Delta))^2}{3b} \\
& + p^0 d (1 + (1-t)(\bar{\delta} - \underline{\delta})/2 + \Delta) + t(Z - \Delta) \\
& + \frac{d^2}{6m} (\bar{\delta} + \Delta - (\underline{\delta} - \Delta))^2 (1-t+t^2) \\
& + \frac{a^2 t}{b} ((Z - \Delta)^2 + (Z - \Delta)(\bar{\delta} + \Delta - (\underline{\delta} - \Delta))) \\
& - \frac{a^2 t^2}{b} (Z - \Delta)(\bar{\delta} + \Delta - (\underline{\delta} - \Delta)) - \frac{a^2 t^2}{2b} (Z - \Delta)^2 \quad (32a) \\
& + \frac{d^2}{2m} ((Z - \Delta)^2 + (Z - \Delta)(\bar{\delta} + \Delta - (\underline{\delta} - \Delta))) \\
& - t(Z - \Delta)(\bar{\delta} + \Delta - (\underline{\delta} - \Delta))
\end{aligned}$$

$$t_{\Delta}^0 = \begin{cases} \max \left\{ 0, \frac{1}{2} - \frac{3(p^0 dbmL - a^2 m(Z - \Delta)^2 + d^2 b(Z - \Delta)L)}{(2a^2 m(2L^2 + 3(Z - \Delta)^2 + 6(Z - \Delta)L) - 2bd^2 L^2)} \right\} & \text{if } a^2 m(2L^2 - 3(Z - \Delta)^2 + 6(Z - \Delta)L) - bd^2 L^2 > 0 \\ 0 & \text{otherwise,} \end{cases} \quad (33a)$$

where $L = \bar{\delta} + \Delta - (\underline{\delta} - \Delta)$.

For a given t , the offer price function is decreasing in Δ , indicating that as the uncertainty of the issuer increases he is willing to accept a lower offer price. If an issuer of unseasoned securities may be taken to be more uncertain about the market reception for its securities than is an issuer of seasoned securities, the issuer of unseasoned securities will accept a lower offer price and hence underpricing, as indicated in the study by Ibbotson [10], would be expected.

The mean proceeds $\bar{x}_{\Delta}(\delta)$ are strictly decreasing in Δ for a given t , so the issuer views the offering as less "valuable" the greater is his uncertainty about the parameter δ . The effect of Δ on the income of the banker and the net proceeds of the issuer is ambiguous in general, however, but as will be demonstrated next, the gain to the issuer from a delegation contract relative to a pure distribution contract is an increasing function of the issuer's uncertainty.

C. A Pure Distribution Contract

The second alternative available to the issuer is to engage the banker only for its distribution services. The issuer knows that the banker will choose the response function $e(\delta, \delta) = ta(\bar{\delta} - \delta)/b$, and to ensure that the banker will distribute the issue, the income $R^*(\delta)$ of the banker, given by

$$\begin{aligned}
R^*(\delta) = & t \left(\frac{a^2 (\bar{\delta} - \delta)^2 t}{b} + dp(\bar{\delta} - \delta) + p^0 d - \frac{1}{2} m(p - p^0)^2 \right) \\
& + T - \frac{a^2 (\bar{\delta} - \delta)^2 t^2}{2b}
\end{aligned}$$

must be nonnegative.²⁰ This implies that the lump-sum payment T must satisfy

$$T(p, t) = \frac{t}{2} m (p - p^0)^2 - t p^0 d$$

The reservation level $\bar{N}(\delta)$ of the issuer will be assumed to be such that the issuer prefers to sell the issue for all δ . The issuer will choose the offer price p and the share t based on his own information about δ , as represented by $f(\delta)$, to maximize his expected net proceeds N^* given by

$$\begin{aligned} N^* &= \int ((1-t)\bar{x} - T) f(\delta) d\delta \\ &= (1-t) \left(\frac{a^2 t \bar{\delta}^2}{3b} + \frac{d\bar{\delta}}{2} p + p^0 d \right. \\ &\quad \left. - \frac{1}{2} m (p - p^0)^2 \right) - \frac{t}{2} m (p - p^0)^2 + t p^0 d \\ &= (1-t) \left(\frac{a^2 t \bar{\delta}^2}{3b} + \frac{d\bar{\delta}}{2} p \right) - \frac{1}{2} m (p - p^0)^2 + p^0 d \end{aligned} \quad (35)$$

The optimal offer price p^* given by

$$p^* = p^0 + \frac{d\bar{\delta}(1-t)}{2m} \quad (36)$$

which is the expectation of the optimal price function $p(\delta)$ in (26) for a delegation contract. Substituting p^* into N^* and maximizing with respect to t yields

$$t^* = \begin{cases} \max \left\{ 0, \frac{1}{2} - \frac{3d^2b + 12dp^0bm/\bar{\delta}}{2(8a^2m - 3d^2b)} \right\} & \text{if } 8a^2m - 3d^2b > 0 \\ 0 & \text{otherwise,} \end{cases} \quad (37)$$

which is bounded above by $\frac{1}{2}$. Comparing t^* with t^0 in (33) when both are positive yields

$$t^0 - t^* = \frac{3d^2b}{2(8a^2m - 3d^2b)} \left[1 + \frac{3p^0mbd/\bar{\delta}}{2a^2m - d^2b} \right] > 0$$

so the issuer gives the banker a smaller share of the proceeds in a pure distribution contract than in a delegation contract. The intuition behind this result is unclear, but it may simply be that the issuer uses the greater share in a delegation contract as a portion of the payment for the banker's information about δ .

The delegation of the offer price decision allows the issuer to take advantage of the banker's information about δ , and the expected proceeds $E(\bar{x}(\delta))$ from a delegation contract using (32) are given by

$$E(\bar{x}(\delta)) = \frac{a^2 t \bar{\delta}^2}{3b} + \frac{d^2 \bar{\delta}^2}{6m} (1 - t^2) + p^0 d (1 + \bar{\delta}/2) \quad (38)$$

²⁰ It may be possible to improve on this contract by providing the banker with a compensation function that he will reject when δ is unfavorable and will accept when δ is favorable, since this would reveal some information about the true δ . In this example, $\bar{N}(\delta)$ is assumed to be such that having the banker always accept the contract is optimal.

The expected proceeds $E(\bar{x}^*(\delta))$ from a pure distribution contract are

$$E(\bar{x}^*(\delta)) = \frac{a^2 t \bar{\delta}^2}{3b} + \frac{d^2 \bar{\delta}^2}{8m} (1 - t^2) + p^0 d(1 + \bar{\delta}/2)$$

so for all $t < 1/2$ the expected proceeds with a delegation contract are strictly greater than with a pure distribution contract. Since the effort expended in the two cases is the same, the total proceeds available to the issuer and the banker are greater under a delegation contract. This does not imply, however, that the issuer is strictly better off with price delegation, since the banker must be compensated for its information about δ .

To determine if the issuer strictly prefers a delegation contract to a pure distribution contract, substitute (36) into (35) and subtract N^* from N in (32) to obtain

$$N - N^* = \frac{d^2 \bar{\delta}^2}{24m} (1 + t)^2 > 0 \quad (39)$$

The issuer strictly prefers a delegation contract to a pure distribution contract, since for any t the difference in (39) is positive, and hence at the optimal shares t^0 and t^* it is also positive. A lower bound on the value to the issuer of the advising services is given by evaluating (39) at $t = t^*$.

To determine the effect of greater uncertainty on the part of the issuer on the value of a delegation contract relative to a pure distribution contract, consider the example of Section II.B. The difference $N_\Delta - N_\Delta^*$ in the net proceeds of the issuer under the two contracts is

$$\begin{aligned} N_\Delta - N_\Delta^* &= \frac{d^2}{24m} (\bar{\delta} + \Delta - (\underline{\delta} - \Delta))^2 (1 - t)^2 \\ &\quad + \frac{d^2 t}{2m} (Z - \Delta)((\bar{\delta} + \Delta - (\underline{\delta} - \Delta))(1 - t) + (Z - \Delta)(2 - t)) \end{aligned}$$

which is strictly increasing in Δ . Greater uncertainty on the part of the issuer thus increases the advantage of a delegation contract over a pure distribution contract because the issuer benefits from the responsive pricing of the banker over a wider range of values of δ .

D. The Direct Sale Alternative

If the issuer sells the issue directly without employing the services of an investment banker, the optimal offer price p^* maximizes the expected proceeds $E\bar{x} = \int \bar{x}f(\delta) d\delta$ and is given by (36) with $t = 0$. The optimal expected proceeds are

$$E\bar{x} = dp^0 \left(1 + \frac{\bar{\delta}}{2}\right) + \frac{d^2 \bar{\delta}^2}{8m} \quad (40)$$

The expected proceeds $E(\bar{x}(\delta))$ from a delegation contract are greater than $E\bar{x}$, since subtracting (40) from (38) yields

$$E(\bar{x}(\delta)) - E\bar{x} = \frac{a^2 t \bar{\delta}^2}{3b} + \frac{d^2 \bar{\delta}^2}{24m} (1 - 4t^2) \quad (41)$$

which is positive since t^0 is bounded above by $\frac{1}{2}$. The first term in (41) represents the value of the distribution services of the banker, and the second term represents the value of the advising services.

To determine the gain to the issuer from a delegation contract relative to a direct sale, subtract (40) from N in (32) to obtain

$$N - E\bar{x} = \frac{d^2 \bar{\delta}^2}{24m} + \frac{t(1-t)\bar{\delta}^2 y}{6mb} - p^0 d \frac{t\bar{\delta}}{2}$$

which is positive for $t = 0$ and hence is positive at the optimal t^0 . The issuer thus strictly prefers a delegation contract over a direct sale, indicating a positive demand for the advising and distribution services of the investment banker.

A delegation contract has two advantages over a direct sale. First, the issuer benefits from the distribution effort of the banker not only because greater effort increases the net proceeds to the issuer but also because the effort expended responds optimally to the information δ . Second, the issuer benefits from being able to price responsively based on the banker's information. The responsive pricing and effort decisions result in a net proceeds function $N(\delta)$ for the issuer that is strictly convex in δ , and by Jensen's inequality the expectation N of $N(\delta)$ is greater than $N(E(\delta))$, so the issuer benefits from the banker's response to his information.

To determine the issuer's preference for a pure distribution contract versus a direct sale, note that a direct sale is a special case of a pure distribution contract for $t = 0$. Consequently, if the issuer finds it optimal to share the proceeds with the banker, a pure distribution contract is preferred to a direct sale. Since the optimal share t^* is increasing in a and decreasing in b , the greater is the marginal return or the smaller is the marginal cost of effort, the stronger is the preference for a pure distribution contract over a direct sale.

III. Conclusions

If the issuer and the banker were equally informed about the capital market, a firm commitment contract would be optimal, and the issuer would have a demand only for the distribution services of the banker which would be supplied at the first-best level. If the banker is better informed than is the issuer, however, the issuer will still have a demand for the banker's distribution services although the inability of the issuer to observe the distribution effort of the banker causes the banker to supply, at least in the example of Section II, less than the first-best effort level under a pure distribution contract. The issuer may be able to improve on a pure distribution contract by employing the advising services of the banker under a delegation contract. Under such a contract, the offer price decision is delegated to the banker who sets the offer price based on his superior information about the capital market. The issuer must compensate the banker for the use of his information, so the banker shares in the gains from his superior information. In the example, the optimal offer price is below the first-best offer price indicating that new issues would be underpriced when the banker is better informed than the issuer. Furthermore, if issuers of unseasoned securities are less well informed about the capital market than are issuers of seasoned securities, the former would

have a greater demand for the advising function of an investment banker. The issuers of unseasoned issues also would be willing to accept a lower price the greater is their uncertainty about the market demand for the issue.

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