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# The Investment Banking Contract For New Issues Under Asymmetric Information: Delegation And The Incentive Problem

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ABSTRACT

In placing a new security issue, an investment banker has an opportunity to obtain private information by conducting preselling activities during the registration period. The task of the issuer is to design a contract that both induces the banker to use this information to the issuer's advantage and provides a disincentive for the banker to price the issue too low in order to reduce the effort required to sell the issue. This paper characterizes the class of price response functions that the issuer can induce the banker to choose under a delegation scheme and demonstrates that delegating the pricing decision to the banker can be optimal.

MOST NEW SECURITY ISSUES are managed and distributed by investment banking syndicates that perform three basic services for the issuer of the securities. First, investment bankers provide advice and counsel regarding the type of securities to be issued, coupon rates, maturity, timing, offer price, etc. Second, the banking syndicate serves an underwriting function by bearing some or all of the risk associated with the proceeds of the issue. Third, the syndicate performs a distribution function by selling the securities to investors. The underwriting or risk-sharing function has been analyzed by Mandelker and Raviv [12] who determined conditions under which firm commitment, best efforts, and standby arrangements are optimal under the assumption that the issuer and the banker have symmetric information regarding the proceeds from a new issue. Also using the assumption of symmetric information, Baron [1] investigated the pricing and distribution of new issues and the incentive problem resulting from the inability of the issuer to observe the effort expended by the banker in distributing the securities. To mitigate the incentive problem in that case, the issuer must sacrifice some gains from optimal risk sharing in order to induce the banker, through the design of the commission payment, to expend more effort in selling the issue than the banker would otherwise expend.

When the issuer and the banker have symmetric information regarding the demand for the issue, the issuer has no reason to seek advice from the investment banker. A principal reason for utilizing the services of an investment banker, however, is that the banker may have better information than does the issuer

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regarding the demand for the issue and the state of the capital market. This informational asymmetry may arise, for example, because the investment banker obtains private information about the demand for the securities through its preselling contacts with potential purchasers. In this case, the potential incentive problems are aggravated because the banker has the opportunity through its advisement function to recommend an offer price that is contrary to the issuer's interests, and because of his limited information, the issuer is unable to determine if the recommended price is appropriate. The principal reason that the issuer's and the banker's interests do not coincide is that distribution of the issue involves substantial costs that are borne by the banker, and thus, the banker has an incentive to limit those costs by pricing lower than the issuer would like. As Van Horne [19, p. 535] states, "the underwriter wants a price that is high enough to satisfy the issuer, but low enough to make the probability of successful sale to investors reasonably high." Stoll [19, p. 101] elaborates: "A second strategy would set the offering price too low, thereby bringing about quick sale of the issue. . . . the underwriter would experience lower costs and might be able to benefit favored customers in this way . . ." While the opportunity for such behavior may be greater for unseasoned than for seasoned issues, the opportunity may be present with any issue.

One strategy that the issuer may adopt when the banker is able to obtain superior information regarding the demand for the issue is to delegate the offer price decision to the banker so that the banker can use its superior information to make a more informed decision than the issuer could make based on his limited information. Such delegation may be desirable even though the banker may not set the same offer price that the issuer would set if the issuer had the same information as the banker. Delegation is likely to be the most common arrangement for pricing new issues, and this paper is concerned with the design of the compensation schedule for the banker under a delegation scheme in order to bring the interests of the banker more in line with those of the issuer.

The seriousness of these incentive problems has received only limited empirical attention.[1] Smith [18] studied underwritten equity issues for the January 1971–December 1975 period and concluded that "underwriters appear to set the offer price below the market value of the stock by at least 0.5 percent [18, p. 274]."[2] Ibottson [10] studied the performance of unseasoned new issues in the aftermarket and concluded that the offer price is set approximately 11.4 percent below the market value. In his study of competitive bidding for corporate securities Christenson [2] tentatively concluded that not only do investment bankers underprice

[1] Friend [6] has presented an earlier study on investment banking compensation for new issues.

[2] Stoll [19, p. 102] tentatively draws the opposite conclusion:

> The fact that on average there is no postoffering price recovery in the short run suggests that the offering price was not set below the market's judgment of the equilibrium price. This conclusion should be tempered by the fact that some negative correlation between pre and postoffering price changes exists particularly in the case of primary and combination issues and by the relatively short period of time (nine trading days) for which postoffering prices were observed. Certainly, more investigation of this point is warranted.

relative to the interests of issuers but they even underprice relative to their own best interests.

> In the case of pricing policies, there is reason to believe, as noted earlier, that investment bankers are overly reluctant to carry inventories of unsold bonds. While this conclusion is still tentative and further research is suggested, if the conclusion is supported it will mean that bankers can improve their overall profitability by pricing somewhat higher even at the expense of carrying higher average inventories. [2, p. 5]

There are two principal factors that may mitigate the incentive to underprice. First, the investment banking industry is to some extent competitive, and a banker that continually prices new issues "lower" than the industry norm is likely to lose some market share.[3] The threat of such losses may restrict deviations from the norm, but this does not imply that the incentive problem is eliminated by competitive pressures but rather that divergence from the norm would not be anticipated. In an industry in which tradition plays an important role (see Hayes [7]), the norm may reflect the results of the incentive problem.[4] The studies by Smith and Ibottson are supportive of this view. As further evidence that the industry may not be competitive, Ederington [5] concluded that the spread on issues sold through competitive bidding decreases as the number of bidders increase.[5]

The second factor that could act to mitigate the incentive problem is the sophistication of the issuer. As Weston and Brigham [22, p. 467] state, "If the issuer is financially sophisticated and makes comparisons with similar security issues, the investment banker is forced to price close to the market."[6] There is

[3] A competitive model involving principal-agent contracting is not yet available, although Ross [17] has provided some initial results on the choice of an agent by a principal.

[4] A study by Davey [4] of 100 companies sheds some light on the competitiveness issue by indicating the extent to which issuers choose among investment bankers:

> Sixty-three companies, or almost two-thirds of those polled, maintain multiple investment banking relationships. The range of such associations extends from a low of two to a high of eighteen: the median is three. ... Two-thirds (67) of participating companies have maintained current investment banking connections for at least the past five years (many of these associations date back a score of years or more); the remaining one-third (33) have either changed investment banking affiliations, added to the number of investment bankers used, or abstained from forming any investment banking association during the period. [3, pp. 7–8]

This survey suggests that many negotiated offering do not involve direct competition among bankers but instead are determined by continuing associations.

[5] An indication that the investment banking industry may not be competitive is the legislation requiring that public utilities solicit competitive bids for new security issues.

[6] Dynamic factors and the market power of an issuer may lead the banker to set the offer price too high.

> An even higher return of about 9.2% widely had been anticipated, as indicated by a paucity of purchase orders for the Michigan Bell securities. "Underwriters are setting aggressive terms on Bell System issues in an attempt to curry favor with AT&T, which is expected to need a huge amount of high-priced financial services in the months ahead," one specialist noted. (*Wall Street Journal*, 11/29/78)
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> Michigan Bell Telephone Co.'s new 9⅛% debentures were marked down drastically only a day after being poorly received by investors in the $100 million offering, dealers said.

recent evidence however that some issuers are dissatisfied with investment banking pricing and commission practices. Robertson [16] reports that

> Since the beginning of the Seventies a few of Morgan Stanley's clients have, for example, arranged their own private placements without using the firm as intermediary. They include Texaco, Mobil, and just last month, International Harvester, which directly placed $150 million of bonds. Other companies are raising very large amounts of capital through such channels as dividend reinvestment plans and employee stock purchase plans.... Exxon has been especially ambitious at do-it-yourself financing. For two bond issues totalling $305 million, Exxon's chief financial officer, Jack Bennett, has conducted "Dutch auctions" in a widely publicized departure from conventional underwriting practices.... Bennett... figures it saved Exxon about $1.9 million compared with what it would have spent on a conventional underwriting. [16, pp. 88 and 90]

These indications of client dissatisfaction with traditional investment banking practices suggest that the incentive problems may be present and may have significant costs to issuers.[7]

The purpose of this paper is to formalize the incentive problems discussed above and to present an analysis of a number of specific issues arising from the incentive considerations. A general formulation of the problem is given in Section II, but does not admit an easy solution except in the case in which the banker is risk neutral. Then, a firm-commitment contract in which the banker bears all the risk is optimal. Except in that case, an optimal contract will involve both parties bearing some risk. To gain insight into the incentive design problem in the other cases, special structures are studied. Section III is concerned with the pricing decision alone, and the main result gives limits on the issuer's ability to change the banker's preferences for the offer price by using a commission payment based on that price. Section IV analyzes the effort incentive problem alone, and under reasonable assumptions it is shown that within the context of linear schemes additional risk is transferred to the banker to induce it to supply more effort than it otherwise would. Given this result, Section V studies simultaneously the effort and pricing decisions and gives conditions under which the issuer can utilize the superior information of the banker by delegating to him the right to set the issue price subject to a lower bound. Some concluding remarks are given in Section VI.

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The American Telephone & Telegraph Co. subsidiary's triple-A rated, 40-year obligation plunged to about 98⅜, where their yield soared to 9.28%, upon being released into the resale market early yesterday. They initially had been priced at 99.628, to yield 9.16%, the most for any comparable Bell System issue in three years.

That sharp markdown reduced a buyer's cost by the equivalent of $12.53 for every $1,000 face amount. It also resulted in a loss of about $6.84 for each $1,000 face amount to the underwriters, who originally envisioned a profit of about $5.69. (*Wall Street Journal*, 11/30/78)

[7] Not only is there increasing pressure from clients to modify traditional practices, but the industry custom of fixed-priced offerings, and hence fixed spreads, is being challenged by the Department of Justice under conditions not dissimilar to those that led to the elimination of fixed brokerage commissions. (Loomis [11]).

## I. The Issue Process and Asymmetric Information

The model to be analyzed involves an issuer who plans to sell a fixed number of securities and has decided to utilize the services of an investment banking house for their sale rather than using a rights offering, for example. The analysis focuses on a "negotiated sale" in which an agreement or contract is to be concluded between the investment banker and the issuer for the sale of the securities.[8] When the issuer has decided to raise capital by selling new securities, he is assumed to meet with the banker at which time they share their information, decide on the specifics of the issue, agree to the terms of the contract, and register the issue with the SEC. At this time the issuer and the banker will be assumed to have symmetric information regarding the demand for the issue.[9]

At the time of registration a preliminary prospectus, the "red herring," is issued, and a registration period of at least twenty days follows. During the registration period, the banker conducts preselling activities.

> During the waiting period between the filing and the offer date, no written sales literature other than the so-called "red herring" prospectus and "tombstone" advertisements are permitted by the SEC. However, oral selling efforts are permitted, and the underwriters can and do note interest from their clients to buy at various prices. These do not represent legal commitment, but are used to help the underwriter decide on the offer price for the issue. (Smith [18] pp. 298–9)

Ibottson [10, p. 263] is more specific:

> Underwriters typically ask the purchasers to "circle" (pledge to subscribe to) the issues at a certain price. Even though this pledge is not legally binding, no purchaser could disguise his demand curves for the issues over a reasonable period of time without giving up his access to the new issue market.

This information is not perfect, of course, because of limited contacts with potential purchasers and because the state of the capital market can change between the registration period and the offer date. The concern addressed here is not with the accuracy of the information received but instead with the informational asymmetry created by the banker's access to information not directly available to the issuer.

Before formalizing this informational asymmetry, it is necessary to specify the demand for the securities. The issuer is assumed to offer a fixed quantity $B$ of securities the demand for which depends on an uncertain state $\theta$, $\theta \in [\underline{\theta}, \bar{\theta}] \subset \mathbb{R}$, of the market specifying how the market perceives the quality of the issue. To simplify the analysis, the offer period will be assumed to be of fixed duration with the demand $Q(p,a,\theta)$ for the securities during the offer period being a function of $\theta$, the offer price $p$, and the distribution effort $a$. The latter may be thought of as

[8] The analysis does not deal with the contractual arrangements between members of the underwriting syndicate or between underwriters and the selling group. The interactions among syndicate members is illustrated by Christenson [2, pp. 24–27].

[9] The issuer may have an informational advantage regarding its own profitability, for example, but unless that information can be communicated to the market so that it affects the demand for the securities, it is not of concern here.

the time of the salesmen allocated to this issue.[10] The states will be ordered such that $Q$ is an increasing function of $\theta$. During the offer period the banker is assumed to conduct stabilizing activities by placing simultaneous buy and sell orders at $p$ so that, hopefully, the remaining securities can be sold at $p$.[11] If stabilization is unsuccessful because of low demand and selling pressure, the unsold securities are assumed to be sold in the resale market at an uncertain price $p(\theta,a)$, satisfying $Q(p(\theta,a),a,\theta) = B$, which depends on the distribution effort as well as the state.[12] The price $p(\theta,a)$ in the resale market is assumed to be such that $p(\theta,a) = p$ if and only if $Q(p,a,\theta) = B$ and $p(\theta,a) < p$ if and only if $Q(p,a,\theta) < B$. The resale price will naturally be assumed to be increasing in $\theta$ and in $a$. The proceeds $x^*(p,a,\theta)$ from the sale thus are

$$x^*(p,a,\theta) = \begin{cases} pQ(p,a,\theta) + p(\theta,a)(B - Q(p,a,\theta)) & \text{if} \quad Q(p,a,\theta) < B \\ pB & \text{if} \quad Q(p,a,\theta) \geq B. \end{cases}$$

The net proceeds $x(p,a,\theta)$ are defined by

$$x(p,a,\theta) = x^*(p,a,\theta) - c,$$

where $c$ represents the cost of registration, legal and auditing fees, printing costs, etc.

Given the assumptions on $Q$ and $p(\theta,a)$, the function $x$ is increasing in $\theta$ when $Q < B$ and will be assumed to be differentiable and concave in $(p,a)$ and to be increasing in $a$ when $Q < B$. It will further be assumed that

$$A.\ x_{p\theta} \geq 0, \quad \text{and} \quad x_{p\theta} > 0 \quad \text{when} \quad Q < B$$

$$B.\ x_{ap} \geq 0, \quad \text{and} \quad x_{ap} > 0 \quad \text{when} \quad Q < B.$$

Assumption $A$ implies that the marginal return from an increase in the offer price is greater for higher values of $\theta$, which corresponds to the parameterization of $\theta$ such that higher values are associated with a more favorable reception for the securities in the capital market. Assumption $B$ implies that a higher price yields

[10] Demand is assumed to be independent of the type of contract agreed to by the issuer and the banker except for the indirect effect of the contract on the distribution effort and the pricing decision.

[11] For a best efforts arrangement the entire issue will be sold at an uncertain price rather than a stabilized offer price, but such an arrangement is optimal only when there is symmetric information, complete observability, and the issuer is risk neutral while the banker is risk averse. These conditions are not reasonable, so the issue will be assumed to be offered to the market at a specified offer price $p$. In practice members of an investment banking syndicate may sell at a discount through "overtrading" and "soft-dollar designations." (see Loomis [11])

[12] Stoll [19] concludes "thus, stabilization appears to occur in response to falling prices and presumably in an attempt to shore them up. The evident lack of success of stabilization makes one wonder why it is engaged in and how the managing underwriter disposes of the stock he purchases. In the model considered here the banker disposes of the securities at $p(\theta,a)$. The determination of the price $p(\theta,a)$ is difficult to characterize as Friend [6, p. 34] states: "Some firms may prefer to carry securities in inventory rather than mark them down when selling proves difficult at offering prices: others may simply dispose of 'sticky' issues at the best prices obtainable after termination of syndicate selling operations."

higher returns to increased effort, which is a property that might be expected to be satisfied.[13]

The informational asymmetry between the banker and the issuer will be represented by assuming that the banker receives through its preselling activities a signal or information in the form of the realization $\omega$, $\omega \varepsilon \Omega$, of a random variable that is not observable by the issuer.[14] At the end of the registration period the investment banker then has a conditional distribution $f(\theta|\omega)$ on the state. The issuer and the banker are assumed to hold identical prior beliefs about the distribution of $\theta$ and about the signal $\omega$, and thus the informational asymmetry arises only because the issuer is unable to observe $\omega$. The distribution of the signal $\omega$ will be assumed to be absolutely continuous with a differentiable density function $f(\omega)$.

The signal $\omega$ will be interpreted as information regarding the perceived quality of the issue with higher values of $\omega$ corresponding to "more favorable" information in the sense that a higher value of $\omega$ results in a distribution $f(\theta|\omega)$ that is stochastically dominant in the first degree or

$$\int_{\bar{\theta}}^{\theta} f_\omega(\theta^+|\omega)d\theta^+ \leq 0 \quad \text{for all} \quad \theta\varepsilon[\underline{\theta},\bar{\theta}] \tag{1}$$

with a strict inequality holding for some $\theta^+$, where the subscript denotes partial derivative. Since $x$ is increasing in $\theta$ for $Q < B$, an increase in $\omega$ results in a stochastically dominant distribution of the net proceeds. Letting $\theta^+(p,a,x)$ be defined by

$$x = x(p,a,\theta^+),$$

the probability that net proceeds will be less than or equal to $x$ is

$$G(x|p,a,\omega) = \int_{\underline{\theta}}^{\theta^+} f(\theta|\omega)d\theta.$$

It will further be assumed that

$$G_{p\omega} \leq 0 \quad \text{for all} \quad x \geq 0, \tag{2}$$

with the strict inequality holding for some $x^+$. This condition states that if more favorable information is obtained a small increase in price can be made that will result in a more favorable distribution of the proceeds. This assumption is used only in interpreting the sufficient condition for Proposition 2.

[13] An example of such a demand function is

$$Q(p,a,\theta) = M(a,\theta) - pN(a,\theta)$$

with $M_a, M_\theta > 0$ and $N_a, N_\theta < 0$.

[14] The case in which an informational asymmetry is present prior to signing the contract is also important but will not be considered here.

## II. The Commission Function

The commission paid by the issuer to the banker is the instrument that the issuer may employ to induce the banker under delegation to utilize the information $\omega$ in the issuer's interests and to expend more effort in distributing the issue than it would otherwise expend. The payment will be represented by an "commission function" $S^*$ that may be a function of any variable that is observable by both the issuer and the banker.[15] In the model considered here, the net proceeds $x$ and the offer price $p$ are observable by the issuer, while $\omega$ and $a$ are not observable.

The net receipts of the issuer are $(x - S^*)$, and the preferences of the issuer will be represented by an increasing, strictly concave von Neumann-Morgenstern utility function $U$. The issuer's preferences are thus represented by[16]

$$\int EU(\omega)f(\omega)\,d\omega = \int\int U(x - S^*)f(\theta|\omega)f(\omega)\,d\theta\,d\omega,$$

where $EU(\omega)$ is the expected utility conditional on $\omega$. The observation that most new issues involve firm commitment arrangements suggests that issuers are risk averse, and the analysis will focus on that case.

The "banker" may be thought of as the managing house representing a syndicate, and the banker's preferences will be assumed to depend on both its compensation $S^*$ and on the effort it expends in distributing the issue. Preferences are represented by a utility function $V(S^*,a)$, where $V_1 > 0$, and $V_{11}$ is nonpositive reflecting risk aversion or risk neutrality. The utility function is assumed to be strictly decreasing in effort, indicating both a preference for the expenditure of less to more effort and a desire not to use "muscle" on customers by "persuading" them to buy securities that they otherwise would not wish to purchase.

The use of firm commitment contracts is not consistent with risk-averse behavior of investment bankers, but the formation of syndicates is inconsistent with risk neutrality unless there are real costs of bankruptcy or decreasing returns to the distribution effort.[17] Another possible explanation of the use of firm

[15] In practice, a banker's compensation depends on a variety of other factors including whether the banker manages the issue and the percentage of the issue he underwrites. For example, Robertson [16] states:

> Nowadays a not atypical spread on a large industrial stock offering of, say, \$100 million might be 3½ percent, or \$3.5 million. For being sole manager, Morgan Stanley generally gets 20 percent of that (\$700,000 in this example) as compensation for devising the selling strategy and selecting and marshalling the other underwriting firms that participate as members of the syndicate. The 20 percent is the industry norm; if there are two or more co-managers, they will usually get equal shares of that.
>
> If Morgan Stanley were to underwrite and sell, say, 20 percent of the shares in the example—as well it might as long as non co-managers were involved—it would receive 20% of the remainder of the spread. That would add another \$560,000, for a total of almost \$1.3 million.

[16] An alternative interpretation of the function $U$ is a market valuation function given an investment $(x - S^*)$, so that $EU$ represents the market value prior to the issue period. Concavity then corresponds to decreasing returns to investment.

[17] Some investment banking houses are reputed for their distributional ability which suggests that the formation of syndicates may be due at least in part to differential ability to place securities.

commitment contracts is that they arise because of tradition and that while investment bankers would prefer to bear less risk they receive sufficient commissions to compensate for the additional risk. For example, Conrad and Frankena [3] argue that investment bankers have risk averse preferences and compensate for greater risks by lowering the offer price so that there is less chance of an unsuccessful issue.

The design of the commission function is assumed to rest with the issuer who is assumed to have some market power relative to the banker. The level of compensation of the banker, however, is assumed to be determined through a negotiation process that will be taken here to pertain to a reservation level $\bar{V}$ of expected utility. The issuer must then design a commission schedule $S^*$ such that[18]

$$\iint V(S^*,a)f(\theta|\omega)f(\omega)\, d\theta\, d\omega \geq \bar{V}. \tag{3}$$

The reservation level $\bar{V}$ may be affected by competitive pressures as well as by the "reputation" of the investment banking house.

Given any specific commission schedule $S^*$ based on the observables $x$ and $p$, the banker will choose price and effort so as to maximize his expected utility. It will do this after observing $\omega$, so at the time the schedule $S^*$ is chosen, the issuer has to consider the response functions $(p(\omega), a(\omega))$ that the banker will choose given $S^*$. The response functions satisfy for each $\omega \in \Omega$

$$(p(\omega), a(\omega)) = \underset{(p,a)}{\operatorname{argmax}} \int V(S^*(x,p), a)f(\theta|\omega)\, d\theta, \forall\omega\in\Omega, \tag{4}$$

where argmax denotes the argument that maximizes the succeeding function. The dependence of $x$ on $(p(\omega), a(\omega))$ in (4) has been suppressed.

The issuer's design problem thus can be defined as

$$\max_{S^*(x,p)} \iint U(x - S^*(x,p(\omega)))f(\theta|\omega)f(\omega)\, d\theta\, d\omega \tag{5}$$

$$S.T.\ (3) \quad \text{and} \quad (4).$$

The solution to this problem is, in general, difficult to characterize, and hence the approach taken here is to restrict attention to limited aspects of the problem. First, the effort decision will be suppressed and attention will be focused on the design of incentives for the pricing decision alone. Next, the price will be taken to be predetermined and the properties of an optimal linear compensation function used to combat the effort incentive problem will be characterized. Given this analysis, the pricing and effort incentive problems will be considered simultane-

[18] Alternatively, the issuer may be considered to maximize a weighted sum of his expected utility and the expected utility of the banker given by

$$W = \iint [U(x - S^*) + \lambda V(S^*,a)]f(\theta|\omega)f(\omega)\, d\theta\, d\omega,$$

where $\lambda$ weights the banker's interests relative to the issuer's interests.

ously in a limited setting. It will be shown that the issuer can always utilize the investment banker's superior information to the benefit of both parties.

Before turning to this analysis, one case for which the general problem has a simple solution will be considered. When the banker is risk neutral and has preferences that are separable in profit and effort, a firm commitment contract of the form $S^*(x,p) = x - K$. where $K$ is a constant, is optimal.

PROPOSITION 1. *Let the banker's preferences be* $V(S^*,a) = S^* - W(a)$. *Then, a firm commitment contract is optimal.*

*Proof.* Let $S^*(x,p)$ be any contract and $(p(\omega), a(\omega))$ the banker's best response function given that contract. This results in an expected return $\bar{x}$ from the sale of the issue and an expected payment $\bar{S}^*$ with $(\bar{x} - \bar{S}^*)$ the expected return to the issuer. Since the issuer is risk averse, he will prefer the certain payment $\bar{x} - \bar{S}^*$ to what he gets from $S^*(x,p)$. In terms of the payment, the banker is indifferent to this arrangement and may improve his position by revising his response functions. Thus, giving the issuer $(\bar{x} - \bar{S}^*)$ at the outset will make him better off and the banker no worse off, which proves that the optimal schedule can be found among the class of firm commitment contracts.

## III. Delegation of the Offer Price Decision

In this section, the effort decision is taken to be fixed or independent of the commission schedule. Furthermore, attention is restricted to commission schedules of the form

$$S^*(x,p) = S(x) + T(p),$$

where $S(x)$ represents a payment based on the net proceeds from the issue and $T(p)$ is a payment based on the offer price set by the banker. Additionally, $S(x)$ is taken as a given, differentiable function with $S'(x) \in [0, 1]$ for all $x$, so that attention can be restricted to how the banker's and the issuer's preferences for the pricing decision can be aligned by the choice of $T(p)$. The assumption on $S(x)$ that $0 \leq S' \leq 1$ means that neither the banker nor the issuer is made worse off by greater net proceeds $x$.

Given any function $T(p)$ chosen by the issuer, the banker will set the price in response to the information $\omega$ it obtains during the registration period. The price response function $p(\omega)$ used by the banker satisfies

$$p(\omega) = \operatorname*{argmax}_{p} EV(\omega) \equiv \int V(S(x) + T(p), a) f(\theta \mid \omega)\, d\theta, \qquad \forall \omega \varepsilon \Omega. \tag{6}$$

Assuming that $T$ is differentiable, the first-order condition corresponding to (6) will be written as[19]

$$v_T T' + v_p = 0, \tag{7}$$

[19] The response function satisfying (6) for a payment function $T(p)$ is assumed to be unique, although in general, uniqueness is difficult to verify.

where

$$v_T = v_T(p(\omega), T(p(\omega)), \omega) \equiv \int V_1 f(\theta \mid \omega)\, d\theta$$

$$v_p = v_p(p(\omega), T(p(\omega)), \omega) \equiv \int V_1 S' x_p f(\theta \mid \omega)\, d\theta,$$

and $x_p = \partial x/\partial p$. The condition in (7) indicates the problem caused by the asymmetric information and how the commission function can be used to mitigate that problem. If a commission payment $T(p)$ were not used in conjunction with delegation, the banker would choose an offer price $p(\omega)$ satisfying $v_p = 0$. An increasing (decreasing) commission function $T(p)$ however will cause the banker to price such that $v_p >$ $(<)$ $0$, so a commission based on the offer price is effective in inducing the banker to price higher (lower) than it otherwise would.

The issuer's problem is thus to choose $T(p)$ in order to influence the response function $p(\omega)$ so that the banker uses the information $\omega$ to further the interests of the issuer. In doing so, the issuer must take into account the response function $p(\omega)$ satisfying (7) and thus chooses $T(p)$ according to the program

$$\max_{T(p)} \iint U(x - S(x) - T(p)) f(\theta \mid \omega) f(\omega)\, d\theta\, d\omega \tag{8}$$

$$\text{S.T.} \iint V(S(x) + T(p), a) f(\theta \mid \omega)\, d\theta\, d\omega \geq \bar{V} \tag{9}$$

$$v_T T'(p) + v_p = 0 \quad \text{for all} \quad \omega \in \Omega. \tag{10}$$

The solution to this program will be characterized in two steps. First, the class of attainable response functions that the issuer can induce the banker to choose using $T(p)$ will be characterized, and second, first-order conditions for the program will be stated and analyzed.

An attainable response function $p(\omega)$ must satisfy two conditions. First, there must exist a function $T(p)$ such that given $T(p)$, $p(\omega)$ satisfies (7). Second, given $T(p)$, the response function $p(\omega)$ must yield a global optimum to (6). Before these conditions are considered, the second-order condition for the response function $p(\omega)$ satisfying (7) will be analyzed using the approach of Riley [15]. If $p(\omega)$ is a strictly increasing, differentiable function so that $p'(\omega) > 0$, differentiation of (7) with respect to $\omega$ yields

$$\frac{\partial}{\partial p}(v_T T' + v_p) = -\frac{1}{p'(\omega)}\left(\frac{\partial}{\partial \omega}(v_T T' + v_p)\right).$$

Since

$$\frac{\partial}{\partial \omega}(v_T T' + v_p) = v_T \frac{\partial}{\partial \omega}\left(\frac{v_p}{v_T}\right),$$

if $\frac{\partial}{\partial\omega}\left(\frac{v_p}{v_T}\right) > 0$ at $p(\omega)$, a strictly increasing differentiable response function satisfying (7) is at least a local optimum. The condition $\frac{\partial}{\partial\omega}\left(\frac{v_p}{v_T}\right) > 0$ states that more favorable information increases the ratio of the marginal utility $v_p$ resulting from the effect of a price increase on $S(x)$ to the marginal utility $v_T$ of total compensation. This property seems intuitively reasonable given the interpretation of information in Section I and will be assumed here. To investigate the plausibility of this assumption, evaluate the derivative to obtain

$$v_T \frac{\partial}{\partial\omega}\left(\frac{v_p}{v_T}\right) = v_{p\omega} - v_p v_{T\omega}/v_T = v_{p\omega} + T' v_{T\omega}. \tag{11}$$

Since an increase in $\omega$ results in a stochastically dominant distribution of $x$ from (1),

$$v_{T\omega} = \frac{\partial}{\partial\omega}\int V_1 f(\theta\,|\,\omega)\,d\theta = \int V_1 f_\omega(\theta\,|\,\omega)\,d\theta < (=)0,$$

if $S(x)$ is increasing and $V_{11} < (=)\ 0$. The term $v_{p\omega}$ in (11) is given by

$$v_{p\omega} = \frac{\partial}{\partial\omega}\int V_1 S' x_p f(\theta\,|\,\omega)\,d\theta = \int V_1 S' x_p f_\omega(\theta\,|\,\omega)\,d\theta,$$

which is positive from (2), since $S(x)$ is an increasing function. In this case a sufficient but not necessary condition for $\frac{\partial}{\partial\omega}\left(\frac{v_p}{v_T}\right) > 0$ when (2) is satisfied is $v_p \geq 0$ at $p(\omega)$.

If the expression in (11) is positive, the following proposition establishes that any nondecreasing response function $p(\omega)$ is attainable through the choice of a payment $T(p)$ and is a global optimum to the banker's choice problem. Furthermore, any attainable response function is a nondecreasing function. This result is a direct consequence of Holmstrom's [8] Theorem 2.15, and its proof is presented here for completeness.

PROPOSITION 2. *If* $\frac{\partial}{\partial\omega}\left(\frac{v_p}{v_T}\right) > 0$ *for all* $(\omega, p)$, *any nondecreasing differentiable price response function* $p(\omega)$ *can be generated by some commission function* $T(p)$. *Conversely, any price function* $p(\omega)$ *that can be generated by a commission function* $T(p)$ *is nondecreasing.*

*Proof.* Assume that $p'(\omega) > 0$. Then $\omega$ can be expressed as a function $\omega(p)$ of $p$, and the first-order condition in (7) can be written as a function of $p$ as

$$v_T(p, T(p), \omega(p))T'(p) + v_p(p, T(p), \omega(p)) = 0$$

for all $p$ such that $p = p(\omega)$; for $\omega \in \Omega$. This is a differential equation in $T(p)$ and under the assumptions on $V$, $f$, and $p(\omega)$, a solution $T(p)$ exists. Consequently, for any $p(\omega)$ such that $p'(\omega) > 0$ there exists a $T(p)$ such that $p(\omega)$ satisfies the first-order condition and hence is at least a local maximum. To show that the local maximum is also a global maximum, assume the contrary. This implies that for $p(\omega)$ satisfying the first-order condition at some $\omega_1$, the banker's indifference curve in the $(p, T)$-plane given by

$$v(p, T, \omega_1) = \int V(S(x) + T, a)\, f(\theta \mid \omega_1)\, d\theta = \bar{v}$$

is tangent to $T(p)$ at $p(\omega_1)$.[20] That is, the slope $-v_p(p, T, \omega_1)/(v_T(p, T, \omega_1))$ of the indifference curve equals the slope of $T(p)$ at $p(\omega_1)$ as in Figure 1. If $p(\omega_1)$ is not a global optimum, however, the indifference curve must intersect $T(p)$ at some other point $p_2 = p(\omega_2)$. Assume $p_2 > p_1$. At $p(\omega_2)$ there is an indifference curve with slope $-v_p(p, T, \omega_2)/(v_T(p, T, \omega_2))$ that is tangent to $T(p)$ at $p(\omega_2)$, since at $p(\omega_2)$ the first-order condition in (7) is satisfied. This implies, since $p_2 > p_1$, that

$$T'(p(\omega_2)) = -\frac{v_p(p(\omega_2), T(p(\omega_2)), \omega_2)}{v_T(p(\omega_2), T(p(\omega_2)), \omega_2)} > -\frac{v_p(p(\omega_2), T(p(\omega_2)), \omega_1)}{v_T(p(\omega_2), T(p(\omega_2)), \omega_1)} \tag{12}$$

as is apparent in Figure 1. Because $p$ is increasing, $p_2 > p_1$ implies $\omega_2 > \omega_1$. Thus, (12) contradicts the assumption that $\frac{\partial}{\partial \omega}\left(\frac{v_p}{v_T}\right) > 0$, so a response function $p(\omega)$ satisfying (7) and such that $p'(\omega) > 0$ is a global optimum. (If $p_2 < p_1$, the same conclusion follows). An analogous argument can be given for the case in which $p'(\omega) = 0$.

It remains to show that any function $p(\omega)$ that satisfies (7) is nondecreasing. This follows again from the argument above. That is, if $v_p/v_T$ is increasing in $\omega$, the slope of the indifference curve for $\omega_2$ ($\omega_2 > \omega_1$) evaluated at $p(\omega_1)$ is more

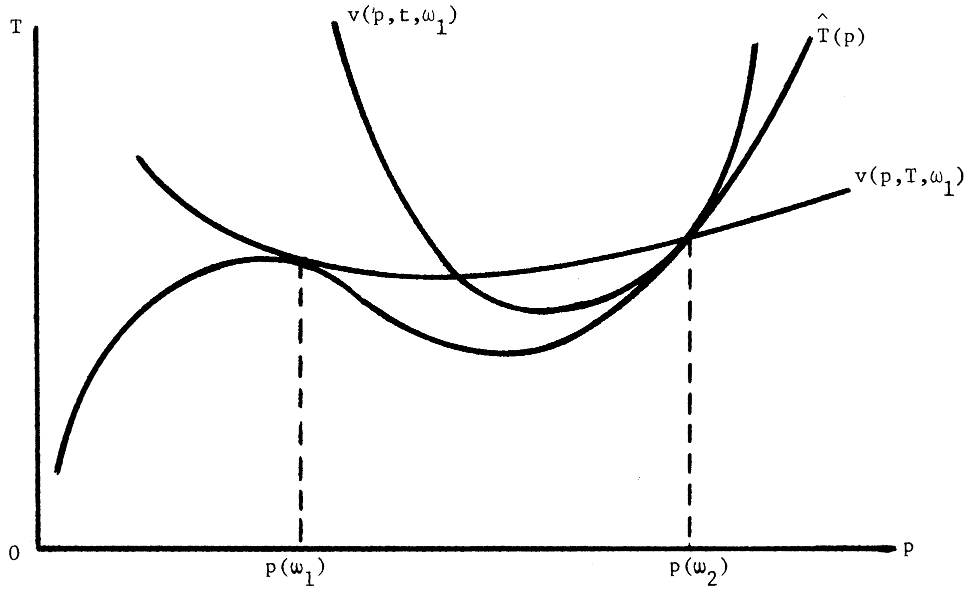


**Figure 1**

[20] Concavity of $V$ in $S^*$ implies that the indifference curve in convex.

negative than for $\omega_1$. Consequently, the price must be increased from $p(\omega_1)$. If $T(p)$ is sufficiently steeply sloped at $p(\omega_1)$, then $p(\omega_2)$ can equal $p(\omega_1)$, so a constant function $p(\omega)$ is also possible.

Proposition 1 demonstrates that the issuer, through the payment function $T(p)$, can induce the banker to choose a higher price the more favorable is the information received during the registration period.

Given the informational asymmetry that naturally results from preselling during the registration period and the likelihood that the banker is risk averse as discussed in Section II, a first-best solution will not be achievable. The issuer thus must settle for a second-best solution utilizing a commission function $T(p)$ to induce the banker to use the information $\omega$ it receives during the registration period to the issuer's advantage. The choice of $T(p)$ involves taking into account both the response function on the part of the banker induced by $T(p)$ and the direct effect of the payment on the expected utilities in (8) and (9). To characterize the second-best solution, the calculus of variations will be used. Since the constraint in (10) involves a control $T$ that is an indirect function of $\omega$, the constraint must be reformulated in order to view (8) – (10) as a control problem. To do this, let $q(\omega) \equiv T(p(\omega))$, so $q'(\omega) = T'p'(\omega)$. If $p'(\omega) \neq 0$, then substituting into (10) yields

$$v_T q' + v_p p' = 0 \qquad \forall\ \omega \in \Omega. \tag{13}$$

Substituting $q(\omega)$ for $T(p)$ in (8) and (9) and replacing (10) by (13) yields an equivalent program from whose solution the optimal $\hat{T}(p)$ can be recovered. The Euler conditions for the second-best $\hat{q}(\omega)$ and $\hat{p}(\omega)$, respectively, are

$$-u_T + \lambda v_T - \psi'(\omega)v_T - \psi(\omega)(v_{T_\omega} + v_T f'(\omega)/f(\omega)) = 0 \tag{14}$$

$$u_p + \lambda v_p - \psi'(\omega)v_p - \psi(\omega)(v_{p_\omega} + v_p f'(\omega)/f(\omega)) = 0, \tag{15}$$

where $u_T = \int U'f(\theta \mid \omega)\, d\theta$, $up = \int U'(1 - S')x_p f(\theta \mid \omega)\, d\theta$, $v_{T_\omega} = \partial v_T/\partial\omega$, $v_{p_\omega} = \partial v_p/\partial\omega$, and $\psi(\omega)$ is the multiplier associated with the constraint in (13).[21] The multiplier $\psi(\omega)$ has the interpretation as the marginal cost to the issuer resulting from the banker's opportunity to choose the response function.

To analyze the second-best solution, solve (14) for $(\lambda - \psi'(\omega) - \psi(\omega)f'(\omega)/f(\omega))$ and substitute into (15) to obtain

$$\psi(\omega)\ [v_p v_{T_\omega} - v_{p_\omega} v_T]/v_T + u_T\left(\frac{u_p}{u_T} + \frac{v_p}{v_T}\right) = 0. \tag{16}$$

Since $v_T \dfrac{\partial}{\partial\omega}\left(\dfrac{v_p}{v_T}\right) = (v_{p_\omega} v_T - v_p v_{T_\omega})/v_T$, the sign of $\psi(\omega)$ if the same as that of

[21] Dividing (14) by $v_T$ and rearranging yields

$$\frac{u_T}{v_T} = \lambda - \psi'(\omega) - \psi(\omega)\left(\frac{v_{T_\omega}}{v_T} + \frac{f'(\omega)}{f(\omega)}\right).$$

The left side is positive for all $\omega$, and hence there exists no differentiable function $\psi(\omega)$ such that the right side is positive for all $\omega$, so solution to the issuer's program exists in the class of unbounded functions (see Mirrlees [13], [14].

$\left(\frac{u_p}{u_T} + \frac{v_p}{v_T}\right)$ if $\frac{\partial}{\partial\omega}\left(\frac{v_p}{v_T}\right) > 0$. To sign this term, consider Figure 2. If the indifference curve

$$u(p, -T(p), \omega) \equiv \int U(x - S(x) - T(p)) f(\theta \mid \omega)\, d\theta = \bar{u}$$

at $p(\omega_1)$ cuts $T(p)$ from below, then the slope $\frac{u_p}{u_T}$ is greater than the slope $-\frac{v_p}{v_T}$. Thus $u_p/u_T > -v_p/v_T$ implies $v_p/v_T + u_p/u_T > 0$, and (16) implies that $\psi(\omega) > 0$. If the issuer's indifference curve cuts $\hat{T}(p)$ from above, then $\psi(\omega) < 0$. Consequently, $\psi(\omega) > (=)(<)\ 0$ implies that the issuer prefers a greater (the same) (a lower) price than that preferred by the banker given the optimal payment function $\hat{T}(p)$. This analysis is summarized as Proposition 3.

PROPOSITION 3. *If* $\frac{\partial}{\partial\omega}\left(\frac{v_p}{v_T}\right) > 0$ *and* $\frac{u_p}{u_T} > (=)(<) -\frac{v_p}{v_T}$, *then* $\psi(\omega) > (=)(<)\ 0$, *and the issuer prefers a price greater than (equal to)(less than)* $\hat{p}(\omega)$ *given* $\hat{T}(p)$.

Proposition 3 thus demonstrates that the cost, as represented by $\psi(\omega)$, of using the payment function to affect the banker's pricing decision is positive (negative) when the issuer prefers a higher (lower) offer price than does the banker. Comparison of the prices preferred by the issuer and the banker is difficult at this level of generality and will not be attempted here. After the next section such a comparison will be made for a special case used to facilitate the analysis of the effort incentive problem.

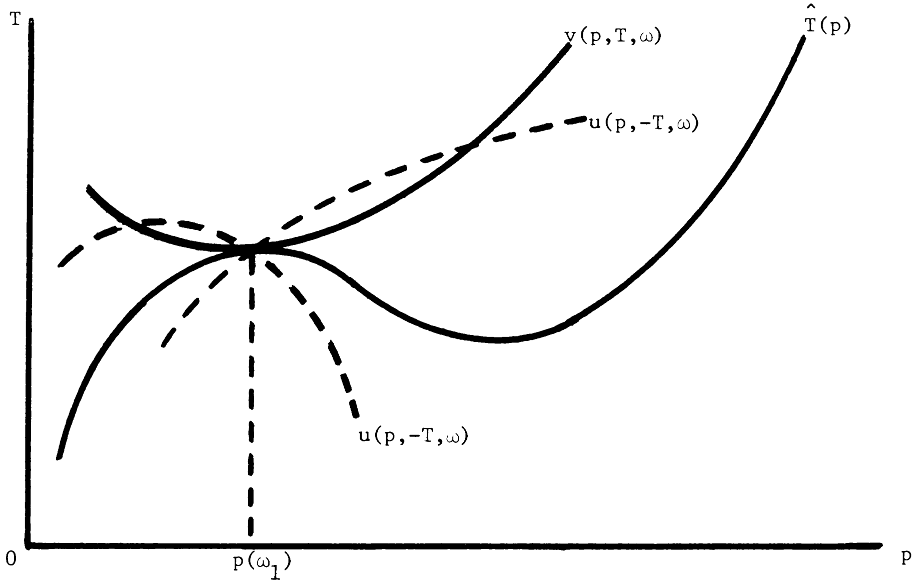


**Figure 2**

## IV. The Distribution Effort Incentive Problem

This section is concerned with the effort incentive problem alone, so initially the price is taken to be fixed by the issuer acting independently of the banker. For analytical tractability the banker's utility function $V$ is assumed to be separable of the form

$$V(S^*, a) = V_*(S^*) - W(a), \tag{17}$$

with $V_*$ concave and increasing and $W$ convex and increasing.

A solution to (3) – (5) with $p$ fixed has been characterized in Holmström [9]. However, since the pricing decision will be reintroduced in the next section, this characterization of a general commission schedule is of less interest because of its complexity. Instead, attention will be restricted to linear commission functions of the form

$$S^*(x) = \alpha x + \beta, \tag{18}$$

with fixed parameters $\alpha$ and $\beta$. This class of functions includes the most frequently used issuer investment banker arrangements such as the firm commitment contract ($\alpha = 1$, $\beta < 0$), stand-by contracts ($0 < \alpha < 1$), and best efforts contracts ($\alpha = 0$, $\beta > 0$).

By Proposition 1 a firm commitment contract will be optimal even with the restriction in (18) if the banker is risk neutral. If both the banker and the issuer are risk averse, then a stand-by contract will be optimal. In order to indicate the nature of the effort incentive problem and the issuer's response to it, the issuer's optimal choice of $\alpha$ and $\beta$ will be compared to the first-best parameters that the issuer would choose if effort could be observed.

With the restrictions and simplifications stated above the second-best problem in (3) – (5) becomes

$$\max_{\alpha,\beta} \int\int U((1-\alpha)x - \beta) f(\theta \mid \omega) f(\omega)\, d\theta\, d\omega, \tag{19}$$

$$a(\omega) = \operatorname*{argmax}_a EV(\omega) = \int V_*(\alpha x + \beta) f(\theta|\omega) f(\omega)\, d\theta\, d\omega - W(a),\ \forall\, \omega \in \Omega \tag{20}$$

$$\int\int V_*(\alpha x + \beta) f(\theta \mid \omega) f(\omega)\, d\theta\, d\omega - \int W(a(\omega)) f(\omega)\, d\omega \geq \bar{V}, \tag{21}$$

where the dependence of $x$ on $a$ and $p$ is again suppressed.

In order to compare the solution of (19) – (21) with the first-best solution that corresponds to the program in (19) and (21) with the incentive constraint in (20) dropped, the effect of $(\alpha, \beta)$ on $a(\omega)$ defined by (20) must be characterized for a specific $\omega$. From (20) the first-order condition is

$$\int V'_*\, \alpha x_a f(\theta \mid \omega)\, d\theta - W'(a(\omega)) = 0, \tag{22}$$

which has a unique solution $a(\omega)$, since $x$ is strictly concave in $a$ and $V_*$ is concave. Differentiating (22) totally with respect to $\beta$ for a fixed $\alpha$ gives

$$\int V_*''\alpha x_a f(\theta \mid \omega)\, d\theta + \frac{\partial^2 EV(\omega)}{\partial a^2} \cdot \frac{\partial a(\omega)}{\partial \beta} = 0. \tag{23}$$

Since $V_*'' < 0$, $\alpha > 0$, $x_a > 0$ and $\partial^2 EV(\omega)/\partial a^2 < 0$ by the second-order condition, (23) implies

$$\frac{\partial a(\omega)}{\partial \beta} < 0. \tag{24}$$

An increase in $\beta$ results in an income effect to the banker, and hence the banker exerts less effort.

Performing the same analysis for $\alpha$ with a fixed $\beta$ yields

$$\int V_*''\alpha x_a x f(\theta \mid \omega)\, d\theta + \int V_*' x_a f(\theta \mid \omega)\, d\theta + \frac{\partial^2 EV(\omega)}{\partial a^2} \cdot \frac{\partial a(\omega)}{\partial \alpha} = 0. \tag{25}$$

The first term in (25) is an income effect analogous to that in (23) and is negative. The second term represents the incentive effect of an increase in $\alpha$ and is positive, so the sign of $\dfrac{\partial a(\omega)}{\partial \alpha}$ is generally ambiguous. To proceed, it will be assumed that the income effect is small enough so that the second term dominates the first. This would be the case if the issuer were only moderately risk averse and/ or the uncertainty about $\omega$ were small. Thus,

$$\frac{\partial a(\omega)}{\partial \alpha} > 0 \tag{26}$$

is assumed, which conforms well with intuition.[22]

To characterize the issuer's response to the effort incentive problem, let $\alpha^*$, $\beta^*$, and $a^*(\omega, p)$ denote the solution to (19) – (21). Also, let $(\bar{\alpha}, \bar{\beta})$ denote the

[22] Another justification of the assumption that an increase in $\alpha$ increases the effort expended by the banker is obtained by differentiating (21) and (22) with respect to $\alpha$ and solving for $d\beta/d\alpha$ and $da(\omega, p)/d\alpha$ to obtain

$$\frac{d\beta}{d\alpha} = -\int\int V_*' x f(\theta \mid \omega) f(\omega)\, d\theta\, f\omega \Big/ \int\int V_*' f(\theta \mid \omega) f(\omega)\, d\theta\, d\omega$$

and

$$\frac{da(\omega, p)}{d\alpha} = -\left\{\int V_*''\alpha x_a\left(x + \frac{d\beta}{d\alpha}\right) f(\theta \mid \omega)\, d\theta + \int V_*' x_a f(\theta \mid \omega)\, d\theta\right\} \Big/ \frac{\partial^2 EV(\omega)}{\partial a^2},$$

where $\partial^2 EV(\omega)/\partial a^2$ is the second-order condition corresponding to (22) which is negative, since $EV(\omega)$ is concave in $a$ by assumption. Since $x \geq 0$ and $V_*' > 0$, an increase in $\alpha$ requires a reduction in $\beta$. The distribution effort increases with $\alpha$ if the numerator of the expression for $da(\omega, p)/d\alpha$ is positive. The second term in the numerator represents the incentive effect on effort of an increased share of the net proceeds and is unambiguously positive. The first term represents the income effect of an increase in $\alpha$ and the corresponding decrease in $\beta$. Since the constraint in (21) remains binding, the income effect would be expected to be small, and hence the sign of the expression in braces would be likely to be dominated by the incentive effect implying that effort increases.

parameters of the Pareto optimal risk sharing contract that the issuer would employ if he were able to observe $\omega$ and implement the response function $a^*(\omega, p)$. The contract parameters $(\bar{\alpha}, \bar{\beta})$ are determined by maximizing (19) with respect to $(\alpha, \beta)$ subject only to (21) and $a(\omega, p) = a^*(\omega, p)$. The following proposition then characterizes the issuer's response to the effort incentive problem.

PROPOSITION 4. *If an increase in $\alpha$ leads to a greater distribution effort, the optimal commission function $(\alpha^*, \beta^*)$ in (19) – (21) is such that $\alpha^* \geq \bar{\alpha}$ and $\beta^* \leq \bar{\beta}$, where $(\bar{\alpha}, \bar{\beta})$ corresponds to the Pareto optimal risk sharing arrangement given $a^*(\omega, p)$.*[23]

*Proof.* Suppose $\bar{\alpha} > \alpha^*$ and hence $\bar{\beta} < \beta^*$. Evaluated at $a^*(\omega, p)$, a change from $(\alpha^*, \beta^*)$ to $(\bar{\alpha}, \bar{\beta})$ will be Pareto improving by definition of $\bar{\alpha}$ and $\bar{\beta}$. Also, the change from $\beta^*$ to $\bar{\beta}$ increases effort from (24) and a change from $\alpha^*$ to $\bar{\alpha}$ also increases effort by hypothesis. The banker thus responds by choosing a higher level of effort at $(\bar{\alpha}, \bar{\beta})$ improving further its welfare. The issuer will be better off as well, since he always prefers higher effort because $x_a \geq 0$. Thus, $(\bar{\alpha}, \bar{\beta})$ is better than $(\alpha^*, \beta^*)$ even under the restriction (20). This contradicts the optimality of $(\alpha^*, \beta^*)$ in (19) – (21), so $\bar{\alpha} \leq \alpha^*$ and $\bar{\beta} \geq \beta^*$.

It is not necessarily true that $\alpha < \alpha^*$ and $\bar{\beta} > \beta^*$, since if for example $U(z) = V_*(z) = \log(z)$, $\beta$ must equal zero to ensure that $x - S(x, p) > 0$ and $S(x, p) \geq 0$.[24] If such cases can be ruled out because, for example, the initial wealth of both parties is sufficient to cover any losses on the issue, then $\bar{\alpha} < \alpha^*$ and $\bar{\beta} > \alpha^*$ obtains. Under the hypotheses of Proposition 4 the issuer deals with the distribution effort incentive problem by increasing the percentage of the proceeds paid to the banker while reducing the fixed payment, so the banker bears a greater share of the consequences of his effort. Since the net proceeds are an increasing function of the distribution effort and the banker has disutility from effort, the issuer prefers a greater distribution effort than does the banker.

[23] This deviation from the first-best risk sharing contract involves losses to the issuer, and those losses are measured by the multiplier $\xi(\omega)$ associated with the constraint in (22). The adjoint equation for the program in (19), (21), (22) is obtained by maximizing the Lagrangian

$$L = \int [(U + \lambda(V - \bar{V}) + \xi(\omega)(V'_* \alpha^* x_a - W'(a))]f(\theta \mid \omega)\, d\theta$$

with respect to $a$ which yields

$$\int U'(1 - \alpha^*)x_a f(\theta \mid \omega)\, d\theta + \xi(\omega)\partial^2 EV/\partial a^2 = 0,$$

where $\partial^2 EV(\omega)/\partial a^2$ is the second-order condition which is negative by assumption. Since $x_a > 0$ when $Q < B$, and $\alpha^* \in (0, 1)$ when both the issuer and the banker are risk averse, the first term is positive. This implies that $\xi(\omega)$ is positive indicating that the issuer always prefers greater effort.

[24] This example assumes that $c = 0$. If $c > 0$, no solution exists for this utility function unless $x > c$ with probability one.

## V. Price Responses and Delegation

Prices will now be reintroduced into the analysis, and the offer prices preferred by the banker and the issuer given any specific $\omega$ will be compared. It will be shown that under certain assumptions the issuer prefers a higher price than does the banker regardless of the private information $\omega$. When this is the case, the issuer can devise a simple incentive scheme under which the issuer delegates the pricing decision to the banker subject to a constraint that the offer price cannot be sold below a specified minimum price. This allows the issuer to utilize the banker's superior information to his own benefit.

Given a price $p$, the previous section defined and analyzed the banker's optimal effort response $a(\omega, p)$, though the dependence on $p$ was suppressed in the notation of that section. Having thus defined $a(\omega, p)$, the banker's optimal price response function $p_B(\omega)$ can be defined by

$$p_B(\omega) = \underset{p}{\text{argmax}} \int V_*(\alpha x(p, a(\omega, p), \theta) + \beta) f(\theta \mid \omega)\, d\theta - W(a(\omega, p)), \qquad \forall\, \omega \in \Omega$$

If $x$ is jointly concave in $(a, p)$, $p_B(\omega)$ will be unique and using (22) satisfies the first-order condition

$$\int V'_* x_p f(\theta \mid \omega)\, d\theta = 0. \tag{27}$$

The offer price $p_I(\omega)$ preferred by the issuer, if he were able to observe $\omega$, is defined by

$$p_I(\omega) = \underset{p}{\text{argmax}} \int U((1 - \alpha) x(p, a(\omega, p), \theta) - \beta) f(\theta \mid \omega)\, d\theta, \qquad \forall\, \omega \in \Omega,$$

and satisfies the first-order condition

$$\int U'(1 - \alpha)(x_p + x_a a_p) f(\theta \mid \omega)\, d\theta = 0, \tag{28}$$

where $a_p$ is the derivative of $a(\omega, p)$ with respect to $p$. This condition takes into account the effects of the offer price directly on the proceeds $x$ and indirectly through the distribution effort expended by the banker, since even if $\omega$ is observable, the distribution effort is not.

To compare $p_I(\omega)$ and $p_B(\omega)$, add (22) and (27) to obtain

$$\int V'_* \alpha (x_p + x_a) f(\theta \mid \omega)\, d\theta - W' = 0. \tag{29}$$

Comparing (28) and (29) suggests that the banker would prefer a lower offer price than would the issuer, *ceteris paribus*, because of the disutility of effort represented by $(-W')$ and because a higher offer price would be expected to require a greater distribution effort. The comparison between $p_I(\omega)$ and $p_B(\omega)$ however is ambiguous in general, so a special case will be considered. A characterization of $a_p$ is required first.

For a given $\omega$ the effort response function $a(\omega, p)$ will be an increasing function of $p$ if and only if from (22)

$$\frac{\partial^2 EV(\omega)}{\partial a \partial p} = \int \{V'_* \alpha x_{ap} + V''_* \alpha^2 x_a x_p\} f(\theta \mid \omega)\, d\theta$$

$$= \int \alpha V'_* \{x_{ap} - \alpha x_a x_p r\} f(\theta \mid \omega)\, d\theta > 0, \tag{30}$$

where $r$ is the Arrow-Pratt index of absolute risk aversion. Since $x_{ap}$ is nonnegative and is positive when the issue is not sold out, the first term in (30) is positive. From (27) and the concavity of expected utility in $p$

$$\int \alpha V'_* x_p f(\theta \mid \omega)\, d\theta \leq 0, \quad \text{for} \quad p \geq p_B(\omega).$$

Since $x_a r > 0$, it seems likely that the expression in (30) is positive. This motivates the assumption that greater effort is expended when the offer price is increased.

The following proposition uses this condition in analyzing the case in which the issuer and the banker have HARA utility functions with the same risk cautiousness. That is, the functions $U$ and $V_*$ are such that

$$-\frac{U'(z)}{U''(z)} = bz + g \quad \text{and} \quad -\frac{V'_*(z)}{V''_*(z)} = bz + d.$$

For this class of utility functions Wilson [23] has shown that the Pareto optimal risk-sharing contract function $S$ is linear in $x$. The following result then obtains.

PROPOSITION 5. *Let $U$ and $V_*$ belong to the class of HARA – utility functions, and assume they have identical risk cautiousness. Let* $(\alpha^*, \beta^*), p_B^*(\omega)$, *and* $\hat{a}(\omega) = a(\omega, p_B^*(\omega))$ *denote the optimal solution to the program* (19), (20), (21), *and* (27), *and assume that a higher price, ceteris paribus, leads to a greater effort. Then,* $p_B^*(\omega) < p_I^*(\omega)$, *where* $p_I^*(\omega)$ *is defined by* (28) *given* $(\alpha^*, \beta^*)$.

*Proof.* As above let $(\bar{\alpha}, \bar{\beta})$ denote the parameters of the Pareto optimal risk-sharing rule given $(\hat{a}(\omega), p_B^*(\omega))$. Since $U$ and $V$ have identical risk cautiousness,

$$\frac{U'((1 - \bar{\alpha})x - \bar{\beta})}{V'_*(\bar{\alpha}x + \bar{\beta})} = \eta, \qquad \forall x,$$

for some $\eta > 0$. From Proposition 4 $\alpha^* \geq \bar{\alpha}$ and $\beta^* \leq \bar{\beta}$, and direct calculation shows that the function $\eta(x)$ defined by

$$\eta(x) \equiv \frac{U'((1 - \alpha^*)x - \beta^*)}{V'_*(\alpha^* x + \beta^*)},$$

is such that

$$\eta'(x) \geq 0. \tag{31}$$

Given $\hat{a}(\omega)$ and $p_B^*(\omega)$, (31) implies that

$$\int_{\underline{\theta}}^{\theta^\circ} V'_*\eta(x(p_B^*, \hat{a}, \theta))x_p f(\theta \mid \omega)\, d\theta + \int_{\theta^\circ}^{\bar{\theta}} V'_*\eta(x(p_B^*, \hat{a}, \theta))x_p f(\theta \mid \omega)\, d\theta$$

$$\geq \int_{\underline{\theta}}^{\theta^\circ} V'_*\eta^\circ x_p f(\theta \mid \omega)\, d\theta + \int_{\theta^\circ}^{\bar{\theta}} V'_*\eta^\circ x_p f(\theta \mid \omega)\, d\theta, \quad (32)$$

where $\eta^\circ \equiv \eta(x(p_B^*, \hat{a}, \theta^\circ))$ and $\theta^\circ$ is defined such that $x_p(p_B^*(\omega), \hat{a}, \theta^\circ) = 0$. The inequality in (32) follows, since on $[\bar{\theta}, \theta^\circ)$, $\eta^\circ > \eta(x(p_B^*, \hat{a}, \theta))$ and on $(\theta^\circ, \bar{\theta}]$, $\eta^\circ < \eta(x(p_B^*, \hat{a}, \theta))$ because $x_{p\theta} > 0$ and $x_\theta > 0$. Then, (27), (32), and the definition of $\eta(x)$ imply that

$$\int U' x_p f(\theta \mid \omega)\, d\theta = \int V'_*\eta(x(p_B^*, \hat{a}, \theta))x_p f(\theta \mid \omega)\, d\theta \geq \int V'_*\eta^\circ x_p f(\theta \mid \omega)\, d\theta = 0.$$

Consequently, the issuer prefers at least as high a price as the banker, when only the choice of price at the fixed effort level $\hat{a}(\omega)$ is considered. By assumption a higher price induces greater effort, and since $(1 - \alpha^*) > 0$ and $x_a > 0$, the issuer's utility increases strictly with effort. Thus, the effect of price on effort will strictly increase the issuer's choice of price from what it would be when effort is ignored. Hence, $p_I^*(\omega) > p_B^*(\omega)$.

The intuition behind this result is based on two observations. First, by Proposition 4 the banker is induced, due to the effort incentive problem, to take on more risk than is Pareto optimal. This increases the risk to the banker in comparison to the issuer's risk, and whereas in the Pareto optimal risk-sharing case they would choose the same price (see Wilson [23]), the banker now prefers a lower price than does the issuer. Second, a higher price induces greater effort, which benefits the issuer. Thus, aspects of risk and effort both indicate that the issuer would choose a price above that which the banker would choose. Intuition suggests that this may be the case for more general utility function specifications, but such a demonstration does not suggest itself.[25]

If $p_I(\omega) > p_B(\omega)$ and both response functions are increasing in $\omega$, then it can be shown that some delegation of the offer price decision is optimal. To demonstrate this, let $\hat{p}$ be the offer price that the issuer would set when the price is not

[25] Under a system of delegation the offer price will be set according to the response function $p_B(\omega)$ satisfying (27). To characterize $p_B(\omega)$ as a function of $\omega$, recall that an increase in $\omega$ results in a stochastically dominant distribution of $\theta$. Thus, if $V_* x_p$ in (27) is increasing in $\theta$, the effect will be to increase the price. The choice of effort does not influence this condition by an envelope argument, so evaluating yields

$$\frac{\partial}{\partial\theta}(V'_* x_p) = V''_*\alpha^* x_\theta x_p + V'_* x_{p\theta} = V'_*\{x_{p\theta} - \alpha^* x_\theta x_p r\}.$$

Since $x_{p\theta} > 0$ by assumption, the derivative $x_p$ is negative for $\theta \in [\underline{\theta}, \theta^\circ)$, so $\frac{\partial}{\partial\theta}(V'_* x_p) > 0$ on that interval. On $(\theta^\circ, \bar{\theta}]$, $x_p > 0$, but since $V'_*$ is decreasing in $\theta$, less "weight" ($V'_*$) is given to those values. This suggests the rather natural result that $p_B^{*\prime}(\omega) > 0$. A similar reasoning can be applied to obtain conditions that guarantee that $p_I^{*\prime}(\omega) > 0$.

delegated. If $\omega$ has sufficiently wide range that for some $\omega$ the price that the banker would set under delegation is above $\hat{p}$, delegation is preferred by the issuer. Delegation is restricted however by not permitting the banker to set a price below the level $\hat{p}$.

PROPOSITION 6. *Consider a commission function $S(x) = \alpha x + \beta$, and assume that $p_I(\omega) > p_B(\omega)$ for all $\omega$ and that for some $\omega$, $p_B(\omega) > \hat{p}$, where $\hat{p}$ is a price fixed before $\omega$ is revealed. Then, both parties can be made better off than at $\hat{p}$ by delegating the pricing decision to the banker under a commission function of the form*

$$S^*(x, p) = \begin{cases} \alpha x + \beta & \text{if} \quad p \in [\hat{p}, \infty) \\ 0 & \text{otherwise.} \end{cases} \tag{33}$$

*Proof.* It is necessary to show that for states $\omega$ for which $p_B(\omega) > \hat{p}$, the issuer prefers $p_B(\omega)$ to $\hat{p}$. Disregarding effort, the issuer's preference over $p$ is concave. Since a lower price reduces effort, it follows that the issuer's preferences over $p$, including the effect on effort, is quasi-concave in the region $p \leq p_I(\omega)$. Thus, the issuer prefers $p_B(\omega)$ to $\hat{p}$, since $\hat{p} < p_B(\omega) < p_I(\omega)$. The banker is better off as well, since it can always choose $\hat{p}$ if it wants to.

This result demonstrates that the issuer can use the banker's superior information to the benefit of both parties by letting the banker determine the offer price. However, the banker is not given complete freedom, since a minimum price is set in order to guarantee a sufficiently high price. A function of the form (33) is generally not optimal, however, since improvements could be achieved by considering more complex function such as $\alpha x + \beta(p)$, for example. It is clear that if such a contract were to improve on (33) the reward for an increase in $\omega$ would have to be positive, since otherwise the banker would have an incentive to choose an even lower price than before with the issuer paying for it. In other words, with a contract of the form $\alpha x + \beta p + \gamma$, $\beta$ must be positive to provide the proper incentives. From a normative point of view this kind of a contract does not appear unrealistic to implement and is strongly reminiscent of the Soviet incentive scheme discussed by Weitzman [21]. With a contract of the general form $\alpha x + \beta(p)$, if more favorable information reduces the marginal cost of an increase in the offer price, then any increasing price response function is attainable as in Proposition 1.[26]

## VI. Conclusions

The process through which new issues are sold in a negotiated offering gives the investment banker an opportunity to learn about the demand for the issue by

[26] The hypothesis analogous to that in Proposition 1 required for this result is

$$\frac{\partial}{\partial \omega}\left(\frac{EV_p(p, \beta, \omega)}{EV_\beta(p, \beta, \omega)}\right) > 0,$$

where $EV(p, \beta, \omega) = \int V_*(\alpha x(p, \bar{a}(\omega), \theta) + \beta) f(\theta \mid \omega)\, d\theta - W(\bar{a}(\omega))$, and $\bar{a}(\omega)$ is the best choice of effort given $p$, $\alpha$, $\beta$ and $\omega$.

conducting preselling activities during the registration period. Recognizing that the banker has superior information, the issuer may delegate the offer price decision to the banker so that the banker can use its superior information. When effort is held constant, more favorable information $\omega$ would be expected to cause the banker to set a higher offer price. Furthermore, a payment function based on the offer price set by the banker is sufficient to induce any response function that is increasing in $\omega$. If the banker is risk neutral, a firm commitment contract is optimal, and the issuer not only prefers to delegate the pricing decision to the banker but finds it optimal to let the banker bear the full consequences of its decisions. When the banker is not risk neutral, a commission payment based in part on the offer price can be effective in inducing the banker to set a price more in the issuer's interests than would otherwise result.

When both delegation and the distribution effort incentive problem are considered in the context of a linear commission function, a firm commitment contract is optimal if the banker is risk neutral. If the banker is risk averse, the optimal commission function is such that both the issuer and the banker bear some of the risk. To induce greater distribution effort, on the part of the banker, however, the issuer lets the banker bear a larger share of the risk. With asymmetric information and HARA utility functions some delegation of the offer price decision is desirable but the issuer sets a minimum below which the offer price cannot be set. Although delegation is preferred, the issuer incurs losses because of his inability to observe either $\omega$ or the distribution effort.

## REFERENCES


1. D. P. Baron, "The Incentive Problem and the Design of Investment Banking Contracts," *Journal of Banking and Finance*, **3** (1979), 157–75.
2. C. Christenson, *Strategic Aspects of Competitive Bidding for Corporate Securities.* Harvard University, Boston 1965.
3. J. Conrad and M. Frankena, "The Yield Spread Between New and Seasoned Corporate Bonds," in *Essays on Interest Rates*, Vol. I, J. Guttentag and P. Cagan, eds. Columbia University Press, National Bureau of Economic Research, New York, 1969.
4. P. J. Davey, *Investment Banking Arrangements*, The Conference Board, New York, 1976.
5. L. H. Ederington, "Uncertainty, Competition and Costs in Corporate Bond Underwriting," *Journal of Financial Economics*, **8** (1974), 337–60.
6. I. Friend, *Investment Banking and the New Issues Market; Summary Volume*, Wharton School, University of Pennsylvania, Philadelphia, 1965.
7. S. L. Hayes III, "Investment Banking: Power Structure in Flux," *Harvard Business Review*, March-April 1971, 56–72.
8. B. Holmstróm, "On Incentives and Control in Organizations," unpublished Ph.D. thesis, Graduate School of Business, Stanford University, Stanford, 1977.
9. B. Holmstróm, "Moral Hazard and Observability," *Bell Journal of Economics*, (Spring, 1979), 74–91.
10. R. G. Ibottson, "Price Performance of Common Stock New Issues," *Journal of Financial Economics*, **2** (September 1975), 235–72.
11. C. J. Loomis, "Paulette Papilsky's Deadly Threat to Wall Street," *Fortune* (23 April 1979), pp. 90–94, 96.
12. G. Mandelker and A. Raviv, "Investment Banking: An Economic Analysis of Optimal Underwriting Contracts," *Journal of Finance*, **32,** (June 1977) 683–94.
13. J. A. Mirrlees, "Notes on Welfare Economics, Information, and Uncertainty," in *Essays on*

*Economic Behavior Under Uncertainty*, M. S. Balch, D. L. McFadden, and S. Y. Wu, eds. North-Holland, Amsterdam, 1974, pp. 243–58.

14. J. A. Mirrlees, "The Optimal Structure of Incentives and Authority Within an Organization," *Bell Journal of Economics*, **7** (Spring 1976), 105–131.
15. J. G. Riley, "Competitive Signalling," *Journal of Economic Theory*, **10** (1975), 174–186.
16. W. Robertson, "Future Shock at Morgan Stanley," *Fortune* (27 February 1979) pp. 82–86, 88, 90, 92.
17. S. A. Ross, "Equilibrium and Agency—Inadmissible Agents in the Public Agency Problem," *American Economic Review*, **69,** (May 1979), 308–317.
18. C. W. Smith, Jr., "Alternative Methods for Raising Capital: Rights Versus Underwritten Offering," *Journal of Financial Economics*, **5** (December 1977), 273–307.
19. H. R. Stoll, "The Pricing of Underwritten Offerings of Listed Common Stocks and the Compensation of Underwriters," *Journal of Economics and Business*, **28** (1975), 96–103.
20. J. C. Van Horne, *Financial Management and Policy*, 4th edition, Prentice-Hall, Englewood Cliffs, N.J., 1977.
21. M. L. Weitzman, "The New Soviet Incentive Model," *Bell Journal of Economics*, **68** (Spring 1976), 251–57.
22. J. F. Weston and E. F. Brigham, *Managerial Finance*, 6th edition, Dryden Press, Hinsdale, Illinois, 1978.
23. R. Wilson, "The Theory of Syndicates," *Econometrica*, **36** (1968), 119–32.