Contract Choice and Pricing of IPOs*

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요 약

This paper proposes a pricing model for IPOs which can reconcile the average underpricing phenomenon with the expected wealth maximizing behaviors of market participants. Under the usual informational asymmetry, the optimal offer price for best efforts IPOs is derived as a function of the uncertainty about market's valuation, the expected return on proposed projects and the size of offerings relative to the firm's market value. Depending on these firm-specific characteristics, best efforts IPOs can be underpriced, fairly priced, or overpriced. Introducing the investment banker as an outside information producer, the model is extended to provide empirical implications for pricing and underwriting contract choice decisions which are consistent with the existing empirical evidences. The model predicts that the issuers with greater uncertainty about market's valuation choose best efforts contract over firm commitment contract and the dispersion of initial returns would be greater for best efforts IPOs than for firm commitment IPOs.

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Ⅰ. Introduction

One of the major puzzles in finance is why IPOs are underpriced on average, that is, the average return from the offer price to the first trade exceeds 10 percent. A number of studies proposed explanations for the IPO underpricing : agency problem between issuers and underwriters [Baron(82)], the winner's curse [Rock(86)], insurance against legal liability [Tinic(88)], signaling for subsequent seasoned offerings [Welch(89), Allen and Faulhaber(89)], mechanism to solicit information in the pre-selling process [Benveniste and Spindt(89)], cascades effect [Welch(92)], issuer's demand for dispersed ownership [Booth and Chua(96)]. However, there is no academic consensus on which explanation is most plausible and the IPO underpricing still remains as a puzzling phenomenon.

This paper proposes an alternative pricing model for IPOs, whose implications for IPO pricing and underwriting contract choice can be consistent with the most of existing empirical evidences. Motivations for this study stems from two, often unnoticed, empirical evidences. First, average initial return is far greater for best efforts IPOs than for firm commitment IPOs. Second, while average initial returns are positive, not all offerings show positive initial returns. Average initial returns tend to be magnified by substantial underpricing by a few best efforts IPOs. It is not rare to observe that the average initial returns are negative for several years, especially during the cold issue markets. According to the IPO database of Ritter (99), for 546 best efforts IPOs from 1980 to 1984, the proportion of negative, zero, and positive initial return is 18 percent, 18 percent and 64 percent, respectively, with the average initial return of 42.3%. For 1,451 firm commitment IPOs during the same period, average initial return is 11.4% with the median initial return of mere 1.6%.

Section 2 describes the basic model for IPO pricing under the best efforts contract. Section 3 extends the basic model to derive optimal offer price for firm commitment IPOs as well as for best efforts IPOs, assuming a simple compensation scheme for investment bankers. Also, the implications for contract choice decision of issuers with different characteristics are examined. Section 4 briefly summarizes the model and its implications and presents concluding remarks.

II. The Model

The setting for the derivation of our basic model is the market for best efforts IPOs. For analytical simplicity, we assume that all the best efforts contracts are 'all or none' type offerings. Under a best efforts contract, the banker promises to put its best efforts to sell the issue at the offer price agreed upon with the issuer. If the banker cannot sell out the issue at that offer price, the offering is withdrawn and the issuer receives no proceeds from the banker. And the banker is not compensated for its efforts.

We assume that each firm is endowed with a project which is not transferable to other firms. When the total number of shares offered is not subscribed, it is assumed that the offering would be withdrawn and the issuer is not allowed to go back to the market with a lower offer price. If the issuer cannot convey the true value of the project to the investors, offering a new issue at the fair price based on inside information would subject the issuer to a positive probability of having an unsuccessful offering and the possibility of losing the project's NPV. The issuer can increase the probability of success by lowering the offer price, which implies that he is selling away a part of the firm at a bargain price. Thus, the optimal offer price involves a tradeoff between the probability of successful offering and the dilution in the issuer's claim when the offer price is set below the fair price.

To provide a formal model for the above scenario, consider an economy in which each firm is endowed with a project that requires a fixed investment outlay, 'I'. Each project has a payoff per dollar invested of 'x_i', where x_i can take one of two values : x_H with probability 'q' and x_L with probability '$(1-q)$', where $x_L < x_H$. With no loss of generality, we assume that the one-period discount rate is zero. The issuer knows the true return on its own project. To finance this project, the issuer must issue 'n' new shares at a fixed offer price, 'OP', so that $n \cdot OP = I$. The issuer owns all the outstanding shares, 'k', of the firm whose total value of assets-in-place is denoted as 'A', both of which are known to everyone. The issuer is assumed to be risk-neutral and maximizes his expected wealth after the IPO.

Although not observing 'x' until it is revealed in the aftermarket, outside investors receive information that is useful for estimating 'x'. This information is denoted by the variable 's' which is related to the value of 'x'. Specifically, we assume that $s = x + \varepsilon$, where ε is uniformly distributed over the interval $[-h, +h]$. Assuming that the prior distribution of 'x' is diffuse, the posterior distribution of investors' estimate conditional on 's' is uniform over the interval, which is $[s - h, s + h]$.

Without knowing 's' of outside investors, the issuer's prior distribution of 's' conditional on 'x' would be uniform over the interval $[x - h, x + h]$. Given the value of 's', the reservation price per share of risk neutral investors, 'y', will be : $y = (A + Is)/(k + n)$. Then, the issuer's prior probability distribution function of 'y' can be written as:

$$f(y) = (k + n)/2hI \text{ on } [a, b] \quad (1)$$

$$\text{where } a = [A + I(x - h)]/(k + n) \quad (2)$$

$$\text{and } b = [A + I(x + h)]/(k + n). \quad (3)$$

Note that 'h' represents the degree of uncertainty to the issuer about the market's valuation of his offering.

The post-offering price per share of the firm, v, will be equal to:

$$\begin{array}{ll} (A + Ix)/(k + n) & \text{if the offering is successful,} \\ A/k & \text{if the offering is unsuccessful.} \end{array}$$

Given that the number of shares owned by the issuer is fixed, maximizing the expected post-offering wealth, E(W), is equivalent to maximizing the expected post-offering price per share, E(v).

Thus, the optimization problem of risk-neutral issuer can be stated as

$$\text{Max } E(v) = (A+Ix)/(k+I/OP) \int_{op}^{b} f(y)dy + A/k \int_{a}^{op} f(y)\,dy \tag{4}$$

subject to the conditions as specified in equations (1), (2) and (3). Making the necessary substitutions and integrating equation (4), this problem can be reduced to:

$$\text{Max } E(v) = \frac{[-k^2xOP^2 + (A(x+2h+1) + Ix(x+h-1))kOP - A(A+I(x-h-1))]}{2hk(kOP+I)} \tag{5}$$
$$\text{subject to} \quad a \le OP \le b \quad \text{and} \quad 0 \le OP.$$

Proposition 1 : Given the value of x and A/I, the optimal offer price, OP^*, is uniquely determined as the maximum of OP_L and OP_E,

$$\text{where} \quad OP_L = [A + I(x-h-1)]/k,$$
$$OP_E = [\sqrt{x(A+Ix)[A+I(x+h)]} - Ix]/kx,$$

Proof : See Appendix.

This optimal offer price, OP^*, will be lower or higher than its fair price, OP_F, depending on the values of 'h', 'x' and 'A/I' as follows :

(1) when $0 < h \leq h_1$, $OP^* = OP_L < OP_F$,
(2) when $h_1 < h \leq h_2$, $OP^* = OP_E \leq OP_F$,
(3) when $h_2 < h$, $OP^* = OP_E > OP_F$,

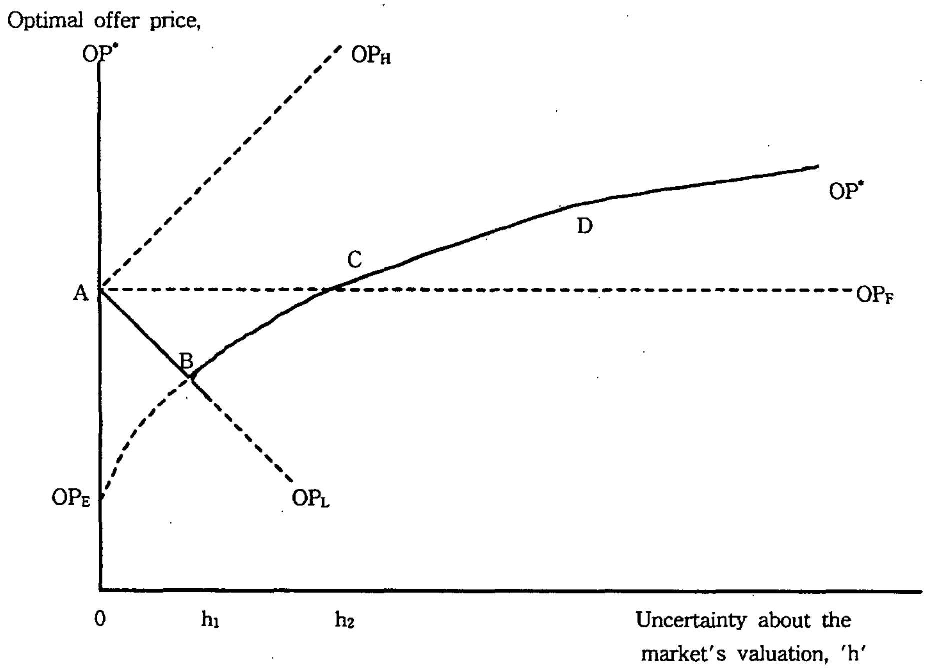
where
$$OP_F = [A + I(x-1)]/k,$$
$$h_1 = (A + Ix)(A + Ix)(2x + 1 - \sqrt{8x+1})/2Ix,$$
$$h_2 = (A + Ix)(x - 1)/I.$$

The optimal offer price results from a tradeoff between the dilution of the issuer's claim and the probability of the unsuccessful offering. Given that the investors will subscribe only to those offerings which they believe are not overpriced, the offering would fail if the investors' estimate is lower than the offer price that he chooses. However, as he lowers the offer price to increase the probability of a successful offering, his share of ownership in the firm will be reduced.

Proposition 1 can be restated in a graphical form. Given the value of 'x' and 'A/I', the path of the optimal offer price for different values of 'h' is depicted by the solid curve ABCD in [Figure 1]. It shows the optimal offer price as a function of the degree of uncertainty to the issuer about the market's valuation of the share (the uncertainty). When the uncertainty is relatively small so that $0<h<h_1$, the issuer will choose OP_L which is the highest offer price that guarantees a successful offering. While this offer price is always lower than the fair price, the dilution from underpricing is small relative to the deadweight loss from an unsuccessful offering.

As the uncertainty increases, the cost of guaranteeing a successful offering increases. Hence, when the uncertainty increases and exceeds 'h_1', it becomes optimal for the issuer to accept a small positive probability of an unsuccessful offering to avoid the dilution of his wealth which becomes prohibitively expensive. However, as long as the degree of uncertainty falls within a moderate range so that $h_1<h<h_2$, optimal offer price chosen by the issuer still involves underpricing.

[Figure 1] Locus of the optimal offer price as a function of 'h', given the values of x and A/I.



When the uncertainty increases beyond a certain level, 'h_2', the issuer chooses to overprice the offering and faces a significantly higher probability of an unsuccessful offering. The decision to overprice stems from the fact that the marginal impact of lowering the offer price further on the probability of an unsuccessful offering decreases as the uncertainty increases. When the uncertainty is extremely large, lowering the offer price below the fair price does not reduce the probability of an unsuccessful offering enough to justify the dilution of the issuer's claim.

Proposition 1 yields several interesting implications for initial return distribution of IPOs. If the after-market price is assumed to reflect the true return on new projects instantaneously as assumed in many empirical studies, simple comparative static analysis of Proposition 1 yields the following results :

$dR/dh > 0$, $dR/dx > 0$, and $dR/d(A/I) < 0$ when $OP = OP_L$,

$dR/dh < 0$, $dR/dx > 0$, and $dR/d(A/I) < 0$ when $OP = OP_E$.

When the uncertainty remains relatively small, initial returns would increases with the uncertainty. When the uncertainty exceeds a certain level, initial returns would decrease with the uncertainty and become negative as issuers choose to overprice. On the other hand, the degree of underpricing would be greater for IPO of firms with new projects yielding higher return since they have more to lose from unsuccessful offerings. Initial returns would be smaller for issuers with larger A/I. Intuitively, the dilution effect from the same degree of underpricing will be larger, the larger the value of assets-in-place relative to the size of new financing from IPO.

Ⅲ. Contract Choice Decision

Under the informational asymmetry as assumed in our model, it is shown that the issuer suffers expected wealth losses (or gains) from two sources : (1) the deadweight loss from taking the chance of losing investment projects with positive NPV, and (2) the dilution (or wealth gain) in the issuer's claim depending on whether the issue is underpriced (or overpriced). Depending on firm specific characteristics, the offering can be underpriced, fairly priced or overpriced, as a result of tradeoff between the deadweight loss and the dilution (or wealth gain).

Given that the model itself does not generate the condition that the offerings should be underpriced on average, the market can fail if investors believe that it is dominated by overpriced offerings. When the possibility of partial sales and the alternative financing capability of issuers are considered, the market is subject to an even severe overpricing incentive problem. Furthermore, the market can be dominated by issuers with no profitable investment projects who attempt to exploit the market by overpricing their offerings if the investors could not distinguish these exploiters from bona-fide issuers with positive NPV projects. Unless the excessive entry of overpriced issues is restrained, the new issues market would be subject to a 'lemons' problem.

Even when this equilibrium can hold up, it is less efficient than the equilibrium under informational symmetry in several respects. Some positive NPV projects would be lost if the offering fails due to a mismatch between the optimal offer price and the market's valuation. At the same time, the market sometimes allows negative NPV projects to be undertaken, though not frequently. Also, the maximized expected wealth is lower than that under informational symmetry except for those issuers whose offerings are successful with overpriced offerings. Thus, the remaining issuers have the incentive to increase their expected wealth by revealing their true values for a cost. One such possibility is that issuers attempt to self-select by sending out signals with attribute-related costs, as in Welch(89) or Allen and Faulhaber(89). Another possibility is that issuers can appoint an 'outside' information producer to certify the value of their shares, as in Beatty and Ritter(86) or Booth and Smith(86).

In this paper, we take the latter approach by assuming that there is no viable signaling mechanism that dominates the certification alternative. Investment bankers is introduced as an outside information producer under two types of underwriting contracts - firm commitment contract and best efforts contract.

1. Optimal Offer Price for Firm Commitment IPOs

Under firm commitment contract, the banker purchases the entire offering at a discounted purchase price and resells it at the offer price. If the issue is not fully subscribed at the offer price, the banker will take up unsold shares. Thus, the issuer is guaranteed the fixed net proceeds regardless of whether the banker is able to sell out the issue or not.

With the guarantee of success under firm commitment contract, the issuer has an incentive to maximize the offer price. Given that the issuer is better informed about the true value than the investment banker, costless transfer of information from the issuer to the banker is not feasible due to moral hazard problem. It is in the best interest of issuers to exaggerate positive information and conceal negative information to maximize the offer price until they are revealed by the market participants. For example, Teoh, Welch and Wong(98) suggest that earnings management through taking positive accruals by the issuers may explain poor long-run performance of IPO despite its positive initial returns. Thus, the use of firm commitment contract requires costly and independent information production by the banker to overcome this cheating incentive,.

We assume that, besides the normal transaction cost associated with the IPO, 'tI', the banker must incur additional cost to acquire information about the true value of firm under firm commitment contract. In doing so, the banker obtains an estimate, OP_F', for the true share price, which is assumed to be uniformly distributed over $[OP_F - e_c, OP_F + e_c]$, where 'e_c' is assumed to be smaller than 'h'. Let's denote this additional information production cost as 'phI' and the total compensation to the banker as 'cI', both of which are assumed to be public knowledge.

To undertake the project, the issuer should raise 'I + cI' so that $m \cdot OP = (1 + c)I$, where 'm' is the number of shares to be offered. And the expected post-offering price of the share is guaranteed to be $Ix/(k + m)$, which is a positive function of the offer price only.

On the other hand, the profit to the banker is

$cI - (t + ph)I$	if the offering is fully subscribed
$m \cdot OP'_F - I - (t + ph)I$	if the offering is undersubscribed.

Thus, the expected profit to the banker is

$$E(\pi) = (c - t - ph)I + Pr^{IB}(y<OP \mid OP_F')\ m\cdot(OP_F' - OP),$$

where $Pr^{IB}(y<OP \mid OP_F')$ is the subjective probability of the banker that the market's valuation is lower than the offer price and, hence, the offering is undersubscribed. The banker will engage in firm commitment contract only when the expected profit, $E(\pi)$, is non-negative.

However, knowing that the optimal choice is the one which makes the expected profit to the banker equal zero, investors will not subscribe to any offering with $cI > (t+ph)I$ even when their valuation is higher than the offer price. Thus, the condition $cI \leq (t + ph)I$ should also be satisfied, if any offering is to be successful.

Thus, the issuer's optimization problem becomes

$$\begin{aligned} &\text{Max } E(W) = k\cdot Ix / (k + m) \\ &\text{subject to} \quad 0 \leq E(\pi), \\ &\qquad OP \geq OP_{Lc}, \\ &\qquad cI \leq (t + ph)I \\ &\text{where } E(\pi) = (c - t - ph)I + Pr\ (y < OP)\ m\cdot[OP_F - OP] \\ &\qquad OP_{Lc} = I(x - h - c - 1) / k. \end{aligned}$$

<u>Proposition 2</u> : Given the values of x and h for an issuer, the optimal offer price, OP^*, and the optimal compensation rate, c^*, are as follows :

(1) if $OP_{Ec} \leq OP_{Fc}$, $OP^* = OP_{Ec}$ and $c^* = c_E$

(2) if $OP_{Ec} > OP_{Fc}$, $OP^* = OP_{Fc}$ and $c^* = t + ph$,

where $OP_{Fc} = I(x - c - 1)/k$,

$OP_{Ec} = I(2x + h - 4c_E - 4 + \sqrt{(2x + h)^2 - 16(1 + c_E)h}]/4k$

c_E is the compensation rate which satisfies $E(\pi \mid OP_{Ec}, c_E) = 0$.

<u>Proof</u> : See Appendix.

Thus, if $OP_{Ec} > OP_{Fc}$, the issue is fairly priced and the compensation paid by the issuer exactly the total cost incurred by the investment banker. If $OP_{Ec} \leq OP_{Fc}$, the issue is underpriced and the explicit compensation paid by the issuer is less than the total cost of the banker. However, the banker is compensated fairly ex ante if the expected profit from taking up underpriced shares is taken into consideration when the entire issue is not sold. Proposition 2 shows that offerings under firm commitment contracts are either fairly priced or underpriced.

Given that investors will not subscribe to any offering with the compensation that exceeds the information production cost, the requirement of non-negative expected profit restrains the banker from pricing the issue higher than its estimate about the fair price. Thus, this requirement will function as a binding constraint to issuers whose optimal offer price is higher than the fair price. At the same time, the use of firm commitment contract will discourage, though not completely, issuers who come to the IPO market only to overprice the offerings.

2. Optimal Offer Price for Best Efforts IPOs

Under best efforts contract, the investment banker assists the issuer with the registration process and performs the distribution function of shares to investors. We assume that the banker, in doing so, obtains an estimate for the true share price, OP_F'', which is assumed to be uniformly distributed over $[OP_F - e_b , OP_F + e_b]$. We also assume that the cost incurred by the banker is 'tI' and that the compensation to the banker is 'bI', both of which are assumed to be public information. Consistent with the data, we assume that the banker is not paid 'bI' by the issuer if the offering turns out to be unsuccessful.

To undertake the project, the issuer should raise 'I + bI' so that $m \cdot OP = (1 + b)I$, where 'm' is the number of shares to be offered. The post-offering wealth of the issuer under best efforts contract is

$k\,Ix\,/\,(k + m)$ if the offering is successful,

0 if the offering is unsuccessful.

On the other hand, the profit to the banker is

$bI - tI$ if the offering is successful,

$- tI$ if the offering is unsuccessful.

Thus, the expected profit to the investment banker is

$$E(\pi) = Pr^{IB}(y > OP \mid OP_F'')\, bI - tI,$$

where $Pr^{IB}(y > OP \mid OP_F'')$ is the subjective probability of the banker that the market's estimate is higher than the offer price. The banker will engage in best efforts IPOs only when the expected profit $E(\pi)$ is non-negative. Thus, the banker requires bI to be greater than 2tI if $Pr^{IB}(y > OP \mid OP_F'') < 1/2$, which occurs when $OP > OP_F''$. However, investors will not subscribe to offerings which they believe overpriced, even if the offer price is lower than their valuation. In other words, investors will not subscribe to any offering with $bI > 2tI$. Thus, if any offering is to be successful, the condition $bI \leq 2tI$ should be satisfied.

Then, the issuer's optimization problem becomes

$$\text{Max } E(v) = Pr(y > OP)\cdot kIx/(k + m)$$
$$\text{subject to } E(\pi) = Pr(y > OP)bI - tI \geq 0,$$
$$bI \leq 2tI,$$
$$OP \geq OP_{Lb},$$
$$\text{where } OP_{Lb} = I(x - h - 1)/k.$$

Proposition 3 : Given the values of x and h for an issuer, the optimal offer price, OP^*, and the optimal compensation rate, b^*, are as follows :

(1) if $OP_{Eb} < OP_{Lb}$, $OP^* = OP_{Lb}$ and $b^* = t$
(2) if $OP_{Lb} \leq OP_{Eb} < OP_{Fb}$, $OP^* = OP_{Eb}$ and $b^* = b_E$
(3) if $OP_{Eb} \geq OP_{Fb}$, $OP^* = OP_{Fb}$ and $b^* = 2t$,

where $OP_{Lb} = I(x - h - b - 1)/k,$
$OP_{Fb} = I(x - b - 1)/k,$
$OP_{Eb} = I\sqrt{x+h+2th}[x+h+1-2\sqrt{x+h+2th}]/k[x+h-\sqrt{x+h+2th}],$
$b_E = 2th/(x + h - \sqrt{x + h + 2th})$

Proof : See Appendix.

This result is similar to Proposition 1, except that the entry of overpriced issues is constrained to a certain degree. This is possible because, given that 'bI' cannot be greater than '2tI', the investment bankers will not engage in best efforts IPOs if they believe that the issue is overpriced, i.e., $OP > OP_F''$. Given OP_F'' of the banker, OP_{Eb} and its 'b_E' should be adjusted to satisfy the requirement that $E(\pi) > 0$. If $OP^* < OP_F''$, the issuer and the banker can agree on the offer price which will be set at OP^*. On the other hand, if $OP^* > OP_F''$, the issuer can either accept OP_F'' or offer the share at OP^* on his own without employing the banker.

However, we should note that this screening mechanism is not perfect. Due to the banker's imperfect information about the true value of shares, overpriced issues can pass through this screening mechanism if $OP_F'' > OP_F$. Nevertheless, the entry of overpriced offerings is constrained to a degree since it is more likely that $OP^* > OP_F''$ when $OP^* > OP_F$.

Meanwhile, the cheating incentive of the issuer under best efforts contract is less than that under firm commitment contract. This is because maximizing the offer price does not coincide with maximizing expected wealth under best efforts contract. The consequence of having an unsuccessful offering falls on the issuer as a deadweight loss. Thus, the issuer will attempt to price the offering as close as possible to the optimal offer price, which is specified above. Those issuers with $OP_{Eb} < OP_{Lb}$ do not need to overstate the true value of share since OP_{Lb} is always lower than OP_F''. But, those issuers with $OP_{Eb} > OP_{Lb}$ will attempt to overstate the true value to increase the probability that $OP_F'' > OP_{Eb}$.

This cheating incentive will increase as 'h' gets larger. However, this problem will not be so serious except for those issuers with $OP_{Eb} > OP_{Fb}$, whose offer price is higher than the fair price. All other issuer will choose the optimal offer price which is lower than the fair price, even when the banker is willing to agree on a higher offer price. Although the banker may want to acquire more accurate information, the cost of doing so may be too high to be justified, especially if information production cost is so large that $(ph+t)I > bI$.

3. Contract Choice Decision

In this section, we examine which contract between best efforts contract and firm commitment contract is optimal for each issuer with different characteristics. For analytical simplicity, consider the case in which the error in the banker's estimate of the true value is zero. Substituting the optimal offer price together with the optimal compensation rate, the expected post-offering wealth under firm commitment offering is:

(1) $E(W \mid OP_{Fc}) = I[x - ph - t - 1]$
if $OP_{Ec} > OP_{Fc}$.

(2) $E(W \mid OP_{Ec}) = Ix[1 - 4(1 + c_E)/(2x + h + \sqrt{(2x + h)^2 - 16h(1 + c_E)})]$
if $OP_{Ec} < OP_{Fc}$.

When $OP_{Ec} > OP_{Fc}$, the expected wealth is a decreasing function of the information production cost, 'phI', at a constant rate. When $OP_{Ec} < OP_{Fc}$, the relation between the expected wealth and the uncertainty is not so clear-cut. However, we know that $E(W \mid OP_{Ec}) > E(W \mid OP_{Fc})$, since OP_{Ec} maximizes the expected post-offering wealth if there is no constraint, as shown in Proposition 2.

In the same way, the expected post-offering wealth with a best efforts offering is:

$$(1)\ E(W \mid OP_{Lb}) = Ix(x - h - t - 1)/(x - h) \qquad \text{if } h < h_{b1},$$
$$(2)\ E(W \mid OP_{Eb}) = Ix[x + h + 1 - 2\sqrt{x + h + 2th}]/2h \qquad \text{if } h_{b1} < h < h_{b2},$$
$$(3)\ E(W \mid OP_{Fb}) = I(x - 2t - 1)/2 \qquad \text{if } h_{b2} < h,$$

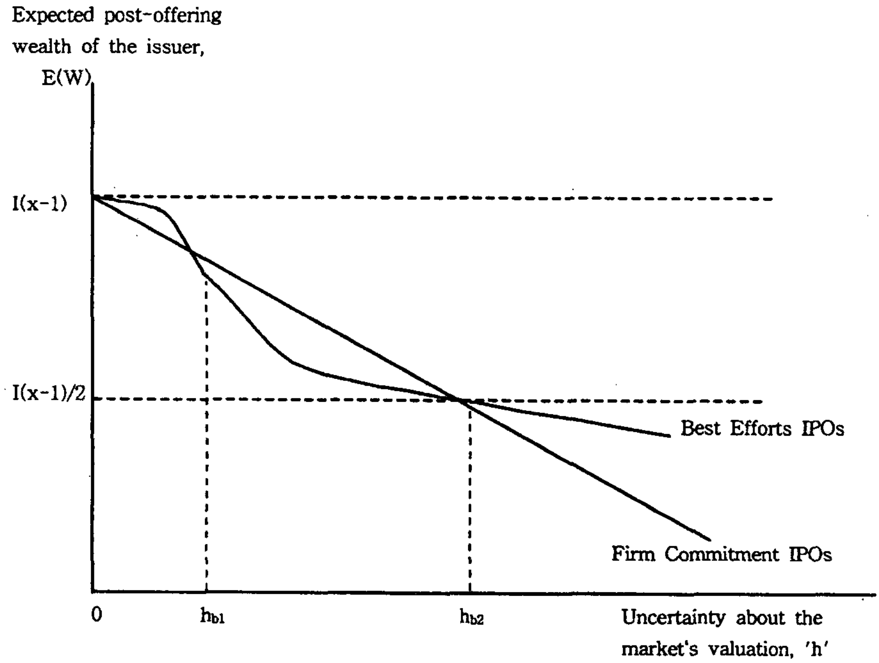
where $h_{b1} = 2x + 2t + 1 - \sqrt{8x(t + 1) + (2t + 1)^2}/2$ and
$h_{b2} = x(x - 1)/(2t + 1)$.

[Figure 2] depicts the relation between the expected post-offering wealth, E(W), and the uncertainty, 'h', for both firm commitment and best efforts contracts. Given the value of 'h', the exact shape and location of the two curves depend on 'tI' and 'phI' as well as 'x' and 'I'. Since the overpricing incentive is controlled by compensation structure for the banker, the benefit to the issuer from using firm commitment contract is the removal of the deadweight loss, while the information production cost of the banker will be born by the issuer. Thus, depending on the importance of the deadweight loss relative to the dilution as well as on the relative magnitude of information production cost, the optimal type of contract is determined for each issuer with different characteristics.

For those IPOs with very small uncertainty, the issuer would use best efforts contract choosing OP_{Lb} which guarantees successful offering. Thus, it is optimal to choose best efforts contract if the information production cost is greater than the cost from the dilution and vice versa.

As the uncertainty gets larger, the cost from the dilution to avoid the deadweight loss is increasing at an increasing rate, while the information production cost is increasing at a constant rate. At some point, if the information production cost is not too large, it becomes optimal to switch to firm commitment contract. The issuer can avoid the entire deadweight loss under firm commitment contract, but the information production cost is assumed to be increasing at a constant rate as the uncertainty increases. On the other hand, when the optimal offer price for issuers who stick to best efforts contract becomes OP_{Fb}, the wealth loss comes from the deadweight loss which remains constant due to constant probability of failure at OP_{Fb}. Thus, at some point, it becomes optimal to switch back to best efforts contract due to prohibitively large information production cost. However, it might have been optimal to use best efforts contract even before the optimal offer price becomes OP_{Fb}, which all depends on the shape and location of the two curves, which are functions of the normal transaction cost, information production cost, expected return on investment projects and the size of investment outlay relative to existing assets of the firm.

[Figure 2] Locus of the expected pots-offering wealth of the issuer as a function of 'h', given the values of x and A/I.



However, it should be noted that some issuers may be excluded from using a best efforts contract if investors believe that it is optimal for those issuers to overprice their offerings, given that the screening function of neither contract is perfect, especially with best efforts contract. One such case would be issuers who are believed by investors to have many viable financing alternatives, which may actually be the case for established firms with a good operating history. It may help explain why only 2.6 percent of seasoned equity issues use a best efforts contract, as documented in Booth and Smith(86). Also, issuers who want to sell off a fraction of their shares as a part of the offering may not be able to use best efforts contracts due to their serious overpricing incentive. For example, only 4 out of 268 initial public offerings in 1977-1982 that included insider selling used a best efforts contract.

Ⅳ. Summary and Conclusion

This paper develops a model for IPO pricing and contract choice decision under the usual setting of informational asymmetry in which inside issuers have better information than outside investors. Under best efforts contract, the issuer faces the positive probability of losing the NPV of the investment when the market's valuation is lower than firm's true value. The issuer can reduce this probability by underpricing the offering, which brings wealth loss from dilution of his share of the firm. The optimal offer price is derived from an optimal tradeoff between the probability of success and the dilution from underpricing. While issuers with relatively small uncertainty would choose to underprice, issuers will raise the offer price as the uncertainty increases. When the uncertainty increases beyond certain level, issuers find it optimal to overprice.

By using firm commitment contract, issuers can buy insurance against the failed offering. However, issuers now attempt to cheat investment banker by overstating firm's value, firm commitment contract requires investment bankers to engage in costly information production on its own and hence entails greater compensation to the bankers than under best efforts contract. Assuming a linear compensation schedule, the model predict that the initial returns under firm commitment contract would be either zero or positive. This contrasts with the model's prediction about IPOs under best efforts contract for which initial returns can be positive, zero and negative depending on the uncertainty. This prediction can be consistent with the observed initial return distribution of best efforts IPOs which has greater dispersion with larger portion of IPOs showing negative initial returns than that of firm commitment IPOs.

Assuming that this information production cost increases as the uncertainty about firm value increases, the model predict that issuers with greater uncertainty about the market's valuation of their shares will use best efforts contract. This is consistent with the empirical evidence of Ritter(87) that issuers with greater uncertainty are more likely to use best efforts contract. This prediction is also consistent with the relative frequency with which best efforts contracts are used among seasoned and unseasoned equity issues. Booth and Smith(86) report that only 2.6 percent of seasoned equity issues used best efforts contract from 1977 to 1982. This is in contrast to their finding that 54.3 percent of IPO used best efforts contract for the same period.

APPENDIX

Proof of Proposition 1

Differentiating equation (5) with respect to OP, we get

$$dE(W)/dOP = k[-k^2x\,OP^2 - 2kIxOP + I^2x(x+h-1) + AI(2x+h) + A^2]/2h\,(kOP+I)^2 \qquad (6)$$

Setting this first derivative equal to zero and solving a quadratic equation in the numerator, we find two critical values :

$$OP = [-Ix + \sqrt{x(A+Ix)(A+I(x+h))}]/kx$$
$$\text{or } [-Ix - \sqrt{x(A+Ix)(A+I(x+h))}]/kx.$$

Differentiating equation (6) with respect to OP, we get

$$d^2E(W)/dOP^2 = -k^2[I^2x(x+h) + AI(2x+h) + A^2]/h\,(kOP+I)^3 \qquad (7)$$

This second derivative would be

positive if $OP = [-Ix - \sqrt{x(A+Ix)(A+I(x+H))}]/kx$ and

negative if $OP = [-Ix + \sqrt{x(A+Ix)(A+I(x+h))}]/kx = OP_E$.

Thus, E(W) is maximized when OP = OP_E only if OP_E satisfies the constraints that $a \leq OP \leq b$ and $0 \leq OP$.

Defining OP_L and OP_H which satisfy equations (2) and (3) respectively, we get $OP_L = [A + I(x - h - 1)]/k$ and $OP_H = [A + I(x + h\ 1)]/k$.

Note that $0 < OP_E$, $OP_E < OP_H$ and $OP_E \leq OP_L$ if $0 < h \leq h_1$

$OP_E > OP_L$ if $h_1 < h$

where $h_1 = (A + Ix)(A + Ix)(2x + 1 - \sqrt{8x+1})/2Ix$

To see whether this optimal offer price implies underpricing or not, it is straightforward to show that $OP_E \leq OP_F$ if $0 < h \leq h_2$

$OP_E > OP_F$ if $h_2 < h$

where $h_2 = (A + Ix)(x - 1)/I$

Given that $h_1 < h_2$, the proposition 1 follows.

Proof of Proposition 2

Given the probability of failure is $Pr(y < OP) = \int_a^{op} f(y)dy = k(OP - OP_L)/2hI$, $E(\Pi) = (c-t-ph)I - k(1+c)(OP-OP_L)(OP-OP_F)/2h \cdot OP$. The LaGrangean for the constrained maximization problem becomes :

$L = IxOP/[kOP + (1+c)I] + \lambda[(c-t-ph)I - \{k(1+c)(OP-OP_L)(OP-OP_F)\}/2hOP]$.

(1) When $\lambda = 0$, there is no stationary point satisfying the first order condition since $dE(W)/dOP > 0$ and $dE(W)/dc < 0$.

However, there are two boundary points : OP_{Lc} with c=t+ph and OP_{Ec} with c=t+ph, where $OP_{Lc} = I(x-h-c-1)/k$ and $OP_{Fc} = I(x -c -I)/k$. Since OP_{Lc} with c=t+ph is dominated by OP_{Fc} with c=t+ph, the only meaningful boundary point is OP_{Fc} with c=t+ph.

(2) When $\lambda \neq 0$ i.e., $E(\Pi) = 0$, from the first order condition, we get $dE(W)/dOP/dE(\Pi)/dOP = dE(W)/dc/dE(\Pi)/dc$. After differentiation and rearrangement, we get $2k^2OP^2 - (2x+h-4c-4)kIOP - (1+c)I^2(2x-h-2c-2) = 0$

From this quadratic equation, the unique real root is found to be

$$OP_{Ec} = I[2x + h - 4c_E - 4 + \sqrt{(2x+h)^2 - 16h(1+c)}]/4k,$$

where c_E is the compensation rate s.t. $E(\pi \mid OP_F', cE) = 0$.

Since it is too complicated to check the second order condition, we will verify that E(W) is maximized at OPEc with c = cE, using the marginal rate of substitution between OP and c with respect to E(W) and E(Π). At a certain levels of E(W) and E(Π),

$$dc/dOP_1 = dc/dOP \mid [E(W) = W^*] = -(1+c)/OP \text{ and}$$

$$dc/dOP_2 = dc/dOP \mid [(E(\Pi) = \Pi^*] = -(1+c)[k^2OP^2 - I^2(x-c-1)(x-h-c-1)] / OP[\{kOP-I(x-c-1)\}\{kOP-I(x-h-c-1)\} + (1+c)I\{2kOP-I(2x-h-2c-2)\} - 2hkIOP].$$

It can be shown that $dc/cOP_1 < dc/dOP_2$ if $OP > OP_{Ec}$ and $dc/cOP_1 > dc/dOP_2$ if $OP < OP_{Ec}$. Thus, E(W) is maximized at OP_{Ec} with c_E.

Given that $OP^* = OP_{Ec}$, $c^* = c_E$ and $E(\pi \mid OP_{Ec}, c_E) = 0$, investors can infer $OP_{Ec} > OP_{Fc}$ if $c_E > t+ph$ and $OP_{Ec} < OP_{Fc}$ if $c_E < t+ph$. Since it is certain that the offering will fail if $c > t+ph$, the issuer chooses OP_{Fc} with $c^* = t+ph$ if $OP_{Ec} > OP_{Fc}$ even when $c_E > t+ph$. When $c_E < t+ph$, the issuer chooses OP_E with $c^* = c_{Ec}$ Thus, Proposition 2 follows.

Proof of Proposition 3

Given the probability of failure is

$$\Pr(y<OP) = \int_a^{op} f(y)dy = k[I(x+h-b-1)-kOP]/2hI,$$

$E(\Pi) = [b\{I(x+h+b-1) - kOP\}/2h] - bI$. The LaGrangean for the constrained maximization problem becomes :

$$L = xOP[I(x+h-b-1) - kOP]/2h[kOP + (1+b)I] + \lambda[b\{I(x+h+b-1) - kOP\}/2h - bI]$$

(1) When $\lambda=0$, there is no stationary point satisfying the first order condition since $dE(W)/dOP > 0$ and $dE(W)/db < 0$.

However, there are two boundary points : OP_{Lb} with b=t and OP_{Fb} with b=2t, where OP_{Lb} = I(x-h-b-1)/k and OP_{Fb} = I(x-b-I)/k.

(2) When $\lambda \neq 0$ i.e., E(Π) = 0, from the first order condition, we get k^2OP^2 - (1+b)2kIOP - $(1+b)I^2(x+h-b-1)$ = 0

From this quadratic equation, the unique real root is found to be

$$OP_{Eb} = I\sqrt{x+h+2th}\,[x+h+1-2\sqrt{x+h+2th}]/[x+h-\sqrt{x+h+2th}]\ k.$$

From E(π | OP_{Eb}) = 0, $b_E = 2th / [x+h-\sqrt{x+h+2th}]$.

It can be shown that E(W | OP_{Eb}, b_E) > E(W | OP_{Lb},t) and E(W | OP_{Eb}, b_E) > E(W | OP_{Fb},2t).

Given the constraints that b < 2t and OP > OP_{Lb}, Proposition 3 follows.

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