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Rights versus Underwritten Offerings: An Asymmetric Information Approach

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ABSTRACT

By assuming asymmetric information between investors and firms seeking new equity, we derive a rational expectations, partially revealing information equilibrium in which three forms of equity financing are observed. The highest quality firms employ a standby rights offers, intermediate quality firms signal their true value in the choice of a subscription price in an uninsured rights offer, while low-quality firms remain indistinguishable to investors by making fully underwritten issues. The model offers justification for many firms using apparently more costly underwritten offers, provides a reason why firms using uninsured rights offers do not set arbitrarily low subscription prices to ensure the success of the issue, and explains the simultaneous existence of the three financing vehicles.

WHEN FIRMS WISH TO raise new equity capital, they have a variety of alternatives available. These alternatives include fully underwritten offers, uninsured rights offers, and standby (insured) rights offers. The literature provides evidence on the choice of financing methods by firms. Smith [11] examines 578 equity offers in the U.S. over the period 1971–1975; 83% of these offerings were underwritten, 7% were rights offers, and 10% were standby rights offers. Similarly, Bhagat [1] reports the predominant use of underwritten offers in the U.S. In contrast, Marsh [5] states that new equity capital in Europe is raised almost exclusively by rights issues; e.g., over 99% of the new equity issued in the U.K. in 1975 was raised via rights offers.

The predominant use of fully underwritten new equity issues in the U.S. rather than the much less costly rights offer has been called an unresolved paradox in finance by Brealey and Myers [2]. Potential explanations have been put forward by several authors. Smith [11] hypothesizes that underwritings provide the managers of the issuing firms with perquisites that are absent in rights offers. Hanson and Pinkerton [3] claim that concern for corporate control influences

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the choice of an equity financing vehicle. Parsons and Raviv [7] derive a rational preference for the underwritten offer by assuming that there are two classes of investors, those who place a high value on the new issue and those that place a low value; however, neither the firm nor the investment banker know how many investors there are of each type. An underwritten offer is made at the higher valuation to attract the high value investors and, if there are an insufficient number of them (the offer is undersubscribed), the remainder of the offer is priced at the lower valuation. No such two-part pricing discrimination is possible using the rights offer, and so the underwritten offer is used because of its superior *benefits*, rather than cost differences.

Bhagat [1], referencing several corporate proxy statements, lists reasons why *cost* differences might actually favor underwritten offers. For example, delay in the acquisition of the equity funds and the uncertainty of the success of a rights offer were cited by firms as "costs" of a rights offer that are absent in underwritten offers.

In the model developed here, we examine the equity financing paradox within a world of asymmetric information: issuing firms are assumed to know more about the quality of their firm than do investors. We allow, as Smith [11] found, higher fixed costs of underwriting, but we also recognize some "indirect" costs of rights offers, as pointed out by Bhagat [1]. We are able to obtain a rational expectations, partially revealing information equilibrium in which three forms of equity financing are observed. The highest quality firms employ a standby rights offer, intermediate quality firms distinguish themselves from other firms by using an uninsured rights offer and optimally selecting the subscription price, and low-quality firms prefer the "pooled" sale of equity at an average price through an uninformed underwriter to avoid the costs of using a rights offer.

Besides providing an alternative reason for the predominant use of the underwritten offer, the model also indicates why firms that make uninsured rights offers do not set arbitrarily low exercise prices to ensure the success of the offer: the subscription price chosen is serving a signalling function.

Our result that the higher quality firms in the population distinguish themselves while low-quality firms choose to remain undistinguished from one another is similar to Viscusi's [13] simple model of costly quality certification. As an example, suppose that there are five products in the market, one each with value (quality) 1, 2, 3, 4, and 5. If undistinguished, all products will sell at the average value, 3. Suppose that for a fixed, exogenous $1 fee, the true value of the product can be revealed. Product 5 will pay 1 to net 4 rather than receive the average 3; with 5 distinguished, the new average value of products 1 through 4 is 2.5; product 4 prefers paying 1 to net 3 rather than receive 2.5; the new average value is 2 and product 3 sees no advantage to distinguishing itself; thus products 1 through 3 stay "pooled" at an average value of 2, while products 4 and 5 distinguish themselves.

In our model, only the higher quality firms are willing to pay the costs incurred with a rights offer. The highest quality firms, as in Viscusi's model, are willing to pay the *exogenous*, fixed investigation cost associated with a standby rights offer. The intermediate quality firms are willing to pay the *endogenously* determined signalling costs incurred with an uninsured rights offer. Finally, the low-

quality firms remain undistinguished, using an uninformed underwriter to sell their shares.

In particular, we consider a world of asymmetric information: we assume that at the time of the announcement of the equity offer, the firm knows more about its future stock price (firm "quality") than either investors or underwriters. We allow three methods of equity financing: fully underwritten offers; uninsured rights offers; and standby (insured) rights offers.

Under the underwritten alternative, the firm sells its shares to an uninformed underwriter at a fixed price; the underwriter then resells the shares to investors at that price plus the underwriter's fixed underwriting expense.

In an uninsured rights offer, the firm sets the subscription price at the time of the announcement of the offer. As opposed to the underwritten offer, the rights offer has lower flotation costs, but a rights offer may fail: the stock price at expiration of the right (the "terminal stock price") may be less than the subscription price of the right. We assume that if a rights offer fails, the firm pays a penalty cost. This cost includes the opportunity costs of foregone positive net present value investments, the costs of covering unsatisfied commitments due to the failure to obtain financing, or the costs of acquiring emergency interim financing.

Very frequently, firms issuing rights contract a standby agreement with an underwriter, by which, for a fee, the underwriter commits to purchase the issue if the stock price at expiration falls below the subscription price. The issuing firm, essentially, buys a put from the underwriter that gives it the option to sell the issue to the underwriter at the subscription price at the expiration date of the rights. The equilibrium fee for the standby agreement is the value of the put option. In order to correctly price the standby agreement, the underwriter must know firm quality. We assume that the underwriter can become informed about firm quality by investigating the firm at a cost which is passed on to the firm using the standby rights offer.

In summary, firms can choose an uninsured rights offer with no flotation costs but with a probability of the offer failing being a function of the subscription price chosen. Or, firms can ensure the success of their rights issue by using a standby rights offer; the cost incurred in this alternative is the investigation cost. Finally, they can choose an immediate underwriting, with flotation costs, carried out by an underwriter that is also uninformed about terminal stock price. The firm's objective is to maximize current stock price net of flotation, investigation, or expected failure costs.

Assuming that firms selling new equity differ only in the distribution of their terminal stock price and assuming that this is not observable by underwriters or investors, a rational expectations, partially revealing separating equilibrium is derived. In this equilibrium, the highest quality firms distinguish themselves through the use of a standby rights offer, incurring the investigation costs. Intermediate quality firms use uninsured rights offers and credibly signal their expected terminal stock price by the setting of the subscription price in the rights offer; higher quality firms set higher subscription prices. The lowest quality firms all sell their shares at a common offer price through an uninformed underwriter, where the offer price correctly reflects the average quality of the firms using an

underwriting. These lower quality firms are better off using the apparently more costly underwriting method because both the costs of signalling and the costs of investigation in a rights offer would be even higher.

Section I develops the dissipative signalling equilibrium when only rights offers without standby agreements are allowed. Firms are shown to disclose their firm type in the setting of the rights offer subscription price. Section II allows firms to choose between an underwritten offer through an uninformed underwriter and a rights offer with no standby. Only higher quality firms use the rights offer in the resulting equilibrium. Section III allows the additional alternative of a rights offer *with* a standby agreement provided by an underwriter that, at a cost, can determine the firm's true type so that the insurance on the rights offer can be correctly priced. The resulting equilibrium in this case is as before except that the highest quality firms use a standby rights offer rather than an uninsured rights offer.

Sections II and III also provide additional equilibria, the existence of which primarily depend upon the relative costs of the different financing methods. Section IV characterizes these equilibria and outlines possible empirical implications of the model. Section V provides concluding comments.

I. The Rights Offer Model

In this section, we assume that a heterogeneous group of firms is selling new equity with an uninsured rights offer, and we defer the possibility of using other financing alternatives to Sections II and III.

We assume all firms will raise the same total amount of equity, varying the number of shares sold inversely with the subscription price. The stock price at the expiration of the right (the "terminal stock price") is a random variable with a probability density known by the issuing firm but not by investors. If the offer fails, i.e., has a terminal stock price less than the subscription price, we assume that the firm incurs a fixed failure cost of F per share. We define $g(P; t)$ as the probability density function of the terminal stock price of a type t firm; the expected future cost of a failed rights offer is:

$$F \int_0^S g(P; t)\, dP$$

where S is the subscription price of the rights offer.[1] We also assume no fixed costs are incurred with a rights offer.[2]

A key assumption of the model is that firms across the population differ in the

[1] Note that $g(P; t)$ is the probability density function of terminal stock price *ignoring* dilution from a successful rights offer (i.e., the "rights-on" price). The expected failure costs, however, must be calculated using the probability density of the ex-rights stock price. Given that when the terminal stock price is equal to or less than the subscription price, the offer fails and there is no dilution, there is no distinction between the rights-on and the ex-rights price. Thus, the probability densities of the rights-on stock price and the ex-rights price are identical for $P \leq S$, and when we compute the expected failure costs we need not make any distinction.

[2] We only require that the fixed costs of an underwriting exceed those of a rights offer; the assumption of zero costs for the rights offer is for simplicity.

probability distribution of their terminal stock price, $g(P;\ t)$, and that the parameter, t, of this distribution is not known to investors at the time of the announcement of the rights offer. We also assume that the realized terminal stock price will be drawn from the distribution $g(P;\ t)$; this assumption is consistent with a rights offer announcement causing investors to increase their analysis of this stock, leading to a resolution of the information asymmetry prior to the maturity date of the right.[3] For example, the announcement of a new equity financing might alert investors to a previously unanticipated investment opportunity for the firm, leading to increased analysis of the company, and eventual resolution of the information asymmetry prior to expiration of the right. We are assuming an information structure such that resolving the asymmetry would not allow ex-ante "contingent contracts" between the firm and investors that would penalize the firm if found by investors to have misrepresented itself at the announcement date.

The above assumption provides incentives for the higher quality (higher expected terminal stock price) firms to distinguish themselves from lower quality firms. In this paper, we hypothesize that the subscription price is used as the signal of quality, and that investors determine a firm's current share value based upon the chosen subscription price.

Also, we assume that firms set the subscription price of the right, S, to maximize $W(t)$, the current value of the type t stock net of expected costs of failure:

$$W(t) \equiv \underset{S}{\text{Max}} \left\{ V(S) - F \int_0^S g(P;\ t)\ dP \right\} \tag{1}$$

where $V(S)$ is the investors' inference of stock value excluding expected failure costs, for a chosen subscription price, S. This type of objective function is similar to Ross [10], who assumes the decision maker's two-part wage is tied to current value and to the success or failure of the firm in the future. An alternative interpretation follows Miller and Rock [6]: the decision maker maximizes a time-weighted average of current firm value and future value. Essentially, we require that in setting S, the firm considers both current value and the probability of failure at expiration of the right.[4]

Finally, for simplicity, we assume that investors are risk neutral and that the discount rate is zero, so that the *true* value of a type t stock (excluding expected failure costs) is

$$V(t) = \int_0^\infty Pg(P;\ t)\ dP. \tag{2}$$

If there is a fully revealing signalling equilibrium, investors will correctly infer the true value of a share, $V(t)$, from the optimally chosen subscription price,

[3] A possible empirical validation of this assumption would be an increased flow of information as measured by increased variability of stock price or volume of trading during the period from the announcement of the rights issue to the expiration of the rights.

[4] Harris and Raviv [4] develop a multiperiod model with logarithmic investor utility and show that maximizing shareholder welfare is essentially equivalent to maximizing a weighted average of the time-series firm values.

$S^*(t)$:[5]

$$V(S^*(t)) = V(t). \tag{3}$$

For a given valuation schedule, $V(S)$, firms choose S to maximize the market value of the stock net of expected failure costs [Equation (1)]. The first- and second-order conditions for a maximum are:

$$\frac{dV(S^*)}{dS^*} - Fg(S^*; t) = 0 \tag{4}$$

$$\frac{d^2V(S^*)}{dS^{*2}} - F\frac{dg(S^*; t)}{dS^*} < 0. \tag{5}$$

Equations (4) and (5) and the consistency condition, (3), define the signalling equilibrium. Investors employ a valuation schedule, $V(S)$, that allows them to correctly infer true value, Equation (3), from the optimally chosen subscription prices, $S^*(t)$, in Equations (4) and (5). In equilibrium, a type t firm has a net share value of:

$$W(t) = V(S^*(t)) - F\int_0^{S^*(t)} g(P; t)\, dP. \tag{6}$$

If an equilibrium exists, the first-order condition indicates $dV(S^*)/dS^* > 0$: firms with higher subscription prices will be valued higher. Also, without loss of generality, we define quality, t, such that higher t implies higher true value: $\frac{dV(t)}{dt} > 0$. Then, differentiating the consistency condition (3) with respect to t,

$$\frac{dV(S^*)}{dS^*}\frac{dS^*}{dt} = \frac{dV(t)}{dt}, \tag{7}$$

we see that $dS^*/dt > 0$: higher value firms will set higher subscription prices in the rights offer.

Finally, substituting Equations (2) and (4) into (7), we obtain a differential equation relating the optimal subscription price, S^*, to firm quality, t:

$$Fg(S^*; t)\frac{dS^*}{dt} = \frac{d}{dt}\int_0^{\infty} Pg(P; t)\, dP. \tag{8}$$

To illustrate the form of the equilibrium, we must specify the density function $g(P; t)$. For the usual assumption of lognormally distributed terminal stock prices, there is no closed-form solution to Equation (8). However, the equilibrium can be easily obtained numerically. For a simple density, the uniform, we are able to derive analytical expressions for the equilibrium. Thus to facilitate the

[5] While Equation (3) ensures correct market valuation, the actual market price will include expected failure costs:

$$V(t) - F\int_0^{S^*(t)} g(P; t)\, dP.$$

The expected failure costs will be known by investors since S^* perfectly reveals the firm type, t.

exposition, for the remainder of the paper, we assume that the terminal stock price of a type t firm is uniformly distributed over the interval $[0, t]$ so that

$$g(P; t) = 1/t$$

and we assume that t lies in the closed interval $[\underline{t}, \bar{t}]$: the population of firms making rights offers varies in type from $\underline{t}$ to $\bar{t}$. In the case of a uniformly distributed terminal stock price, Equation (2) becomes

$$V(t) = t/2 \tag{9}$$

so that $dV(t)/dt = \frac{1}{2}$. Population stock values thus range from $\underline{t}/2$ to $\bar{t}/2$.

In the case of a uniformly distributed terminal stock price, explicit functions for $S^*(t)$ and $V(S)$ can be derived. Substituting the first-order condition, Equation (4), into Equation (7) and using Equation (9), yields

$$Fg(S^*; t)\frac{dS^*}{dt} = \frac{dV(t)}{dt}$$

or

$$F\left(\frac{1}{t}\right)\frac{dS^*}{dt} = \frac{1}{2}. \tag{10}$$

The ordinary differential Equation (10) has the solution

$$S^*(t) = \frac{t^2}{4F} + K.$$

Imposing the standard boundary condition that the minimum quality firm bears no signalling costs:[6]

$$S^*(\underline{t}) = 0 \Rightarrow K = -\frac{\underline{t}^2}{4F}.$$

Then the optimal subscription price as a function of firm type is[7]

$$S^*(t) = \frac{1}{4F}(t^2 - \underline{t}^2). \tag{11}$$

Next, using Equations (9) and (3):

$$V(S^*) = V(t) = t/2.$$

Substituting this into Equation (11) and solving for V provides the equilibrium inference schedule:

$$V(S) = (FS + \underline{t}^2/4)^{1/2} \tag{12}$$

used by investors to infer value from the signal, S.

[6] Since firms of type t will raise no funds if $S^*(t) = 0$, the technically correct boundary condition would have $S^*(\underline{t}) = \varepsilon$, with ε very close to zero. Firm $\underline{t}$ would then bear some positive expected failure cost since $g(0, t) = 1/\underline{t} > 0$. Using $S^*(\underline{t}) = 0$ keeps the analysis simple without affecting the results.

[7] As a consequence of using the uniform distribution for terminal stock price, we must assume a sufficiently large F to ensure that $S^*(\bar{t}) < \bar{t}$. No such assumption would be necessary with, for example, a lognormally distributed terminal stock price.

Using equation (12) in the optimization, Equation (1), it is easy to verify the first- and second-order conditions (4) and (5), respectively. Also, the consistency condition (3) is satisfied.[8]

If investors use Equation (12) to infer stock value from the subscription price, then firms maximizing Equation (1) will set their subscription price according to Equation (11); substituting this into Equation (12) yields the true stock value. This is, therefore, a fully revealing rational expectations equilibrium.

Finally, Equations (6), (11), and (12) provide the equilibrium net current value of the share of a type t firm:

$$W(t) = \frac{t}{4} + \frac{\underline{t}^2}{4t}. \tag{13}$$

It is easy to show that $W(t)$ is strictly increasing and convex in t for all $t > \underline{t}$.

The magnitude of the dissipative signalling costs are then given by

$$V(t) - W(t) = \frac{t}{4} - \frac{\underline{t}^2}{4t}$$

which is strictly increasing in t. In equilibrium, firms set their subscription price as an increasing function of their quality, but by doing so, higher quality firms increase the probability of failure and incur higher dissipative signalling costs.

From Equation (11), it is easy to see that higher fixed failure costs lead to lower subscription prices for all firms. Nevertheless, in our simple model with risk neutrality and uniformly distributed terminal stock price, equilibrium share values, as given by Equation (13), are independent of the fixed failure costs: a higher F is exactly offset by a lower S^*.

Figure 1 plots the net value function (13), $W(t)$, and the gross value function (9); the difference $V(t) - W(t)$ reflects the dissipative signalling costs incurred by the firms. This points out that *apparently* costless rights offers are, in a signalling equilibrium, actually costly. Given that firms must incur this cost in a rights offer, we examine, in the next section, whether some firms could actually *reduce* their costs by using the *apparently* more costly fully underwritten offer.

II. Allowing for Fully Underwritten Equity Offers

In this section, we introduce into the model described in Section I a perfectly competitive underwriter that will immediately buy and resell the equity of any firm in return for a fixed fee, U. The underwriter is also uninformed about firm type and cannot distinguish between firm types that request his services. He will sell the shares of all firms that use his services at the same price (to be defined in a rational expectations sense shortly), and the firms will receive this amount

[8] The Spence [12] requirement that marginal signalling costs be negatively correlated with quality is met here. With uniformly distributed terminal stock price, total costs are FS/t so that marginal cost is F/t. Clearly, marginal cost is decreasing in t.

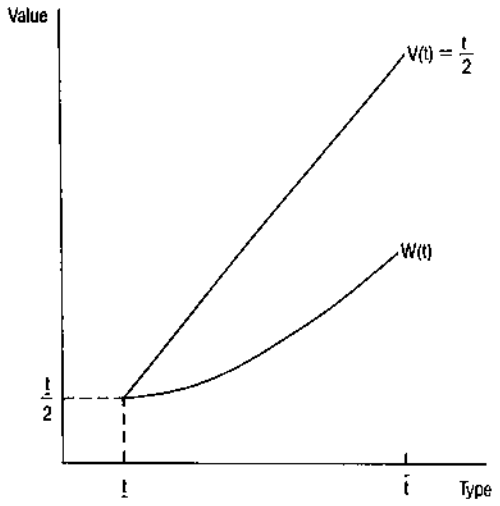

Figure 1. Value in the Rights Offer Signalling Equilibrium

net of the underwriter fee. The fixed fee, U, is an exogenously set "spread," equal to the underwriter costs in this perfectly competitive case.[9]

We will show that the introduction of the underwriter does not alter the subscription price valuation schedule, $V(S)$, offered by investors. Any firm choosing a rights offer will disclose its true quality and so investors will correctly price securities using the rights offer.

We wish to determine which firm types will use a rights offer and which will use an underwriter. Since the underwriter cannot screen firm types, the net proceeds to any firm using the underwriter must be independent of the firm type, t. Let $A(t)$ be the average value of all firms in the population of type t and lower, that is from $\underline{t}$ to t. If all firms of type t and lower use the underwriter, the correct offer price must be $A(t)$, and the net proceeds to the firms will be $A(t) - U$.

Let $n(t)$ be the number of firms of type t in the population, i.e., a population density. Then, $A(t)$ is given by

$$A(t) = \frac{\int_{\underline{t}}^{t} n(x)V(x)\,dx}{\int_{\underline{t}}^{t} n(x)\,dx}. \tag{14}$$

[9] In our model, the underwriter plays no other role than to allow firms to avoid potential failure costs of a rights offer. We assume that firms choosing an underwritten offer sell their issue to the underwriter at the same time they would announce a rights offer, if they chose that financing method. In the equilibrium developed here, the underwriter correctly prices the underwritten issues on average and immediately resells them. Thus, the underwriter bears no risk. Given that all agents know the distribution of firm types and that the underwritten issues are correctly priced on average, by buying *all* of the offerings investors can completely diversify away the risk of purchasing shares of unknown type.

For concreteness, we assume a hyperbolic population density:[10]

$$n(t) = \frac{k}{t} \quad \text{for} \quad t \in [\underline{t}, \bar{t}]. \tag{15}$$

Using the value function, $V(t)$, Equation (9), and population density, $n(t)$, Equation (15), in Equation (14) yields:

$$A(t) = \frac{t - \underline{t}}{2 \operatorname{Ln}(t/\underline{t})}. \tag{16}$$

From Equation (16), it can be shown that $A(t)$ is increasing and concave in t, and that $A(\underline{t}) = \underline{t}/2$.

We will now derive a rational expectations equilibrium in which the uninformed underwriter offers a fixed amount, $A(t^*) - U$, to all firms that use the underwriter such that

(i) all types $t > t^*$ will, acting in their own best interests, fully reveal their firm type through the setting of the subscription price in a rights offer as shown in Section I;
(ii) all types $t < t^*$, acting in their own best interests, will employ the services of the underwriter, and all types will receive the same net proceeds;
(iii) the underwriter rationally anticipates the firm types using his services ($t < t^*$) and correctly prices the offers at the average $A(t^*)$.

Define as t^* the firm type that is indifferent to a rights offer or an underwriting. If the underwriter prices the offer as $A(t^*)$ and all firm types $t < t^*$ use his services (we will show that this will indeed be the case) then, using Equations (13) and (16), t^* is defined by:

$$A(t^*) - U = W(t^*). \tag{17}$$

Figure 2 characterizes the equilibrium when firms can choose between a rights offer and an underwritten offer. Curve $A(t) - U$ represents the net proceeds to all firms of type t and below, if all those firms use the underwriter; as in Figure 1, $W(t)$ represents the current stock value of a type t firm using a rights offer. The intersection of these two curves at t^* represents the equilibrium satisfying Equation (17) and the equilibrium conditions (i) through (iii) listed previously.

This solution is stable: since $W(t^* + \varepsilon) > A(t^* + \varepsilon) - U$ (small $\varepsilon > 0$), all firm types $t > t^*$ prefer signalling through a rights offer to using the underwriter; also, $W(t^* - \varepsilon) < A(t^* - \varepsilon) - U$ so that all firm types $t < t^*$ prefer using the underwriter rather than signalling their type through a rights offer. Thus, the underwriter, by offering a fixed price $A(t^*) - U$ will attract all firm types $t < t^*$ and is, therefore, correctly pricing these issues.

Note that t_1^*, in Figure 2 also satisfies Equation (17), but it does *not* satisfy

[10] $n(t) = k/t$ was chosen to simplify $A(t)$ and also provide that there be more low-quality than high-quality firms in the population. This condition helps ensure that the costly separating equilibrium using rights offers is preferred by the high-quality firms to a "pooled" solution where all firms use the underwritten offer and are valued at the population average. See Riley [8] for a simple exposition of the stability of separating equilibria.

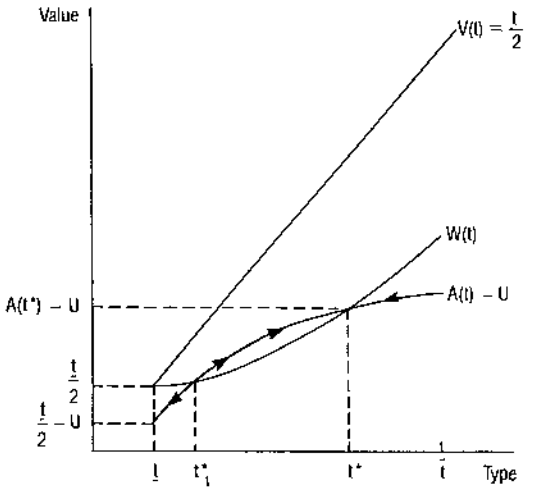

Figure 2. Equilibrium Value Allowing for Underwritten Offers

equilibrium conditions (i) through (iii). To see this, note that firm types $t_1^* - \varepsilon$ would prefer to signal through a rights offer rather than use the underwriter. Thus, $A(t_1^*) - U$ does not represent an equilibrium offer.

We have derived a rational expectations, partially revealing information equilibrium as portrayed in Figure 2. The equilibrium is *partially* revealing in that investors do not distinguish among firm types $t < t^*$ that all use the underwritten offer. The investors do distinguish among the firm types $t > t^*$ by inferring true value, $V(t)$, from the subscription price "signal" in those rights offers. The equilibrium is characterized by rational expectations in the sense that uninformed investors and underwriters correctly anticipate firms' choices and correctly price securities given their information.

The equilibrium described may not be stable in the Nash sense if, as assumed above, there is a continuum of firm types, t. The possible instability is similar to the "lower end unravelling" problem (Riley [9]); intuitively, since the lowest quality firm using a rights offer, t^*, is incurring positive signalling costs, there are incentives for investors to offer an alternative contract, call it A, with valuation $V = t^*/2$, but a lower subscription price, $S_A < S^*(t^*)$ to allow lower signalling costs. It can be shown that contract A will be attractive to some set of firm types $t \in [t_0, t^0]$ where $t_0 < t^*$ and $t^0 > t^*$; the average value of firms in this "pool" $[t_0, t^0]$ may exceed $t^*/2$, so that offering contract A is profitable to investors. Thus, the Nash equilibrium using the schedule $V(S)$ is destroyed.

However, the $V(S)$ schedule *is* stable in a "reactive equilibrium." If an investor offers the contract A described above, it can be shown that the highest quality firm attracted to contract A, t^0, can be induced to accept another contract which is profitable to the investor offering it. Similar offers will attract other firm types t, $t^* < t < t^0$, away from contract A. The end result of these counter offers is that contract A only attracts firm types $t < t^*$; since contract A had value $t^*/2$, it is unprofitable to the investor that offered it. If the investor contemplating offering the contract A anticipates the reactions of other investors as described here, contract A will *not* be offered, and $V(S)$ supports a stable "reactive equilibrium."

To summarize, since $S^*(t^*) > 0$, the lowest quality firm signalling with the subscription price in an uninsured rights offer is incurring positive signalling costs. The signalling firms would like to reduce their signalling costs by reducing their subscription price while still being correctly valued. As we argue above, however, such a signalling schedule will not be offered by investors because they anticipate the ultimate unprofitability of such contracts. The signalling equilibrium in our model is, therefore, a reactive equilibrium rather than a Nash equilibrium. Additionally, assuming a finite number of firm types, t, will allow a discrete schedule similar to $V(S)$ to support a Nash equilibrium. This finite-type model Nash equilibrium has all the characteristics previously described in the continuous-type case.

The equilibrium in which firms use both rights offers and underwritten issues depends upon the parameters $\underline{t}$, $\bar{t}$, and U. For example, increasing U in Figure 2 shifts the curve $A(t) - U$ downwards. When the underwriting costs, U, are large enough such that $A(t) - U$ does not intersect $W(t)$, then the equilibrium of Section I obtains: all firms signal their type using a rights offer. Alternatively, if the parameters are such that $A(\bar{t}) - U > W(\bar{t})$, as in Figure 3, the equilibrium is characterized by all firms remaining undistinguished by using the underwritten offer at the price $A(\bar{t}) - U$.

To summarize, our model allows for the following three possible equilibria:

Case 1: $U \geq \underset{t\in[\underline{t},\bar{t}]}{\text{Max}}[A(t) - W(t)]$, all firms use rights offers

Case 2: $A(\bar{t}) - W(\bar{t}) < U < \underset{t\in[\underline{t},\bar{t}]}{\text{Max}}[A(t) - W(t)]$ firm types $t > t^*$ use a rights offer and types $t < t^*$ use the underwriter

Case 3: $U \leq A(\bar{t}) - W(\bar{t})$, all firms use the underwriter.

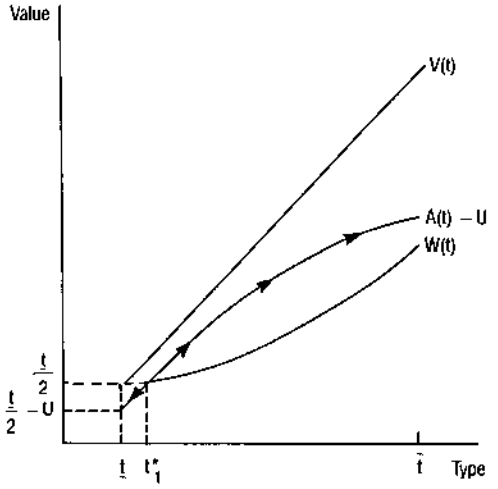

Figure 3. Equilibrium Value Allowing for Underwritten Offers: Low Underwriting Costs

III. Allowing for Insured Rights Offers

In this section, we extend our model to consider the possibility of firms using a rights offer combined with a standby agreement with an underwriter. The standby agreement terms provide that, in exchange for a fee the underwriter promises to purchase, at the subscription price, all the shares in the offer not taken by other investors; this is, of course, equivalent to the firm buying puts on the new shares. However, in order to correctly price the insurance, the uninformed underwriter must become informed. We assume that the true firm type, t, can only be obtained at an investigation cost, C.

The competitive underwriter passes the investigation cost C through to the firm choosing the standby rights offer. The net value to the firm of using this arrangement is $V(t) - C$; the insurance premium paid by the firm to the underwriter is exactly equal to the value of the put to the firm and therefore does not appear in the net value to the firm. Because the firms are insured and the insurance is correctly priced, both the firms and the underwriter in a standby rights offer are indifferent to the setting of the subscription price. Also since investors can observe the standby terms, they can infer the true stock value, $V(t)$.

Figure 4 introduces the standby rights offer alternative graphically with the straight line, $V(t) - C$. The financing alternatives used in equilibrium depend upon C in addition to the parameters, $\underline{t}$, $\bar{t}$, and U. In what follows, we describe all possible relevant combinations of equilibrium financing choices. To help categorize these equilibria, we define $\hat{t}$ as the positive root of the equation:

$$W(\hat{t}) = V(\hat{t}) - C$$

or

$$\frac{\hat{t}}{4} + \frac{\underline{t}^2}{4\hat{t}} = \frac{\hat{t}}{2} - C$$

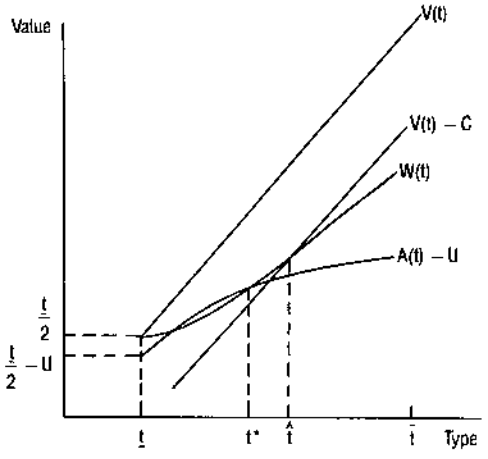

Figure 4. Equilibrium Value Allowing for Standby Rights Offers: High Investigation Costs

with the solution:

$$\hat{t} = 2C + (4C^2 + \underline{t}^2)^{1/2}. \tag{18}$$

$\hat{t}$ is shown in Figure 4 as the unique positive intersection of $V(t) - C$ and $W(t)$.

If $\hat{t} \in (t^*, \bar{t})$ as shown in Figure 4, all three financing alternatives are employed: high-quality firms ($t > \hat{t}$) optimally choose a standby rights offer since the investigation costs are less than the costs of signalling; medium quality firms ($t^* < t < \hat{t}$) choose an uninsured rights offer, and low-quality firms ($t < t^*$) use the uninformed underwriter. Thus,

Case 4: $\hat{t} \in (t^*, \bar{t})$, firm types $t < t^*$ use the underwriter, firm types $t^* < t < \hat{t}$ use a rights offer, and firm types $t > t^*$ use a standby rights offer.

The next possible equilibrium combination of financing alternatives is obtained when either $\hat{t} < t_1^*$ or when t_1^* does not exist (as in Case 1). Figure 5 portrays the situation when $\hat{t} < t_1^*$. From this figure, it is clear that low-quality firms ($t < \hat{t}$) prefer signalling their type through an uninsured rights offer while high-quality firms ($t > \hat{t}$) prefer the standby rights offer. Thus,

Case 5: $\hat{t} \in (\underline{t}, t_1^*)$ (or t_1^* does not exist), firm types $t < \hat{t}$ use an uninsured rights offer, and types $t > \hat{t}$ use the standby rights offer.

The final equilibrium combination of financing alternatives occurs when $t_1^* < \hat{t} < \min(t^*, \bar{t})$. Figure 6 represents such a situation in which $t_1^* < \hat{t} < t^*$. To characterize this equilibrium, which will result in firms optimally using underwritten offers or standby rights offers, we define the firm type, τ, by

$$V(\tau) - C = A(\tau) - U \tag{19}$$

as shown in Figure 6. Using the same arguments employed in Case 2 of Section I, low-quality firms ($t < \tau$) prefer an underwritten offer with fixed net

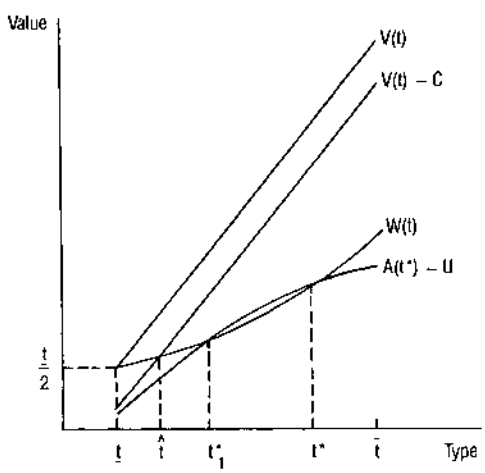

Figure 5. Equilibrium Value Allowing for Standby Rights Offers: Low Investigation Costs

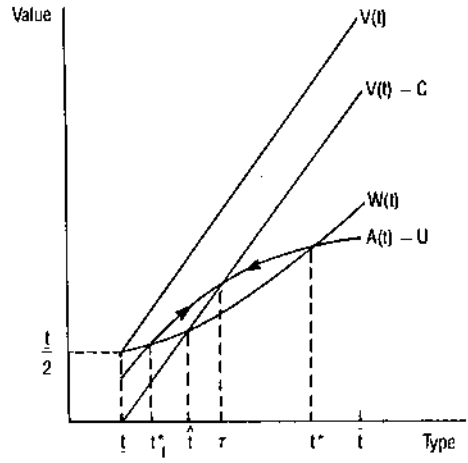

Figure 6. Equilibrium Value Allowing for Standby Rights Offers: Intermediate Investigation Costs

proceeds $A(\tau) - U$ and high-quality firms ($t > \tau$) prefer a standby rights offer. Thus,

Case 6: $t_1^* < \tau < \min(t^*, \bar{t})$, firm types $t < \tau$ use an underwritten offer, and types $t > \tau$ use a standby rights offer.

From Cases 4 through 6, it is clear that the proportion of firms using the standby rights offer decreases as the investigation cost increases. If $C > \max\{V(\bar{t}) - W(\bar{t}),\ V(\bar{t}) - (A(\bar{t}) - U)\}$, then no firms use the standby rights offer, and Cases 1 through 3 characterize the equilibrium.

The above derivation of Cases 1 through 6 exhaust all possible equilibrium combinations of financing alternatives. Different parameterizations lead to the use of different financing methods, but the method chosen always has the same ranking relative to firm type: if employed, standby rights offers are used by relatively high-quality firms; rights offers, if used, are taken by low-quality firms relative to the standby rights offer and by high-quality firms relative to those using an underwriter. If used, underwritten offers are taken by low-quality firms.

IV. Empirical Implications of the Model

The model developed in the preceding sections provides equilibrium financing arrangements by firms seeking external financing. Table I summarizes the possible alternatives; which equilibrium obtains depends upon the relative costs under each financing method. In this section, we suggest testable empirical implications which would be consistent with our model.

The basic idea behind the empirical hypotheses suggested here is that there is information content in the choice of a financing method by the firm; the choice reveals, either partially or totally, the quality of the firm. The announcement by a firm of a financing method should, therefore, impact its stock price.

Table I

Summary of Possible Equilibrium Financing Alternatives

Case	Underwritten Offer	Rights Offer	Standby Rights Offer	Key Parameters
1	—	All	—	Large U, Large C
2	$t < t^*$	$t > t^*$	—	Medium C, Large C
3	All	—	—	Small U, Large C
4	$t < t^*$	$t^* < t < \hat{t}$	$t > \hat{t}$	Medium U, Medium C (C larger relative to U)
5	—	$t < \hat{t}$	$t > \hat{t}$	Small C relative to U
6	$t < \tau$	—	$t > \tau$	Medium U, Medium C

Hypothesis 1: The "quality" of firms using a rights offer (either uninsured or standby) is higher than that of firms using an underwriter.

For empirical purposes, we interpret firm quality as the return on the new investment funds not anticipated by the market. Our model implies that this unanticipated gain is signalled by the financing choice.

Hypothesis 2: The quality of firms using standby rights offers is higher than that of firms using uninsured rights offers.

Hypothesis 3: The quality of firms using standby rights offers is higher than that of firms using an underwriter.

Hypothesis 4: The quality of firms using uninsured rights offers is higher than that of firms using an underwriter.

Hypotheses 1 through 4 completely rank the financing alternatives relative to quality. The following two hypotheses are based upon the signalling equilibrium for the uninsured rights offers.

Hypothesis 5: The quality of firms using an uninsured rights offer is positively correlated with the subscription price chosen.

To test this hypothesis, it must be reinterpreted in terms of the discount of the subscription price relative to the pre-announcement market price: the quality of firms using the uninsured rights offer is negatively correlated with the subscription price discount.

Hypothesis 6: Firms using uninsured rights offers set their subscription price at a level such that there is a significant probability of failure of the offer.

The signalling equilibrium of Section I requires that firms incur signalling costs to truthfully reveal their firm type. In our model, these costs take the form of expected failure costs, implying a positive probability of failure of the offer. The empirical evidence of this hypothesis is that we observe failed uninsured rights offers.

Hypothesis 7: Given positive investigation costs in the standby rights offer, this method of financing will never be exclusively used.

It is clear from Table I that the standby rights offer is only observed in conjunction with some other alternative.

Our model provides a multiplicity of equilibria depending upon relative costs of the different financing alternatives. For instance, the proportion of firms in the population using standby rights offers increases as investigation costs decrease. This suggests the possibility of segmenting firms by relative investigation costs and examining the financing methods used by these segments. Suppose there is an empirical proxy for investigation costs; according to our model, segmenting the population of firms on this proxy will provide segments that vary in the proportion of firms in the segment using the standby rights offer.

Hypothesis 8: For subpopulations with different investigation costs, the proportion of firms using standby rights offers varies inversely with investigation costs.

V. Concluding Comments

The model derived here provides an alternative explanation to those previously offered concerning two "paradoxes" in finance: (i) most firms selling new equity use the apparently more costly underwritten offer rather than the less costly rights offer, and (ii) firms that use uninsured rights offers do not ensure the success of the offer by setting arbitrarily low subscription prices, even though shareholder wealth is unaffected by the level of the subscription price in a perfect market. We are also able to justify the simultaneous existence of three forms of financing vehicles: standby rights offers; uninsured rights offers; and underwritten offers. Also, the implications of our model may provide insights into the observed differences in the choice of new equity financing vehicles in different countries.

A key factor in the model is that firms using an uninsured rights offer *do* risk incurring penalty costs if the offer fails, and the existence of this cost of signalling allows higher quality firms to use the subscription price to credibly disclose their high quality in a dissipative signalling equilibrium. For lower quality firms, however, the dissipative signalling costs of an uninsured rights offer (which are unobservable when the financing choice is made, and therefore difficult to measure empirically) exceed the fee and possible undervaluation incurred in an underwritten offer. These low-quality firms thus optimally choose an underwritten equity sale. The highest quality firms find it less expensive to incur the investigation costs of a standby rights offer. For these firms, the correctly priced insurance provided by the standby agreement allows them to be indifferent to the choice of a subscription price.

As with most theories, the derivation of our model requires simplifying assumptions. For example, we assume risk neutrality, uniformly distributed terminal stock price, and a hyperbolic population density. However, we believe the nature of these assumptions is not critical to the form of the results of the model.

A critical assumption of our model is that sufficient time passes the between setting of the rights offer subscription price and expiration of the right for there to be significant stock price movement. These price changes are attributable

both to the resolution of the information asymmetry between management and investors (the firm type, t) and to random, unanticipated events [a realization of the distribution, $g(P;\ t)$]. This assumption is, however, potentially testable. Suggested proxies for the resolution of the information asymmetry over the period from the announcement of the rights offer to the expiration date of the right are both the change in the trading volume in the stock and the standard deviation of the daily rate of return on the stock in this rights period relative to before and after the rights period.

In spite of the simplifying assumptions used in our model, the results provide a set of reasonable implications. It remains to be seen if the data is consistent with the empirical implications of the model.

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