Overpricing (and Underpricing) in IPOs: A Model of Excess Initial Returns*

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Abstract

This paper develops a model in which new issues, in equilibrium, may be overpriced or underpriced, depending on parameter values. The ability of an investor to withdraw from the offering upon observing unfavorable information implies that the decision to participate in it contains a valuable option. It is shown that the presence of this option will generate overpricing in equilibrium to the extent that the option value exceeds the corresponding adverse selection cost. The empirical implications of the model are closely consistent with the pattern of overpricing and underpricing revealed by the data.

Keywords: initial public offerings, overpricing, option value, underpricing, winner's curse, over-allotment option.
JEL Classification: G10, G32

1 Introduction

The underpricing of Initial Public Offerings (IPOs) of common stocks is well known.[1] The overall evidence, however, reveals average overpricing as well as underpricing, depending on the type of security offered for sale. And while the underpricing phenomenon is relatively well understood, the overpricing phenomenon is not. Indeed, why are some types of IPOs overpriced on average, while others are underpriced? This paper attempts to answer this question by developing a model in which IPOs, in equilibrium, may be overpriced as well as underpriced, depending on parameter values.

The formal model extends the winner's curse argument of Rock (1986), where underpricing arises as a compensation to less-informed investors for the adverse selection risk that they incur in competing against better informed investors for allocations. The main adjustments relative to Rock are (a) to allow the number of shares floated in the offering to be positively related to demand[2], and (b) to let less-informed (as well as well-informed) investors obtain independent signals about the issue. As in Rock, underpricing arises as a result of adverse selection in the allocation of shares moving the distribution that generates the returns observed in the market to stochastically dominate (in the first order sense) the allocation weighted distribution relevant to less-informed investors. The present paper, using a more general specification of the IPO market, shows that this return dominance may be reversed and thus generate overpricing in equilibrium, despite the presence of adverse selection.

Intuitively, letting less-informed investors observe independent signals implies that investors will request shares in the offering only upon obtaining favorable information. This implies in turn that the *conditional* expectation relevant to investors actually submitting bids in the offering will exceed the *unconditional* expectation implied by the returns observed in the market. However, whether this is sufficient to generate overpricing in equilibrium will depend on the corresponding adverse selection problem. In general, it is shown that the IPO will be overpriced in equilibrium (rather than underpriced) to the extent that the number of shares that are floated in the offering is

[1] See e.g. Ibbotson and Ritter (1997) for a review.

[2] In firm commitment contracts this obtains through the over-allotment option, which allows the underwriter to increase the number of shares by up to 15% of the amount stated in the offering prospectus. The over-allotment option contributes to a positive relation between the supply of shares and demand if the probability of it being exercised is increasing in the amount of ex-post underpricing. (Ellis, Michaely, and O'Hara (2000) and Aggrawal (1998) find that this is indeed the case for IPOs of common stocks). Best efforts are marketed with a pre-specified maximum and minimum number of shares to be floated, which generates the type positive relation between demand and supply indicated in (a).

sufficiently elastic with respect to demand, that investors are sufficiently similar in the precision of their information, and that the fraction of well-informed to less-informed investors is not too large.

From a slightly different perspective, the fact that less-informed investors (observing independent signals) are able to withdraw from the issue upon observing unfavorable information, implies that their participation gives them a potentially valuable option. In a competitive market, however, the value of this option is captured by the issuer, which may result in ex ante overpricing. Indeed, the offering will be overpriced in equilibrium to the extent that the value of this option is greater than the corresponding adverse selection cost.

In this sense, overpricing represents a benefit of going public, reflecting the ability of the issuer to extract informational rents from less-informed investors. This is analogous to, and nicely counterbalances, the underpricing cost arising from the adverse selection problem facing the same set of investors.

As noted, our model suggests that a necessary condition for overpricing to arise in equilibrium is that the number of shares floated is positively related to demand. This follows Ritter's (1987) suggestion that a positive relation between the size of the offering and the demand for allocations will ameliorate the winner's curse problem facing less-informed investors and thus reduce the need for underpricing.[3] The present paper shows that if less-informed investors receive independent signals about the issue, then a positive relation between the size of the offering and demand not only will reduce the adverse selection problem facing less-informed investors, but may even reverse it and generate overpricing in equilibrium.

As already indicated, the overall empirical evidence on IPOs indicates average overpricing in addition to underpricing. Specifically, Wang, Chan, and Gau (1992) find overpricing (at the 5 % level) in a sample of Real Estate Investment Trusts (REITs) IPOs.[4] More recently, Datta, Iskander-Datta, and Patell (1997) find zero excess initial returns in their overall sample of corporate bonds IPOs, but significant overpricing

[3]Relatedly, Benveniste and Spindt (1989) argue that these features will reduce the costs of eliciting information from investors by reducing the required degree of underpricing. In Barzel, Habib, and Johnsen (2000) underpricing is used as a tool to prevent excess search; they show that the use of the over-allotment option reduces the profits from excess search and hence increases the critical price at which the issue can be sold with zero excess search. Chowdry and Sherman (1996) show that favoring uninformed investors will reduce the winner's curse problem, and hence reduce the need for underpricing.

[4]On the other hand, Ling and Ryngart (1997) find underpricing in a more recent sample of REITs IPOs. Consistent with the present model, they find that this switch from overpricing to underpricing is associated with greater adverse selection (for more on this, see Section 4).

both in the case of investment grade bonds and bonds issued by NYSE/AMEX firms (both significant at the 1% level). Peavy (1990) finds zero initial returns in his overall sample of IPOs of closed-end funds, but significant overpricing (at the 1% level) in the case of closed-end stock funds.[5] Finally, Muscarella (1988) finds zero excess initial returns in his overall sample of MLP IPOs, but overpricing (at the 10% level) in some of his subsamples. Although the evidence on IPO overpricing is not as overwhelming as the evidence on underpricing, it is at least as puzzling. Indeed, why would rational profit maximizing investors buy securities that on average fall in price during the first day of trading?

The formal model is related to that of Chemmanur (1993), where underpricing represents a compensation to informed investors for their costs of acquiring information about the issue. In his model, as in Section 3 of the present paper, investors are homogeneous in the precision of their information. But although overpricing does arise in his model, he does not pursue this. In any case, an important difference between the two is that the present model includes an adverse selection problem as in Rock and lets that be the source of underpricing. As we shall see, this produces a model with an empirical content highly consistent with the pattern of IPO over/underpricing found in the data.[6]

The rest of the paper is organized as follows. Section 2 describes the basic model. Section 3 assumes that investors are homogeneous in the precision of their information and shows that only overpricing is possible in this case. Section 4 examines the general case where there are both informed and less-informed investors present in the market, in which case both overpricing and underpricing will be possible in equilibrium. Section

[5] Muscarella, Peavy, and Vetsuypens (1992) find overpricing in a sample of closed-end funds (all sold with an over-allotment option). They find that the negative initial returns in IPOs of closed-end funds are significantly different (at the 1% level) from the positive returns in a comparison sample of common stock IPOs, but do not report the significance level for negative returns on closed-end funds. Weiss (1989) reports overpricing for both US stock funds (10 % level) and bond funds (5 % level) in the case of index adjusted returns, but insignificant negative returns in the case of unadjusted returns. Finally, Hanley, Lee, and Seguin (1996) find no initial overpricing in their sample of closed-end fund IPOs, but "sharp price declines" once the price stabilization period has ended. They suggest that initial selling pressure indicates initial overpricing.

[6] Also, the two models differ in the way over/underpricing is defined and derived. For example, while we compare the IPO price to ex ante expected post-issue *market* value of *completed* issues, Chemmanur compares it to the firm's ex ante expected true value (as is common). However, this requires that IPOs never fail, which is not the case in practice. For example, Dunbar (1998) find failure rates for firm commitment offerings and best effort offerings to be around 30%. If these estimates are at the high end, Benveniste, Busaba, and Guo (1999) in a more recent sample of firm commitment offerings find failure rates ranging from 7.5% to 23 %, which they find to be large enough to change the sign of some of their parameter estimates (see also footnote 9).

Table 1: **Sequence of Events**

Date 0:	• The issuer announces the terms of the offering $\{P_0, N, n(\cdot), n^*\}$. • $\hat{n}_I \in [0, n_I]$ well-informed investors and $\hat{n}_u \in [0, n_u]$ less-informed investors obtain favorable information and submit bids. • If $\hat{n}_I + \hat{n}_u \geq n^*$ the offering is over-subscribed and goes through; otherwise, the offering is under-subscribed and fails.
Date 1:	• Firm's aftermarket value $V(\hat{n}_I, \hat{n}_u)$ is established.
Date 2:	• Firm's true value v is realized (and revealed).

5 concludes the paper.

2 The Model

The formal model has three dates—0, 1, 2—and contains a firm that is going public on date 0. The true value of this firm is given by $v \in \{v_B, v_G\}$, where $v_G > v_B$, which is revealed on date 2. Until then, no one has perfect information about v. Everybody is risk neutral. The riskless rate is zero.

The IPO terms are given by $\{P_0, N, n^*, n(\cdot)\}$, where P_0 denotes the price per share, N is the total number of shares that will be outstanding after the offering is completed, and n^* represents the minimum number of shares that will be floated in the offering, meaning that the issue will be withdrawn if the demand for allocations falls short of n^*. Finally, $n(\cdot) \in [n^*, N]$ denotes the total number of shares that floated, thus leaving $N - n(\cdot)$ shares to be retained by the issuer.

It is assumed that $n(\cdot)$ is increasing in the demand for allocations, which implies that the size of the issue will be positively related to demand. As noted, firm commitment offerings are generally sold with an over-allotment provision and best efforts are sold with a pre-specified minimum and maximum number of shares to be sold.

The pool of IPO investors contains a total of $n_I + n_u$ investors, where n_I of these are *well-informed* (or '*informed*') and n_u are *less-informed*. Investors become informed at no cost by observing independent signals $s \in \{s_G, s_B\}$ (informed investors) and $s^u \in \{s^u_G, s^u_B\}$ (less-informed investors). The signal observed by informed investors is naturally more precise than that observed by less-informed investors.[7]

[7]Note that the issuer plays no role in the model so whether she has private information or not is unimportant. In a more general model in which the issuer is given a specific maximization problem to solve, the precision of her information would affect the optimal IPO terms and hence the number of informed and uninformed investors, but the basic intuition behind our over/underpricing result would remain unaffected.

An investor will request an allocation in the offering only after obtaining favorable information (a type G signal). Let $\hat{n}_I$ and $\hat{n}_u$ denote the number of informed and less-informed investors who obtain favorable information and hence submit bids. The random variables $\hat{n}_I$ and $\hat{n}_u$ are binomially distributed on $[0, n_I]$ and $[0, n_u]$. The total number of bidders is $\hat{n}_I + \hat{n}_u$. Successful bidders are allocated one share each, which implies that the offering will succeed if $\hat{n}_I + \hat{n}_u \geq n^*$ and fail otherwise.

The number of shares floated in the offering, $n(\cdot)$, is assumed to be increasing in the demand for allocations, $\hat{n}_I + \hat{n}_u$. Specifically, let $a \in [0, 1]$ be a measure of the degree to which $n(\cdot)$ is increasing in $\hat{n}_I + \hat{n}_u$. In particular, a larger a will mean a stronger correlation, with the size of the offering perfectly elastic in demand if $a = 1$, and perfectly inelastic in demand if $a = 0$. Also, $n(\cdot)$ will be increasing in a, with $n(\cdot; 0) = n^*$ and $n(\cdot; 1) = \hat{n}_I + \hat{n}_u$. Finally, the probability of obtaining an allocation in the offering is $\beta(\hat{n}_I, \hat{n}_u) \equiv \frac{n}{\hat{n}_I + \hat{n}_u}$.

Let $V(\hat{n}_I, \hat{n}_u)$ denote the firm's aftermarket value as a function of the number of investors who obtain favorable information about the firm, and let $P(\hat{n}_I, \hat{n}_u)$ denote the associated probability.[8] It is assumed that $V(\hat{n}_I, \hat{n}_u)$ is increasing in $\hat{n}_I$ and $\hat{n}_u$, which is to say that the firm's aftermarket value will reflect (at least part of) the information observed by investors.

The issue is clearly overpriced ex post if $NP_0 > V(\hat{n}_I, \hat{n}_u)$ and underpriced if $NP_0 < V(\hat{n}_I, \hat{n}_u)$. To generate over- and underpricing in the ex ante sense we need the expression for the average aftermarket value of completed offerings:

$$\overline{v} = \Big(\sum_{0}^{n_u} \sum_{\underline{\hat{n}}}^{n_I} P(\hat{n}_I, \hat{n}_u) \Big)^{-1} \sum_{0}^{n_u} \sum_{\underline{\hat{n}}}^{n_I} P(\hat{n}_I, \hat{n}_u) V(\hat{n}_I, \hat{n}_u), \tag{1}$$

where $\underline{\hat{n}} \equiv \max(n^* - \hat{n}_u, 0)$. The issue is now *overpriced* in equilibrium if $P_0 > \overline{v}/N$ and *underpriced* if $P_0 < \overline{v}/N$.[9] The average initial return, $\overline{r}_0$ (say), is given by $\overline{r}_0 = \frac{\overline{v}}{NP_0} - 1$, so overpricing implies that IPOs generate negative initial returns on average ($\overline{r}_0 < 0$).

[8] $P(\cdot)$ ($E(\cdot)$) and $P(\cdot|\cdot)$ ($E(\cdot|\cdot)$) will denote unconditional and conditional probabilities (expectations) throughout.

[9] As an alternative to $\overline{v}$, we could (as is generally done) use the firm's ex ante expected value $\underline{v} \equiv P(v_G)v_G + P(v_B)v_B$ when defining over/underpricing. However, it is $\overline{v}$ that is picked up empirically, since $\underline{v}$ implicitly assumes that IPOs never fail, which is not the case in practice. For example, Beneveniste, Busaba, and Guo (1999) find failure rates to be high enough to affect the signs of some of the parameter estimates in their regressions (see also footnote 6). In addition, since $\underline{v} < \overline{v}$, the use of $\underline{v}$ implies an analytical bias towards overpricing. So, although $\underline{v}$ may be appropriate when comparing different degrees of underpricing, it is not if we want to prove the existence of ex ante overpricing.

3 Overpricing

In this section we derive equilibrium overpricing under the assumption that investors are homogenous in the precision of their information. Specifically, we let the issue be priced along the participation constraint for informed investors. This implies that less-informed investors will choose not to participate in the offering.

The participation condition for informed investors is given by:

$$P(s_G)\sum_{n^*}^{n_I} P(\hat{n}_I|s_G)\beta(\hat{n}_I)[V(\hat{n}_I)/N - P_0] = 0, \tag{2}$$

which reflects that an investor will request an allocation only upon obtaining favorable information about the issue. Solving (2) with respect to NP_0 yields

$$NP_0 = \overline{v}_I, \tag{3}$$

where

$$\overline{v}_I \equiv \left(\sum_{n^*}^{n_I} P(\hat{n}_I|s_G)\beta(\hat{n}_I)\right)^{-1}\left(\sum_{n^*}^{n_I} P(\hat{n}_I|s_G)\beta(\hat{n}_I)V(\hat{n}_I)\right), \tag{4}$$

which represents the value of the issue from the perspective of investors observing favorable signals. In other words, $\overline{v}_I$ represents a conditional expectation over post-issue market value based on favorable information, discounted by the fact that the issue in general will be rationed ($a < 1$). Note that $\overline{v}_I$ is increasing in a, which is to say that the value of the issue from the perspective of those investors who request shares in the offering is decreasing in the extent of rationing. If $a = 1$, there is no rationing, in which case $\overline{v}_I$ represents an undiscounted expectation conditioned on favorable information.

Recall that the IPO is overpriced in equilibrium if $NP_0 = \overline{v}_I > \overline{v}$ (or $\overline{r}_0 < 0$). This is considered in the following proposition.

Proposition 1 *Suppose that the IPO is priced along the participation condition for informed investors (condition (2)), then if $a > 0$ the offering is overpriced ($\overline{r}_0 < 0$). Otherwise, if $a = 0$, then $\overline{r}_0 = 0$.*

Proof: See Appendix.

Hence, if the number of shares floated in the offering is fixed ($a = 0$), then the IPO in equilibrium will be priced to generate zero excess returns ($\overline{r}_0 = 0$). Basically, with investors homogeneous in the precision of their information, there is no adverse selection and hence no underpricing, as in Rock. As a natural extention of this result, it follows that if the number of shares floated is positively related to demand ($a > 0$), the IPO, in equilibrium, will be overpriced ($\overline{r}_0 < 0$).

Intuitively, for the IPO to be overpriced in equilibrium, it is necessary that the valuation $\overline{v}_I$ of investors who are actually submitting bids in the offering exceeds the average aftermarket value $\overline{v}$ of the issue. To see how this is possible, suppose (for the sake of argument) that the issuer supplies exactly $\hat{n}_I + \hat{n}_u$ shares in the offering ($a = 1$). In this case, there is no rationing and $\overline{v}_I$ represent an undiscounted *conditional* expectation over post-issue market value based on favorable information. Since $\overline{v}$ represents the corresponding *unconditional* expectation, the absence of rationing implies unambigously that $\overline{v}_I > \overline{v}$. In a competitive market, the issuer puts $NP_0 = \overline{v}_I$, which implies $NP_0 > \overline{v}$ and hence overpricing. Suppose then that $a < 1$, so that the issue in general will be rationed. This will clearly reduce $\overline{v}_I$, and hence reduce the amount of overpricing, since $\overline{v}$ is independent of a, until there is no overpricing at $a = 0$.

From a slightly different perspective, since investors are able to withdraw from the offering upon observing unfavorable information, their participation gives them a (potentially) valuable option. Indeed, this option takes a strictly positive value so long as the number of shares that are floated in the offering is positively related to demand. In a competitive market, however, the value of this option is captured by the issuer and manifests itself through average overpricing.

As is well known, option values are increasing in the risk of the underlying asset. For our setting, this should imply a positive relationship between ex ante uncertainty and the degree of overpricing. Indeed, this implication is verified in the numerical analysis conducted in Section 4, and parallels a well known implication of the winner's curse argument that greater ex ante uncertainty will lead to more underpricing, by increasing the adverse selection problem facing less-informed investors (Beatty and Ritter, 1986).

One empirical implication of our overpricing result is that if an empirical researcher measures ex post returns by doing a simple average return across all issues during a certain period, she will compare the offer price with the unconditional mean and thus incorrectly conclude that the average return to investors was negative. To measure the returns actually achieved by IPO investors, she would need investors' *conditional* expected returns. One way this could be done is to compute the average return weighted by the amount raised by the firm (relative amounts indicated in the offering prospectus), since, in equilibrium, type G firms would be able to sell more shares in the IPO (and therefore raise more money) than type B firms. The idea being that more investors would obtain a positive signal for type G firms, and therefore more investors would bid for their shares.

4 Overpricing or Underpricing?

We now examine the relation between the option value associated with the IPO and the adverse selection cost. To do this, less-informed investors are re-introduced into the model.

The issue will then be priced along the participation constraint for less-informed investors, given by

$$P(s_G^u)\sum_{1}^{n_u}\sum_{\underline{\hat{n}}}^{n_I} P(\hat{n}_I,\hat{n}_u|s_G^u)\beta(\hat{n}_I,\hat{n}_u)[V(\hat{n}_I,\hat{n}_u)/N - P_0] = 0, \tag{5}$$

which is solved for in terms of NP_0 to yield

$$NP_0 = \left(\sum_{1}^{n_u}\sum_{\underline{\hat{n}}}^{n_I} P(\hat{n}_I,\hat{n}_u|s_G^u)\beta(\hat{n}_I,\hat{n}_u)\right)^{-1}\sum_{1}^{n_u}\sum_{\underline{\hat{n}}}^{n_I} P(\hat{n}_I,\hat{n}_u|s_G^u)\beta(\hat{n}_I,\hat{n}_u)V(\hat{n}_I,\hat{n}_u). \tag{6}$$

As before, the issue is overpriced if $NP_0 > \overline{v}$ and underpriced if $NP_0 < \overline{v}$, where $\overline{v}$ is given by (1). Simulations performed (comparing (1) and (6)) show that the model generate overpricing as well as underpricing, depending on parameter values.[10] The results from our simulations are reported in tables 2, 3, and 4. They are summarized in the following proposition.

Proposition 2 *The initial return is* (*i*) *increasing in the difference in information precision between well-informed and less-informed investors,* (*ii*) *increasing in the fraction of well-informed investors;* (*iiia*) increasing *in ex-ante uncertainty for issues that are* underpriced *in equilibrium, and* (*iiib*) decreasing *in ex-ante uncertainty for issues that are* overpriced *in equilibrium.*

Results (*i*) - (*iiia*) are well known implications of the winner's curse argument, generated here in a setting that allows IPOs to be overpriced as well as underpriced in equilibrium. Results (*iiia*) and (*iiib*) may seem contradictory by implying that greater ex ante uncertainty will push both towards greater underpricing and towards greater overpricing.[11] Intuitively, greater ex ante uncertainty increases the extent of adverse selection, which in itself would lead to more underpricing. Similarly, greater ex ante uncertainty will increase the option value in the IPO, pulling towards more

[10] For the purpose of the simulations, we put $n(\cdot) = an^* + (1-a)(\hat{n}_I + \hat{n}_u), a \in (0,1)$; $V(\hat{n}_I, \hat{n}_u)$ was calculated as a conditional expectation based on $(\hat{n}_I, \hat{n}_u)$. The *Mathematica* code that was used is available upon request.

[11] Although our simulations are not exhaustive, we have been unable to generate any other pattern.

$\frac{n_I}{n_I+n_u}$	.05	.20	.35	.50	.65	.80	.95
$\overline{r}_0$	-2.97%	-0.65%	1.77%	4.32%	6.95%	9.60%	12.11%

Table 2: The table relates the initial return $\overline{r}_0$ to the fraction of informed investors $\frac{n_I}{n_I+n_u}$ for parameters $P(s_G|v_G) = .85$, $P(s_B|v_B) = .7$, $P(s^u_G|v_G) = .6$, $P(s^u_B|v_B) = 0.55$, $P(v_G) = .65$, $v_G = 2000$, $v_B = 0$, $n^* = 5$, $n_I + n_u = 20$, and $a = .20$.

Δ	0	.10	.20	.30	.35
$\overline{r}_0$	-4.49%	-1.44%	7.59%	22.25%	31.83%

Table 3: The table relates the initial return $\overline{r}_0$ to the difference in information precision between informed and less-informed investors, $\Delta = P(s_i|v_i) - P(s^u_i|v_i)$. The parameter values used are $P(s_G|v_G) = P(s_B|v_B) = .85$, $v_G = 2000$, $v_B = 0$, $n^* = 5$, $P(v_G) = .5$, $n_I = n_u = 10$, and $a = .20$. Note also that $P(s^u_G|v_G) = P(s^u_B|v_B)$, starting at .85 ($\Delta = 0$) and going to .5 ($\Delta = .35$).

overpricing. The issue will be overpriced in equilibrium to the extent that the value of option exceeds the corresponding adverse selection cost. Implications (*iiia*) and (*iiib*) combined suggest that if the option value exceeds the adverse selection cost to yield overpricing at a low level of ex ante uncertainty, it will continue to do so at higher levels of uncertainty (and vice versa). One implication of this result is that over/underpricing cannot be explained by looking at differences in risk, which may help to explain why overpricing has been documented in such relatively diverse claims as REITs (which are relatively risky) and investment grade bonds (which are relatively safe).

The positive relation predicted between underpricing and ex ante uncertainty is well documented (see e.g. Beatty and Ritter, 1986). Interestingly enough, Wang, Chan, and Gau (1992) find a significant positive relation between the degree of overpricing and ex ante uncertainty in their sample of REITs IPOs, which they suggest is "inconsistent with existing IPO theories." Their evidence, however, is clearly consistent with the present model, and hence not inconsistent with the winner's curse argument.

Examining corporate bonds IPOs, Datta, Iskander-Datta, and Patell (1997) find overpricing for investment grade bonds and underpricing for junk grade bonds. Based on informal inferences from Rock, it may be tempting to attribute this finding in part to differences in risk. However, as already indicated, (*iiia*) and (*iiib*) suggest that it is not so much differences in risk that contribute to this result, but other factors such as the type and composition of investors as well as the amount of asymmetric information. Indeed, as a testable implication, (*iiia*) and (*iiib*) predict that the initial return will be decreasing in bond rating for investment grade bonds and increasing in bond rating for junk grade bonds.

In general, our model predicts overpricing unless the adverse selection problem is

$\sigma^2_{ex\ ante}$	.25	.50	.75	1.00	1.25	1.50
$\overline{r}_0 > 0$	2.03%	3.42%	4.43%	5.20%	5.80%	8.52%
$\overline{r}_0 < 0$	-1.48%	-2.53%	-3.32%	-3.92%	-4.40%	-6.63%

Table 4: The table relates the initial return $\overline{r}_0$ to ex-ante uncertainty for parameter values $P(s_G|v_G) = .85$, $P(s_B|v_B) = .7$, $P(s^u_G|v_G) = .65$, $P(s^u_B|v_B) = 0.55$, $v_B = 0$, $E(v) = P(v_G)v_G = 800$, $n^* = 5$, $n_I = n_u = 10$, and $a = .20$. To generate $\overline{r}_0 > 0$ [$\overline{r}_0 < 0$], we let $P(s^u_G|v_G) = .65$ [$P(s^u|v_G) = .7$].

too severe. This is consistent with the general evidence on over/underpricing. For example, as already noted, the evidence on IPOs of corporate bonds (Datta et al., 1997) shows that junk grade bonds are underpriced on average, while investment grade bonds are overpriced. Since asymmetric information and hence adverse selection is less of a problem in investment grade bonds than in junk grade bonds, this evidence is consistent with our model (and hence Rock). Similarly, Ling and Ryngaert (1997) find that the overpricing result of Wang et al. (1992) switches to underpricing in more recent data. Consistent with our model, Ling and Ryngaert find this switch to be associated with greater institutional participation and more asymmetric information (and not changes in underlying risk). Finally, as noted in the Introduction, there is evidence of overpricing in closed-end funds IPOs. These are claims on already traded assets, so the extent of adverse selection is likely to be low, which is consistent with our model.

5 Concluding Remarks

Consistent with the empirical evidence, the present paper develops a model that shows that IPOs may be overpriced in equilibrium as well as underpriced. The model ties overpricing to the winner's curse argument of Rock (1986), and shows that if less-informed investors obtain independent signals about the issue and if the size of the offering can be increased in the face of strong demand, then there may be overpricing rather than underpricing in equilibrium despite the presence of adverse selection. Rock shows that underpricing arises from adverse selection in the allocation of shares causing the distribution that generates the returns observed in the market to stochastically dominate (in the first order sense) the allocation weighted distribution relevant to the marginal investor. The present paper shows that a more general specification of the IPO market may reverse this return dominance to generate overpricing in equilibrium, rather than underpricing.

More generally, investors obtain independent signals and will withdraw from the offering upon observing unfavorable information. Participating in the offering, therefore, gives each investor a potentially valuable option. In a competitive market, the value of this option is captured by the issuer and will result in overpricing to the extent that it exceeds the corresponding adverse selection cost. In this sense, overpricing represents a benefit of going public and reflects the ability of the issuer to extract informational rents from investors, just as underpricing represents a cost of going public due to adverse selection.

As is well known, greater risk increases the adverse selection problem facing less-informed investors, and thus leads to more underpricing. In the present setting, however, greater risk also increases the option value embedded in the offering, thus increasing the potential for overpricing. Hence, whether the issue, in equilibrium, will be overpriced or underpriced will not be determined by differences in risk. Instead, our model suggests this will be determined by other factors such as the degree of asymmetric information between investors, as well as by the fraction of well-informed to less-informed investors in the market. This was shown to be consistent with the overall evidence on over/underpricing. In addition, the model is able to account for why overpricing has been detected in diverse claims such as REITs (which are relatively risky) and investment grade bonds (which are relatively safe).

APPENDIX

Proof of Proposition 1: The issue is overpriced if $NP_0 = \overline{v}_I > \overline{v}$. With only informed investors present in the market, it will be the case that

$$\overline{v} = \left(\sum_{n^*}^{n_I} P(\hat{n}_I)\right)^{-1} \left(\sum_{n^*}^{n_I} P(\hat{n}_I) V(\hat{n}_I)\right). \quad (A.1)$$

Observe further that $\overline{v}_I$ can be expressed in terms of $P(\hat{n}_I)$ as follows:

$$\overline{v}_I = \left(\sum_{n^*}^{n_I} R(\hat{n}_I) P(\hat{n}_I)\right)^{-1} \left(\sum_{n^*}^{n_I} R(\hat{n}_I) P(\hat{n}_I) V(\hat{n}_I)\right), \quad (A.2)$$

where

$$R(\hat{n}_I) \equiv \frac{\beta(\hat{n}_I) P(\hat{n}_I|s_G)}{P(\hat{n}_I)}. \quad (A.3)$$

It follows that $\overline{r}_0 < 0$ (or $\overline{v}_I > \overline{v}$) if $R(\hat{n}_I)$ is increasing in $\hat{n}_I$ and that $\overline{r}_0 = 0$ if $R(\hat{n}_I) = constant$. To see that $R(\hat{n}_I)$ is indeed increasing in $\hat{n}_I$ for $a > 0$, note that

$$P(\hat{n}_I) = P(\hat{n}_I|v_G)\, P(v_G) + P(\hat{n}_I|v_B)\, (1 - P(v_G)), \quad (A.4)$$

and that

$$P(\hat{n}_I|v_G) = \begin{pmatrix} n_I \\ \hat{n}_I \end{pmatrix} P(s_G|v_G)^{\hat{n}_I} (1 - P(s_G|v_G))^{n_I - \hat{n}_I}. \quad (A.5)$$

Therefore

$$P(\hat{n}_I) = \frac{n_I!}{\hat{n}_I!(n_I - \hat{n}_I)!} \Big[P(s_G|v_G)^{\hat{n}_I} (1 - P(s_G|s_G))^{n_I - \hat{n}_I} P(v_G)$$

$$+ P(s_G|v_B)^{\hat{n}_I} (1 - P(s_G|v_B))^{n_I - \hat{n}_I} P(v_B) \Big]. \quad (A.6)$$

Similarly, we have

$$P(\hat{n}_I|s_G) = P(\hat{n}_I - 1|v_G) P(v_G|s_G) + P(\hat{n}_I - 1|v_B) P(v_B|s_G), \quad (A.7)$$

and

$$P(\hat{n}_I - 1|v_i) = \begin{pmatrix} n_I - 1 \\ \hat{n}_I - 1 \end{pmatrix} P(s_G|v_i)^{\hat{n}_I - 1} (1 - P(s_G|v_i))^{n_I - \hat{n}_I} \text{ for } i = G, B \quad (A.8)$$

and therefore

$$\beta(\hat{n}_I) P(\hat{n}_I|s_G) = \frac{n(\hat{n}_I; a)}{\hat{n}_I} \frac{(n_I - 1)!}{(\hat{n}_I - 1)!(n_I - \hat{n}_I)!} \Big[P(s_G|v_G)^{\hat{n}_I - 1} (1 - P(s_G|s_G))^{n_I - \hat{n}_I} P(v_G|s_G)$$

$$+P(s_G|v_B)^{\hat{n}_I-1}(1-P(s_G|v_B))^{n_I-\hat{n}_I}P(v_B|s_G)\Bigg]. \qquad (A.9)$$

Substituting $P(v_G|s_G) = \frac{P(s_G|v_G)P(v_G)}{P(s_G)}$ and $P(v_B|s_G) = \frac{P(s_G|v_B)P(v_B)}{P(s_G)}$ into (A.9) and rearranging gives

$$\beta(\hat{n}_I)P(\hat{n}_I|s_G) = \frac{n(\hat{n}_I;a)}{n_I P(s_G)}\frac{n_I!}{\hat{n}_I!(n_I-\hat{n}_I)!}\Bigg[P(s_G|v_G)^{\hat{n}_I}(1-P(s_G|v_G))^{n_I-\hat{n}_I}P(v_G)$$

$$+P(s_G|v_B)^{\hat{n}_I}(1-P(s_G|v_B))^{n_I-\hat{n}_I}P(v_B)\Bigg]. \qquad (A.10)$$

Using $(A.10)$ and $(A.6)$ in $(A.3)$ yields

$$R(\hat{n}_I;a) = \frac{\beta(\hat{n}_I)P(\hat{n}_I|s_G)}{P(\hat{n}_I)} = \frac{n(\hat{n}_I;a)}{n_I P(s_G)}. \qquad (A.11)$$

Since $n(\cdot;a)$ is strictly increasing in $\hat{n}_I$ for $a \in (0,1]$, it follows that $R(\hat{n}_I;a)$ is strictly inceasing in $\hat{n}_I$ for $a \in (0,1]$. Hence, $\overline{r}_0 > 0$ for $a \in (0,1]$. Finally, since $R(\cdot;0) = \frac{n^*}{n_I P(s_G)}$ = constant, it follows that $\overline{r}_0 = 0$ at $a = 0$. □

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