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STOCK MARKET CONDITION AND PRICING OF INITIAL PUBLIC OFFERINGS: A THEORY AND EVIDENCE FROM THE KOSDAQ STOCK MARKET*

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In this paper we incorporate downward sloping demand curve into the well-known winner's curse model of Rock (1986) that explains the underpricing in IPOs, and examine the additional implications that this has in the pricing of the IPO. Specifically, we derive theoretical implications on how the degree of underpricing changes both in the size of IPOs and in the size of active investors. Our theory predicts the same relationships as the basic winner's curse theory of Rock in the "cold issue" markets. Unlike Rock's theory, however, our model shows that these relationships may change in the "hot issue" markets. This possibility of systematic dependence of the relationships on the market condition as indicated in our theory, is shown to be empirically supported by the IPO data in the KOSDAQ stock market.

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1. INTRODUCTION

An initial public offering (IPO) is the process that a privately-held company "goes public" by issuing publicly traded equity. Going public may promote more efficient capital flows both by opening a direct channel between the enterprise and individual investors and by enhancing the liquidity of the firm's share. In the 1990s, there was a surge of IPOs in the U.S., prominently by new technology companies in such areas as information, communication, and biology. In Korea, the KOSDAQ stock market played a crucial role in inducing a boom of establishments of small new-technology companies through high volumes of

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IPOs since mid 1999. Although there was an overheating of market during the so-called "internet bubble" period, the IPOs of young companies in the NASDAQ and the KOSDAQ stock markets provided incentives to induce angel and venture capital investments to these small companies.

The firms engaged in IPOs encounter the classic problems of asymmetric information in selling their newly issued securities. The investors face a more severe adverse selection problem because the uncertainty on a firm's intrinsic value is greater for a new firm. Furthermore, this uncertainty is amplified by the moral hazard problem that the separation of ownership and management creates on the manager. Such acute issues of asymmetric information are construed as underlying the well-known empirical anomalies associated with IPOs, such as underpricing of new issues, distinct cycles in the volume and underpricing of IPOs, and long-run underperformance (Ritter (1998)).

The short-run underpricing refers to the phenomenon that the average initial returns on IPOs are abnormally high after taking into account the reasonable risk premium associated with the firms' uncertainty. This is the best-known empirical anomaly associated with IPO and exists in most nations (Loughran, Ritter, and Rydqvist (1994)), hence generated a large literature both theoretical and empirical.

Apparent cyclical variations in the volume of IPOs positively correlated with the level of initial returns, are also prominent in the IPO market. The U.S. experienced periods of high initial returns and volume, known as "hot issue" markets, around 1983, 1986, and recently since mid 1990s. In Korea, the Korea Stock Exchange experienced a hot issue market in 1988, and recently there was an unprecedented rush of IPOs in the KOSDAQ stock market. The observed distinct cycles of hot and "cold issue" markets seem to suggest that the market condition may play an important role in the IPO processes.

The long-run underperformance of IPOs refers to the phenomenon that the stock prices typically perform poorly in the several years following the IPO (and high initial returns). Loughran and Ritter (1995) report that during 1970-90, the average total return on the IPOs in the U.S. from the market price shortly after trading commences for 3 years is -20%. Similar patterns are observed in many other countries. This phenomenon may reflect the issuers' strategic timing of IPOs in the context of the aforementioned cycle of market conditions: IPO volume is high near market peaks when market to book ratios are high. We also observe in Korea that the firms' performances tend to be higher than average shortly before the IPOs.[1]

A lot of research efforts have been made to account for these prominent

[1] This appears to be true in other countries, too. Teoh, Wong, and Rao (1998) found evidence that on average IPO firms have high positive issue-year earnings and abnormal accruals, from the IPO data in the U.S. between 1980 and 1990.

features associated with IPOs. In particular, as reviewed in the next section, various theories have been developed to explain the phenomenon of underpricing, including the well-known work of Rock (1986) based on the winner's curse argument. Numerous empirical studies also exist on underpricing.

Theoretical studies on underpricing almost invariably model the demand side as consisting of one or two groups of investors with identical information and preferences. Since these identical investors (in the same group) all want a share at one specific price or lower, the market demand discretely jumps at one or two prices. Such demand patterns comply with the efficient markets hypothesis, which is a foundational basis of conventional finance and predicts horizontal or nearly horizontal demand curves for stocks at a price level that precludes the workings of arbitrage. Although this prediction is theoretical appealing, it would prevail only under rather stark conditions which may not reflect the reality well, e.g., the investors need to have unlimited borrowing capabilities. In fact, some convincing empirical evidence had been documented by researchers, such as Shleifer (1986), that questions the horizontal demand for stocks and suggests that financial markets are not an exception to one of the most fundamental economic principles, namely, the *downward sloping* demand curve.

In this paper we reinstate downward sloping demand curves into the winner's curse model by revamping the modeling of the demand side of the IPO market, and examine the additional implications that this extension has over and above the existing studies. The basic model that we suggest to do this is a natural one: a large pool of investors are ex-ante identical, but receive random private signals regarding the expected value of the firm in question according to a common continuous distribution. This distribution, however, varies in line with the true value of the firm, which aims to capture the heterogeneity among investors in the real world. Given the prior on the firm's true value, the investors update their posterior beliefs using their private signals via Bayes' rule. Since these posteriors are continuously distributed, they generate a downward sloping demand curve. As it turns out, just a single group of such investors suffices to exhibit the effect of the winner's curse because of heterogeneous signals.

The comparative statics results in existing studies are limited to changes in the characteristics of the IPO firms, because the discrete demand does not provide sufficient ground for more general comparative statics. With downward sloping demand reinstated from fundamentals, the comparative statics results can now be derived legitimately for market variables, which we believe are important because they may carry useful implications in promoting the capital market efficiency, e.g., through regulation.

Specifically, we derive theoretical implications on how the degree of underpricing changes both in the size of IPOs and in the size of active investors. Our theory predicts the same relationships as the basic winner's curse theory of Rock (1986) in the cold issue markets. Unlike the Rock's theory, however, our model shows that these relationships may change in the hot issue markets.

If these relationships are indeed empirically observed to change depending on the market conditions in a manner consistent with our theory, it would suggest that incorporating downward sloping market demand enhances the explanatory power upon the basic winner's curse model. We provide a test on this using recent data in the KOSDAQ stock market. The KOSDAQ stock market is appropriate for our purpose since it provides a sample distinctively divided into hot (before March 2000) and cold (after March 2000) markets. Our findings confirm the commonly predicted relationships in cold markets, and show that the same relationships cease to exist in hot markets, which is consistent with our theoretical results.

The next section provides some background by reviewing the related literature. Section 3 extends the basic winner's curse model by incorporating downward sloping demand, and derives some theoretical implications. Section 4 reports the results of empirical tests on these implications. Section 5 contains some concluding remarks.

2. BACKGROUND AND RELATED LITERATURE

The persistent large-scale underpricing of initial public offerings drew a lot of attention from researchers both in economics and finance for more than two decades. Following the rigorous documentations by, among others, Ibbotson (1975) and Ritter (1984), several explanations based on asymmetric information have been provided for this puzzling phenomenon, namely, that the initial returns on the IPOs are much higher than the reasonable risk premium for investors betting on unknown stocks: the average first-day return of new issues is 16.3% for 1960-1987, according to Ibbotson, Sindelar and Ritter (1994).

A prominent explanation is based on the winner's curse argument. Rock (1986) presents a model with two groups of investors, where one group is informed about the prospects of the IPO firm and the other is not. In his model the informed investors crowd out the uninformed investors for the IPOs that are priced favorably for the investor; on the other hand, only the uninformed investors subscribe (unknowingly) for those that are priced unfavorably. As a result, the uninformed investors face the winner's curse: their purchases are biased toward the unprofitable issues, because better ones are rationed (hence are less likely to be allotted) due to the high demand from the informed investors while unprofitable ones are not. Anticipating this bias, the uninformed investors are willing to participate only if the IPOs are priced low enough to compensate the expected loss from such bias. That is, underpricing arises to keep the uninformed investors in the market. Note that this theory implies that underpricing would be more severe when the information disadvantage is greater for the uninformed investors, for then the bias would be larger. This implication is extended to explain the underwriters' "reputation" as reflecting the lower degrees of risk of the firms that they bring to the market, thereby indicating lower degrees of underpricing for the firms they underwrite (Beatty and Ritter (1986), Carter and Manaster (1990)).

An alternative explanation is offered by the signaling-based models (Allen and Faulhaber (1989), Grinblatt and Hwang (1989), Welch (1989)) that formalize Ibbotson's (1975) conjecture that new issues may be underpriced to "leave a good taste in investors' mouths." The basic idea of these models is that the good IPO firms use underpricing to signal their good quality to the investors (all of whom are modeled as uninformed) and separate themselves from their worse counterparts, so that they can enjoy a better price at the subsequent seasoned offerings. Such a signaling works when the worse counterparts (firms) find it too costly to imitate the same level of underpricing at the IPO.

Other interesting explanations also exist. Baron (1982) demonstrates that underpricing occurs in the optimal contract between the IPO firm and the underwriter, for it helps reduce the moral hazard problem of the underwriter's selling effort. Benveniste and Spindt (1989) model the pre-market as an auction and show that underpricing is needed to elicit positive information from the investors, because it functions as a reward for revealing information. Tinic (1988) points out that underpricing reduces the probability of lawsuits if subsequently the firm does not perform well, and also the damages from them.

Many studies exist that contain empirical findings relevant for assessment of the various explanations mentioned above. Among them, Michaely and Shaw (1994) specifically test the winner's curse argument and the signaling-based models described above by using the U.S. data during 1984-1988. Their primary findings support the winner's curse argument (e.g., IPOs do not appear underpriced in markets where investors know a priori that they do not have to compete with informed investors) but are inconsistent with the signaling-based models (e.g., firms that underprice more appear less interested in the reissue market and perform better). Lawsuit avoidance hypothesis is questioned in light of the Ritter's (1998) finding that some countries where securities class actions are unknown have as much underpricing as in the U.S.

One straightforward implication of Rock's model is that larger IPOs would experience less underpricing. This is because, given a fixed size of informed investors, the larger is the IPO, the less exposed are the uninformed investors to the adverse selection of bad issues (i.e., the winner's curse), which reduces the need for underpricing to attract them. The empirical findings on this relationship, however, are mixed: Michaely and Shaw (1994) find greater underpricing for larger issues while Ibbotson, Sindelar and Ritter (1994) report the opposite. Using the data on Korea for 1988-1989, Kang (1990) found, in line with the Rock's implication, that the size of offering is negatively related with initial returns of IPO. Lee, Lim, and Yeon (1995) also tested for a similar period (1988-1990) and found that the size of offering is the most significant explanatory variable for the initial return with a negative sign.

The distinct cycles of hot and cold markets are prominent in the IPO market (see, e.g., Ibbotson, Sindelar and Ritter (1994)): "hot" periods of very high volume and extreme underpricing of new issues are followed by "cold" periods of very few new issues and little underpricing. Considering the market's capacity that absorbs the large amount of new issues in the hot market, it seems plausible to associate market cycles with shifts in the market demand curve due to changes in the size of active investors. Such a market condition (in terms of the strength of demand) may have substantive influences on the equilibrium response including underpricing, as reported by Hunt-McCool, Koh, and Francis (1996).[2] The simple demand side of Rock's model appears inadequate to address this issue, because it does not accommodate expansion or reduction of downward sloping demand curves. In the next section we develop a model that complements Rock's essential insight with a downward sloping demand curve by introducing continuously varying perception of investors.

3. MARKET COMPARATIVE STATICS OF THE IPO MARKET

3.1 Model

There are three parties in the model, an IPO firm, an underwriter/investment bank, and a continuum of ex-ante identical investors of measure s. Briefly, the timing is as follows: The firm tells the bank about its private type t ; the bank determines the IPO price p and the commission C ; based on his own signal, each investor decides whether to subscribe or not at this price. We assume that each investor may subscribe either one share or none. All the players are risk neutral and there is no discounting.

The firm offers the entire firm, the size of which is denoted by k with the following interpretation: the issue will be sold out if investors of measure k subscribe (k reflects the real size of the firm, hence is not a strategic variable.). The firm privately observes its type $t=g$ (good) or b (bad) with even probabilities (qualitatively the same results are obtained when they realize with uneven probabilities.). The firm's type t is the true value of the firm (per share) in the next (and final) period. Assume $g>b>0$. The firm sends a message m (treated as cheap talk) to the bank regarding t. The firm tries to maximize the revenue R from the IPO.

The bank observes the size, s, of the active investors pool. We interpret higher s as reflecting hot issue market. Based on s and the message m received from the firm, the bank determines the offer price p. The bank gets a commission as a fixed fraction of R.[3] So the bank's objective is also to maximize R.

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[2] They applied the stochastic frontier approach to the data on the U.S. for 1975-1984 to find that the measure of IPO underpricing is sensitive to the market period.

Note that both the good and bad firms will send the same message in equilibrium, because the bad firm will always imitate the good firm. Since the firm and the bank have the same objectives, without loss of generality one can collapse the two into one player who, knowing s but not t (as in Rock's model), sets p to maximize the expected value of R.[4]

Each investor observes a private signal, $r \in [0,1]$, which realizes according to a differentiable density function f_t depending on the firm's true type $t=g, b$. Let F_t denote the associated cumulative distribution function. We assume the monotone likelihood ration property (MLRP), that is, $f_g(r)/f_b(r)$ is increasing in r: this simply means that a higher r is more likely when the firm is of a good type, which is natural in the considered environment.

Based on the observed signal r, each investor will update his posterior belief that the firm's type is g by Bayes' rule, which we denote by

$$\beta(r)=f_g(r)/(f_g(r)+f_b(r)).$$

The MLRP implies that β is increasing in r. This reflects the idea that investors have their own assessments on the quality of the firm, which on average is in line with the true quality t.

The investors also observe k and s, the sizes of the firm and the active investors pool, respectively. Based on k, s, his own signal r and the issue price p, each investor makes a subscription decision that maximizes the net expected gain. That is, they will subscribe if and only if the expected t based on the posterior belief β, is greater than p. If there is oversubscription, shares are rationed randomly to the subscribers and those who get a share pay p. The game described above is common knowledge.

3.2 Equilibrium and Some Comparative Statics

Recall that the posterior β increases in r. So, an investor with a higher r has a higher β, hence is more inclined to subscribe. Given k, s, and p, therefore, there is a threshold level $r^*(k,s,p)$ such that investors subscribe for the issue if and only if their signal $r \geq r^*$. Note that k and s affect the level of r^*, because they affect the likelihood of oversubscription, hence that of getting a rationed share whose expected quality may differ from that of an un-rationed share. Since the demand for IPO shares is $s(1-F_t(r^*))$ when the size of

[3] This assumption is based on an empirical finding of Hansen (2001) that the banks basically charge the same rate (7%) as a result of competition. In principle, however, the commission rate can be endogenous.

[4] However, this ceases to be the case if one extends the model to allow for multiple banks that may compete, e.g., through their own investor pools.

investors is s and the firm's type is t, the revenue of the firm from IPO will be $R_g = \min\{k, s - sF_g(r^*)\} \times p$ if the firm's type is $t = g$, and $R_b = \min\{k, s - sF_b(r^*)\} \times p$ if $t = b$.

Note that it is not optimal to price so low that there will be oversubscription even when $t = b$, for it would be better to price slightly higher and still get full subscription. Hence, $k \geq s - sF_b(r^*)$, in equilibrium and, therefore, $R_b = (s - sF_b(r^*)) \times p$.

Oversubscription is possible when $t = g$. In fact, in view of its prevalence in practice, we will analyze equilibria in which oversubscription occurs when $t = g$, i.e., $s - sF_g(r^*) > k$. In this case, a subscriber is allotted a share with a probability
$z(k, s, p) = k/(s - sF_g(r*))$ when $t = g$. The equilibrium condition that the marginal investor (i.e., with a signal r^*) must be indifferent between subscribing and not, is

$$p(\beta(r^*)z + 1 - \beta(r^*)) = \beta(r^*)zg + (1 - \beta(r^*))b. \tag{1}$$

The LHS is the expected payment of the marginal investor when he subscribes at a price p, and the RHS is the expected true value of the share that he will get. This captures the winner's curse effect behind underpricing, namely, that the investors internalize biased allotment towards bad issues (i.e., $z < 1$) in their investment decisions.

Anticipating subscriptions from investors with signals $r^*(k, s, p)$ and higher, the bank sets an optimal price p^* to maximize the expected revenue R(hence, its commission):

$$\underset{p}{\text{Max}} \frac{1}{2}(pk + p(s - sF_b(r^*(k, s, p)))). \tag{2}$$

We analyze the environments in which the bank obtains an interior solution, so that the equilibrium price p^* is characterized by the FOC:

$$k + s - sF_b(r^*(k, s, p)) - spf_b(r^*(k, s, p))\frac{\partial r^*}{\partial p} = 0. \tag{3}$$

In the light of empirical evidence, we also assume

$$P^* < {}^{g+b}/_2, \text{ and} \tag{A1}$$

$$\lim_{k \to 0} z(k, s, p^*) > 0 \tag{A2}$$

Some justifications of these conditions are in order. Although our model captures the essence of Rock's insight (i.e., winner's curse effect), underpricing may not be guaranteed for certain functions f_t and parameter values due to explicit optimization of the seller facing a (stochastic) downward sloping market demand. (A1) ensures that we analyze environments in which such optimization entails underpricing which is an observed reality (note that $^{g+b}/_2$ is the unconditional expected value of the firm).[5] (A2) simply says that in equilibrium oversubscription does not occur to such an extreme extent that the investors completely give up hope of receiving a good issue,[6] which is also supported by empiricism. The subsequent analysis and results are carried out and stated under these conditions.

Now we examine the two comparative statics of interest in light of the IPO market cycles, namely, $\frac{\partial p^*}{\partial k}$ and $\frac{\partial p^*}{\partial s}$. First, by differentiating (3) w.r.t. k and rearranging, we get

$$s\frac{\partial p^*}{\partial k}\left[(2f_b+p^*f_b'\frac{\partial r^*}{\partial p})\frac{\partial r^*}{\partial p}+p^*f_b\frac{\partial^2 r^*}{\partial p^2}\right]$$

$$=1-s\left(\frac{\partial r^*}{\partial k}\left(f_b+p^*f_b'\frac{\partial r^*}{\partial p}\right)+p^*f_b\frac{\partial^2 r^*}{\partial p\partial k}\right) \tag{4}$$

It is immediate to verify from the second order condition of the optimization (2), that the formula in the bracket on the LHS of (4) is positive. So, the sign of $\frac{\partial p^*}{\partial k}$ coincides with that of the RHS of (4). Roughly speaking, *ceteris paribus*, this sign is positive if s is small; it can be negative only if s is big and the formula in the big parentheses on the RHS is positive. This observation is formalized in Proposition 1 below and is proved in the Appendix.

Proposition 1: Given g, b, f_g and f_b, there exists a strictly positive $\hat{s}$ such that $\frac{\partial p^*}{\partial k}>0$ for all k if $s<\hat{s}$. For $s>\hat{s}$, the sign of $\frac{\partial p^*}{\partial k}$ can be negative and may change depending on k.

To get an intuition for this result, notice that in equilibrium the positive marginal revenue from incremental sale when $t=b$, is counter-balanced by the negative marginal revenue when $t=g$ because it only means a lower price for a fixed sales volume (at full subscription level). The change in the former, positive marginal revenue caused by an increase in k tends to be proportional to s while that in the latter is independent of s. When s is small, therefore, the

[5] In fact, (A1) is much stronger than what is necessary for our results: it suffices to assume that p^* is bounded away from the maximum level of p that satisfies (1), i.e., when $r^*=1$.

[6] Suppose, for instance, that if k is sufficiently small relative to s, it is optimal to price just low enough to get full subscription when $t=g$ because the small incremental subscription when $t=b$ does not justify further price reduction. In this case (A2) is trivially satisfied.

overall change in marginal revenue is dominated by the change in the latter. So, the overall marginal revenue drops as k increases because larger k (sales volume) means larger negative marginal revenue when $t=g$, which in turn prompts a price increase to restore marginal revenue back to the optimal level.

For large s, on the other hand, the change in the former, positive marginal revenue may dominate, but the direction of this change is not definite: in addition to increasing the market demand, a higher k also brings about a change in the slope of the market demand curve for $t=b$, which may as well overshadow the effect of the increased demand.

As for $\frac{\partial p^*}{\partial s}$, by differentiating (3) w.r.t. s, we get

$$s\frac{\partial p^*}{\partial s}\left[(2f_b+p^*f_b'\frac{\partial r^*}{\partial p})\frac{\partial r^*}{\partial p}+p^*f_b\frac{\partial^2 r^*}{\partial p^2}\right]$$

$$=1-F_b-pf_b\frac{\partial r^*}{\partial p}-s\left(\frac{\partial r^*}{\partial s}\left(f_b+p^*f_b'\frac{\partial r^*}{\partial p}\right)+p^*f_b\frac{\partial^2 r^*}{\partial p\partial s}\right)$$

$$=-\frac{k}{s}-s\left(\frac{\partial r^*}{\partial s}\left(f_b+p^*f_b'\frac{\partial r^*}{\partial p}\right)+p^*f_b\frac{\partial^2 r^*}{\partial p\partial s}\right) \tag{5}$$

where the second equality follows from (3). By an analogous argument as before, the sign of $\frac{\partial p^*}{\partial s}$ coincides with that of the RHS of (5). From this formula we derive implications on the effects that changes in the market condition may have on underpricing, as stated below s and proved in the Appendix.

Proposition 2: Given g, b, f_g and f_b, there exists a strictly positive $\hat{s}$ such that $\frac{\partial p^*}{\partial s}<0$ for all k if $s<\hat{s}$. For $s>\hat{s}$, the sign of $\frac{\partial p^*}{\partial s}$ can be positive and may change depending on k.

4. EMPIRICAL EVIDENCE FROM INITIAL RETURNS OF THE IPOs IN THE KOSDAQ STOCK MARKET

In Rock's model, as the size of informed investors gets smaller relative to the issue size, the effect of winner's curse becomes milder and hence, the degree of underpricing gets reduced. Regardless of market conditions, therefore, the degree of underpricing would be inversely related with the size, k, of issue and positively with the size, s, of the active investors pool. These implications coincide with the predictions of our model stated in Propositions 1 and 2, respectively, in cold markets (i.e., when s is small). In hot markets, however, our theory predicts that these relationships may, if not necessarily, change and hence, may differ from the predictions of Rock's model.

Whether incorporating a downward sloping market demand enhances the explanatory power of the model upon Rock (1986), therefore, is an empirical question. In this section, we try to answer this question using the recent data in the KOSDAQ stock market. Our findings confirm the relationships commonly predicted by Rock's model and ours in cold markets. More importantly, we find that the same relationships cease to exist in hot markets (in fact, reverse relationships are found although not significant), which is consistent with our theoretical results.

4.1 Data and Methodology

We examine the initial aftermarket performance of the IPOs in the KOSDAQ stock market over the period from May 1999 to August 2001. After excluding IPOs with insufficient data, the sample includes 347 IPOs of primary shares that initially went public on the KOSDAQ stock market.

We believe the IPOs in the KOSDAQ stock market (KOSDAQ, hereafter) serves our purpose adequately. First, the KOSDAQ has been playing a major role as an IPO market since 1999. More than 500 firms have been listed since 1999 and many of them issued primary shares. In particular, since 24^{th} of May 1999, the KOSDAQ introduced a book building mechanism to accommodate the market demand for IPO issues in setting the offer price and deregulated the price setting of the IPO so that it is fully determined by market mechanism. Therefore, unlike the IPOs of the Korean Stock Exchange where price setting were under government regulation (before 1988) or were negotiated between the issuer and the underwriter without considering market demand, the IPO procedure of the KOSDAQ is comparable to the main spirit of the current model. Second, although the aftermarket performance of the IPOs in the KOSDAQ is heavily influenced by the internet or high-technology bubble from late 1999 to early 2000, the KOSDAQ provides a sample distinctively divided into hot (before March 2000) and cold (after March 2000) markets. This sharp distinction provides an adequate sample to study the effect of market demand on the pricing of the IPO.

In most empirical studies on the IPO, the initial returns to measure the degrees of underpricing is usually calculated using the offering price and the first-day closing price. However, the first-day closing price is not an adequate measure of initial returns in our sample, because the KOSDAQ regulates daily price movement within a band of plus and minus 12%, and in many IPOs the closing price of the first-day trading hits the upper limit and often continues to rise by hitting the daily limit consecutively with a small volume of trading, until a large trading occurs. In addition, the price band for the first-day trading has been widened upward from plus 12% to 100% since July 25, 2000. Therefore, we use two alternative measures to take care of the problem posed by the daily price band.

First, the initial return is calculated as the difference between the offering price and the closing price on the first day that did not hit the daily upper limit. Then the degree of underpricing is computed by calculating the excess initial return after adjusting for the market return between the day that the offer price is set and the first day of trading: the degree of underpricing for firm i, r_{it} (return-(1) hereafter), is defined as

$$r_{it}=\frac{P_{it}/P_{i0}}{M_{it}/M_{i0}}-1.$$

P_{i0} and M_{i0} are, respectively, the offering price and the KOSDAQ composite index on the day that the offering price is set, which usually is a month before listing. P_{it} and M_{it} are, respectively, the closing price and KOSDAQ composite index on the day t, when the closing price is within the daily price band.

Second, since many IPO stocks show drastic initial price movements for some days after listing due to daily price band, we compute a hypothetical return under the assumption that an investor sells out his or her shares in the same proportion every day for a month after listing. Thus, the alternative measure of excess initial return to the IPO stock, Ar_{it} (return-(2) hereafter), is defined as the average daily return for a month after listing:

$$Ar_{it}=\frac{1}{N}\sum_{t=1}^{N} r_{it}.$$

We set N to be 20 to cover the initial 20 trading days in the first month after the IPO.

To start with, we test two, generally accepted implications of the basic winner's curse argument on underpricing for the entire sample period, i.e. without taking into account the market demand conditions. These two implications have been tested and largely supported in previous studies.

The first of the two implications is regarding the degree of uncertainty of the IPO firm: since the winner's curse problem arises from the intrinsic uncertainty on the firm's true value, firms with greater uncertainty should underprice more. The KOSDAQ classifies "venture" firms and gives a favor in the procedure of IPO. Venture firms are usually high-technology related, small sized and young, and they are favorably treated by being exempted from the several requirements on the amount of capital, age, and asset-liability ratio for the approval of listing. Therefore, the venture firms pose greater uncertainty and as a result, would experience larger underpricing than non-venture firms. The second implication is the inverse relationship between the degree of underpricing and the issue size (with the gross proceeds as a proxy), as already discussed earlier.

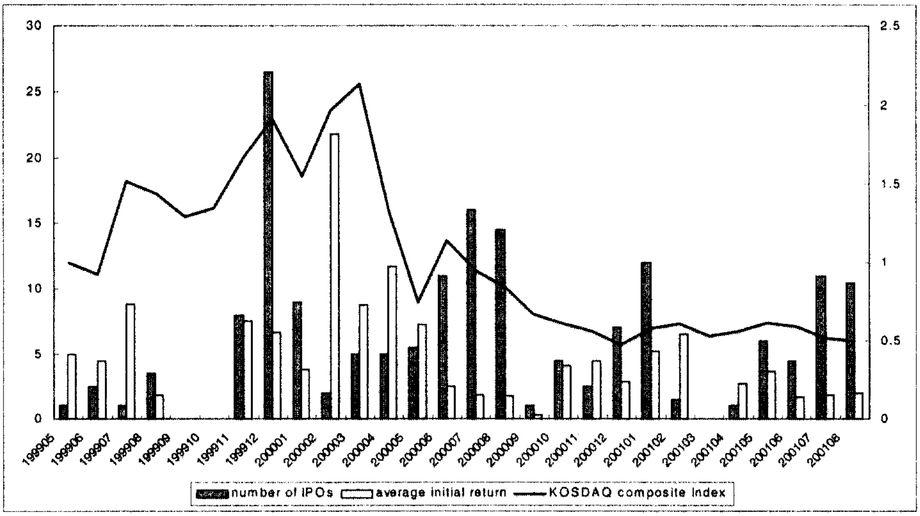
Next, we test the aforementioned, further implications of our theory on the effects that market conditions may have on the pricing of the IPO. To do this, we select a hot market period and a cold market period from the sample, according to the KOSDAQ composite index. Then, we test whether the relationships commonly predicted by Rock's model and ours are confirmed in the cold period; and whether these relationships persist in the hot period as Rock's model predicts, or they change as our model allows.

To test the implications, in Section 4.2 we compare the difference between the means of excess initial returns by the concerned group of the IPO stocks. In Section 4.3, we report the regression results of the excess initial returns on the plausible determinants of IPO pricing.

4.2 Basic Statistics and Testing of the Difference between the Means

Figure 1 shows the volume of the IPOs, the degree of underpricing (return-(1)) and the KOSDAQ composite index for the sample period. As is well known, the KOSDAQ was hot up until March 2000 and cooled down thereafter in the long haul. Browsing the short term cycles of hot and cold periods, we notice that the volume and the average initial returns of the IPOs are serially correlated, depicting the hot issue market phenomenon as Ibbotson, Sindelar, and Ritter(1994) showed for the U.S. The volume of the IPOs shows a strong tendency to be high following hot periods and the initial returns are contemporaneous with the market conditions of the initial trading days. Market conditions appear to influence the IPOs in the KOSDAQ as much as in other stock markets already shown by other studies. The average initial return for the whole sample is quite high: return-(1) and return-(2) are 1.4376 and 0.9049,

[Figure 1] IPOs in the KOSDAQ stock market: May, 1999-August, 2000.



Note: The average initial return (Return-(1)) is calculated as the difference between the offering price and the closing price on the first day that did not hit the daily upper limit.

respectively. Although direct comparisons are hard due to the differences in methodology, the degree of underpricing in the KOSDAQ IPOs seems to be much higher than the IPOs in the Korea Stock Exchange (0.7810 for the period of 1980-90 according to Lougran, Ritter, and Rydqvist (1994)) and the U.S stock market (0.5872 for the same sample period, computed from Ritter's dataset). Considering that the KOSDAQ IPOs consist of relatively young firms with uncertain prospects and that such active IPOs are unprecedented in Korea, such high a degree of underpricing is not surprising for the KOSDAQ IPOs.

Table 1 compares the initial returns between different groups of firms relevant for testing the general implications of the basic winner's curse model explained above. The initial returns turn out to be much higher when the return-(1) measure is used than when the return-(2) measure is used.

First, the initial returns are compared between the IPOs of venture firms and those of non-venture firms. The initial returns for venture firms are higher as expected in both return-(1) and return-(2). The difference between venture and non-venture firms is significant at 5 percent level, confirming the implication of the winner's curse model.

Second, we divide the sample into three groups by the size of gross proceeds and compare the initial returns between the upper third and the lower third groups, to see the difference in the degree of underpricing by the size of offerings. The figures show that the initial returns of the IPOs with larger proceeds tend to be lower, in conformity with the winner's curse model. The difference between the large and small IPOs is significant at 1 percent level for return-(2).

[Table 1] Excess Initial Returns by the different groups of IPOs

	Mean	Standard Deviation	mean	Standard Deviation	t-statistic of difference
(1) The Type of the Firms					
	Non-Venture		Venture		
Return-(1)	1.0817	1.4026	1.6726	2.1834	2.0110*
Return-(2)	0.7215	0.8644	1.0259	0.8963	2.1591*
No. IPOs	138		209		
(2) The Size of Gross Proceeds					
	Small		Large		
Return-(1)	1.6001	1.6015	1.1589	2.0867	1.5392
Return-(2)	1.1291	0.8958	0.6875	0.8754	3.2251**
No. IPOs	113		113		

Note: Return-(1) is the difference between the offering price and the closing price on the first day that did not hit the daily upper limit. Return-(2) is the average excess return for the initial 20 trading days. The t-statistics of differences are calculated on the basis of pairwise comparison, and (*) and (**) denote significance at the 0.05 and 0.01 levels, respectively.

The empirical result in Table 1 shows that the KOSDAQ exhibits the basic implications of, hence appears consistent with, the winner's curse model of underpricing. Now we test the further implications of our theory, namely, the effects of market conditions on the pricing of the IPO, by checking if systematic differences are observed between hot and cold markets. In Figure 1, the KOSDAQ composite index shows a long rising trend up until March 2000 and sharply declines thereafter. It cooled further down until August 2001. We divide the sample period into hot and cold markets with April 2000 as a break point and compare the means of initial returns by the group.

Table 2 compares the initial returns between venture and non-venture firms within hot and cold markets. In the hot market prior to April 2000, the initial returns for venture firms are significantly higher. This is similar to the result from the whole sample. However, in the cold market, the initial returns for venture firms are not significantly different from those for non-venture firms. It may imply that the greater underpricing of venture firms in the whole sample is partly driven by the overreaction of investors toward the high-tech oriented venture firms, as one may expect. In any event, the different patterns of underpricing between venture and non-venture firms depending on the market condition, underscore possible systematic effects of market demand.

[Table 2] The initial returns by the Type of Firms in hot and cold markets

	Mean	Standard Deviation.	Mean	Standard Deviation	t-statistic of the difference
	Non-venture		Venture		
Hot market					
Return-(1)	0.9917	1.2643	3.1248	3.3914	5.2050**
Return-(2)	0.4848	0.6963	1.3615	0.8349	7.1221**
No. IPOs	53		55		
Cold market					
Return-(1)	1.1378	1.4868	1.1539	1.1802	0.0752
Return-(2)	0.8691	0.9280	0.9061	0.8895	0.2541
No. IPOs	85		154		

Note: Hot market is the sample period prior to April 2000, and the cold market is the sample period thereafter.

Table 3 examines the potential effect of the market condition on the relationship between the issue size and the degree of underpricing. We find that in the cold markets, the IPOs with larger gross proceeds tend to experience significantly less underpricing. This is consistent with the implications of both the basic winner's curse model and our model that incorporates downward sloping market demand. In the hot market, on the other hand, the IPOs with larger gross proceeds show greater underpricing, although statistically not significant. This change of relationship is possible in our model, but not in the basic winner's curse model.

[Table 3] The initial Return by the size of gross proceeds in hot and cold markets

	Mean	Standard Deviation.	Mean	Standard Deviation	t-statistic of the difference
	Small		Large		
Hot market					
Return-(1)	1.6351	2.1583	1.9979	2.9533	0.5783
Return-(2)	0.8073	0.8210	0.8727	0.7950	0.3337
No. IPOs	34		34		
Cold market					
Return-(1)	1.4541	1.2025	0.8977	1.5329	2.5221*
Return-(2)	1.2428	0.8856	0.6126	0.9127	4.3765**
No. IPOs	78		78		

Note: The large and the small groups are, respectively, the upper third and the lower third of the sample in each market in their gross proceeds.

Finally, Table 4 examines the potential effect of the market condition on the relationship between the market trend and the degree of underpricing. Based on the KOSDAQ composite index in Figure 1, the KOSDAQ underwent a cooling-off period during September and October 1999 on its rising trend toward the peak in March 2000. We single out the IPOs whose prices were set and shares were distributed during this cooling-off period within the hot market, and compare their initial returns with other IPOs during the hot period. The figures indicate that the cooling-off within the hot market leads to greater underpricing although the difference is not significant. Next, by the same procedure, we compare the IPOs in a further cooling period (July-December, 2001) within the cold market, and other IPOs in the cold period (April-June, 2001).[7] We find that further cooling within the cold market leads to less underpricing. This result is statistically significant at 5 percent level for return-(1). Again, the observed change of relationship between hot and cold periods is possible in our model, but not in the basic winner's curse model.

[7] The KOSDAQ composite index shows that the KOSDAQ sharply turned into a cold market after March 2000, briefly rebounded in June, and then further cooled off until December.

[Table 4] Underpricing of IPOs in cooling periods in hot and cold markets

	Mean	Standard Deviation.	Mean	Standard Deviation	t-statistic of the difference
	IPOs in cooling period		Others		
Cooling off in hot market					
Return-(1)	2.4473	4.1712	2.0939	2.4884	0.3289
Return-(2)	0.9560	0.7680	1.0017	0.9063	0.2137
No. IPOs	16		92		
further cooling off in cold market					
Return-(1)	1.0736	0.9711	1.5179	1.7478	2.0426*
Return-(2)	0.9826	0.8403	1.0515	1.0573	0.4681
No. IPOs	33		95		

Note: The cooling period in hot market is September to October, 1999, and the further cooling period in cold market is July to December, 2000.

Summarizing, the Tables 2 to 4 show that testing the model of underpricing could be sensitive to the market conditions of the sample. It means that the degree of underpricing is nontrivially affected by the market demand conditions.

4.3 Regression Analysis

We regress initial returns on the type of firms and the issue size to test the implications of the model using an alternative method. The results are presented in Table 5 in two panels with the two measures of degree of underpricing, return-(1) in panel A and return-(2) in panel B. The regression results for the whole sample disregarding the market conditions indicate that the IPOs of venture firms and smaller issue sizes tend to have greater underpricing significantly, which is consistent with the implications of the basic winner's curse model.

To examine the market condition effect, we introduced the dummy for the hot market. It is significant at 1 percent level when the dependent variable is return-(1) but not when the dependent variable is return-(2). It may be due to the fact that prior to March 2000, many newly offered stocks experienced consecutive days hitting upper limit of daily price band immediately after listing and then underwent the period of drastic price movement of ups and downs until their prices stabilized. The split of the sample into the hot and cold markets shows that the dummy for venture firms is significant only in the hot market, which may be due to the overreaction of investors toward the high-tech IPOs. In both Panel A and B, the coefficients for the size of proceeds are significantly negative in the cold market but not in the hot market, again in

[Table 5] Regressions of initial returns on selected variables

Panel A:

Whole sample					
Constant	VENT	LSIZE	HOT	nobs.	adj R^2
2.161	0.651	-0.260		337	0.034
(4.246)**	(3.041)**	(-2.298)*			
1.541	0.765	-0.200	0.948	337	0.080
(2.974)*	(3.632)**	(-1.793)*	(4.210)**		
Hot market					
Constant	VENT	LSIZE	COOL	nobs.	adj R^2
1.198	2.229	-0.067		103	0.139
(1.113)	(4.240)**	(-0.263)			
1.160	2.224	-0.069	0.347	103	0.132
(1.120)	(4.261)**	(-0.271)	(0.470)		
Cold market					
Constant	VENT	LSIZE	COOL	nobs.	adj R^2
2.210	0.065	-0.248		234	0.019
(4.944)**	(0.366)	(-2.530)*			
3.341	0.133	-0.395	-0.708	165	0.066
(5.431)**	(0.590)	(-3.188)*	(-3.059)*		

Panel B:

Whole sample					
Constant	VENT	LSIZE	HOT	nobs.	adj R^2
1.593	0.351	-0.208		337	0.071
(6.691)**	(3.620)**	(-4.058)**			
1.595	0.348	-0.208	-0.003	337	0.068
(6.618)**	(3.581)**	(-4.022)**	(-0.026)		
Hot market					
Constant	VENT	LSIZE	COOL	nobs.	adj R^2
0.568	0.924	-0.031		103	0.254
(1.736)	(6.050)**	(-0.413)			
0.568	0.924	-0.031	0.003	103	0.247
(1.724)	(6.018)**	(-0.410)	(0.015)		
Cold market					
Constant	VENT	LSIZE	COOL	nobs.	adj R^2
2.196	0.089	-0.306		234	0.078
(7.299)**	(0.747)	(-4.634)**			
2.952	0.199	-0.420	-0.343	165	0.138
(7.512)**	(1.388)	(-5.315)**	(-2.323)*		

Note: The dependent variables are return-(1) for panel A and return-(2) for panel B. The independent variables are: C=intercept; VENT=dummy variable equal to 1 if the IPO firm is classified as a venture firm in the KOSDAQ, and 0 otherwise; LSIZE= log of the gross proceeds; HOT=dummy variable equal to 1 if the date of offering is prior to April 2000; COOL=dummy variable equal to 1 if the date of offering is classified as cooling off periods. Numbers in parentheses are t-statistics. (*) and (**) denote significance at the 0.05 and 0.01 levels, respectively.

conformity to our theory as opposed to the basic winner's curse theory. This means that, even after controlling for the fact that venture firms tend to raise smaller proceeds, the inverse relationship between the degree of underpricing and the issue size is significant only in the cold market. Finally, we introduce the dummy of cooling period both in the hot and cold markets. The cooling off in the hot market appears to lead to greater underpricing although not significant, while further cooling in the cold period results in less underpricing with significance. Again, this dependence of the relationship on the market condition can be inferred from our theory but not the basic model. Overall the regression analysis leads to a conclusion similar to the one from the test of the difference between means.

To summarize, the basic winner's curse model is not rejected by our empirical findings in the KOSDAQ but falls short of accounting for the systematic dependence of underpricing on the market demand conditions that the data exhibit. This systematic dependence can be explained by our theory that incorporates downward sloping market demand. It needs be noted, though, that the high initial returns in the hot market in the sample may also be attributable to the overoptimism of investors in the so-called internet or high-tech bubble.

5. CONCLUSION

In this paper we reinstate downward sloping demand curve into the basic winner's curse model, and examine the additional implications that this has in the pricing of the IPO. Theoretically, we show that the degree of underpricing may be systematically affected by the market conditions. The basic winner's curse model implies that, regardless of the market condition, the degree of underpricing would be inversely related with the issue size, and positively related with the active investors pool that generate the market demand. The extended model in the current paper predicts that the same relationships will prevail in the cold market, but it also indicates that the relationship may change in the hot market. This possibility of systematic dependence of the relationships on the market condition as indicated in our theory, is shown to be empirically supported by the IPO data in the KOSDAQ.

This paper emphasizes the importance of the market demand conditions in the pricing of the newly offered issues and shows that the introduction of downward sloping demand curve may add new theoretical implications that carry empirical contents. However, this study may be fruitfully extended in several ways. For one, the model may be explored further to clarify the environments in which the reversion of the relationships actually takes place (as opposed to simply showing the possibility of reversion). For another, further empirical investigation on other countries may be useful in determining how generally the implications of our model are valid. For instance, the history-long, U.S. data on IPOs may generate a more conclusive testing on the validity of the main implications of the paper.

APPENDIX

Proof of Proposition 1: First we derive a preliminary result. Observe that if k tends to 0 then r^* should approach 1, because in equilibrium oversubscription does not happen when $t=b$, i.e., $k \geq s-sF_b(r^*)$. Then, $\beta(r^*)$ exceeds $^1/_2$ as k tends to 0, which in turn implies that p^* should exceed $^{g+b}/_2$ according to (1), violating (A1). Hence, we conclude that k is bounded away from 0, i.e., $k > \underline{k}$ for some $\underline{k} > 0$. In other words, the equilibrium that we are interested in would not arise if the firm's size gets arbitrarily small.

Next, note that if $\frac{\partial r^*}{\partial k}$, $\frac{\partial r^*}{\partial p}$ and $\frac{\partial^2 r^*}{\partial p \partial k}$ are all bounded above in absolute values, then the formula in the big parenthesis after s on the RHS of (4) is bounded in absolute value, say, by $B>0$. Then, the proposition is proved by setting $\hat{s}={}^1/_B$. The proof is complete, therefore, if we show that the three derivatives above are indeed bounded. We show this for $\frac{\partial r^*}{\partial k}$. Analogous arguments work for the other two derivatives.[8]

Differentiating (1) w.r.t. k and rearranging, we get

$$\frac{\partial r^*}{\partial k}[\beta'(r^*)k(g-p)+(p-b)(\beta'(r^*)(s-sF_g(r^*))+s(1-\beta(r^*))f_g(r^*))]$$
$$=-\beta(r^*)(g-p).$$

The RHS is obviously bounded (cf. (A1)). So, $\frac{\partial r^*}{\partial k}$ is bounded if the bracket on the LHS is bounded away from 0. (Incidentally, note that the expression in this bracket is positive, hence $\frac{\partial r^*}{\partial k}$ is negative.) Since each term in the bracket is positive, it is indeed bounded away from 0 if one of the terms, say the first term, is. This is in fact the case if $\beta'(r)$ is bounded away from 0, because $k > \underline{k}$ as shown above and $p^* < {}^{g+b}/_2$ by (A1). Finally, it is straightforward to prove that $\beta'(r) = \frac{f'_g(r)f_b(r)-f_g(r)f'_b(r)}{(f_g(r)+f_b(r))^2}$ is bounded away from 0, because the MLRP means that the first derivative of $f_g(r)/f_b(r)$ is defined and positive on [0,1]. This completes the proof. Q.E.D.

Proof of Proposition 2: As before, if $\frac{\partial r^*}{\partial s}$, $\frac{\partial r^*}{\partial p}$ and $\frac{\partial^2 r^*}{\partial p \partial s}$ are all bounded

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[8] The argument for $\frac{\partial^2 r^*}{\partial p \partial k}$ requires that $\beta''(r)$ be bounded, which is the case with an additional technical assumption that f_t is twice differentiable on [0,1].

above in absolute values, then the formula in the big parenthesis after s on the RHS of (5) is bounded in absolute value, say, by $B>0$. Set $\hat{s}=\sqrt{k/B}$. Then, the proposition obtains because the RHS of (5) is less than $-k/\hat{s}+\hat{s}B=0$. The proof is complete, therefore, if we show that the three derivatives above are indeed bounded. It is already shown for $\frac{\partial r^*}{\partial p}$. We prove it for $\frac{\partial r^*}{\partial s}$ below. An analogous argument works for $\frac{\partial^2 r^*}{\partial p \partial s}$.

Differentiating (1) w.r.t. s and rearranging, we get

$$\frac{\partial r^*}{\partial s}[\beta'(r^*)k(g-p)+(p-b)(\beta'(r^*)(s-sF_g(r^*))+s(1-\beta(r^*))f_g(r^*))]$$
$$=(1-\beta(r^*))(1-F_g(r^*))(p-b)$$

The RHS is obviously bounded. So, $\frac{\partial r^*}{\partial k}$ is bounded if the bracket on the LHS is bounded away from 0, which has already been shown in the previous proof. Q.E.D.

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