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ABSTRACT

Two major problems are well-known in IPO research as "IPO puzzles." First, a first listing price is much higher than the offering price set by the underwriter, which is called "underpricing." Second, in the long-run the share price becomes much lower than the offering price, which is called "long-run underperformance." A vast body of research explains why these IPO puzzles coexist.

Assuming that investors' opinions diverge, we conclude that even the offering price is distorted through strategic interaction between the entrepreneur and the underwriter. Specifically, the offering price is already "overpriced." Hence, the share price will drop substantially as information asymmetry between both the entrepreneur and the underwriter and investors is mitigated after the IPO, which delivers long-run underperformance. Our experiment supports these conclusions.

Keywords: IPO puzzles; Earnings management; Experiment

I. INTRODUCTION

Two major problems, well-known as "IPO puzzles," remain unsolved in IPO research. First, in the short run, it is observed that an IPO firm's first listing price is much higher than the offering price (Ibbotson 1975; Ritter 1984; Loughran and Ritter 1995; Loughran and Ritter 2002; Ritter and Welch 2002; Loughran and Ritter 2004). The difference between them is the so-called "money left on the table." Second, it is also observed that in the long-run the share price becomes much lower than the offering price (Aggarwal and Rivoli 1990; Ritter 1991; Loughran and Ritter 1995; Ritter and Welch 2002), which is called "long-run underperformance."

This leads to the question: "Which is the fundamental value, the first listing price or the offering price?" Two primary research streams attempt to answer this question. First, according to traditional theories, which assume that investors are rational and have homogeneous expectations (Markowitz 1952; Sharpe 1964; Lintner 1965; Black and Scholes 1973), it is argued that the first listing price is the fundamental value. Hence, the difference between them is the "underpricing," in that the underwriter underpriced the IPO firm. Several theories have been developed to explain why underpricing exists, based on adverse selection (Rock 1986; Beatty and Ritter 1986), signaling (Allen and Faulhaber 1989; Welch 1996), agency theory (Baron and Holmstrom 1980; Baron 1982), and information revelation (Benveniste and Spindt 1989). Second, according to behavioral theories, which assume that investors' opinions diverge (Miller 1977; Shleifer 1986; Chen, Hong, and Stein 2002; Chatterjee, John, and Yan 2012), it is argued that the offering price is the fundamental value. Hence, the difference between them can be observed as the investors' sentiment bubble (Cornelli, Goldreich, and Ljungqvisit 2006; Da, Engelberg, and Gao 2011; Dorn 2009).

Our research differs from both traditional and behavioral theories in that neither the first listing price nor the offering price is the fundamental value. This enables us to explain why the IPO puzzles coexist.

Our model's settings are distinguishable from most research based on traditional theories in two points. First, traditional theories assume that investors have homogeneous expectations, and hence, the demand curve is flat. However, this is an unrealistic premise because it is implausible that investors have the same opinion on security prices in the real world. According to Miller (1977), we assume investors' opinions diverge, and hence, the share's demand curve slopes downward to the right, which is a sharp contrast to traditional theories.[1] Second, we assume that the capital market perceives the entrepreneur's higher ownership retention at the IPO as good news. Namely, the demand curve shifts upward as the ownership retention increases.[2] These settings enable us to explore the strategic interaction between the entrepreneur and the underwriter.

In our model, an underwriter sets an offering price based on forecasts of the firm's future performance. Hence, an incentive exists for the entrepreneur to overstate earnings.[3] On the other hand, the underwriter may benefit from a higher offering price because the underwriting fee generally increases with the proceeds.[4] Hence, the underwriter overlooks overstated earnings and sets a higher offering price, especially when the demand of the shares is sufficiently high.[5] However, if the underwriter sets the offering price too high, the underwriter might incur a loss due to shares left unsold.

Hence, in a situation that the ownership retention is high enough, the entrepreneur and the underwriter can *both* benefit from overstated earnings and an "overpriced" offering price. Therefore, we can even conclude that the offering price is already "overpriced" to the fundamental value through the strategic interaction between the entrepreneur and the underwriter. This conclusion is a sharp contrast to those from most prior research, based on traditional and behavioral theories.

Hence, the difference between the first listing price and the offering price represents investors' sentiment bubble, and the share price will substantially decrease as information asymmetry between *both* the entrepreneur *and* the underwriter and investors is mitigated after the IPO. This delivers long-run underperformance.

Our paper offers several contributions to IPO research. First and the most important, our conclusion is that the first listing price is already "overpriced." This is a sharp contrast to

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1 Traditional theories, such as Sharpe (1964) and Lintner (1965), assume no divergence in investors' opinions, and hence, the demand curve is flat.

2 This assumption is consistent with the empirical findings of Fan (2007), which state that ownership retention is positively related to IPO firms' valuation.

3 Prior empirical research on earnings management around IPOs had mixed results. While Teoh et al. (1998) observed aggressive earnings management, Ball et al. (2008) argued that IPO-firms reported rather conservative earnings before IPOs.

4 Chen et al. (2000) observed that more than 90 percent of IPOs raising $20-$80 million had underwriting fees that were exactly seven percent of the proceeds in US from 1995 to 1998. Abrahamson et al. (2011) observed that "seven percent solution" expanded in 1998-2007.

5 See, for example, Baron (1982), Chen and Mohan (2002), and Deloof and Inghelbrecht (2009). Deloof et al. (2009) specifically argue that the final offering price is decided by considering current market conditions.

those of vast prior research, which argues that IPO firms are underpriced. Therefore, this paper could offer new insights for IPO research

A few papers have argued that the offering price exceeds the fundamental value. Ljungqvist, Nanda, and Singh (2006) argue as such, on the assumption of a divergence in investors' opinions; however, their setting is rather restrictive in that the entrepreneur only sells and does not issue shares at IPOs, and the IPO firms do not engage in business activities afterward. Our model's settings are more realistic in that an entrepreneur both issues and sells shares at the IPO, and the firm engages in business activities afterward. Under the more realistic situations, we conclude that the offering price is already "overpriced." Hence, our paper is a theoretical extension of Ljungqvist et al. (2006).

Purnanandam and Swaminathan (2004), using 2,288 IPOs in US from 1980 to 1997, compares the offering prices to the fundamental values. They used share prices of the non-IPO industry peers as the fundamental value of the IPO firms, and argue that IPOs are systematically overvalued at the offer prices. However, the limitation of archival research is that we cannot help being using proxy variables to unobservable variables. Instead of that, we conduct an experiment to test the theoretical predictions. Experiments, rather than other empirical methods, can create a controllable environment that corresponds to the model, and test directly theoretical predictions of the model. Hence, our paper is a refinement of Purnanandam and Swaminathan (2004).

Our paper contributes to experimental IPO studies. Several experimental studies exist regarding how ownership retention functions as a signaling device in IPOs.[6] However, these studies do not address earnings management. On the other hand, several experimental studies examine earnings management.[7] However, these studies do not address earnings management in an IPO context. To the best of our knowledge, this paper is the first experimental study that investigates the relationship between ownership retention and earnings management in IPOs. Therefore, this paper could provide a clue to issues inherent in IPOs.

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6 Mayhew, Schatzberg, and Sevcik (2004), based on Datar, Feltham, and Hughes's (1991) model, find that the entrepreneur uses ownership retention to signal the IPO firm's value when computerized investors are programmed to behave as Datar et al.'s (1991) model assumes. Trueman (1986) develops a model in which the entrepreneur uses capital investment and ownership retention as signals in IPO settings.

7 See, for example, Hirst (1994), Hirst and Hopkins (1998), Maines and McDaniel (2000), Tan and Jamal (2006), Chen et al. (2012).

The remainder of this paper is organized as follows: In Section 2, we develop a theoretical model without earnings management costs, which is then tested. Section 3 describes the experimental design, and Section 4 reports the results. We extend the model in Section 5 by introducing earnings management costs. Section 6 summarizes the paper.

II. MODEL

The Model's Settings

We consider a two-period model; in the first period (hereafter, "period 0"), a risk-neutral entrepreneur who owns all of the firm's shares (N shares) decides that the firm will go public at the beginning of the second period (hereafter, "period 1"). The entrepreneur issues another N shares at the IPO, and sells $S = (1 - w)N$ owned shares ($0 \leq \mathrm{w} \leq 1$).

As the payoff from selling the shares increases in the public offering price P_0 decided by an underwriter, the entrepreneur has an incentive to increase it by managing earnings in financial statements issued at the end of period 0. Let θ and μ be true earnings and the amount of earnings management in period 0, respectively. The reported earnings e can be written as

$$e = \theta + \mu.$$

We assume that $0 \leq \mu \leq \theta$, or $\theta \leq e \leq 2\theta$.

The firm conducts business activities in period 1. The probability of its success is assumed to be p $(0 < p < 1)$, and with this success the share price will increase to $P_1 = P_0 + \alpha$ $(\alpha > 0)$ at the end of period 1. However, a risk exists that the earnings management will be revealed. We assume the probability is q $(0 < q < 1)$. If so, the share price will decrease by $k\mu$ $(0 \leq k \leq 2)$ in period 1.[8] If the business activity fails, with the probability as $1 - p$, the share price will decrease to $P_1 = 0$ at the end of period 1 irrelevant of whether the earnings management is revealed.

Hence, the entrepreneur maximizes

$$\begin{aligned}
&(1 - q)[P_0 S + p(P_0 + \alpha)(N - S)] + q[P_0 S + p(P_0 + \alpha - k\mu)(N - S)] \\
&= N\{[1 - (1 - p)w)]P_0 + wp(\alpha - q\mu k)\}.
\end{aligned}$$

As N is positive and constant, for simplicity we define the entrepreneur's payoff as

[8] We assume $\alpha > k\mu$ to avoid cases of $P_1 < 0$.

$$U_e = [1-(1-p)w)]P_0 + wp(\alpha - q\mu k).$$

According to Miller (1977), we assume that investors' opinions diverge; hence, the share's demand curve slopes downward to the right, as illustrated in Figure 1.[9] Let the share's demand curve be

$$P + D(P) = a + f(w),$$

where P and $D(P)$ are a share price and the share's inverse demand function, respectively. a represents a degree of the firm's popularity, and we assume $a > 2N$.[10]

Higher ownership retention after the IPO is perceived as good news by investors, as this signals that the entrepreneur may have private information regarding the firm's favorable prospects, and shifts the demand curve upward, as displayed in Figure 1. Specifically,

$$f(0) = 0, \quad f(w)_{w \neq 0} > 0, \quad f'(w) > 0.$$

We assume that the marginal effect of retention w is decreasing, or $f''(w) < 0$.

Insert Figure 1 about here.

Generally, an underwriter's payoff increases in the product of an offering price and how many shares (Q) are sold in the market. Hence, for simplicity we define the underwriter's payoff as $P_0 Q$. It is clear that a higher offering price increases the underwriter's payoff as long as the shares' demand exceeds the supply. However, an excessively high offering price results in excess supply, and decreases the underwriter's payoff.

We assume that the underwriter decides the offering price by considering two factors. The first is the earnings in period 0. As an underwriter cannot observe true earnings, but rather, the reported earnings that might be managed by the entrepreneur, the underwriter can only provide an estimate, in other words, to estimate earnings management. The larger estimated earnings management leads the underwriter to quote a lower offering price. The second involves the owner's retention. As the underwriter knows that investors perceive higher ownership retention as good news, this leads him to quote a higher offering price.

Hence, we assume that the underwriter decides an offering price P_0 according to

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9 Traditional theories, such as Sharpe (1964) and Lintner (1965), assume no divergence in investor's opinions, and hence, the demand curve is flat.

10 This is a typical assumption regarding demand curves.

$$P_0 = x + g(w) + e - \hat{\mu} = [x + \theta] + [g(w) + \mu - \hat{\mu}] = FV + OP,$$

where x (> 0), θ (> 0), and $\hat{\mu}$ (≥ 0) are the firm's value at the beginning of period 0, the true earnings in period 0, and the earnings management estimated by the underwriter, respectively, and where $g(0) = 0$, $g(w)_{w \neq 0} > 0$, and $g'(w) > 0$. We further assume that $g'(w)$ is less than N,[11] and the marginal effect of the retention on $g(w)$ is decreasing, or $g''(w) < 0$. Hence, $x + \theta$ and $g(w) + \mu - \hat{\mu}$ are interpreted as the fundamental value FV and the overpricing OP, respectively.

Hence, the underwriter's problem involves maximizing U_u.

$$U_u = P_0 Q = \begin{cases} P_0(N+S) & \text{if } N + S \leq D(P_0) \\ P_0 D(P_0) & \text{otherwise} \end{cases}$$

$$= \begin{cases} P_0(N+S) & \text{if } P_0 \leq a + f(w) - (N+S) \\ P_0(a + f(w) - P_0) & \text{otherwise} \end{cases}$$

$$= \begin{cases} -(N+S)[\hat{\mu} - (x + g(w) + e)] \\ \quad \text{if } \hat{\mu} \geq x + g(w) - f(w) + e - a + N + S \\ -[\hat{\mu} - (x + g(w) + e)][\hat{\mu} - (x + g(w) - f(w) + e - a)] \\ \quad \text{otherwise.} \end{cases}$$

Insert Figure 2 about here.

The intersections of $U_u = P_0(N+S)$ and $U_u = P_0 D(P_0)$ are $\hat{\mu}_1 = x + g(w) - f(w) + e - a + (2 - w)N$ and $\hat{\mu}_2 = x + g(w) + e$, noted in Panel A and B of Figure 2.[12] It is noteworthy that the larger the earnings management, the higher the $\hat{\mu}_1$, and that the higher the retention, the lower the $\hat{\mu}_1$:

$$\frac{\partial \hat{\mu}_1}{\partial \mu} = 1,$$

$$\frac{\partial \hat{\mu}_1}{\partial w} = g'(w) - f'(w) - N < 0 \qquad (f'(w) > 0, 0 < g'(w) < N).$$

We solve the problem in a case without earnings management costs ($k = 0$) for simplicity, as the implications are qualitatively the same as in a case with earnings management costs ($k >$

[11] This assumption only implies that the curve $g(w)$ is not steep in $0 \leq w \leq 1$.

[12] We assume in Panel A and B of Figure 2 that the axis of symmetry for U_u is greater than $\hat{\mu}_1$. We demonstrate why this assumption is appropriate in Appendix A.

0). And then we examine the theoretical predictions by experiment. In Section 5, we solve the problem in a case with earnings management costs as an extension.

Solutions without Earnings Management Costs

We solve the problem by considering two benchmark cases (involving "very popular" and "unpopular" firms) and a primary case (with a "popular" firm).

Benchmark Case (I): A "Very Popular" Firm, with $\boldsymbol{a \geq x + 2\theta + 2N}$

We call a firm with $a \geq x + 2\theta + 2N$ a "very popular" firm, in that even if the entrepreneur sells all owned shares at the IPO($w = 0$), and manages earnings to a maximum degree ($\mu = \theta$),

$$\hat{\mu_1}|_{w=0,\mu=\theta} = x + 2\theta - a + 2N \leq 0.$$

Hence, the underwriter chooses $\hat{\mu}^* = 0$, as indicated in Panel A of Figure 2.

As $P_0 = x + g(w) + \theta + \mu$,

$$U_e = \{1 - (1-p)w\}(x + g(w) + \theta + \mu) + wp\alpha.$$

As $\partial U_e / \partial \mu = 1 - (1-p)w > 0$, the entrepreneur chooses $\mu^* = \theta$.

Hence, U_e can be written as

$$U_e = \{1 - (1-p)w\}(x + g(w) + 2\theta) + wp\alpha.$$

$$\frac{dU_e}{dw} = p\alpha - (1-p)\{g(w) + wg'(w) + x + 2\theta\} + g'(w) \equiv \phi_0^H(w).$$

As $g'(w) > 0$, $g''(w) < 0$,

$$\frac{d^2U_e}{dw^2} = \frac{d\phi_0^H(w)}{dw} = -2(1-p)g'(w) + \{1 - (1-p)w\}g''(w) < 0.$$

Hence, $\phi_0^H(w)$ is a strictly decreasing function of w.

$$\frac{\partial \phi_0^H(w)}{\partial p} = \alpha + g(w) + wg'(w) + x + 2\theta > 0.$$

$$\frac{\partial \phi_0^H(w)}{\partial \alpha} = p > 0.$$

These two inequalities demonstrate that the larger the values of p and α, the more upward the curve $\phi_0^H(w)$ shifts. As $\phi_0^H(w)$ is a strictly decreasing function of w, as illustrated in Figure 3, the optimal retentions are as follows:

[A_0] When p and/or α are large enough to hold $\phi_0^H(1) \geq 0$, $w^* = 1$.
[B_0] When p and/or α are such that these hold $\phi_0^H(1) < 0 < \phi_0^H(0)$, $0 < w^* < 1$.
[C_0] When p and/or α are small enough to hold $\phi_0^H(0) \leq 0$, $w^* = 0$.

Insert Figure 3 about here.

Therefore, $\hat{\mu}^* = 0$, $\mu^* = \theta$, and $0 \leq w^*(p, \alpha) \leq 1$, and

$$OP^* = g(w^*) + \theta > 0.$$

The implications of these solutions are threefold. First, and most important, the IPO firm is always overpriced at the IPO. Second, the entrepreneur whose firm is "very popular" to investors manages earnings to a maximum degree because the entrepreneur knows the underwriter chooses to estimate zero earnings management. Third, the entrepreneur nevertheless sells shares when an expected loss from holding those shares is sufficiently larger than an expected return from business activities.[13]

Benchmark Case (II): An "Unpopular" Firm, with $\boldsymbol{a < x + g(1) - f(1) + \theta + N}$

We call a firm with $a < x + g(1) - f(1) + \theta + N$ an "unpopular" firm, in that even if the entrepreneur holds all owned shares at the IPO ($w = 1$), and does not manage earnings at all ($\mu = 0$),

$$\hat{\mu}_1|_{w=1,\mu=0} = x + g(1) - f(1) + \theta - a + N > 0.$$

Hence, the underwriter chooses $\hat{\mu}^* = \hat{\mu}_1$ illustrated in Panel B of Figure 2.

Since $P_0 = x + g(w) + e - \hat{\mu}^* = f(w) + (w - 2)N + a$,

$$U_e = \{1 - (1 - p)w\}\{f(w) + (w - 2)N + a\} + wp\alpha. \tag{1}$$

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[13] The expected return from business activities is $p\alpha$. As the offering price when $w = 0$ is $P_0 = x + 2\theta$, the expected loss from holding those shares is $(1 - p)(x + 2\theta)$. In the extreme case that an expected loss is sufficiently larger than an expected return, say $\phi_0^H(0) = p\alpha - (1 - p)(x + 2\theta) + g'(0) < 0$, the entrepreneur sells all owned shares.

This implies the entrepreneur's payoff is irrelevant of the reported earnings. Hence, the entrepreneur chooses $\mu^* = any(0 \leq \mu^* \leq \theta)$.

$$\frac{dU_e}{dw}$$
$$= -(1-p)\{f(w) + wf'(w) + 2(w-1)N + a\} + f'(w) + N + p\alpha$$
$$\equiv \phi_0^L(w).$$

As $f'(w) > 0$ and $f''(w) < 0$,

$$\frac{d^2U_e}{dw^2} = \frac{d\phi_0^L(w)}{dw} = -2(1-p)\{f'(w) + N\} + \{1-(1-p)w\}f''(w)$$
$$< 0.$$

Hence, $\phi_0^L(w)$ is a strictly decreasing function of w.

$$\frac{\partial\phi_0^L(w)}{\partial p} = f(w) + wf'(w) + 2(w-1)N + a + \alpha > 0 \qquad (a > 2N).$$
$$\frac{\partial\phi_0^L(w)}{\partial\alpha} = p > 0.$$

From these two inequalities above, the larger the values of p and α, the more upward the curve $\phi_0^L(w)$ shifts. As $\phi_0^L(w)$ is a strictly decreasing function of w, as illustrated in Figure 4, the optimal retentions are as follows:

[a_0] When p and/or α are large enough to hold $\phi_0^L(1) \geq 0$, $w^* = 1$.
[b_0] When p and/or α are such that these hold $\phi_0^L(1) < 0 < \phi_0^L(0)$, $0 < w^* < 1$.
[c_0] When p and/or α are small enough to hold $\phi_0^L(0) \leq 0$, $w^* = 0$.

Insert Figure 4 about here.

Therefore, $\hat{\mu}^* = \hat{\mu}_1 > 0$, $\mu^* = any(0 \leq \mu^* \leq \theta)$, and $0 \leq w^*(p,\alpha) \leq 1$, and

$$OP^* = g(w^*) + \mu^* - \hat{\mu}_1 = (a-2N) + f(w^*) + w^*N - x - \theta \gtreqless 0.$$

The implications of these solutions are threefold. First, we cannot decide whether the IPO firm is overpriced or underpriced. Second, the entrepreneur whose firm is "unpopular" to investors does not have an incentive to manage earnings, because the underwriter only focuses on components of the demand function (w, a, N) and ignores reported earnings (e)

when deciding the offering price. Third, the entrepreneur nevertheless holds shares when an expected return from business activities is sufficiently larger than an expected loss from holding those shares.[14]

Primary Case: A "Popular" Firm, with $\boldsymbol{x + g(1) - f(1) + \theta + N \leq a < x + 2\theta + 2N}$

We call a firm that is neither very popular nor unpopular a "popular firm." The sign of $\hat{\mu}_1 = x + g(w) - f(w) + e - a + (2 - w)N$ can be either positive or negative, depending on μ and w.

It is implausible that a "very popular firm" exists, such that even if the entrepreneur sells all owned shares and manages earnings to a maximum degree, the underwriter chooses to estimate no earnings management. On the other hand, it is unlikely that an "unpopular firm" will go public, such that even if the entrepreneur holds all owned shares and does not manage earnings at all, the underwriter suspects that the entrepreneur managed earnings to some degree. Hence, firms that actually go public are considered as "popular firms."

We examine whether the entrepreneur can increase the payoff through changing the equilibriums by increasing ownership retention. Suppose that for $w = w_1$, the underwriter chooses $\hat{\mu}^* = \hat{\mu}_1 > 0$ (hereafter "unpopular equilibrium"), and that for $w = w_2 \equiv \mathrm{w}_1 + \Delta w$ ($\Delta w > 0$), the underwriter chooses $\hat{\mu}^* = 0$ (hereafter "very popular equilibrium"). In the unpopular equilibrium,

$$U_e^1 = \{1 - (1 - p)w_1\}\{f(w_1) + (w_1 - 2)N + a\} + w_1 p\alpha,$$

and in the very popular equilibrium,

$$U_e^2 = \{1 - (1 - p)w_2\}\{x + g(w_2) + 2\theta\} + w_2 p\alpha.$$

Necessary and sufficient conditions that the entrepreneur can increase the payoff by increasing ownership retention are that: in the very popular equilibrium the entrepreneur does not sell all the shares,[15] in the unpopular equilibrium the entrepreneur does not hold all the

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[14] The expected return from business activities is $p\alpha$. As the offering price when $w = 0$ is $P_0 = a - 2N$, the expected loss from holding those shares is $(1 - p)(a - 2N)$. When the expected return is sufficiently larger than the expected loss, say $\phi_0^L(0) = -(1 - p)(a - 2N) + f'(0) + N + p\alpha > 0$, the entrepreneur holds some or all of the shares.

[15] This is equivalent to $[\mathrm{A}_0]$ or $[\mathrm{B}_0]$ in Benchmark Case(I).

shares,[16] and the entrepreneur's payoff increases from the change in the equilibriums. Specifically,

$$\phi_0^H(0) \equiv p\alpha - (1-p)(x+2\theta) + g'(0) > 0.$$

$$\phi_0^L(1) \equiv p\alpha + f'(1) + N - (1-p)\{f(1) + f'(1) + a\} < 0.$$

$$\begin{aligned} &U_e^2 \equiv \{1-(1-p)w_2\}\{x + g(w_2) + 2\theta\} + w_2 p\alpha \\ &> \{1-(1-p)w_1\}\{f(w_1) + (w_1 - 2)N + a\} + w_1 p\alpha \equiv U_e^1. \end{aligned}$$

Insert Figure 5 about here.

The shadowed area in Figure 5 satisfies all the above conditions, and for any points (p, α) in the shadowed area, w_1 and Δw ($\Delta w > 0$) exist, which satisfy $0 \leq w_1 < w_2 = w_1 + \Delta w \leq 1$. The proof is provided in Appendix B.

Altogether, with the exception that p and/or α are too small or too large, the entrepreneur can increase the payoff through changing the underwriter's estimation by increasing the owner's retention. Ultimately, the very popular equilibrium is realized, and at that point, the IPO firm is overpriced. Hence, we have a proposition:

Proposition

Neither in a situation that p and/or α are small enough for the entrepreneur in the very popular equilibrium to sell all the shares nor in a situation that p and/or α are large enough for the entrepreneur in the unpopular equilibrium to hold all the shares,

1. the entrepreneur increases ownership retention and manages earnings to the maximum degree,
2. the underwriter chooses to estimate no earnings management, and
3. the IPO firm is overpriced.

As the entrepreneur knows that in a higher retention case it is optimal for the underwriter to decide the offering price by assuming the entrepreneur does not manage earnings at all, the entrepreneur chooses higher retention and a maximum level of earnings management. On the

[16] This is equivalent to [b_0] or [c_0] in Benchmark Case(II).

other hand, as the underwriter knows that higher retention is perceived as good news by investors, the underwriter chooses to estimate no earnings management irrelevant of whether the underwriter believes that the entrepreneur did not manage earnings, as far as the demand of the share exceeds the supply.

Firms that go public in a real world can be considered neither a very popular nor unpopular firm. Hence, this proposition can explain the strategic interaction between the entrepreneur and the underwriter. We examine this proposition through experiment in the following section.

III. EXPERIMENTAL DESIGN

Experimental Parameters and Variables

We conduct an experiment to test the theoretical predictions based on the previous section's model. As the implications of the earnings management cost case are qualitatively same as those without these costs, for simplicity we experiment without them. Experimental parameters are deliberately specified so we can examine the interaction between the entrepreneur of a "popular firm" and the underwriter. In the experiment, participants take the role of either the entrepreneur or the underwriter. The entrepreneur is assumed to own 100 shares of his or her firm, that is, $N = 100$, and at the IPO issues an additional 100 shares and sells S owned shares.

The experiment's sequence of events is as follows: First, nature selects the true earnings, θ, from the set {80, 100, 120} and the entrepreneur observes the realized earnings. Second, the entrepreneur chooses both the level of earnings management μ and the number of shares S, which are sold at the IPO. Regarding earnings management, the entrepreneur chooses reported earnings e among (i) true earnings (i.e., $e = \theta$), (ii) 1.5 times the true earnings (i.e., $e = 1.5\theta$), and (iii) double the true earnings (i.e., $e = 2\theta$). This means that (i) when $e = \theta$, the earnings management $\mu = 0$; (ii) when $e = 1.5\theta$, $\mu = 0.5\theta$; and (iii) when $e = 2\theta$, $\mu = \theta$. For example, if true earnings is 100, then the entrepreneur chooses the reported earnings from the set {100, 150, 200}. Furthermore, the number of shares S is chosen from the set {0, 50, 100}.

After the entrepreneur's decision, the underwriter then observes both the reported earnings and the number of shares sold by the entrepreneur, and assesses the reported earnings by choosing the expected level of earnings management from the set {0, 1/4, 1/2, 3/4, 1}. For example, if the reported earnings is $e = 200$ and the underwriter chooses 3/4, then the underwriter's estimation of the earnings management $\hat{\mu}$ is calculated as $(200 \times 3/4) = 150$.

Depending on the entrepreneur's decisions, μ and S, and the underwriter's decision, $\hat{\mu}$, the offering price, the shares' market supply and demand, and the stock's trading volume are determined, as follows:

$$\text{Offering Price } (P_0) = 100 + 10 \times (1 - S) + \theta + \mu - \hat{\mu},$$
$$\text{Demand} = -P_0 + 10 \times (1 - S) + 450,$$
$$\text{Supply} = 100 + 100 \times S,$$
$$\text{Stock Trading Volume} = \min \{\text{Demand}, \text{Supply}\}.$$

Finally, the firm's business activities achieve success with a probability of 75 percent, and the share price will increase to $P_1 = P_0 + 100$, while with a probability of 25 percent, the business activities fail and the share price will decrease to $P_1 = 0$. The entrepreneur and underwriter both know the probability for success. The entrepreneur's payoff is calculated as follows:

$$U_e = P_0 \times S + 0.75 \times (P_0 + 100) \times (1 - S).$$

The underwriter's payoff does not depend on their success in business and is calculated as follows:

$$U_u = P_0 \times \text{Stock Trading Volume}.$$

We provide relevant portions of the experiment's research instrument at the end of the paper. Analyses are conducted on both participants' roles. In accordance with our theoretical model, we compare predicted equilibrium with the participants' actual behavior. We measure four variables for the entrepreneur's role: (a) the amount of the reported earnings by true earnings; (b) the number of shares that an entrepreneur continues to hold at IPO; (c) the expected amount for the underwriter's estimation of earnings management, denoted by $\mathrm{E}_e(\hat{\mu})$; and (d) the future expectation for own success in business. We measure two variables for the underwriter's role: (a) the assessment level of expected earnings management, and (b) the expected true earnings, denoted by $\mathrm{E}_u(\theta)$.

Hypotheses

The Entrepreneur's Behavior

A conflict of interest may exist between the entrepreneur and underwriter in our experimental setting. This is because if the entrepreneur manages earnings upward and the resulting offering price increases, then the underwriter might incur loss from the unsold shares. Hence, the underwriter will be motivated to severely assess reported earnings (i.e., a larger $\hat{\mu}$) so the offering price decreases.

However, the entrepreneur can increase the shares' market demand by increasing the level of ownership retention (i.e., a smaller S). This reduces the underwriter's risk and alters the situation. In other words, if the entrepreneur retains higher ownership, then earnings management might also become beneficial to the underwriter. As stated in the previous section's Proposition 1, we expect that the entrepreneur uses ownership retention to signal commitment, and manages earnings upward. This is because the entrepreneur anticipates that the underwriter's reported earnings assessment becomes more optimistic with high ownership retention.

We introduce three variables regarding the entrepreneurs' behavior to investigate the aforementioned conjecture, derived from the theoretical model: the earnings management, shareholding, and unreliability ratios. The earnings management ratio (μ/θ) is an entrepreneur's amount of earnings management (μ) divided by true earnings (θ). The higher the ratio is, the more upward the entrepreneur manages earnings. The shareholding ratio (w) is the number of shares that an entrepreneur continues to hold at IPO ($100 - S$), divided by the number of shares held before the IPO. The higher this ratio, the higher the entrepreneur's commitment level. The unreliability ratio ($\mathrm{E}_e(\hat{\mu})/\theta$) is the entrepreneur's expected amount of the underwriter's earnings management estimation ($\mathrm{E}_e(\hat{\mu})$) divided by true earnings (θ). This is entrepreneur's expectations for the underwriter's decision. The following hypotheses are tested using these variables:

H1a. Commitment and earnings management: The relationship between the earnings management and shareholding ratios

When earnings management ratio equals 100 percent, entrepreneurs have a higher level of shareholder commitment.

H1b. Optimistic estimation bias: The relationship between the earnings management and unreliability ratios

The earnings management ratio is higher than the unreliability ratio.

The Underwriter's Behavior

When reported earnings are high, as aforementioned, the resulting offering price is likely to be higher, and the underwriter risks incurring loss from unsold shares. However, as stated in Proposition 2, we expect that the underwriter optimistically assesses reported earnings if the entrepreneur's ownership retention is sufficiently high. This is because the risk of incurring loss due to unsold shares diminishes and the underwriter can also benefit from a higher offering price. This suggests that even if the underwriter detects the entrepreneur's earnings management, it might be overlooked because a strict assessment of reported earnings leads to a lower offering price.

We introduce three variables for our analysis of underwriters' behavior: the earnings management estimation ratio, expected true earnings, and the level of earnings management permission. The earnings management estimation ratio ($\hat{\mu}/e$) is defined as the level of earnings estimation, which is defined as the amount of earnings management estimation ($\hat{\mu}$) divided by reported earnings (e). *Expected true earnings* ($\mathrm{E}_u(\theta)$) is defined as the amount of true earnings (θ) that the underwriter estimates. This involves the underwriters' expectations for entrepreneurs' decision making. The level of earnings management permission ($(e-\hat{\mu})/\mathrm{E}_u(\theta)$) is defined as the earnings after the assessment ($e-\hat{\mu}$) divided by expected true earnings ($\mathrm{E}_u(\theta)$), which is the level at which the underwriter would permit entrepreneurs' earnings management. The higher this level, the more the underwriter may permit earnings management. We test the following hypotheses using these variables:

H2a. Commitment and assessment: The relationship between shareholding and earnings management estimation ratios

The higher the shareholding ratio, the lower the earnings management estimation ratio, and especially with high reported earnings.

H2b Rational expectation for true earnings: The relationship between the shareholding ratio and expected true earnings

The expected true earnings are decided independently from the shareholding ratio.

H2c. Commitment and permission: The level of earnings management permission

The higher the shareholding ratio, the higher the level of earnings management permission.

Our hypotheses are based on Propositions 1 and 2 in the theoretical model. Note that if experimental results support the above hypotheses, or Propositions 1 and 2, then Proposition 3 is automatically supported. Specifically, we can argue that the IPO firm is overpriced.

Participants and Procedures

We conducted two sessions with the same parameters to follow the experimental design. Participants were recruited from a business studies program at a large private university, and 25 students participated in the experiment. Participants were randomly assigned the role of either the entrepreneur or the underwriter upon their arrival at the lab. Thirteen assumed the entrepreneur's role, and twelve were the underwriter; the roles remained constant throughout the session. Participants were on average 19.5 years old, and 60 percent were male. Experimental earnings were converted to cash as a reward for the participants. The entrepreneur role earned an average of 18.10 USD; the underwriter role earned an average of 16.70 USD. The experiment sessions lasted for nearly 80 minutes, including instructions.

In the lab, the participants were assigned a computer and given a written instruction. The experimenter then read the instruction aloud, and the participants answered quizzes to check their understanding of the game. The instruction used an economic frame because our experimental setting is somewhat complicated. We believe that the participants can imagine a more concrete situation through the appropriate framing. Additionally, they can use both a payoff calculator and payoff table to calculate their payoff.

We used the strategy method in all sessions, in which participants compose contingent decisions for all possible scenarios.[17] In this method, first, participants formulate contingent choices for every possible decision node; they are then matched; finally, the appropriate choices are conducted for the nodes that are reached, and the other contingent choices are ignored (Casari and Cason 2009, 157). Casari and Cason (2009) argue that this method has several advantages. First, researchers can collect a large volume of data because participants make decisions for all possible situations. Second, compared to the standard game method, the strategy method elicits more careful decisions. Third, providing monetary compensation based on the final matched outcome provides financial incentives for the participants. This ensures a certain level of internal validity. Each participant in the experiment used a

[17] See Brandts and Charness (2011) for a review regarding the strategy method.

computer to access the website designated to the assigned role and responded to all the possible cases involving our experimental parameters, as stated in the previous subsection.

IV. RESULTS

Manipulation Check

We use the variable (d), which is the future expectation for own success in business as a manipulation check for the entrepreneur's role. The average of it was 77 percent. This result was consistent with the experimental assumption, success with a probability of 75 percent. This result indicates that the participants of the entrepreneur's role estimated it with rationality.

As a manipulation check for the entrepreneur's and underwriter's roles, we use a post-experimental Cognitive Reflection Test questionnaire, which was designed to assess a specific cognitive ability (Frederick 2005). This assesses individuals' ability to suppress an intuitive and spontaneous wrong answer in favor of a reflective, deliberate right answer. The average points for the entrepreneur's role was 1.31, and the underwriter's role was 1.42, which were higher than that of the average United States undergraduate (1.24) (see Frederick 2005, Table 1). We find evidence that our experimental manipulations and controls were effective for the experiment.

Testing Hypothesis 1: The Entrepreneur's Behavior

First, we analyze Hypothesis 1. Table 1 provides descriptive statistics of the results of the entrepreneur's behavior.

Insert table 1 about here.

Table 1 illustrates that the average earnings management and shareholding ratios tended to exceed 50 percent. This result implies that the entrepreneur managed earnings upward, with a high shareholding commitment level. Table 1 also reports, conversely, that the earnings management ratio was higher than the unreliability ratio, with a statistically significant difference at the 5 percent level (the exact binomial test, p value = 0.050). The result supports Hypothesis H1b, which implies that the entrepreneur thought that the underwriter would consider an optimistic estimation of earnings management and permit the entrepreneur's earnings management as long as the latter assumed a high shareholding commitment level.

Figure 6 reports a scatterplot of the relationship between the earnings management and shareholding ratios. Table 2 focuses on the column on the right, in which the earnings management ratio is 100 percent, from Figure 6, which is the observation number for the participant who takes 100 percent of earnings management at each shareholding ratio.

Insert figure 6 and table 2 about here.

Figure 6 demonstrates that the participant who assumes a high rate of earnings management tends to have a higher shareholding commitment level. The rate when the earnings management and shareholding ratios are 100 percent was 30.8 percent. Table 2 illustrates that the participant who assumes 100 percent of the earnings management ratio tends to have a higher shareholding commitment level. A statistically significant difference exists among them at the 1 percent level (the chi-squared test $\chi^2(2) = 7.28$, with p value = 0.002). The result supports Hypothesis H1a.

Our experiment's results, in conclusion, support Hypotheses H1a and H1b. As our model anticipated, the entrepreneur managed earnings upward with a high shareholding commitment level, as the entrepreneur anticipated that the underwriter would permit the entrepreneur's earnings management.

Testing Hypothesis 2: The Underwriter's Behavior

Second, we analyze Hypothesis 2. Table 3 provides descriptive statistics for the results of the underwriter's behavior.

Insert table 3 about here.

Table 3 reports that the earnings management estimation ratio was especially low when the shareholding ratio was high (100 percent). This result implies that underwriters permit the entrepreneurs' earnings management when they assume a higher shareholding commitment level. Table 3 also indicates that the underwriters tended to estimate true earnings adequately, regardless of entrepreneurs' shareholding commitment level. There was no statistically significant difference in the estimated true earnings by the shareholding ratios (the Kruskal-Wallis test, with p value = 0.50). The result supports Hypothesis H2b.

Table 4 provides the number of participants who assume a zero estimation of earnings management at the higher and lower levels of both reported earnings and the shareholding ratio. Figure 7 notes the ratio of participants who assume a zero estimation of earnings management especially when reported earnings are at a maximum level of 240.[18]

Insert table 4 and figure 7 about here.

Table 4 notes that when reported earnings are at a higher level,[19] a bias exists for the number of zero estimation among the shareholding ratio: the higher the shareholding ratio becomes, the higher the number of zero estimation. A statistically significant difference exists among them at a 5 percent level (using the 3-sample test for equality of proportions: $\chi^2(2) = 7.07$, p value = 0.029). The result supports Hypothesis H2a. Figure 7 states a more robust result when the reported earnings are at a maximum level of 240, or the true earnings is equal to 120 and the earnings management ratio is 100 percent. A statistically significant difference exists at the 1 percent level ($\chi^2(2) = 11.25$, p value = 0.003). This result also supports Hypothesis H2a. The underwriters in our model, and especially when reported earnings are higher (e.g., 240), choose an estimation level depending on the shareholding ratio: the higher the shareholding ratio, the more optimistic the assessment.

Figure 8 provides the average level of earnings management permission.

Insert figure 8 about here.

Figure 8 indicates that the higher shareholding ratio, the higher the level; a statistically significant difference exists among the three groups at the 10 percent level (the Kruskal-Wallis test; $\chi^2(2, N = 288) = 4.744$, p value = 0.093).[20] This implies that the underwriter is permissive to earnings management, and especially when the shareholding ratio is 100 percent. The result supports Hypothesis H2c. The underwriters in our model tend to optimistically estimate earnings management, and especially when the shareholding ratio is higher.

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18 We extract the subsample, in which the reported earnings are 240.

19 Specifically, the higher level indicates the case in which the reported earnings are 160, 180, 200, and 240.

20 A post-hoc test using Mann-Whitney tests with Holm's correction displayed a significant difference between the group with 50 percent of the shareholding ratio and that with 100 percent of the shareholding ratio at a 10 percent level ($p = 0.082$), and between the group with 0 percent of the shareholding ratio and that with 100 percent of the shareholding ratio at a 5 percent level ($p = 0.044$).

Our experiment's results, in conclusion, support Hypotheses H2a, H2b, and H2c. As expected by our model, the underwriter tends to provide an optimistic assessment, and especially when the shareholding ratio was higher, although the underwriter was aware of the entrepreneur's earnings management. The underwriter permits the entrepreneur's earnings management because the former supposedly believes that the underwriter's own optimistic assessment would increase stock value, and the underwriter could obtain a high profit. The underwriter is quite rational. Our theoretical and experimental findings suggest that the entrepreneur uses ownership retention to signal commitment and manages earnings upward, and that the underwriter optimistically assesses reported earnings. Ownership retention signals commitment, so that the entrepreneur's and underwriter's interests are aligned. Therefore, the offering price is distorted through strategic interaction between the entrepreneur and the underwriter.

V. EXTENSION: SOLUTIONS WITH EARNINGS MANAGEMENT COSTS

We demonstrate the solutions with earnings management costs as an extension of those without them. We solve the problem by considering two benchmark cases (with "very popular" and "unpopular" firms) and a primary case (with a "popular" firm).

Benchmark Case (I): A "Very Popular" Firm, with $\boldsymbol{\alpha \geq x + 2\theta + 2N}$

The underwriter chooses $\hat{\mu}^* = 0$ as in the case without earnings management costs, as noted in Panel A of Figure 2. However, in this case there are earnings management costs $k\mu$ in the entrepreneur's payoff.

$$\begin{aligned} U_e &= \{1-(1-p)w\}P_0 + wp(\alpha - qk\mu) \\ &= [1-\{1-(1-qk)p\}w]\mu + \{1-(1-p)w\}\{x+g(w)+\theta\} + wp\alpha. \end{aligned}$$

$$\frac{\partial U_e}{\partial \mu} = 1 - \{1-(1-qk)p\}w.$$

The entrepreneur's solutions are:

$$(\mu^*, w^*) = \begin{cases} (\theta,1) \quad (\theta, 0<w^*<1) \quad (\theta,0) & \text{when } \partial U_e/\partial\mu > 0 \\ (any,1) \quad (any, 0<w^*<1) & \text{when } \partial U_e/\partial\mu = 0. \\ (0,1) \quad (0,0<w^*<1) & \text{when } \partial U_e/\partial\mu < 0 \end{cases}$$

The proof is provided in Appendix C. Hence,

$$OP^* = g(w^*) + \mu^* > 0.$$

The solutions' implications are threefold. First, and most important, the IPO firm is always overpriced at the IPO. Second, the entrepreneur does not always manage earnings to a maximum degree due to earnings management costs. Third, when the entrepreneur sells all owned shares, the entrepreneur manages earnings to a maximum degree.

Benchmark Case (II): An "Unpopular" Firm, with $\boldsymbol{a < x + g(1) - f(1) + \theta + N}$

The underwriter chooses $\hat{\mu}^* = \hat{\mu}_1 > 0$ as in the case without earnings management costs, illustrated in Panel B of Figure 2. The entrepreneur's payoff is

$$U_e = \{1 - (1-p)w\}\{f(w) + (w-2)N + a\} + wp(\alpha - qk\mu).$$

As $\partial U_e / \partial \mu = -wpqk < 0$, the entrepreneur chooses $\mu^* = 0$. Hence, U_e can be written as

$$U_e = \{1 - (1-p)w\}\{f(w) + (w-2)N + a\} + wp\alpha.$$

As this is the same as Equation (1) in the case without earnings management costs, the optimal retention can be obtained in the same way. Therefore,

$$OP^* = g(w^*) - \hat{\mu}_1 = (a - 2N) + f(w^*) + w^*N - x - \theta \gtreqless 0.$$

The solution's implications are also qualitatively the same as in the case without earnings management costs.[21]

Primary Case: A "Popular" Firm, with $\boldsymbol{x + g(1) - f(1) + \theta + N \le a < x + 2\theta + 2N}$

The entrepreneur's payoff is

$$U_e = \{1 - (1-p)w\}P_0 + wp(\alpha - qk\mu).$$

We examine whether the entrepreneur can increase the payoff through changing equilibriums by increasing ownership retention. Note that in the "very popular" equilibrium,

[21] The only difference from the case without earnings management costs is that the entrepreneur chooses $\mu^* = 0$. However, this does not change the implications that the entrepreneur does not have an incentive to manage earnings because the underwriter does not use them when deciding the offering price.

$$(\mu^*, w^*) = \begin{cases} (\theta,1) & (\theta,0<w^*<1) & (\theta,0) & \text{when } \partial U_e/\partial\mu > 0 \\ (any,1) & (any,0<w^*<1) & & \text{when } \partial U_e/\partial\mu = 0. \\ (0,1) & (0,0<w^*<1) & & \text{when } \partial U_e/\partial\mu < 0 \end{cases}$$

Insert Figure 9 about here.

Necessary and sufficient conditions that the entrepreneur can increase the payoff by increasing ownership retention are that: in the very popular equilibrium the entrepreneur does not sell all the shares,[22] in the unpopular equilibrium the entrepreneur does not hold all the shares,[23] and the entrepreneur's payoff increases from the change in the equilibriums.

When the expected cost qk is so small that $\mu^* = \theta$ in the very popular equilibrium, and that $\phi_0^L(1) = 0$ is located above $\phi^{H,max}(0) = 0$, the shadowed area in Panel A and B of Figure 9 satisfies all the above conditions, and for any points (p, α) in the shadowed area, w_1 and Δw ($\Delta w > 0$) exist, which satisfy $0 \le w_1 < w_2 = w_1 + \Delta w \le 1$. The proof is provided in Appendix F.

When the expected cost qk is so large that $\mu^* = any(0 \le \mu^* \le \theta)$ or 0 in the very popular equilibrium, the shadowed area in Panel C of Figure 9 satisfies all the above conditions, and for any points (p, α) in the area, w_1 and Δw ($\Delta w > 0$) exist, which satisfy $0 \le w_1 < w_2 = w_1 + \Delta w \le 1$. The proof is provided in Appendix G.

Together, except if p and/or α are too small or too large, the entrepreneur can increase the payoff through changing the underwriter's behavior, by increasing the owner's retention. This conclusion is qualitatively the same as that from Section 2. Hence, the implications in the case without earnings management costs can be extended to the case that includes them.

VI. CONCLUSION

Underpricing and long-run underperformance have existed as unsolved puzzles in IPO research. We develop a theoretical model on the assumption that investors' opinions diverge, and hence, the share's demand curve slopes downward to the right. We predict that the entrepreneur increases ownership retention and manages earnings to a maximum degree, and the firm is overpriced to the fundamental value. The last prediction is a sharp contrast to a

22 This is equivalent to $[A_0]$ or $[B_0]$ in Case(I).
23 This is equivalent to $[b_0]$ or $[c_0]$ in Case(II).

vast body of prior research that argues the IPO firm is underpriced, and can explain long-run underperformance. Through an experiment, we obtain results that support our predictions.

Our theoretical and experimental findings suggest that the entrepreneur uses ownership retention to signal commitment and manage earnings upward, and that the underwriter overlooks distorted earnings.

To the best of our knowledge, this is the first paper that explains the IPO puzzles using both theory and experiment. Therefore, our research could provide a cornerstone to answer "Why do the IPO puzzles coexist?"

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Appendix A

The axis of symmetry for $U_s = -[\hat{\mu} - (x + g(w) + e)][\hat{\mu} - (x + g(w) - f(w) + e - a)]$ is:

$$\hat{\mu}_a = x + g(w) + e - \frac{1}{2}[f(w) + a].$$

As $\hat{\mu}_1 = x + g(w) - f(w) + e - a + (2 - w)N$,

$$\hat{\mu}_a - \hat{\mu}_1 = \frac{1}{2}[f(w) + a - 2(2 - w)N].$$

Consider a case of $\hat{\mu}_a \leq \hat{\mu}_1$ and $w = 1$, or specifically,

$$a \leq 2N - f(1).$$

As $a > 2N$ from the assumption of the demand function, no cases exist of $\hat{\mu}_a \leq \hat{\mu}_1$ and $w = 1$. However, in the real world, IPO firms exist in which entrepreneurs hold all the shares they own ($w = 1$). Hence, it is appropriate to assume $\hat{\mu}_a > \hat{\mu}_1$.

Appendix B

From $\phi_0^H(0) \equiv p\alpha - (1 - p)(x + 2\theta) + g'(0) > 0$,

$$\alpha > \frac{1}{p}\left(x + 2\theta - g'(0)\right) - (x + 2\theta)$$
$$\text{where} \quad x + 2\theta - g'(0) > 0.$$

From $\phi_0^L(1) \equiv p\alpha + f'(1) + N - (1 - p)(f(1) + f'(1) + a) < 0$,

$$\alpha < \frac{1}{p}(f(1) + a - N) - (f(1) + f'(1) + a)$$
$$\text{where} \quad f(1) + a - N > 0, \quad f(1) + f'(1) + a > 0.$$

$\phi_0^H(0) = 0$ represents a set of marginal points (p, α) that compel a very popular firm's entrepreneur to sell all owned shares. $\phi_0^L(1) = 0$ represents a set of marginal points (p, α) that compel the unpopular firm's entrepreneur to hold all owned shares. As for a certain p $(0 < p < 1)$, the α that satisfies $\phi_0^L(1) = 0$ is larger than the α that satisfies $\phi_0^H(0) = 0$, the curve $\phi_0^L(1) = 0$ is located above the curve $\phi_0^H(0) = 0$. Hence, the set of (p, α) that satisfies $\phi_0^H(0) > 0$ and $\phi_0^L(1) < 0$ is the shadowed area in Figure 5.

We prove that $(w_1, w_2 = w_1 + \Delta w)$ exists, which satisfies $U_e^2 > U_e^1$ in that area. Let P_0^H and P_0^L be offering prices in the very popular and unpopular equilibrium, respectively. Namely,

$$P_0^H = x + g(w_2) + 2\theta, \quad P_0^L = f(w_1) + (w_1 - 2)N + a \quad (P_0^H > P_0^L).$$

Consider Δw, such that

$$0 < \Delta \mathrm{w} < (1 - \mathrm{w}_1)\left(1 - \frac{P_0^L}{P_0^H}\right). \tag{B1}$$

As

$$(1 - w_1)\left(1 - \frac{P_0^L}{P_0^H}\right) < 1, \qquad 0 < \mathit{\Delta} w < (1 - w_1)\left(1 - \frac{P_0^L}{P_0^H}\right) < 1,$$

Hence,

$$w_1 < w_2 = w_1 + \mathit{\Delta} w < w_1 + (1 - w_1)\left(1 - \frac{P_0^L}{P_0^H}\right).$$

As

$$1 - \left[w_1 + (1 - w_1)\left(1 - \frac{P_0^L}{P_0^H}\right)\right] = (1 - w_1)\frac{P_0^L}{P_0^H} \geq 0,$$

$$0 \leq \mathrm{w}_1 < w_2 = w_1 + \Delta w < w_1 + (1 - w_1)\left(1 - \frac{P_0^L}{P_0^H}\right) \leq 1. \tag{B2}$$

From $U_e^2 > U_e^1$ and $(1-w_1)P_0^L - (1-w_2)P_0^H < 0$,[24]

$$\alpha > \frac{w_1 P_0^L - w_2 P_0^H}{w_2 - w_1} + \frac{1}{p} \cdot \frac{(1-w_1)P_0^L - (1-w_2)P_0^H}{w_2 - w_1}$$
$$\text{where} \quad \frac{w_1 P_0^L - w_2 P_0^H}{w_2 - w_1} < 0, \text{and} \quad \frac{(1-w_1)P_0^L - (1-w_2)P_0^H}{w_2 - w_1} < 0. \tag{B3}$$

From Equations (B2) and (B3), $(w_1, w_2 = w_1 + \Delta w)$ exists, which satisfies $U_e^2 > U_e^1$ in the shadowed area in Figure 5.

Appendix C

We find solutions as follows: First, we find the optimal retention in the case of $\mu^* = \theta, any(0 \leq \mu^* \leq \theta),$ and 0. Next, for each case we examine whether $\partial U_e/\partial \mu > 0$, $\partial U_e/\partial \mu = 0$, and $\partial U_e/\partial \mu < 0$ holds respectively.

(i) when $\boldsymbol{\mu^* = \theta}$, that is $\boldsymbol{\partial U_e/\partial \mu > 0}$

$$U_e = \{1 - (1-p)w\}\{x + g(w) + 2\theta\} + wp(\alpha - qk\theta).$$

$$\begin{aligned}\frac{\partial U_e}{\partial w} &= -(1-p)\{x + g(w) + 2\theta\} + \{1 - (1-p)w\}g'(w) + p(\alpha - qk\theta) \\ &= p(\alpha - qk\theta) - (1-p)\{x + g(w) + wg'(w) + 2\theta\} + g'(w) \\ &\equiv \phi^{H,max}(w)\end{aligned}.$$

As $g'(w) > 0, g''(w) \leq 0$,

$$\begin{aligned}&\frac{d^2 U_e}{dw^2} \\ &= \frac{d\phi^{H,max}(w)}{dw} = -2(1-p)g'(w) + \{1 - (1-p)w\}g''(w) < 0.\end{aligned}$$

Hence, $\phi^{H,max}(w)$ is a strictly decreasing function of w.

$$\begin{aligned}&\frac{\partial \phi^{H,max}(w)}{\partial p} \\ &= \alpha + x + g(w) + wg'(w) + (2 - qk)\theta \\ &\qquad > 0 \quad (0 < q < 1, 0 < k \leq 2),\end{aligned}$$

[24] $(1-w_1)P_0^L - (1-w_2)P_0^H < 0$ can be easily obtained from Equation (B1).

$$\frac{\partial \phi^{H,max}(w)}{\partial \alpha} = p > 0,$$
$$\frac{\partial \phi^{H,max}(w)}{\partial q} = -pk\theta < 0,$$
$$\frac{\partial \phi^{H,max}(w)}{\partial k} = -pq\theta < 0.$$

Hence, the larger p and the larger α shift the curve $\phi^{H,max}(w)$ upward, and the larger q and the larger k shift the curve $\phi^{H,max}(w)$ downward. Note that $\phi^{H,max}(w)$ is a strictly decreasing function of w.

[A^{max}] When p and/or α are large enough, and/or q and/or k are small enough to hold $\phi^{H,max}(1) \geq 0$, $w^* = 1$. Hence, $(p, \alpha, q, k), (0 < p < 1, 0 < q < 1, 0 < k \leq 2)$ exists, which holds $\partial U_e/\partial\mu|_{w^*=1} = (1 - qk)p > 0$.

[B^{max}] When p, α, q, and k are such that hold $\phi^{H,max}(1) < 0 < \phi^{H,max}(0)$, $0 < w^* < 1$. Hence, $(p, \alpha, q, k), (0 < p < 1, 0 < q < 1, 0 < k \leq 2)$ exist, which holds $\partial U_e/\partial\mu|_{0<w^*<1} = 1 - (1 - (1 - qk)p)w^* > 0$. The proof is provided in Appendix D.

[C^{max}] When p and/or α are small enough, and/or q and/or k are large enough to hold $\phi^{H,max}(0) \leq 0$, $w^* = 0$. As $\partial U_e/\partial\mu|_{w^*=0} = 1$, any $(p, \alpha, q, k), (0 < p < 1, 0 < q < 1, 0 < k \leq 2)$ holds $\partial U_e/\partial\mu|_{w^*=0} > 0$.

(ii) when $\boldsymbol{\mu^* = any(0 \leq \mu^* \leq \theta)}$, that is $\boldsymbol{\partial U_e/\partial\mu = 0}$, or $\boldsymbol{\mu^* = 0}$, that is $\boldsymbol{\partial U_e/\partial\mu < 0}$

$$U_e = \{1 - (1 - p)w\}\{x + g(w) + \theta\} + wp\alpha.$$

$$\begin{aligned}\frac{\partial U_e}{\partial w} &= -(1 - p)\{x + g(w) + \theta\} + \{1 - (1 - p)w\}g'(w) + p\alpha \\ &= p\alpha - (1 - p)\{x + g(w) + wg'(w) + \theta\} + g'(w) \\ &\equiv \phi^{H,any,0}(w)\end{aligned}.$$

As $g'(w) > 0, g''(w) < 0$,

$$\frac{d^2U_e}{dw^2} = \frac{d\phi^{H,any,0}(w)}{dw} = -2(1-p)g'(w) + \{1-(1-p)w\}g''(w) < 0.$$

Hence, $\phi^{H,any,0}(w)$ is a strictly decreasing function of w.

$$\frac{\partial\phi^{H,any,0}(w)}{\partial p} = \alpha + x + g(w) + wg'(w) + \theta > 0,$$

$$\frac{\partial\phi^{H,any,0}(w)}{\partial\alpha} = p > 0.$$

Note that $\phi^{H,any,0}(w)$ is a strictly decreasing function of w.

[A^{any,0}] When p and/or α are large enough to hold $\phi^{H,any,0}(1) \geq 0$, $w^* = 1$. Hence, $(p,\alpha,q,k), (0 < p < 1, 0 < q < 1, 0 < k \leq 2)$ exists, which holds $\partial U_e/\partial\mu|_{w^*=1} = (1-qk)p = 0$. $(p,\alpha,q,k), (0 < p < 1, 0 < q < 1, 0 < k \leq 2)$ also exists, which holds $\partial U_e/\partial\mu|_{w^*=1} = (1-qk)p < 0$. The proof is provided in Appendix E.

[B^{any,0}] When p and α are such that hold $\phi^{H,any,0}(1) < 0 < \phi^{H,any,0}(0)$, $0 < w^* < 1$. Hence, $(p,\alpha,q,k), (0 < p < 1, 0 < q < 1, 0 < k \leq 2)$ exists, which holds $\partial U_e/\partial\mu|_{0<w^*<1} = 1-(1-(1-qk)p)w^* = 0$. $(p,\alpha,q,k), (0 < p < 1, 0 < q < 1, 0 < k \leq 2)$ also exists, which holds $\partial U_e/\partial\mu|_{0<w^*<1} = 1-(1-(1-qk)p)w^* < 0$. The proof is provided in Appendix E.

[C^{any,0}] When p and/or α are small enough to hold $\phi^{H,any,0}(0) \leq 0$, $w^* = 0$. As $\partial U_e/\partial\mu|_{w^*=0} = 1$, no (p,α,q,k) exists that holds $\partial U_e/\partial\mu|_{w^*=0} \leq 0$.

From (i) and (ii), the solutions are

$$(\mu^*, w^*) = \begin{cases} (\theta,1) \quad (\theta, 0 < w^* < 1) \quad (\theta,0) & \text{when } \partial U_e/\partial\mu > 0 \\ (any,1) \quad (any, 0 < w^* < 1) & \text{when } \partial U_e/\partial\mu = 0. \\ (0,1) \quad (0,0 < w^* < 1) & \text{when } \partial U_e/\partial\mu < 0 \end{cases}$$

Appendix D

For a certain (p, q, k) where $0 < p < 1$ $0 < qk < 1$, we can select α large enough to satisfy $0 \simeq \phi^{H,max}(1) < 0$. Then,

$$0 < w^* < 1 \qquad (w^* \simeq 1).$$
$$\frac{\partial U_e}{\partial \mu} \simeq (1 - qk)p > 0.$$

Appendix E

[A^{any,0}] For a certain (p, α) that satisfies $\phi^{H,any,0}(1) \geq 0$, $w^* = 1$. For a certain (q, k) that satisfies $qk = 1$, $\partial U_e/\partial \mu|_{w^*=1} = (1 - qk)p = 0$. For a certain (q, k) that satisfies $qk < 1$, $\partial U_e/\partial \mu|_{w^*=1} = (1 - qk)p < 0$.

[B^{any,0}] For a certain p, we can select α large enough to satisfy $0 \simeq \phi^{H,any,0}(1) < 0$.

$$0 < w^* < 1 \qquad (w^* \simeq 1).$$
$$\frac{\partial U_e}{\partial \mu} \simeq (1 - qk)p.$$

In the vicinity of $qk = 1$, (q, k) exists, which satisfies $\partial U_e/\partial \mu|_{0<w^*<1} = 0$. As $0 < qk < 2$, (q, k) that satisfies $qk \simeq 2$ and $qk < 2$, $\partial U_e/\partial \mu|_{0<w^*<1} < 0$.

Appendix F

The offering price in the unpopular equilibrium is

$$x + g(w_1) + \theta - \hat{\mu}_1 \equiv P_0^{L,0}.$$

The offering price in the very popular equilibrium is

$$x + g(w_2) + 2\theta \equiv P_0^H.$$

Hence, $P_0^H > P_0^{L,0}$. From $U_e^2 > U_e^1$ and $(1 - w_1)P_0^{L,0} - (1 - w_2)P_0^H < 0$,[25]

[25] $(1 - w_1)P_0^{L,0} - (1 - w_2)P_0^H < 0$ is obtained in the same way as in the case without earnings management costs.

$$\alpha > \frac{w_1 P_0^{L,0} - w_2 P_0^H + w_2 qk\theta}{w_2 - w_1} + \frac{1}{p} \cdot \frac{(1-w_1)P_0^{L,0} - (1-w_2)P_0^H}{w_2 - w_1}$$
$$\text{where} \quad \frac{(1-w_1)P_0^{L,0} - (1-w_2)P_0^H}{w_2 - w_1} < 0.$$

Appendix G

The offering price in the unpopular equilibrium is

$$x + g(w_1) + \theta - \hat{\mu}_1 \equiv P_0^{L,0}.$$

The offering price in the very popular equilibrium is

$$x + g(w_2) + \theta \equiv P_0^{H,0}.$$

Hence, $P_0^{H,0} > P_0^{L,0}$. From $U_e^2 > U_e^1$ and $(1-w_1)P_0^{L,0} - (1-w_2)P_0^{H,0} < 0$,[26]

$$\alpha > \frac{w_1 P_0^{L,0} - w_2 P_0^{H,0}}{w_2 - w_1} + \frac{1}{p} \cdot \frac{(1-w_1)P_0^{L,0} - (1-w_2)P_0^{H,0}}{w_2 - w_1}$$
$$\text{where} \quad \frac{w_1 P_0^{L,0} - w_2 P_0^{H,0}}{w_2 - w_1} < 0, \text{and} \quad \frac{(1-w_1)P_0^{L,0} - (1-w_2)P_0^{H,0}}{w_2 - w_1} < 0.$$

Instruction: Portions of Research Instrument for the Experiment

1. The role

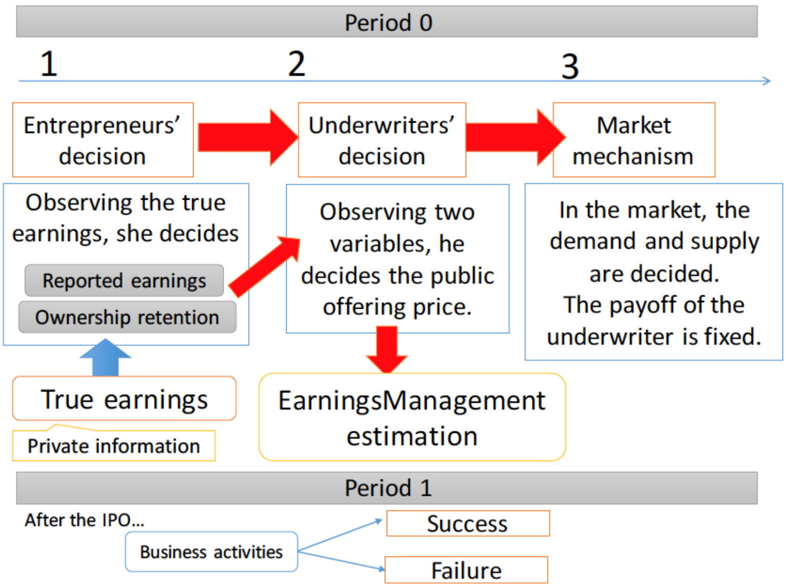
There are two roles in this experiment: entrepreneurs and underwriters. The allocation of participants to these roles is completely random and computerized.

2. Background and timeline

The entrepreneur whose company will go public on a stock exchange considers the value of both the company's reported earnings and the number of shares which the entrepreneur continues to hold at IPO. The managing underwriters will assess the reported earnings. After the IPO, the company continues to conduct business activities. The deterministic future success of the firm is contingent on the state of nature. Figure (a) illustrates this timeline.

Figure (a) The timeline

[26] $(1-w_1)P_0^{L,0} - (1-w_2)P_0^{H,0} < 0$ is obtained in the same way as in the case without the earnings management costs.



3. The entrepreneur's decision making

First, the entrepreneur observes the company's true earnings (80, 100, or 120), and decides the amount of reported earnings (1, 1.5, or 2 times higher than true income). Table (a) displays the relationship between true and reported earnings. The true earnings is private information for the entrepreneur, and the higher the reported earnings, the higher the share price. Second, the entrepreneur also decides the number of shares which will be sold at IPO (0, 50, or 100). The total number of shares, which the entrepreneur holds prior to IPO, is 100. The higher the number of shares sold, the higher the entrepreneur's profit through stock sales, but the lower the profit from future business success. Subsequently, the entrepreneur also decides the expected amounts for the underwriter's earnings management estimation and the future expectation for business success.

		Reported Earnings		
		1 time	**1.5 times**	**2 times**
	80	80	120	160
True	100	100	150	200
Earnings	120	120	180	240

Table (a) The relation between true earnings and reported earnings

4. The underwriter's decision making

First, the underwriter observes reported earnings and the number of shares that the entrepreneur sells, then assesses reported earnings and decides the level of expected earnings management (0, 1/4, 1/2, or 1 time per reported earnings). Figure (b) notes the relationship between the assessment level and earnings after the assessment. The higher the earnings after assessment, the higher the share price. Second, the underwriter decides expected true earnings (80, 100, or 120).

Figure (b) The relationship between the assessment level and earnings after the assessment, per the reported earnings

When the reported earnings = 240

	0	1/4	1/2	3/4	1
Assessment	0	60	120	180	240
Earnings after the assessment	240	180	120	60	0

When the reported earnings = 200

	0	1/4	1/2	3/4	1
Assessment	0	50	100	150	200
Earnings after the assessment	200	150	100	50	0

When the reported earnings = 180

	0	1/4	1/2	3/4	1
Assessment	0	45	90	135	180
Earnings after the assessment	180	135	90	45	0

When the reported earnings = 160

	0	1/4	1/2	3/4	1
Assessment	0	40	80	120	160
Earnings after the assessment	160	120	80	40	0

When the reported earnings = 150

	0	1/4	1/2	3/4	1
Assessment	0	37.5	75	112.5	150
Earnings after the assessment	150	112.5	75	37.5	0

When the reported earnings = 120

	0	1/4	1/2	3/4	1
Assessment	0	30	60	90	120
Earnings after the assessment	120	90	60	30	0

When the reported earnings = 100

	0	1/4	1/2	3/4	1
Assessment	0	25	50	75	100
Earnings after the assessment	100	75	50	25	0

When the reported earnings = 80

	0	1/4	1/2	3/4	1
Assessment	0	20	40	60	80
Earnings after the assessment	80	60	40	20	0

5. The company's stock price

The company's stock price is decided, as follows:

The stock price

$$= 100 + 10\times\left(\frac{100-[\text{The number of shares that the entrepreneur sells}]}{100}\right)$$

$$+ [\textit{earnings after the assessment}].$$

6. Profit

Entrepreneurs' and underwriters' profits are decided as follows:

The entrepreneur's profit

$$= \quad [\text{Stock Price}] \times [\text{The number of shares that the entrepreneur sells}]$$

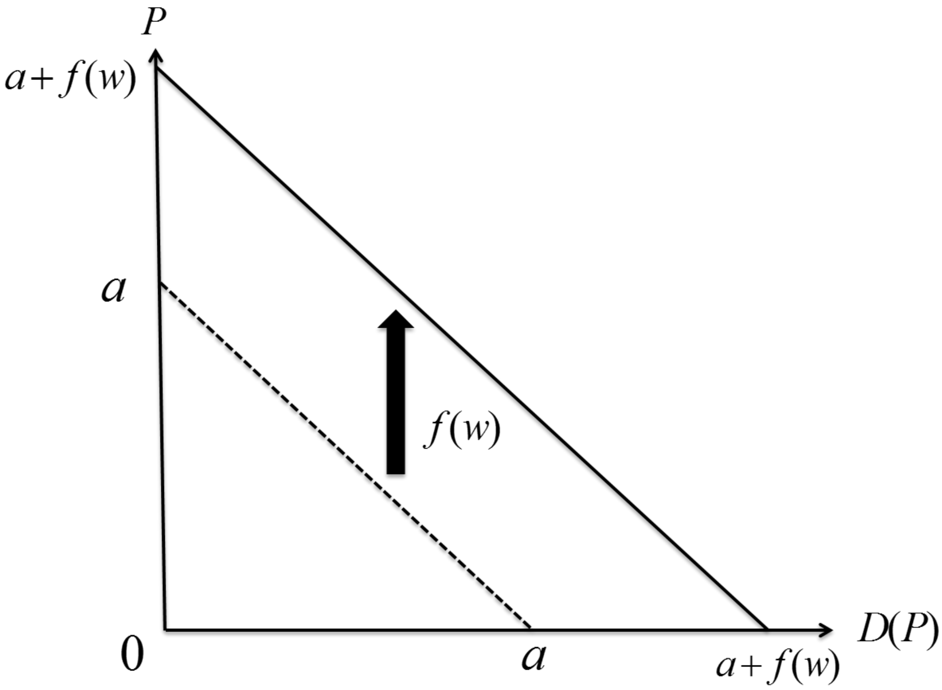
$$+ \begin{cases} ([\text{Stock Price}] + 100) \times \left(\frac{100 - [\text{The number of shares that the entrepreneur sells}]}{100}\right) \times 100 \\ \qquad (\cdots \mathit{If\ Success}) \\ 0 \quad (\cdot \cdot \cdot \mathit{If\ the\ business\ activities\ fail}), \end{cases}$$

The underwriter's profit

$$= \quad [\text{Stock price}] \times [\text{Stock trading volume}].$$

FIGURE 1

Demand Curve

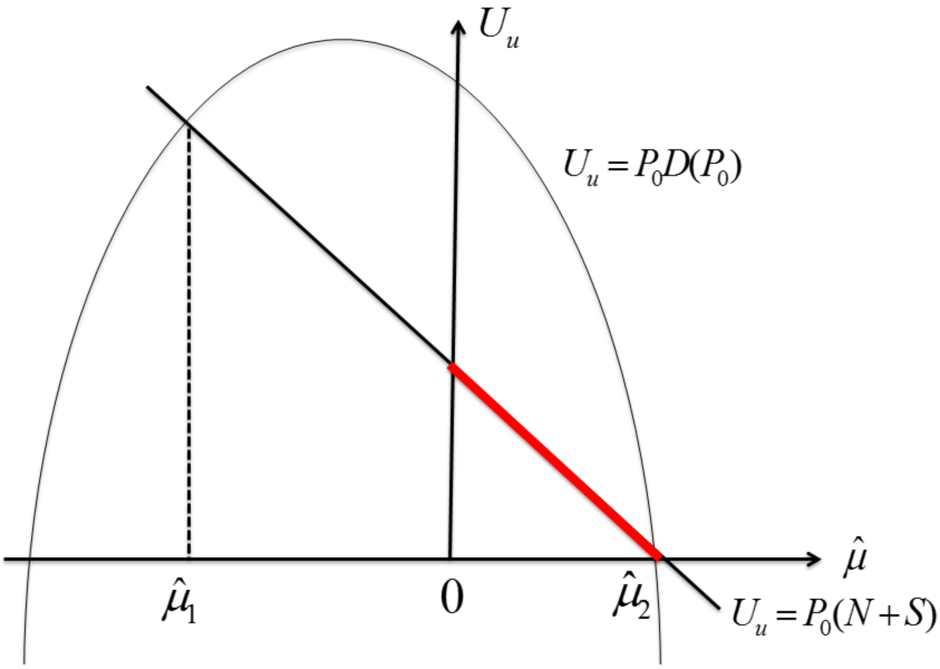


The dotted line and the solid line indicate demand curves where $w = 0$ and $w > 0$, respectively.

FIGURE 2

An Underwriter's Payoff

Panel A: Benchmark Case of a "Very Popular" Firm ($a \geq x + 2\theta + 2N$)

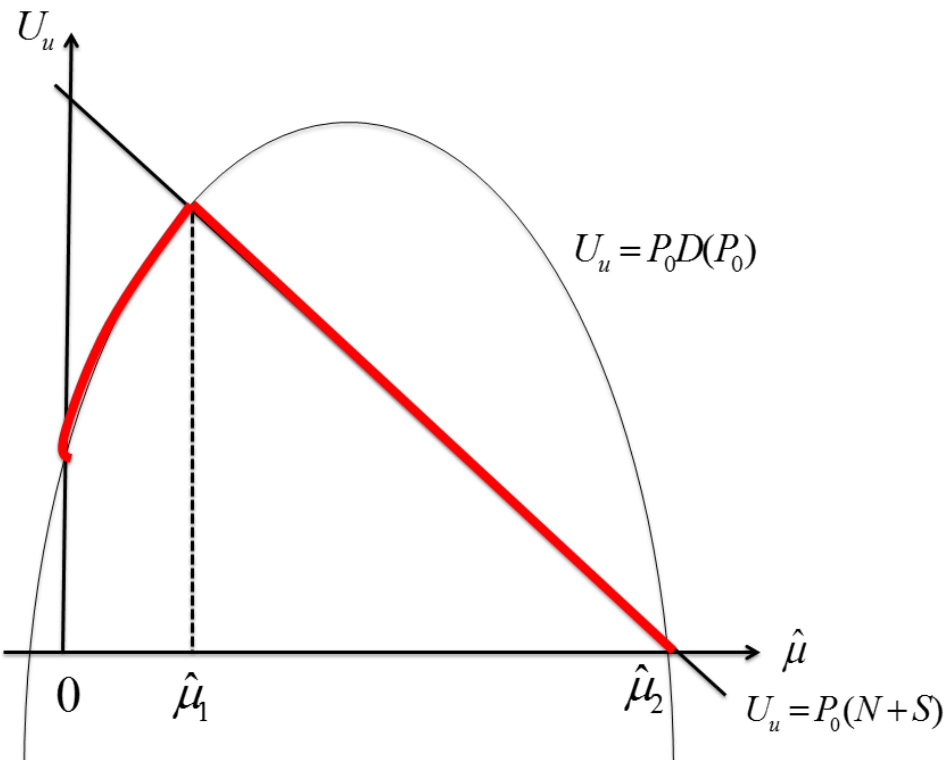


The red line indicates an underwriter's payoff.

FIGURE 2

An Underwriter's Payoff

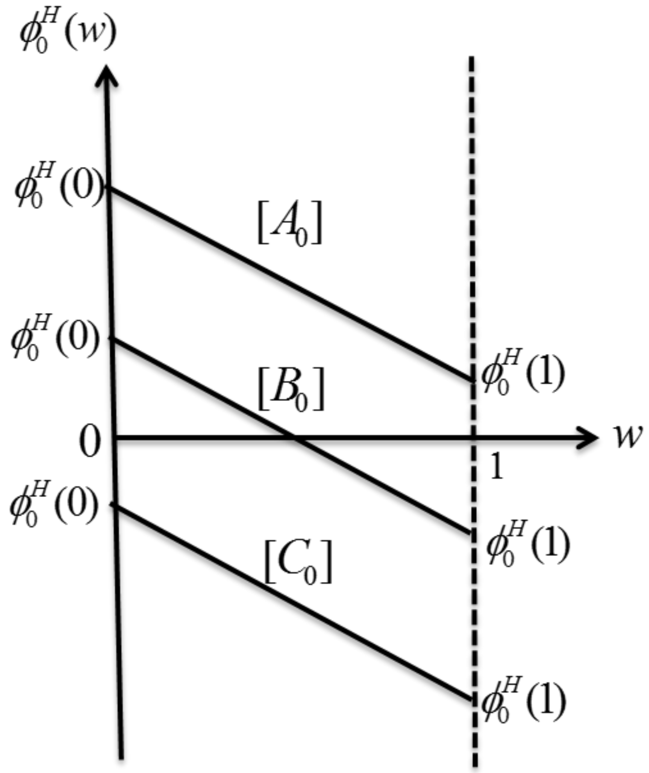
Panel B: Benchmark Case of an "Unpopular" Firm ($\boldsymbol{a < x + g(1) - f(1) + \theta + N}$)



The red curve indicates an underwriter's payoff.

FIGURE 3

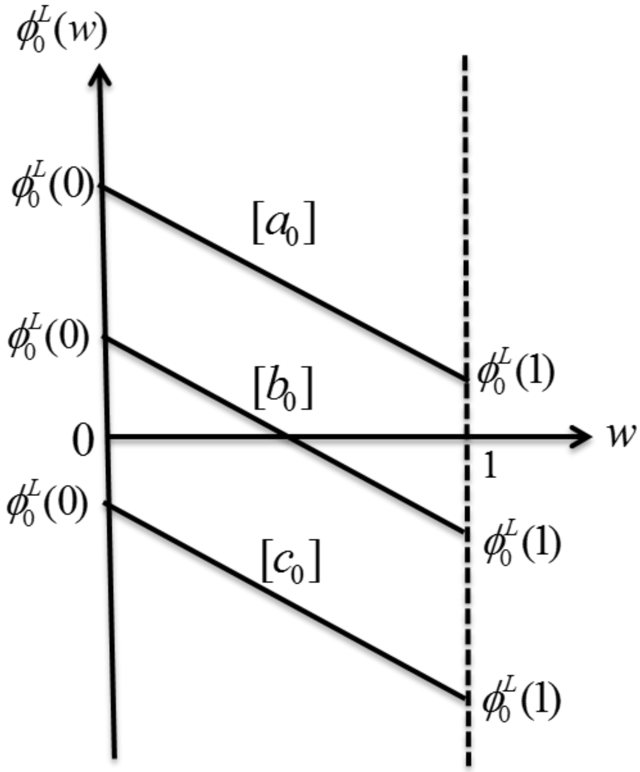
Determination of the Very Popular Firm's Optimal Retention



$\phi_0^H(w)$ is a derivative function of the entrepreneur's payoff where $0 \leq w \leq 1$.

FIGURE 4

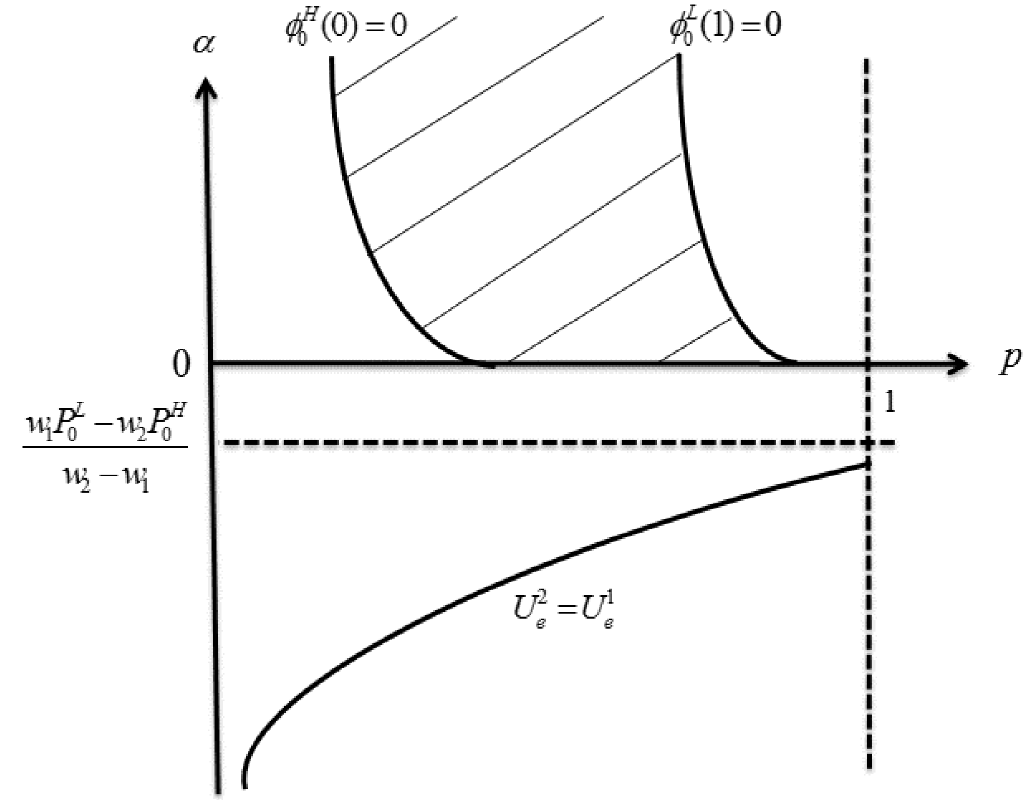
Determination of the Unpopular Firm's Optimal Retention



$\phi_0^L(w)$ is a derivative function of the entrepreneur's payoff where $0 \leq w \leq 1$.

FIGURE 5

The Area in Which the Entrepreneur Can Change Equilibriums without Earnings Management Costs



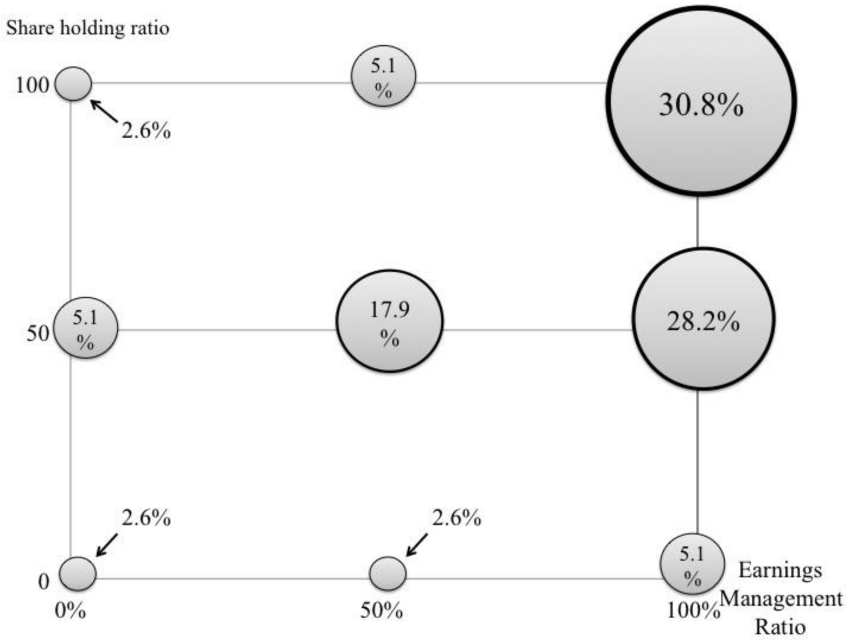
$\phi_0^H(w) \equiv \partial U_e/\partial w$ in the very popular equilibrium without earnings management costs.

$\phi_0^L(w) \equiv \partial U_e/\partial w$ in the unpopular equilibrium without earnings management costs.

For any points (p, α) in the shadowed area, w_1 and Δw $(\Delta w > 0)$ exist, which satisfy $0 \leq w_1 < w_2 = w_1 + \Delta w \leq 1$.

FIGURE 6

Scatterplot of the Relationship Between the Earnings Management and Shareholding Ratios



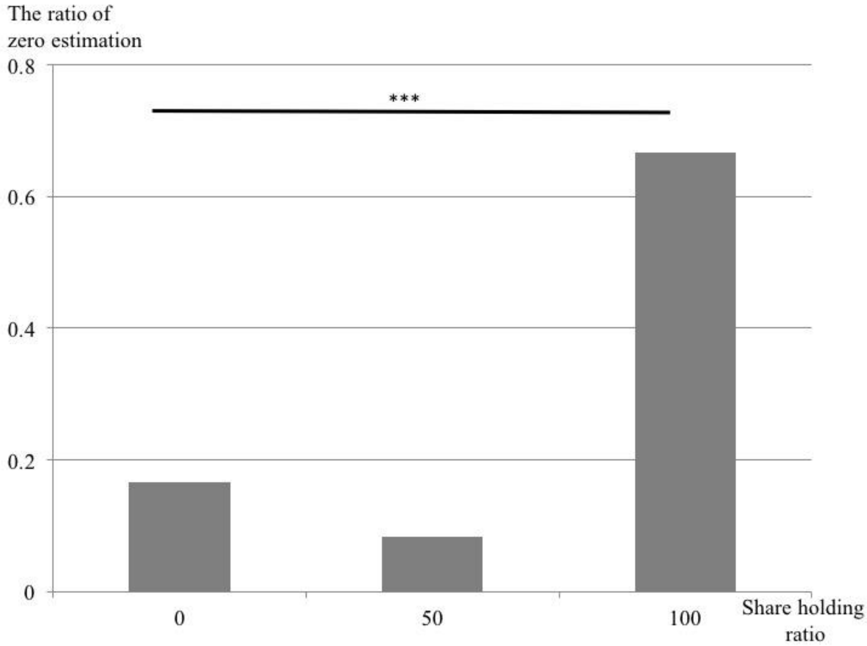
Scatterplot displays values for two variables for a set of data.

"Earnings Management Ratio" is defined as an entrepreneur's amount of earnings management divided by true earnings.

"Shareholding Ratio" is defined as the number of shares that an entrepreneur continues to hold at IPO divided by the number of shares held before the IPO.

FIGURE 7

The Ratio of Participants Who Take a Zero Estimation of Earnings Management at Each Shareholding Ratio (Especially When Reported Earnings is Maximized at 240)



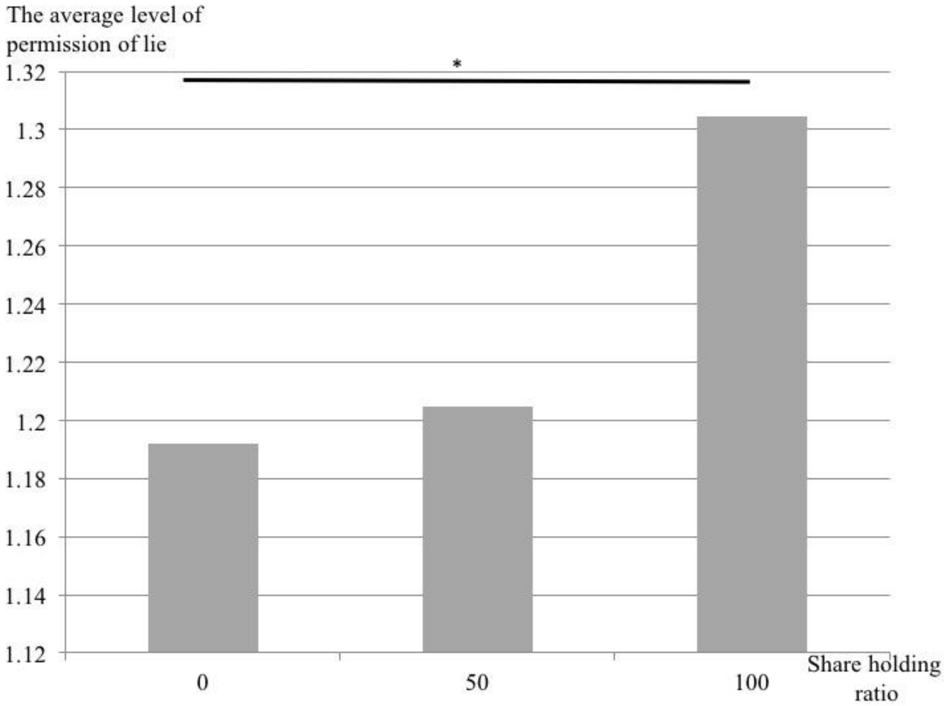
"Zero estimation of earnings management" is defined as the underwriters' estimation when participants of the underwriters' role assess the entrepreneurs' earnings management as zero.

"Shareholding Ratio" is defined as the number of shares that an entrepreneur continues to hold at IPO divided by the number of shares held before the IPO.

*** indicates $p < 0.01$.

FIGURE 8

The Average Level of Earnings Management Permission at Each Shareholding Commitment Level.



"Earnings management permission" is defined as the earnings after the assessment divided by expected true earnings, which is the level that at which the underwriter would permit the entrepreneurs' earnings management.

"Shareholding Ratio" is defined as the number of shares that an entrepreneur continues to hold at IPO divided by the number of shares held before the IPO.

* indicates $p < 0.10$.

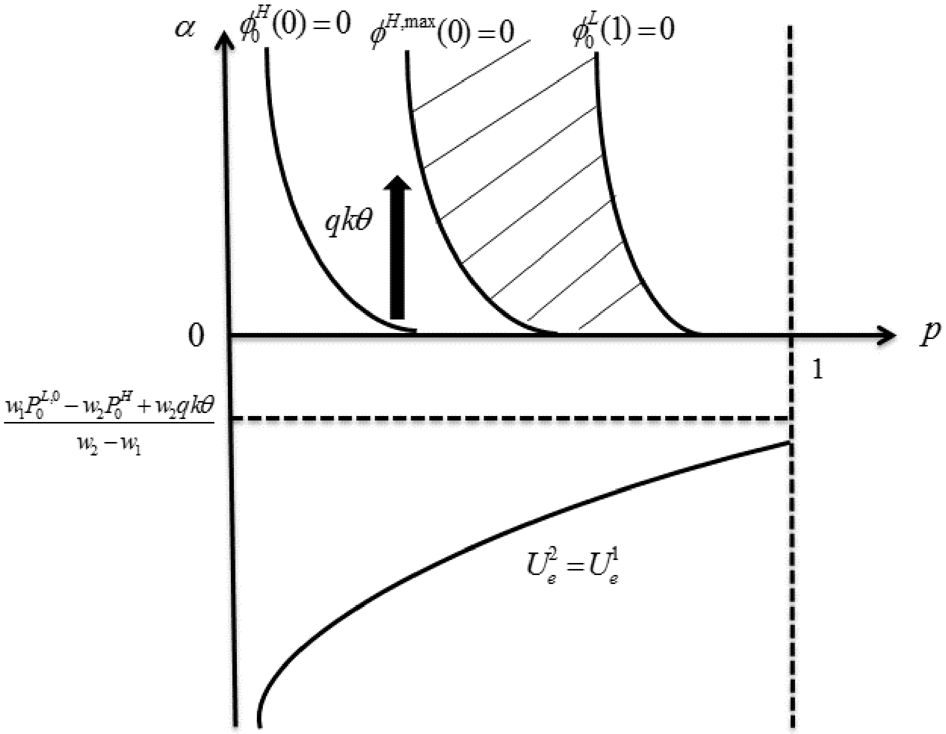
FIGURE 9

The Area in Which the Entrepreneur Can Change Equilibriums

with Earnings Management Costs

Panel A: $\boldsymbol{\mu^* = \theta}$ in the Very Popular Equilibrium

(in the Case of $\boldsymbol{w_1 P_0^{L,0} - w_2 P_0^H + w_2 qk\theta \le 0}$)



$\phi_0^H(w) \equiv \partial U_e / \partial w$ in the very popular equilibrium without earnings management costs.

$\phi_0^L(w) \equiv \partial U_e / \partial w$ in the unpopular equilibrium without earnings management costs.

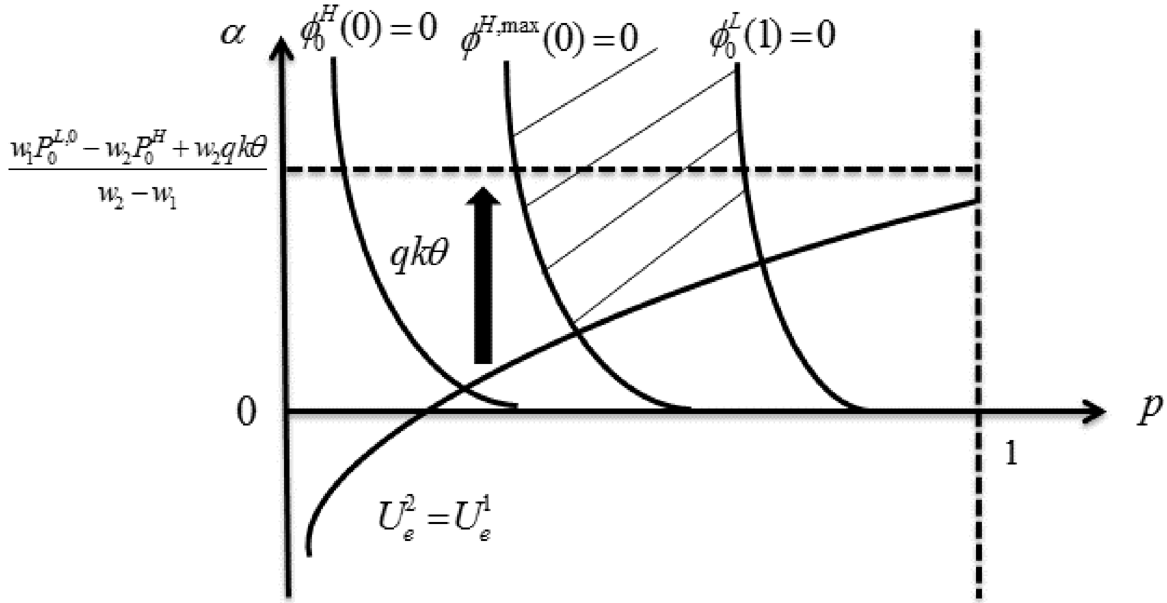
$\phi^{H,max}(w) \equiv \partial U_e / \partial w$ when $\mu^* = \theta$ in the very popular equilibrium with earnings management costs, as shown in Appendix C. For any points (p, α) in the shadowed area, w_1 and Δw $(\Delta w > 0)$ exist, which satisfy $0 \le w_1 < w_2 = w_1 + \Delta w \le 1$.

FIGURE 9

The Area in Which the Entrepreneur Can Change Equilibriums with Earnings Management Costs

Panel B: $\mu^* = \theta$ in the Very Popular Equilibrium

(in the Case of $w_1 P_0^{L,0} - w_2 P_0^{H} + w_2 qk\theta > 0$)



$\phi_0^H(w) \equiv \partial U_e/\partial w$ in the very popular equilibrium without earnings management costs.

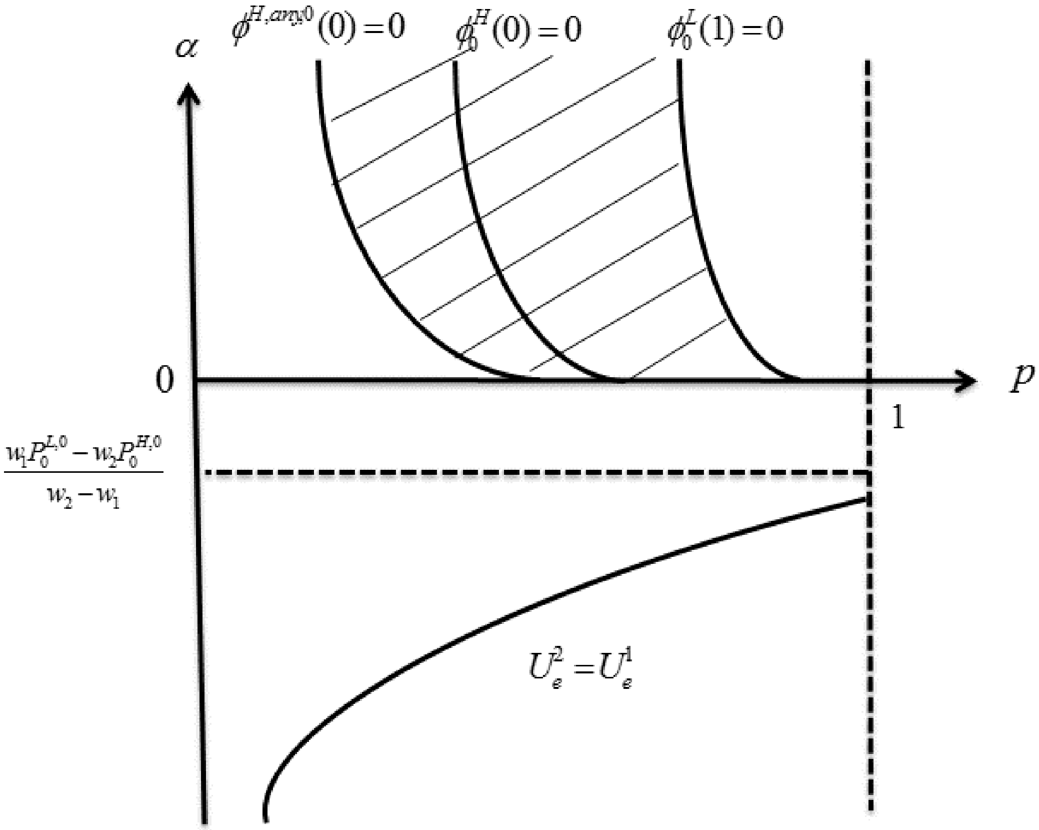
$\phi_0^L(w) \equiv \partial U_e/\partial w$ in the unpopular equilibrium without earnings management costs.

$\phi^{H,max}(w) \equiv \partial U_e/\partial w$ when $\mu^* = \theta$ in the very popular equilibrium with earnings management costs, as shown in Appendix C. For any points (p, α) in the shadowed area, w_1 and Δw $(\Delta w > 0)$ exist, which satisfy $0 \leq w_1 < w_2 = w_1 + \Delta w \leq 1$.

FIGURE 9

The Area in Which the Entrepreneur Can Change Equilibriums with Earnings Management Costs

Panel C: μ^{*} = any or 0 in the Very Popular Equilibrium



$\phi_0^H(w) \equiv \partial U_e/\partial w$ in the very popular equilibrium without earnings management costs.

$\phi_0^L(w) \equiv \partial U_e/\partial w$ in the unpopular equilibrium without earnings management costs.

$\phi^{any,0}(w) \equiv \partial U_e/\partial w$ when μ^{*} = any or 0 in the very popular equilibrium with earnings management costs, as shown in Appendix C. For any points (p, α) in the shadowed area, w_1 and Δw $(\Delta w > 0)$ exist, which satisfy $0 \leq w_1 < w_2 = w_1 + \Delta w \leq 1$.

TABLE 1

The Results of the Entrepreneur's Behavior

			True Earnings		
		Total	80	100	120
Obs.		39	13	13	13
Earnings Management Ratio	Ave.	0.73	0.88	0.76	0.65
	SD	0.33	0.21	0.31	0.41
Shareholding Ratio	Ave.	0.64	0.73	0.57	0.61
	SD	0.31	0.31	0.26	0.34
Unreliability Ratio	Ave.	0.44	0.41	0.51	0.41
	SD	0.47	0.49	0.51	0.38
Future Expectation for	Ave.	0.77	0.77	0.92	0.62
Business Success	SD	0.42	0.42	0.42	0.49

"Earnings Management Ratio" is defined as an entrepreneur's amount of earnings management divided by true earnings.

"Shareholding Ratio" is defined as the number of shares that an entrepreneur continues to hold at IPO divided by the number of shares held before the IPO.

"Unreliability Ratio" is defined as the entrepreneur's expected amount of the underwriter's earnings management estimation divided by true earnings.

"Future Expectation for Business Success" is defined as an entrepreneur's estimation of business status at the period 1. If participants anticipate their own business success, the index = 1. Otherwise, the index = 0.

"True earnings" is decided by nature from the set {80, 100, 120} and the entrepreneur observes the realized one.

TABLE 2

The Observed Number of Participants Who Take 100 Percent of the Earnings Management Ratio at Each Shareholding Commitment Level (H1a)

		Shareholding Ratio		
	Total	0%	50%	100%
Obs.	25	2	11	12
(Ratio)	100%	8%	44%	48%
p value			0.002	

"Shareholding Ratio" is defined as the number of shares that an entrepreneur continues to hold at IPO divided by the number of shares held before the IPO.

"p value" is at the chi-squared test because we test H1a by the chi-squared test.

TABLE 3

The Results of the Underwriter's Behavior (H2b)

			Shareholding Ratio		
		Total	0%	50%	100%
	Obs.	288	96	96	96
Earnings Management	Ave	0.185	0.198	0.188	0.169
Estimation Ratio		(0.284)	0.270	0.268	0.311
Expected True Earnings	Ave	100.69	101.04	101.88	99.17
		(15.79)	(16.17)	(14.17)	(16.81)

"Earnings Management Estimation Ratio" is defined as the level of earnings estimation, which is defined as the amount of earnings management estimation divided by reported earnings.

"Expected True Earnings" is defined as the amount of true earnings that the underwriter estimates.

"Shareholding Ratio" is defined as the number of shares that an entrepreneur continues to hold at IPO divided by the number of shares held before the IPO.

TABLE 4

The Number of Participants Who Take the Zero Estimation of Earnings Management at the Higher and Lower Levels of Reported Earnings and Each Shareholding Ratio

Reported Earnings		Shareholding Ratio 0	50	100
Higher Level (160-240)	Obs.	48	48	48
	The number of the zero assessment	19	25	32
Lower Level (80-150)	Obs.	48	48	48
	The number of the zero assessment	33	32	34

"Zero estimation of earnings management" is defined as the underwriters' estimation when participants of the underwriters' role assess the entrepreneurs' earnings management as zero.

"Higher Level" of the reported earnings indicates the case in which the reported earnings are 160, 180, 200, and 240.

"Lower Level" of the reported earnings indicates the case in which the reported earnings are 80, 100, 120, and 150.

"Shareholding Ratio" is defined as the number of shares that an entrepreneur continues to hold at IPO divided by the number of shares held before the IPO.