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by

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The Toehold Effect in Corporate Takeovers: Evidence from Laboratory Markets

Abstract

We explore experimentally whether and how a bidder's toehold solves the free-rider problem in corporate takeovers. We found that under symmetric information on the post-takeover value between the bidder and shareholders, the bidder's toehold induces shareholders' tendering and increases the probability of takeover success. Under asymmetric information, however, although the effect of bidder's toehold on shareholders' tendering is limited, the toehold still significantly increases the probability of takeover success. This occurs because the toehold reduces the number of the shares needed for takeover success. We claim that the toehold effect arises not only from the tendering effect proposed by Shleifer and Vishny (1986), but also from a number effect that has not been mentioned in previous takeover literature.

In corporate takeovers, bidders often have acquired some shares of the target firm prior to the takeover bid. This initial shareholding of the bidder in takeovers is called a toehold. Bradley, Desai, and Kim (1988) report that in their sample of 236 successful tender offers over the period 1963-1984, 81 (34.32%) of the bidders have toeholds. Betton and Eckbo (2000) report that in 1353 tender offers from 1971 to 1990, over a half (723) of the bidders own toeholds and that the average toehold ratio (the bidder's toeholds / total number of shares) over all the samples is 14.57%.

Why do bidders tend to own a toehold? While researchers have provided various answers to this question, the most well-known one appears to be that the bidder's toehold alleviates the free-rider problem in takeovers.[1] The free-rider problem in corporate takeovers was first pointed out by Grossman and Hart (1980). They claimed that shareholders are not willing to tender their shares in a takeover situation even though the bidder offers a higher price than the current value of their shares because shareholders expect the value to increase even further post-takeover. In other words, shareholders attempt to "free ride" on other shareholders who tender their shares at the bidder's price. If every shareholder thinks this way, a takeover should never succeed. After Grossman and Hart, many scholars have explored under what condition this free-rider problem occurs and if there are any ways to get around to it.[2]

Shleifer and Vishny (1986) proposed that the bidder's toehold can be a solution to the free-rider problem. They suggest that if the bidder owns the shares (the toeholds) in the target prior to the takeover, he can afford a higher bid than the

[1] Another explanation prevailing among practitioners is that if the market is unaware of the toehold purchase the bidder may be able to initiate the acquisition without paying a premium for the takeover bid. In addition, Burkart (1995), Singh (1998), and Bulow, Huang, and Klemperer (1999) examine the effect of the toehold on bidding strategies in a takeover contest among multiple bidders.

[2] Bradley, Desai, and Kim (1988) suggest that two-tiered offers may resolve the free-rider problem. Bebchuk (1989) indicates that with unconditional offers, takeovers succeed with positive probabilities. Bagnoli and Lipman (1988) and Holmstrom and Nalebuff (1992) find that when

post-takeover value; the shareholders tender the shares and a takeover succeeds. Their argument has been often discussed not only in subsequent theoretical literature (see, Hirshleifer's 1995 survey article) but also in corporate finance textbooks (Grinbratt and Titman 1998, Tirole 2006) and the textbooks on takeovers and M&As (Weston, Siu, and Johnson 2001, Sudarsanam 2003).

Empirical evidence also supports their theory. Walking (1985) and Betton and Eckbo (2000) report that the probability of takeover success increases with the size of the toehold. In addition, Madden (1981), Holderness and Sheehan (1985), Mikkelson and Ruback (1985), and Choi (1991) show that toehold acquisitions of the target shares cause positive stock price reactions, which is consistent with the theory that the toehold acquisition increases the likelihood of takeover and the probability of its success.

From this discussion and empirical evidence, the bidder's toehold seems to be a critical remedy for the free-rider problem in real takeover markets. We should note, however, that Shleifer and Vishny's (1986) original work indicates that the toehold is only a partial solution to the problem under asymmetric information on the post-takeover value. Their model shows that if a bidder knows the post-takeover value but shareholders do not, the toehold does not necessarily induce the shareholders to tender their shares and often fails to increase the probability of takeover success. We consider this point important, because in real takeover markets, it is likely that information asymmetry exists between the bidder and shareholders.

In this paper, we examine whether the bidder's toehold solves the free-rider problem, and if it does, how this toehold effect arises. In particular, we are interested in whether the toehold effect may be limited under asymmetric information environments,

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shareholders are not atomistic, they have incentives to tender the shares.

which seem to characterize the real takeover markets.

To achieve our aim, we conducted laboratory experiments, rather than analyzing the field data. Running experiments has the advantage of allowing us to control environments and directly examine the effect of the specific factors concerned. We created experimental markets in which the bidder either has no toehold or a 20% toehold under both symmetric and asymmetric information. This experimental design enables us to analyze the toehold effects directly and compare the results between symmetric and asymmetric information environments.

We found that under symmetric information, the bidder's toehold increases the shareholders' tendering and the probability of takeover success. Under asymmetric information, however, the bidder's toehold induces shareholders' tendering only when the post-takeover value is high; when it is low, we did not find that the toehold increases the shareholders' tendering probability. These experimental results support Shleifer and Vishny's theory.

At the same time, however, we also obtained a result that contradicts their theory: for low post-takeover values under asymmetric information, while the bidder's toehold does not increase the shareholders' tendering probability, it raises the probability of takeover success. In other words, the toehold effect arises even though the toehold does not induce shareholders to tender.

From this observation, we claim that the toehold effect arises not only from the higher bid to increase shareholders' tendering probability, as proposed by Shleifer and Vishny (1986). It also comes from the fact that the bidder's toehold reduces the number of shares needed to complete the takeover. We call the former the tendering effect and the latter the number effect. The number effect is intuitively clear and can be predicted from the results of threshold public goods experiments (Ledyard, 1995), but it has not been explored explicitly in the previous literature on takeovers.[3] We show that the number effect is significant in our experimental markets, especially in asymmetric information sessions. From this result, we conjecture that in real takeover markets that are characterized by asymmetric information, the number effect plays a crucial role in increasing the probability of takeover success.

This paper is organized as follows. Section 1 reviews takeover models and presents the hypotheses to be tested. Section 2 describes our laboratory takeover markets and experimental procedures. Section 3 presents the experimental results and tests the hypotheses on the toehold effects. Section 4 compares two sources of the toehold effect, the tendering effect and the number effect. Section 5 concludes.

1. The Toehold Effect in Corporate Takeovers

1.1 Symmetric Information Case

Consider that one bidder (raider) attempts to take over a firm by purchasing the firm's shares from atomistic shareholders, that is, shareholders who have a very small stake in the firm. Prior to the takeover bid, this bidder has already held a fraction of α (< 0.5) of the total number of the firm's shares S. The bidder offers a bid price per share x to the atomistic shareholders, and the shareholders decide whether to tender their shares. If the bidder can successfully purchase $(0.5 - \alpha)$S, then he succeeds in the takeover and gains control of the firm. Under his control, the value of the firm rises by the amount $z > 0$ per share, which is assumed to be known by both the bidder himself and the shareholders (symmetric information). If the bidder cannot acquire $(0.5 - \alpha)$S, then he fails in the takeover and makes no purchase of the shares at all (i.e. the bidder has

[3] In Hirshleifer and Titman's (1990) model, the probability of takeover success increases with the bidder's toehold, which partly arises due to what we call the number effect in our paper. However, they did not explicitly mention this effect in their paper.

made a conditional offer).[4] In this case the firm value stays at the pre-takeover value under the incumbent management, which is assumed to be zero.[5] Since z is positive, it is obvious that the success of the takeover produces social benefits.

The bidder's profit from a successful takeover is

$$[\alpha z + (0.5 - \alpha)(z - x)]\ S. \tag{1}$$

From (1), for the bidder to obtain gain from the takeover, the bid must satisfy

$$x < [0.5/(0.5-\alpha)]z. \tag{2}$$

Next, let us consider the shareholders' decision. With a successful takeover, the shareholders obtain the bid price x per share if they have chosen to tender shares, whereas they obtain z per share if they have held onto their shares. With an unsuccessful takeover, no transaction occurs, and the shareholders earn zero profits whether or not they have chosen to tender their shares. In addition, since each shareholder is atomistic, his tendering decision does not affect the outcome of the takeover. Under these conditions, the (weakly) dominant strategy for the shareholder is to tender the shares if $x \geq z$ and not to tender if $x < z$.

To examine the toehold effect on takeover outcomes, first consider the case where the bidder has no toeholds, i.e., $\alpha = 0$. In this case, the profitable bid condition (2) becomes $x < z$. With this bid, however, the shareholders do not tender the shares. Therefore a takeover never succeeds even if the takeover is socially efficient. This is the free-rider problem in takeovers that Grossman and Hart (1980) pointed out.

The bidder's toeholds ($\alpha > 0$) can solve this problem. Let us consider the case where $\alpha = 0.2$ (from our experimental settings described later). Then, the profitable bid

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4 In this paper, we only examine the takeover models for conditional offers. As for unconditional offers (offers committing the bidders to purchase tendered shares whether or not takeovers succeed), Bebchuk (1989) presents the model under the atomistic shareholders' assumption and Bagnoli and Lipman (1988) develop the theoretical consideration under the finite shareholders' assumption.

5 This assumption is the same as that in Hirshleifer and Titman (1990). Under this assumption, z is

condition (equation (2) above) becomes $x < (5/3) z$, which indicates that the bidder can afford to offer a bid greater than z. This occurs because a successful takeover provides the bidder with not only the profit from the takeover bid (0.3(z - x)) but also some gains from his own toeholds (0.2z). Therefore, when the bidder makes a bid $z \leq x < (5/3) z$, the shareholders tender the shares and the takeover succeeds.

The above arguments suggest that the bidder's toeholds (α) change takeover outcomes: (i) when $\alpha = 0$, the bidder makes a bid $x < z$, no shareholders tender the shares and a takeover never succeeds; (ii) when $\alpha = 0.2$, the bidder makes a bid $z \leq x < (5/3) z$, all shareholders tender the shares, and a takeover always succeeds.

While these results give us obvious predictions, they require the assumption of rationality of both the bidder and all the shareholders and therefore do not reflect the reality of takeover outcomes. Some recent literature suggests that there exist some noise traders in financial markets (see, Shleifer 2000). We can easily predict that their existence may change takeover outcomes. For example, if the bidder finds fulfillment in successful takeovers, he may make a bid greater than z even when $\alpha = 0$.[6] Also, there may be a bidder who does not recognize the shareholders' tendering condition ($x \geq z$) and may fail to make a successful bid even when $\alpha = 0.2$. Furthermore, if some shareholders neglect z or have liquidity needs[7] and tender the shares to a bid smaller than z, even a bidder with no toeholds ($\alpha = 0$) can realize a successful takeover. We wish to claim, however, that even if these noise or liquidity trader effects exist, there is no reason for them to be different between the no toeholds case ($\alpha =0$) and the

equal to the post-takeover value.

6 Roll (1986) also suggests the possibility that the bidder overvalues z, makes a higher bid than the true value of z, and a takeover can be successful in real takeover markets. He calls it the "hubris hypothesis of takeovers".

7 In market microstructure literature, it is common to assume the existence of liquidity traders. Bolton and Von Thadden (1998) develops a model where the existence of liquidity traders

toeholds case (α =0.2). Therefore, we present the following hypotheses on the toehold effect in takeovers, comparing the prediction of takeover outcomes when α =0 with that of α =0.2.

Hypotheses (S1)-(S3): (Symmetric Information Case)

When both a bidder and the shareholders know the value of z,

(S1) Bids are higher in the toehold case (α =0.2) than in the no toehold case (α =0).

(S2) Shareholders' tendering probability is higher in the toehold case (α =0.2) than in the no toehold case (α =0).

(S3) The probability of takeover success is higher in the toehold case (α =0.2) than in the no toehold case (α =0).

1.2 Asymmetric Information Case

Next consider the case where a bidder knows z, but shareholders do not (asymmetric information). This case was first examined by Shleifer and Vishny (1986).

Shleifer and Vishny (1986) argue that shareholders form a rational expectation of z to make their tendering decisions. The rational shareholders would recognize that the bidder must make a profitable bid that satisfies $x < [0.5/(0.5-\alpha)]z$ (equation (2) from the previous subsection). Then after observing the bid x, they would expect that $z > [(0.5-\alpha)/0.5]\,x$.

To see this point in more detail, let us assume that z's prior distribution is uniform over [0, 200], which corresponds to our experimental settings described in the following section. Then, the shareholders' conditional expected value of z, $E(z \mid x)$, is

alleviates the free-rider problem and increases successful takeovers.

$$E(z \mid x) = [\ [(0.5\text{-}\alpha)/0.5]x + 200]/2. \tag{3}$$

The shareholders tender the shares if the bid is larger than (or equal to) this expected value of z, that is, $x \geq [\ [(0.5\text{-}\alpha)/0.5]x + 200]/2$. Rearranging this, we get

$$x \quad \geq \quad [200 / (1+2\alpha)] \equiv x_c \, . \tag{4}$$

(4) shows that the shareholders tender the shares only when the bid x is greater than the critical value x_c.

Let us explore the toehold effect. First consider the case where the bidder has no toehold ($\alpha = 0$). In this case, the shareholders tender the shares only if $x \geq 200$ ($x_c = 200$). By making this bid, however, no bidder obtains positive profits since the maximum value of z is 200. Therefore, in equilibrium every bidder offers $x < 200$, all the shareholders do not tender, and a takeover never succeeds. Grossman and Hart's (1980) free-rider problem arises even under asymmetric information.[8]

Next consider the toeholds case where $\alpha = 0.2$. Substituting $\alpha = 0.2$ into (4), we find that the shareholders tender the shares only if $x \geq 142.86$. Since the bidder's profitable condition is $x < (5/3)\ z$ (as we saw above), a bidder with $z \geq 85.71$ can offer this acceptable bid. Therefore, a high-z bidder ($z \geq 85.71$) offers $x \geq 142.86$, all shareholders tender the shares, and a takeover always succeeds. On the other hand, a low-z bidder ($z < 85.71$) offers $x < 142.86$, no shareholders tender the shares, and a takeover never succeeds. These results indicate that under asymmetric information the bidder's toehold gives rise to successful takeovers, but this occurs only when a bidder has a high z.

The shareholders' tendering decisions and equilibrium takeover outcomes in the asymmetric information case are summarized in Table 1. As mentioned in the previous subsection, taking into account the existence of noise traders in the market, we present the following hypotheses on the toehold effect in takeovers, comparing the prediction of takeover outcomes in α =0 with that in α =0.2.

Hypotheses (A1-1), (A1-2), (A2-1), (A2-2), (A3-1), and (A3-2): (Asymmetric Information Case)

When a bidder knows the value of z but shareholders do not, and z's prior distribution is uniform over [0, 200] ,

> *(A1-1) When x < 142.86, the shareholders' tendering probability is not significantly different between the no toehold case (α =0) and the toehold case (α =0.2).*
>
> *(A1-2) When x ≥ 142.86, the shareholders' tendering probability is significantly higher in the toehold case (α =0.2) than in the no toehold case (α =0).*
>
> *(A2-1) When z < 85.71, the shareholders' tendering probability is not significantly different between the no toehold case (α =0) and the toehold case (α =0.2).*
>
> *(A2-2) When z ≥ 85.71, the shareholders' tendering probability is significantly higher in the toehold case (α =0.2) than in the no toehold case (α =0).*
>
> *(A3-1) When z < 85.71, the probability of takeover success is not significantly different between the no toehold case (α =0) and the toehold case (α =0.2).*
>
> *(A3-2) When z ≥ 85.71, the probability of takeover success is significantly higher in the toehold case (α =0.2) than in the no toehold case (α =0).*[9]

These hypotheses suggest that under asymmetric information the bidder's toehold increases the shareholders' tendering probability and the probability of takeover

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[8] Shleifer and Vishny (1986) show this result by considering it as a special case of their model.

[9] The toehold effect on the bidder's bid is ambiguous under asymmetric information: the theory does not offer an exact prediction on which bid is higher—when α =0 or 0.2.

success only when a bidder has a high z ($z \geq 85.71$). Therefore, the bidder's toehold does not necessarily alleviate the free-rider problem. This result is in a sharp contrast to that of the case of symmetric information, where the toehold effect arises for all z.

2. Experimental Design and Procedures

To test the hypotheses explained in the previous section, we created takeover markets in the laboratory. Since we focus on whether takeover outcomes are caused or affected by the bidder's initial toehold, we wish to exclude any other institutional factors that might affect takeover outcomes (such as two-tiered offers, unconditional offers, dilution opportunities, or non-atomistic shareholders). In other words, we constructed experimental markets as close to Grossman and Hart's and Shleifer and Vishny's models as possible. We explain our experimental designs and procedures below.

Our experiments were conducted in January and May 1998, and May and June 2004, using undergraduate students at Osaka University who volunteered to participate in a "decision-making game." In order to mitigate any value biases, we (the experimenters) did not use any terms that would indicate that the experiment was about takeovers.[10] We told participants that they were buying and selling commodities in the experiment. Thus, during the experiments, words about takeovers used in this paper (e.g. "bidder," "shareholder," "share") were replaced by those about commodity trading (e.g. "buyer," "seller," "commodity").

We conducted four kinds of treatments: the symmetric information case without bidder's toehold (SN), the symmetric information case with bidder's toehold (ST), the asymmetric information case without bidder's toehold (AN), the asymmetric

[10] In this respect, we follow the previous experiments of Kale and Noe (1997) and Cadsby and Maynes (1998).

information case with bidder's toehold (AT). We ran five sessions for each treatment. Each session consisted of one group of 21 persons (one bidder and 20 shareholders), so 420 students participated in our experiments in total. No subject participated in more than one session. All students were inexperienced in the sense that they had never participated in the same kind of experiment before.

Before the experiment was started, the experimenter assigned roles to each participant by lottery. These roles were fixed during the experiment. In all experiments, both the bidder and shareholders were told in the instructions that (i) the post-takeover value z varies from 0 to 200 at intervals of 10, (ii) the z value in each period will be determined at random, (iii) one experiment consists of 20 rounds. The reason why we repeated the same game for 20 rounds is because we wanted subjects to learn the game sufficiently as they received feedback results in each round. In the symmetric information experiment, z was revealed both to the bidder and shareholders, while in the asymmetric information experiment, z was revealed only to the bidder at the beginning of each round, but not to the shareholders before their decision makings. No communication among subjects was allowed throughout the experiment. Each participant sat at her desk with side-board blinders to ensure as much privacy and anonymity as possible.

One round of the experiment for the symmetric information experiments (SN and ST) proceeded as follows.

1) The experimenter informs the bidder and shareholders of z (0, 10, 20, … ,180, 190, 200).
2) Looking at the value of z revealed by the experimenter, the bidder offers a bid price x to the shareholders.
3) Observing the bid price x, the shareholders choose either "to tender" (accept the

offer) or “not to tender” (reject the offer).

4) Finally, the experimenter announces to all of the participants the number of shareholders who have tendered the share.

One round of the asymmetric information experiment (AN and AT) was the same except that the information on the post-takeover value (z) was revealed only to the bidder, not to shareholders, in the beginning of each round, and the value was announced publicly to shareholders after the outcome of takeover bidding was determined.

Treatments SN/AN and treatments ST/AT are different as to whether the bidder initially holds the shares of the target firm or not. In experiments SN and AN, a bidder initially has no shares, and each shareholder owns one share (i.e., shareholders as a whole have 20 shares). We call these experiments the *no toehold session*. In these experiments, when the bidder can purchase the shares from 10 shareholders or more, she succeeds in the takeover. Then the bidder’s payoff is 10 (z – x), and the shareholders who have accepted (tendered) the offer (x) obtain the offered price x, while the shareholders who have rejected the offer (not tendered) obtain the post-takeover value z.[11] [12] When 9 shareholders or less accept the offer, the takeover fails. Then, no transaction occurs,[13] and both the bidder’s and shareholders’ payoffs

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[11] In fact, in determining each shareholder’s payoff, we judged the takeover outcome by the number of shareholders who accepted the offer *other than her.* We will explain this point later.

[12] This shareholder payoff structure assumes that shareholders, having decided to tender, can sell their shares with *certainty* in successful takeovers. Although this “certainty assumption” is introduced to make shareholders’ decisions easier, it contradicts the bidder’s behavior in our setting in that she never buys more than 10 shares in successful takeovers. For consistency of the experimental procedures, we would have to drop this certainty assumption and adopt the “uncertainty assumption,” determining by lottery which shareholders could sell the shares when the number of tendering shareholders is more than 10 in successful takeovers. We can show, however, that the optimal tendering strategy of shareholders under the uncertainty assumption is the same as that under the certainty assumption (not tendering is the weakly dominant strategy for shareholders under both assumptions). Therefore, we adopt the certainty assumption for simplicity in our experiments.

[13] We consider conditional offers. See footnote 4.

are zero.[14]

In experiments ST and AT, the bidder initially holds 5 shares and each shareholder holds one share as in experiments SN and AN. That is, the bidder's toehold is 20% (5/25) of the shares (α=0.2, see section 1). We call these experiments the *toehold session*. In these experiments, when the bidder can purchase the shares from 8 shareholders or more, she obtains more than half of the shares ((5+8)/25) and succeeds in the takeover. Then, the bidder's payoff is 5z + 8(z − x), while the shareholders' payoffs are the same as in experiments SN and AN. When 7 shareholders or less accept the offer, the takeover fails, and all the participants' payoffs are zero.

In addition to repetition of the rounds, we gave subjects both the payoff table for the bidder and the payoff table for shareholders, so that subjects could understand the game structure for both roles.[15]

Our experimental markets exclude the opportunities of two-tiered offers, unconditional offers, and dilution but still include the other institutional factor that may affect takeover outcome—non-atomistic shareholders. Bagnoli and Lipman (1988) and Holmstrom and Nalebuff (1992) show that when there are only a finite number of shareholders, each shareholder determines her tendering decision by recognizing its impact on the probability of success, and consequently she has more incentive to tender; takeovers are successful even in the no toeholds case. This implies that, under usual laboratory settings, unless we gather an infinite number of participants for experiments, we are unable to exclude non-atomistic shareholders' behavior.[16]

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[14] This setting is the same as the models we addressed in Section 1.

[15] In the first sessions of AN and AT, we did not give subjects both the bidder's payoff table and the shareholder's table. After the sessions, we reconsidered our experimental designs and decided to give subjects both the tables in the rest of the sessions.

[16] One may argue that 20, the number of shareholders in our experiment, is large enough to ensure atomistic shareholder markets. However, this intuitive argument is false. The results of the non-atomistic shareholder models indicate that even when the number of shareholders is 20, each

Therefore, to create the atomistic market as in Grossman and Hart's and Shleifer and Vishny's models, we needed to construct some experimental device that makes each shareholder make her decision without considering its effect on the probability of takeover success. For this purpose, the takeover outcome (success or failure) for each shareholder was determined by the number of shareholders to tender *other than herself*. To be specific, if 10 (8 in the toehold case) or more shareholders *other than her* tender, she obtains the payoff in the case of takeover success (gets x if she has tendered, z if she has not). In this setting, each shareholder's tendering decision does not affect the outcome of takeovers for that shareholder, and she is expected to decide whether to tender or not as if she were an atomistic shareholder. On the other hand, for the bidder (and for us, the experimenters), we follow the usual rule, i.e., takeovers succeed if 10 (8 in the toehold case) or more shareholders accept the bidder's offer.[17] For more details about our experimental procedures, see the players' instructions that are shown in the Appendix.

We paid the participants monetary rewards related to the payoffs they gained in the experiment. The average monetary rewards of participants were \$ 32.04 (3,576 yen) for sellers and \$ 32.78 (3,651 yen) for bidders.[18] It took about 110 minutes to

shareholder's decision and the takeover outcome differ considerably from those under atomistic shareholder markets. For example, let us suppose that the post-takeover value z is 100 and a bidder with no initial shares offers a bid price (x) of 75. Then, using equation 2 of Kale and Noe's (1997) paper, we obtain the theoretical results that (i) each of the 20 shareholders chooses the mixed strategy where she tenders her share with probability of 0.506; (ii) the probability of takeover success is 60.94%. These results are far from Grossman and Hart's results (no shareholders tender and no takeovers are successful). Judging from this numerical example, in the usual laboratory setting we cannot expect that 20 shareholders behave as atomistic shareholders would.

[17] Under our experimental device, different takeover outcomes among the participants may occur in the same round. For example, suppose that just 10 shareholders accept the offer in the no toehold case. Then a takeover is successful for a bidder and non-tendering shareholders, but it is unsuccessful for tendering shareholders because the number of tendering shareholders *other than* each tendering shareholder is 9. These different outcomes among the participants seem odd, but we consider that this possibility does not significantly affect the behavior of each participant.

[18] We calculated the subjects' earnings at the rate of \$1.00 = 130 yen for the experiments in 1998, and \$1.00 = 110 yen for the experiments in 2004.

conduct one experiment.

3. Experimental Results

3.1 Data

Tables 2, 3, 4, and 5 show the raw data from our experiments SN, ST, AN and AT respectively. These tables indicate information about the value of z presented to the bidder by the experimenter,[19] the bid price x offered by the bidder, and the numbers of shareholders who tendered the share for each round. The numbers in bold and underlined suggest that a takeover was successful in those rounds. The bottom three rows of the table present the average bid price, the tendering probability (total number of tendering shareholders / total number of shareholders (20×20)), and the number of rounds of successful takeovers.

We find that a nontrivial number of shareholders tender the shares and takeovers can be successful even in the no-toehold sessions. In Tables 2 and 4 (Experiment SN and AN), we observe that the number of shareholders who tender is far from zero in each round. For example, in the first round of Group SN-1 in Table 2, z is 150, x is 100, and 5 (of 20) shareholders tendered the shares. In the fourth round of Group SN-1, z is 170, x is 140, 10 shareholders chose to tender. Although Grossman and Hart's (1980) free-rider problem proposition states that no shareholders tender at all, we do not find any rounds consistent with their proposition. As a natural consequence of this, takeovers were successful in some rounds. In Table 2 (SN), takeovers succeeded in 1, 7, 6, 9, and 5 rounds in Groups SN-1, SN-2, SN-3, SN-4, and SN-5, respectively. In Table 4 (AN), takeovers succeeded in 5, 3, 4, 1, and 8 rounds in Groups AN-1, AN-2, AN-3, AN-4, and AN-5, respectively. These results

[19] The values of z for each period had been determined by the experimenter with dice before the experiments. To make comparisons easily, we used the same sequence of z for all the groups.

suggest that shareholders are not necessarily as rational as takeover models suppose: there are a considerable number of noise traders or shareholders who chose to tender, although the theory claims that not tendering is the best strategy.[20]

At the same time, Tables 2-5 also appear to show that the toehold effect exists in our experimental markets: the bidder's toehold has a positive effect on the probability of takeover success. In the symmetric information experiments, we find that the number of rounds of successful takeovers is larger in the toehold sessions than in the no-toehold sessions: takeovers are successful in 1, 7, 6, 9, and 5 rounds in each of the sessions in experiments SN (see the bottom row of Table 2) and in 15, 11, 16, 14, and 17 rounds of each of the sessions in experiments ST (Table 3). In the asymmetric information experiments, we observe the same tendency: takeovers are successful in 5, 3, 4, 1, and 8 rounds in each of the sessions in experiments AN (Table 4) and in 10, 13, 17, 14, and 13 rounds of each of the sessions in experiments AT (Table 5). We explore how this toehold effect arises by testing the hypotheses presented in section 1.

3.2 Hypotheses testing

3.2.1 Symmetric Information Experiments

Table 6 presents the statistics of takeover outcomes in the symmetric information experiments. It shows the average bid, shareholders' tendering decisions, and takeover success of each of the no-toehold (SN) and toehold (ST) treatments. From these data, we test the hypotheses (S1), (S2), and (S3) and obtain the following

[20] In addition to the noise trader explanation, we can consider several reasons why some shareholders tendered the shares in the SN and AN experiments. One possibility is that some chose cooperative behavior because they had altruistic preferences or they expected that others would cooperate as well in the future rounds, as observed in some public goods experiments. Another possibility is that for some reason, a bidder overbid, and shareholders tendered the shares. We will not explore the reason for shareholders' tendering in more detail, since the purpose of this paper is focused on the toehold effect. The important point is, however, that for whatever reason, a nontrivial number of shareholders tendered the shares. This observation leads to our original hypothesis on the toehold effect described in Section 4.

results.[21]

Result (S1). *Bids (x) are higher in the toehold sessions (α =0.2) than in no toehold sessions (α =0).*

In Table 6, we find that the average bid price is 90.8 in SN sessions and 110.8 in ST sessions. The difference is 20.0 which is significant at the 1% level (p=0.005).[22] This result supports Hypothesis (S1); the bidder can afford to make a higher bid when she initially holds the shares. In fact, the bidder offers a bid (x) higher than z in only 5 rounds of 100 in five no-toehold sessions (SN) but in 51 rounds of 100 in five toehold sessions (ST).

Result (S2). *Shareholders' tendering probability is higher in the toehold sessions (α =0.2) than in no toehold sessions (α =0).*

We easily predict that with the higher bids more shareholders are induced to tender in the toehold sessions. Table 6 shows that, of 2000 shareholders' tendering decisions, they chose to tender 810 times in SN sessions and 1155 times in ST sessions respectively. The tendering probability is 0.405 in SN and 0.578 in ST. This difference, 0.173, is shown to be significant at the 1% level (p=0.000). This result supports Hypothesis (S2); more shareholders tender the shares in response to higher bids in the toehold sessions.

Result (S3). *The probability of takeover success is higher in the toehold sessions (α*

[21] As for shareholders' tendering decisions, since the membership of each group was fixed in our experiment, one may ask whether shareholders' tendering decisions were not independent during 20 round repetitions. To check whether this independence issue affects our results, we conducted a series of regression analyses on shareholders' tendering probability including the round number as one of the independent variables. We found that the round number had no significant effect on shareholders' tendering probability. Therefore we assume that shareholders' tendering decisions are independent in the following analysis. The details of the analyses will be given upon request.

[22] The null hypothesis that variance of bids between in SN and ST is equal is rejected by Levine's test with 5% significant level (p = 0.037). Therefore, we used Welch's t-test to test the difference in

=0.2) than in no toehold sessions (α =0).

Higher tendering probability leads to higher probability of takeover success. Table 6 shows that of 100 rounds, takeovers succeeded 28 times in SN and 73 times in ST. Hence, the probability of takeover success is 0.28 in the no-toehold sessions and 0.73 in the toehold sessions. The difference 0.45 is significant at the 1% level (p = 0.000). This result supports Hypothesis (S3).

Therefore, in symmetric information experiments, we obtain the results supporting the theoretical predictions of the toehold effect. The bidder's toehold alleviates the free-rider problem in takeovers: the bidder who can internalize the benefits of takeovers can afford to make a higher bid, more shareholders tender the shares, and takeovers succeed more frequently.

3.2.2 Asymmetric Information Experiments

Table 7 summarizes the statistics of takeover outcomes in the asymmetric information experiments. We compare the average bid, tendering decisions and the probability of takeover success between the no-toehold sessions (AN) and the toehold sessions (AT). In this table, we observe that the bidder's toehold affects the takeover outcomes under the asymmetric information experiments as well.

First, the bid is higher in the toehold sessions than in the no-toehold sessions. Table 7 shows that the average bid is 93.7 in AN and 108.9 in AT and the difference (15.2) is significant at the 1% level (p=0.002). Second, shareholders' tendering probability is higher in the toehold sessions than in the no-toehold sessions. The table indicates that for all samples the tendering probability is 0.397 in AN and 0.445 in AT and the difference is significant at the 1.7% level. One may notice, however, that this

the average bid.

difference (0.048) in the tendering probability is relatively small; in the symmetric information experiments, we have already observed that the difference in the tendering probability between SN and ST is much larger (0.173, see Table 6). We will examine this point later. Third, the probability of takeover success is higher in the toehold sessions than in the no-toehold sessions. The table shows that for all samples the probability of takeover success is 0.21 in AN and 0.67 in AT and the difference (0.46) is significant at the 1% level (p = 0.000).

While we have seen the toehold effect in the asymmetric information experiments as a whole, we should note that the theoretical hypotheses shown in section 1.2, (A1-1, A1-2, A2-1, A2-2, A3-1, and A3-2) claim that under asymmetric information, the toehold effect arises only when the bidder has a high enough z (≥85.71) to be able to afford to make a high bid (≥142.86). We tested the validity of the hypotheses and obtained the following results.[23]

Result (A1-1). *When x < 142.86, shareholders' tendering probability is not significantly different between the no toehold sessions (α =0) and the toehold sessions (α =0.2).*

Result (A1-2). *When x ≥ 142.86, shareholders' tendering probability in the toehold sessions (α =0.2) is significantly higher than that in no toehold sessions (α =0).*

Table 7 indicates that when shareholders are offered a low bid (x < 142.86), the shareholders' tendering probability is 0.386 in AN and 0.403 in AT; the difference (0.017) in not statistically significant (p=0.270). On the other hand, when shareholders are offered a high bid (x ≥ 142.86), the shareholders' tendering probability is 0.475 in

[23] As in the symmetric cases, we also assume that shareholders' tendering decisions are independent, because we confirmed that the round number showed no significant effect on shareholders' tendering probabilities in the regression analyses. The details of the analyses are available upon request.

AN and 0.615 in AT; the difference (0.140) is significant at the 0.1% level. These results support Hypotheses A1-1 and A1-2. Under asymmetric information on z, the bidder's toehold increases the shareholders' tendering probability only when the bidder makes a high bid. This finding naturally leads us to the following results.

Result (A2-1). *When z < 85.71, the shareholders' tendering probability is not significantly different between the no toehold sessions (α =0) and the toehold sessions (α =0.2).*

Result (A2-2). *When z ≥ 85.71, the shareholders' tendering probability is significantly higher in the toehold sessions (α =0.2) than in the no toehold sessions (α =0).*

Table 7 shows that when the bidder has a low z (<85.71), the shareholders' tendering probability turns out to be 0.373 in AN and 0.348 in AT; the difference -0.025 is not statistically significant. At the same time, when the bidder has a high z (≥85.71), the shareholders' tendering probability in AT (0.486) is higher than that in AN (0.407) and this difference is significant (p= 0.000). These results support Hypotheses A2-1 and A2-2, which are derived from Shleifer and Vishny (1986)'s model; under asymmetric information, the bidder's toehold can induce shareholders to tender their shares only when the bidder has a high enough z to be able to afford to make higher bids. Even with the toehold, low-z bidders still have difficulty in overcoming the free-rider problem. This is the reason that we observed the smaller difference in the tendering probability between the AN and AT experiments (0.048), compared to the difference between the SN and ST experiments (0.173).

Result (A3-1). *When z < 85.71, the probability of takeover success in the toehold sessions (α =0.2) is significantly higher than that in the no toehold sessions (α =0).*

Result (A3-2). *When z ≥ 85.71, the probability of takeover success in the toehold* *sessions (α =0.2) is significantly higher than that in the no toehold sessions (α =0).*

Table 7 suggests that the probability of takeover success is significantly higher in the toehold sessions than in the no toehold sessions, irrespective of the value of z. When z < 85.71, the probability of takeover success is 0.20 in AN and 0.50 in AT (Result A3-1); when z ≥ 85.71, the probability of takeover success is 0.214 in AN and 0.743 in AT (Result A3-2); both differences between the toehold and no-toehold sessions are significant (P= 0.015 and 0.000). We should note that Result A3-1 does *not* support Hypothesis A3-1 which states that a low-z bidder's toehold should *not* increase the probability of takeover success. In addition, Result A3-1 is difficult to interpret from Result A2-1 indicating that a low-z bidder's toehold does not change shareholders' tendering probability. On the other hand, Result A3-2 supports Hypothesis A3-2 which claims that a high-z bidder's toehold increases the probability of takeover success.

The question is why even a low-z bidder toehold has significant positive effects on the probability of takeover success; why does it increase successful takeovers although it does not raise shareholders' tendering probability? In the following section, we will answer this question.

4. Where does the toehold effect come from?

Empirical studies report that the bidders' toeholds have positive effects on takeover outcomes. Walking (1985) finds a positive relationship between bidders' toeholds and the probability of takeover success, using data from the U.S. capital markets over the period 1972-76. Betton and Eckbo (2000) also show that toeholds increase the probability of initial bid success. These findings on the positive effects of toeholds on takeover success are usually explained by Shleifer and Vishny's (1986) theory: the bidder with a toehold can afford to offer a higher bid and consequently shareholders are more likely to tender. We call this the *tendering effect* of toeholds.

Observing our experimental results, however, the tendering effect does not seem to be the only mechanism through which the toehold increases the probability of takeover success. As we saw in Results A2-1 and A3-1, while the low-z (<85.71) bidder's toehold *does not* raise the shareholders' tendering probability, it *does* increase the probability of takeover success. Therefore we need to explore another mechanism that explains the positive effect of toeholds on takeover success.

Another mechanism we suggest is that given shareholders' tendering decisions, the bidder's toehold increases the probability of takeover success by reducing the number of shares needed to make the takeover successful. For example, in our laboratory, to make a takeover successful, while a bidder has to purchase 10 shares or more in the no toehold sessions (SN and AN), he has to purchase only 8 shares or more in the toehold sessions (ST and AT). We call this effect the *number effect* of toeholds. We should note that no number effect exists in Shleifer and Vishny's model, because they predict only two outcomes of shareholders' behavior: all shareholders tender or all do not tender. In that case, the probability of takeover success is either 1 or 0 and is not affected by the number of shares needed for takeover success. The number effect arises only when the tendering probability of shareholders as a whole is between 0 and 1. This is the case where there are some noise and/or liquidity traders or shareholders making tendering decisions probabilistically (Hirshleifer and Titman 1990).

This number effect of toeholds can be predicted from the experimental results of threshold public goods games. In threshold public goods games, each member of a group is asked to make a private contribution to the public good, and if the sum of the contributions of all members reaches the stated threshold level, the public good is provided. Every member is better off if the good is provided, but each has an incentive to free-ride on the contributions of others. This game is very similar to our takeover experiment; the threshold level of contribution corresponds to the number of shares to be tendered for takeover success.

The experimental results of the threshold public goods games suggest that decreases in thresholds decrease contributions but increase the probability of the provision of the public good.[24] This result clearly shows that the lower threshold itself makes it easier for contributions to reach the threshold, independent of the change in contribution. From this result, in our takeover game, we conjecture that increases in the toehold (lower threshold for takeover success) increase the probability of takeover success irrespective of the change in the number of tendered shares: the number effect arises.

While this number effect seems to be intuitively clear, it has been unexplored in studies on the toehold effect in takeovers. As far as we know, the toehold effect has been solely explained by the tendering effect in Shleifer and Vishny (1986). We wish to understand the mechanism of the toehold effect more exactly, how much the toehold effect comes from the tendering effect and how much comes from the number effect.

Unfortunately, empirical studies are not sufficient to answer this question. In real takeover markets, there might be other factors in which toeholds increase the probability of success[25] and it is not an easy task to control these factors and isolate some specific effects from naturally occurring phenomena. In contrast, our experimental research gives us an opportunity to focus on the specific effects and to measure their magnitude in a controlled laboratory environment. Below, we examine

[24] See, Ledyard's (1995) survey, in particular, Table 2.12 in his article.

[25] Walking (1985) discusses two other hypotheses on the positive effect of toeholds on takeover success. One is the strong influence of the bidder on the target management, and the other is the

the magnitude of the tendering effect and the number effect in our laboratory.

Figures 1 and 2 illustrate the distributions of rounds classified by the number of tendering shareholders in symmetric information experiments, SN and ST, respectively. For example, in Figure 1, we observe that there are 20 rounds in SN in which seven shareholders tendered their shares. The dotted vertical line in each figure represents the threshold for takeover success or failure in each experiment.

Comparing these two figures, we may confirm the tendering effect on takeover success. In SN (Figure 1), the numbers of rounds are large (the bars are long) for the rounds in which the number of tendering shareholders lies from 5 to 10, and the bars are short for rounds in which the number of tendering shareholders exceeds 10. On the other hand, in ST (Figure 2), the numbers are larger for the rounds in which the number of tendering shareholders exceeds 10, compared to those in SN. This move of the bars toward the right direction should contribute to more successful takeovers in ST, which represents the tendering effect. At the same time, we also observe the number effect in ST. In ST (Figure 2), the dotted vertical line (the threshold for the takeover outcome) shifts to the left, which makes the rounds with 8 and 9 tendering shareholders successful. These rounds amount to 16 rounds, which represents the number of successful takeovers brought by the number effect.

Figures 3 and 4 illustrate the distributions of rounds classified by the number of tendering shareholders in asymmetric information experiments, AN and AT, respectively. These figures seem to suggest that the tendering effect is relatively small under asymmetric information. In AN, the numbers of rounds are large (the bars are long) for the rounds in which the number of tendering shareholders lies from 5 to 10. In AT, the numbers of rounds are large (the bars are long) for the rounds in which the

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increased shareholder fear of becoming inactive minorities.

number of tendering shareholders lies from 6 to 12. This small tendering effect may contribute to increases in successful takeovers in AT. At the same time, we should note that the number effect appears to be of more importance in AT. In AT, the dotted vertical line (the threshold for the takeover outcome) shifts to the left, which makes the rounds with 8 and 9 tendering shareholders successful. Since these rounds amount to 33 rounds out of 67 successful takeover rounds, we can say that a significant part of takeover success in AT is attributable to the number effect.

To grasp the exact magnitude of each effect, we calculate the probability of takeover success in the toehold sessions (ST and AT) assuming that takeovers succeed when a bidder purchases 10 (not 8) shares or more. This hypothetically calculated probability of success in the toehold sessions can be interpreted as the probability of success in the toehold sessions without the number effect, since the number of the shares required for takeover success (10) is the same as that in the no toehold sessions. This calculated probability is 0.57 (57%) in ST and 0.34 (34%) in AT.

Using these calculated probabilities, we obtain the magnitude of the tendering effect and the number effect for both the symmetric and asymmetric sessions. Table 8 summarizes the results. Columns (1), (2), and (3) represent the (actual) probability of takeover success in the no-toehold sessions, the hypothetically calculated probability of takeover success in the toehold sessions, and the (actual) probability of takeover success in the toehold sessions, respectively. The tendering effect can be calculated by column (2) minus column (1); the number effect can be calculated by column (3) minus column (2); the total toehold effect is the sum of these two effects.

The first row in Table 8 shows that in symmetric information experiments, the tendering effect is 29%, the number effect is 16%, and the total toehold effect amounts to a 45% rise in the probability of success. The tendering effect accounts for about two thirds of the total toehold effect. On the other hand, the second row in Table 8 shows that in asymmetric information experiments, the tendering effect is only 13%, the number effect is 33%, and the total toehold effect amounts to a 46% rise in the probability of success. This suggests that the number effect contributes to takeover success 2.5 times more than the tendering effect.

We can easily understand that the number effect tends to be larger than the tendering effect under asymmetric information. Both Hypotheses (A2-1) (A2-2) and Results (A2-1) (A2-2) suggest that a bidder's toehold does not increase the shareholders' tendering probability when the bidder has a low z (< 85.71). The third and fourth rows in Table 8 indicate that in asymmetric information experiments, when z < 85.71, the tendering effect is not positive (negative; −7%), which reflects the fact that the tendering probability is not higher in AT than in AN (see Table 7).

However, even in that case, due to the large number effect (37%), the total toehold effect turns out to be a 30% rise in the probability of takeover success (see the third row of Table 8). This is the answer to the question raised at the end of the last section why even a low-z bidder's toehold increases successful takeovers. Our experimental results suggest that even under asymmetric information, the bidder's toehold increases the probability of takeover success via the number effect, which arises in the markets with noise and/or liquidity traders.

5. Concluding Remarks

Empirical studies have reported that the bidder's toehold increases the probability of takeover success. This evidence is usually explained by the idea proposed by Shleifer and Vishny (1986) that a bidder with a toehold can internalize the benefits of takeover, thus overcoming the free-rider problem in takeovers. Our laboratory data basically support their idea: under symmetric information the bidder's toehold raises the bid price, induces the shareholders' tendering, and therefore increases the probability of takeover success; under asymmetric information this tendering effect of the toehold is observed only when the bidder has a high post-takeover value. At the same time, our laboratory results also show that even when the bidder's toehold *does not* induce the shareholders' tendering (e.g. the case of a low-z bidder under asymmetric information), it *does* increase the probability of takeover success. This occurs because the bidder's toehold reduces the number of shares needed for successful takeovers; we call this the number effect.

Although this number effect seems to be easily predicted from the experimental results of threshold public goods games, it has not been mentioned in previous takeover literature. However, our laboratory data suggest the economic significance of the number effect. Under symmetric information experiments, out of a 45% rise in the probability of takeover success by the bidder's toehold (the total toehold effect), 29% amounts to the tendering effect and 16% amounts to the number effect. Under asymmetric information experiments, the number effect is much larger; out of 46% rise of the total toehold effect, 13% amounts to the tendering effect and 33% amounts to the number effect. From these results, we conjecture that in real takeover markets that are characterized by asymmetric information, the number effect plays a crucial role in solving the free-rider problem and increasing the probability of takeover success.

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Table 1:

Shareholders' Decision and Takeover Outcomes under Asymmetric Information

Shareholders' Tendering Decision		
	α =0 (No Toehold)	α =0.2 (Toehold)
x < 142.86	Not tender	Not tender
x ≥ 142.86		Tender

Equilibrium Takeover Outcomes		
	α =0 (No Toehold)	α =0.2 (Toehold)
z < 85.71	Shareholders do not tender. Takeover unsuccessful	Shareholders do not tender. Takeover unsuccessful
z ≥ 85.71		Shareholders tender. Takeover successful

This table explains the theoretical predictions on shareholders' decisions and takeover outcomes for treatments under the asymmetric information. The top half compares the rational choices for shareholders in the no toehold case (α =0) and in the toehold case (α =0.2). In the no toehold case, the rational choice for shareholders is not to tender regardless of the raider's offer (x). In the toehold case, the rational choice for shareholders is opposite for x < 142.86 and x ≥ 142.86, reflecting the raider's profit condition. The bottom half shows the predicted takeover outcomes according to the post-takeover value (z), reflecting the raider's profit condition and shareholders' decisions described above.

Table 2
Results of Experiment SN
(Symmetric information and No-toehold)

Round Number	The Value of Z	Group SN-1		Group SN-2		Group SN-3		Group SN-4		Group SN-5	
		Bid Price	# of tendering share-holders	Bid Price	# of tendering share-holders	Bid Price	# of tendering share-holders	Bid Price	# of tendering share-holders	Bid Price	# of tendering share-holders
1	150	100	5	120	**11**	100	8	130	**15**	140	8
2	100	60	2	80	9	50	3	50	7	100	**17**
3	190	140	6	170	**10**	150	**11**	150	6	160	**11**
4	170	140	**10**	180	**18**	140	8	160	**12**	160	**10**
5	150	110	6	120	5	100	9	120	**11**	140	7
6	140	100	3	130	7	110	7	120	9	100	4
7	180	130	5	190	**18**	150	**11**	140	8	160	**10**
8	50	30	6	40	**14**	40	**13**	40	**10**	40	8
9	150	100	3	130	9	100	7	130	9	140	7
10	30	20	6	50	**20**	20	7	20	**10**	10	5
11	70	40	5	60	9	50	**10**	50	6	50	**10**
12	90	80	7	80	6	70	8	80	**12**	70	7
13	160	100	2	110	7	130	7	150	**11**	130	6
14	120	100	6	100	9	90	**10**	100	**10**	110	8
15	120	60	2	100	5	90	7	90	4	100	8
16	50	40	8	30	9	40	7	40	6	40	9
17	90	70	4	70	**12**	70	7	80	6	80	7
18	30	10	2	10	6	30	**18**	20	7	20	8
19	180	100	3	140	7	150	7	150	8	160	8
20	60	50	7	40	8	40	6	50	**10**	50	7
Average Bid Price	Tendering Probability	79.00	0.245	97.50	0.498	86.00	0.428	93.50	0.443	98.00	0.413
# of Rounds of Successful Takeovers		1		7		6		9		5	

We ran five sessions (Group SN-1, Group SN-2, Group SN-3, Group SN-4, and Group SN-5) for the symmetric information with no toehold treatment. A session consists of twenty rounds (Round Number). The value of Z (the post-takeover value) for each round was the same across the sessions. Announced bid prices by a bidder in each session are reported in the "Bid Price" columns. There were twenty subjects as shareholders in each session and how many of them tendered their shares were reported in the columns of "# of tendering shareholders." The numbers in bold and underlined in each "# of tendering shareholders" column indicate successful takeovers (ten sellers or more tendered their shares). "# of Rounds of Successful Takeovers" indicates the number of successful takeovers in each session. In the bottom two rows, "Average bid price" and "Tendering Probability," and "# of Rounds of Successful Takeovers" were calculated and counted from the results reported above.

Table 3

Results of Experiment ST

(Symmetric information and Toehold)

Round Number	The Value of Z	Group ST-1		Group ST-2		Group ST-3		Group ST-4		Group ST-5	
		Bid Price	# of tendering share-holders	Bid Price	# of tendering share-holders	Bid Price	# of tendering share-holders	Bid Price	# of tendering share-holders	Bid Price	# of tendering share-holders
1	150	130	**11**	140	6	180	**20**	150	**18**	160	**19**
2	100	90	**11**	90	7	110	**18**	80	7	80	**9**
3	190	150	7	200	**19**	200	**19**	180	**9**	200	**19**
4	170	150	4	170	**16**	170	**18**	160	**11**	180	**19**
5	150	140	**9**	140	**8**	140	**9**	140	4	160	**19**
6	140	130	**9**	130	6	130	7	140	**16**	130	6
7	180	170	**9**	190	**20**	180	**17**	190	**19**	180	**16**
8	50	30	4	40	4	40	**9**	50	**16**	40	**11**
9	150	140	**9**	140	5	140	**10**	150	**13**	130	7
10	30	20	**12**	30	**11**	20	4	20	4	10	4
11	70	50	5	60	4	60	**9**	70	**14**	70	**16**
12	90	80	**8**	100	**18**	80	**9**	80	5	90	**16**
13	160	160	**17**	150	6	150	6	160	**14**	150	**9**
14	120	120	**15**	120	**12**	110	7	120	**13**	120	**14**
15	120	110	7	110	5	120	**17**	130	**20**	120	**13**
16	50	50	**15**	60	**19**	50	**16**	40	6	50	**13**
17	90	90	**15**	90	**10**	90	**16**	90	**15**	80	**8**
18	30	30	**13**	40	**20**	30	**13**	20	**8**	40	**20**
19	180	180	**12**	180	**10**	180	**15**	180	**13**	180	**12**
20	60	50	**8**	50	5	180	**15**	40	2	60	**13**
Average Bid Price	Tendering Probability	103.5	0.500	111.5	0.528	112.0	0.635	109.5	0.568	111.5	0.658
# of Rounds of Successful Takeovers		15		11		16		14		17	

We ran five sessions (Group ST-1, Group ST-2, Group ST-3, Group ST-4, and Group ST-5) for the symmetric information with toehold treatment. A session consists of twenty rounds (Round Number). The value of Z (the post-takeover value) for each round was the same across the sessions. Announced bid prices by a bidder in each session are reported in the "Bid Price" columns. There were twenty subjects as shareholders in each session and how many of them tendered their shares were reported in the columns of "# of tendering shareholders." The numbers in bold and underlined in each "# of tendering shareholders" column indicate successful takeovers (eight sellers or more tendered their shares). "# of Rounds of Successful Takeovers" indicates the number of successful takeovers in each session. In the bottom two rows, "Average bid price" and "Tendering Probability," and "# of Rounds of Successful Takeovers" were calculated and counted from the results reported above.

Table 4
Results of Experiment AN
(Asymmetric information and No-toehold)

Round Number	The Value of Z	Group AN-1		Group AN-2		Group AN-3		Group AN-4		Group AN-5	
		Bid Price	# of tendering share-holders	Bid Price	# of tendering share-holders	Bid Price	# of tendering share-holders	Bid Price	# of tendering share-holders	Bid Price	# of tendering share-holders
1	150	100	**<u>13</u>**	110	**<u>12</u>**	110	9	90	6	110	9
2	100	80	9	40	6	80	6	80	3	90	9
3	190	150	7	120	4	130	6	130	4	100	6
4	170	110	7	110	6	150	**<u>13</u>**	150	9	180	**<u>11</u>**
5	150	110	9	90	9	120	**<u>12</u>**	130	8	150	**<u>12</u>**
6	140	110	**<u>14</u>**	130	9	120	9	120	6	130	8
7	180	140	**<u>12</u>**	160	9	130	7	170	9	150	**<u>13</u>**
8	50	30	1	60	5	30	**<u>10</u>**	50	**<u>10</u>**	70	**<u>14</u>**
9	150	110	5	100	**<u>10</u>**	130	9	130	9	150	8
10	30	50	7	40	8	30	6	10	5	40	9
11	70	50	5	50	6	50	7	50	7	70	**<u>12</u>**
12	90	70	5	90	7	60	7	70	9	80	5
13	160	130	9	130	**<u>10</u>**	120	7	140	8	100	**<u>10</u>**
14	120	100	6	120	6	110	**<u>10</u>**	110	7	130	**<u>11</u>**
15	120	100	**<u>10</u>**	100	6	100	9	110	7	120	5
16	50	40	7	80	9	40	9	40	8	60	**<u>11</u>**
17	90	70	7	80	6	70	6	80	8	100	7
18	30	20	**<u>10</u>**	60	7	20	6	40	8	40	7
19	180	150	7	190	7	140	9	170	9	80	8
20	60	30	5	50	7	50	5	60	8	40	5
Average Bid Price	Tendering Probability	87.50	0.388	95.50	0.373	89.50	0.405	96.50	0.370	99.50	0.450
# of Rounds of Successful Takeovers		5		3		4		1		8	

We ran five sessions (Group AN-1, Group AN-2, Group AN-3, Group AN-4, and Group AN-5) for the asymmetric information with no toehold treatment. A session consists of twenty rounds (Round Number). The value of Z (the post-takeover value) for each round was the same across the sessions. Announced bid prices by a bidder in each session are reported in the "Bid Price" columns. There were twenty subjects as shareholders in each session and how many of them tendered their shares were reported in the columns of "# of tendering shareholders." The numbers in bold and underlined in each "# of tendering shareholders" column indicate successful takeovers (ten sellers or more tendered their shares). "# of Rounds of Successful Takeovers" indicates the number of successful takeovers in each session. In the bottom two rows, "Average bid price" and "Tendering Probability," and "# of Rounds of Successful Takeovers" were calculated and counted from the results reported above.

Table 5
Results of Experiment AT
(Asymmetric information and Toehold)

Round Number	The Value of Z	Group AT-1		Group AT-2		Group AT-3		Group AT-4		Group AT-5	
		Bid Price	# of tendering share-holders	Bid Price	# of tendering Share-holders	Bid Price	# of tendering share-holders	Bid Price	# of tendering share-holders	Bid Price	# of tendering share-holders
1	150	130	**12**	120	**13**	160	**15**	130	**12**	140	**12**
2	100	100	**9**	100	**8**	180	**17**	70	5	110	7
3	190	130	**11**	120	**8**	140	**11**	170	**12**	140	**8**
4	170	140	7	90	5	160	**17**	140	6	150	**15**
5	150	100	5	160	**8**	140	**14**	140	7	140	**9**
6	140	100	6	160	**9**	120	**11**	160	**8**	140	7
7	180	120	7	150	**11**	130	**9**	190	**15**	150	**8**
8	50	80	**8**	10	4	70	**10**	80	6	100	7
9	150	110	**9**	170	**17**	120	**10**	140	**12**	130	**9**
10	30	40	6	40	4	40	**8**	40	**10**	110	**9**
11	70	80	**8**	90	7	50	**8**	70	6	100	6
12	90	80	2	110	**8**	60	**9**	110	**8**	100	**8**
13	160	150	**10**	160	**12**	120	**8**	150	**11**	130	5
14	120	160	7	130	**8**	120	**10**	130	**10**	100	**13**
15	120	130	**8**	130	6	100	**12**	130	6	100	**14**
16	50	60	**8**	80	6	50	3	60	**11**	80	**10**
17	90	120	7	110	**11**	90	7	100	**9**	90	**8**
18	30	20	4	40	**8**	50	5	40	**8**	80	**8**
19	180	190	**20**	150	**9**	130	**14**	180	**13**	90	7
20	60	30	4	60	7	70	**8**	60	**8**	70	4
Average Bid Price	Tendering Probability	103.5	0.395	100.9	0.423	105.0	0.515	114.5	0.458	112.5	0.435
# of Rounds of Successful Takeovers		10		13		17		14		13	

We ran five sessions (Group AT-1, Group AT-2, Group AT-3, Group AT-4, and Group AT-5) for the asymmetric information with toehold treatment. A session consists of twenty rounds (Round Number). The value of Z (the post-takeover value) for each round was the same across the sessions. Announced bid prices by a bidder in each session are reported in the "Bid Price" columns. There were twenty subjects as shareholders in each session and how many of them tendered their shares were reported in the columns of "# of tendering shareholders." The numbers in bold and underlined in each "# of tendering shareholders" column indicate successful takeovers (eight sellers or more tendered their shares). "# of Rounds of Successful Takeovers" indicates the number of successful takeovers in each session. In the bottom two rows, "Average bid price" and "Tendering Probability," and "# of Rounds of Successful Takeovers" were calculated and counted from the results reported above.

Table 6
Takeover Outcomes of Symmetric Information Experiments

	SN (No Toehold)	ST (Toehold)	Difference
Average Bid Price	90.8 (46.072)	110.8 (53.742)	20.0** (p=0.005)
Tendering Decisions			
Opportunity	2000	2000	
Tendered	810	1155	
Not Tendered	1190	845	
Tendering Prob.	0.405	0.578	0.173*** (p = 0.000)
Takeover Success			
Opportunity	100	100	
Success	28	73	
Failure	72	27	
Prob. of TOB Success	0.280	0.730	0.450*** (p = 0.000)

This table summarizes the results of experiments for the no toehold case and the toehold case under the symmetric information treatment (SN and ST). The second row compares the average bid price for SN and ST. The numbers in parentheses are standard deviations. The results for tendering decisions count how many times subjects chose to tender their shares and how many times they did not from all samples (Opportunity) in SN and ST, and then the tendering probability (Tendering Prob.) was derived from the results. The results for takeover success count how many times takeover bids were successful and how many times they failed from all samples (Opportunity) in SN and ST, and then the probability of successful takeover bids (Prob. of TOB success) was derived from the results. In the rightmost column, we showed the difference between SN and ST for average bid price, tendering probability, and probability of takeover success respectively. In the same column, the numbers in the parentheses indicate the significance level. *** indicates 0.1% significant difference; ** indicates 1% significant difference. We used Welch's t-test to test for average bid price and Chi square test for the others.

Table 7
Takeover Outcomes of Asymmetric Information Experiments

	AN (No Toehold)	AT(Toehold)	Difference
Average Bid Price	93.7 (41.430)	108.9 (40.946)	15.2*** (p=0.002)
Tendering Decisions			
All Sample			
Opportunity	2000	2000	
Tendered	794	890	
Not Tendered	1206	1110	
Tendering Prob.	0.397	0.445	0.048* (p = 0.017)
X < 142.86			
Opportunity	1760	1600	
Tendered	680	644	
Not Tendered	1080	956	
Tendering Prob.	0.386	0.403	0.017 (p = 0.270)
X ≥ 142.86			
Opportunity	240	400	
Tendered	114	246	
Not Tendered	126	154	
Tendering Prob.	0.475	0.615	0.140*** (p = 0.001)
Z < 85.71			
Opportunity	600	600	
Tendered	224	209	
Not Tendered	376	391	
Tendering Prob.	0.373	0.348	–0.025 (p = 0.367)
Z ≥ 85.71			
Opportunity	1400	1400	
Tendered	570	681	
Not Tendered	830	719	
Tendering Prob.	0.407	0.486	0.079*** (p = 0.000)

Table 7 continued

Takeover Success			
All Sample			
Opportunity	100	100	
Success	21	67	
Failure	79	33	
Prob. of TOB Success	0.210	0.670	0.460*** (p = 0.000)
Z < 85.71			
Opportunity	30	30	
Success	6	15	
Failure	24	15	
Prob. of TOB Success	0.200	0.500	0.300** (p = 0.015)
Z ≥ 85.71			
Opportunity	70	70	
Success	15	52	
Failure	55	18	
Prob. of TOB Success	0.214	0.743	0.529*** (p = 0.000)

This table summarizes the results of experiments for the no toehold case and the toehold case under the asymmetric information treatment (AN and AT). Similar to Table 6, the second row compares the average bid price for AN and AT. The numbers in parentheses are standard deviations. The results for tendering decisions counts how many times subjects chose to tender their shares and how many times they did not from all samples (Opportunity) in AN and AT, and then the tendering probability (Tendering Prob.) was derived from the results. According to the theoretical predictions for the asymmetric information case, results for tendering decisions are categorized by the range of the value of bid prices (X) and the post-takeover value (Z) (see Table 1). The results for takeover success show how many times takeover bids were successful and how many times they failed from all samples (Opportunity) in AN and AT, and the probability of successful takeover bids (Prob. of TOB Success) was derived from the results. According to the theoretical predictions for the asymmetric information case, results for takeover success are categorized by the range of the value of the post-takeover value (Z) (see Table 1). In the rightmost column, we showed the difference between AN and AT for average bid price, tendering probability, and probability of takeover success respectively. In the same column, the numbers in the parentheses indicate the significance level. *** indicates 0.1% significant difference; ** indicates 1% significant difference; * indicates 5% significant difference. We used Welch's t-test to test for average bid price and Chi square test for the others.

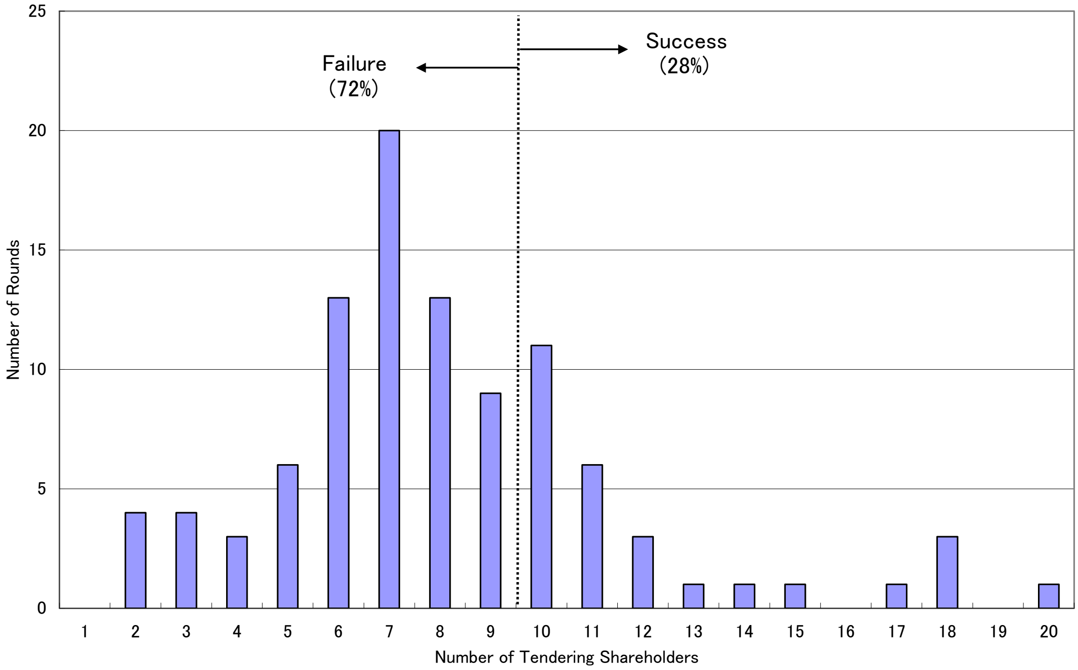
Table 8

Tendering Effect and Number Effect

	(1) Probability of Takeover Success in No-toehold Session	(2) Hypothetically Calculated Probability of Takeover Success in Toehold Session	(3) Probability of Takeover Success in Toehold Session	(4) Tendering Effect = (2) − (1)	(5) Number Effect = (3) − (2)	(6) Total Toehold Effect = (4) + (5)
Symmetric Information	0.28	0.57	0.73	0.29	0.16	0.45
Asymmetric Information	0.21	0.34	0.67	0.13	0.33	0.46
Asymmetric Information ($z < 85.71$)	0.20	0.13	0.50	− 0.07	0.37	0.30
Asymmetric Information ($z \geq 85.71$)	0.214	0.428	0.743	0.214	0.315	0.529

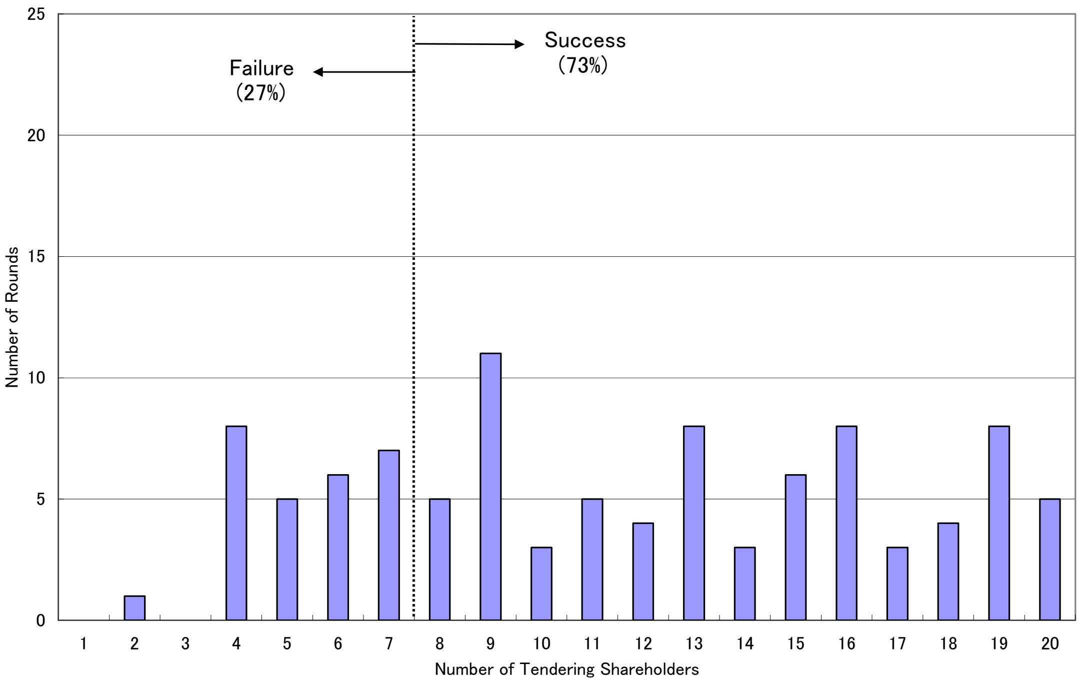
This table computes the tendering effect and the number effect in the results of both symmetric and asymmetric treatments with toeholds (ST and AT). The values in column (1) are the (actual) probability of takeover success in the no-toehold sessions. The values in column (2) are the hypothetically calculated probability of takeover success in the toehold sessions, and they are calculated by assuming that takeovers succeed when a bidder purchases 10 (not 8) shares or more. The values in column (3) represent the (actual) probability of takeover success in the toehold sessions. The tendering effect, column (4) can be calculated by subtracting column (1) from column (2); the number effect, column (5), can be calculated by subtracting column (2) from column (3); the total toehold effect, column (6), is the sum of these two effects. According to the theoretical predictions for the asymmetric information case, results for the bottom two rows are categorized by the range of the value of the post-takeover value (Z) (see Table 1).

Figure 1 The Distribution of the Rounds Classified by Number of Tendering Shareholders
Experiment SN (Symmetric information and No toeholds)



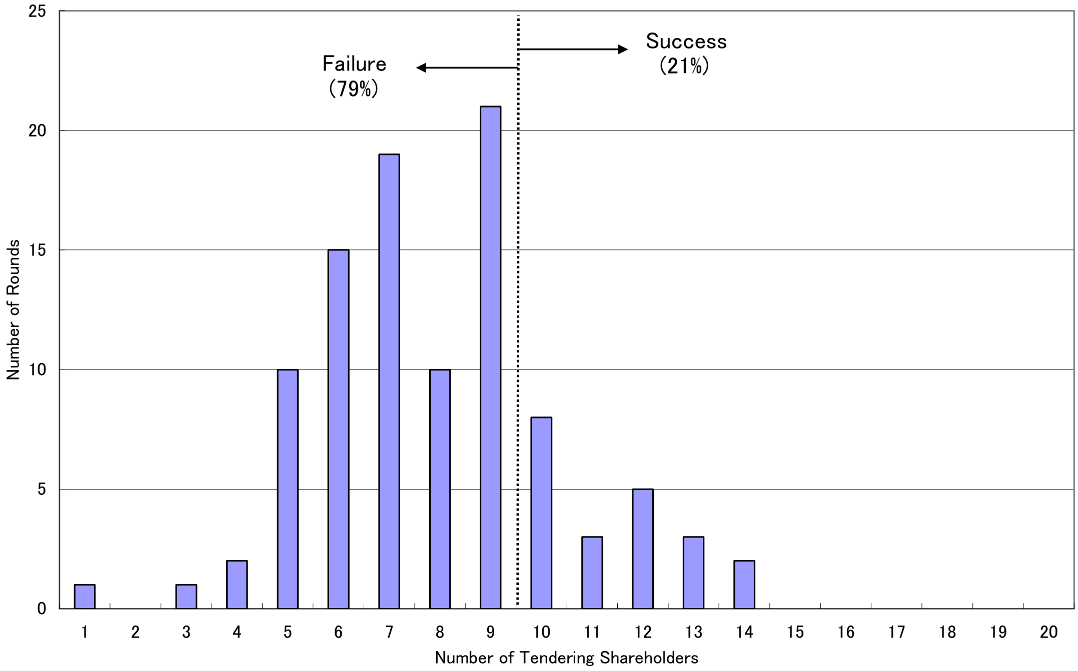
The distributions of the number of tendering shareholders under the symmetric information with no toehold are illustrated. The data counts how many times (rounds) each number of shareholders tendered in all sessions under the symmetric information with no toehold.

Figure 2 The Distribution of the Rounds Classified by Number of Tendering Shareholders
Experiment ST (Symmetric information and Toeholds)



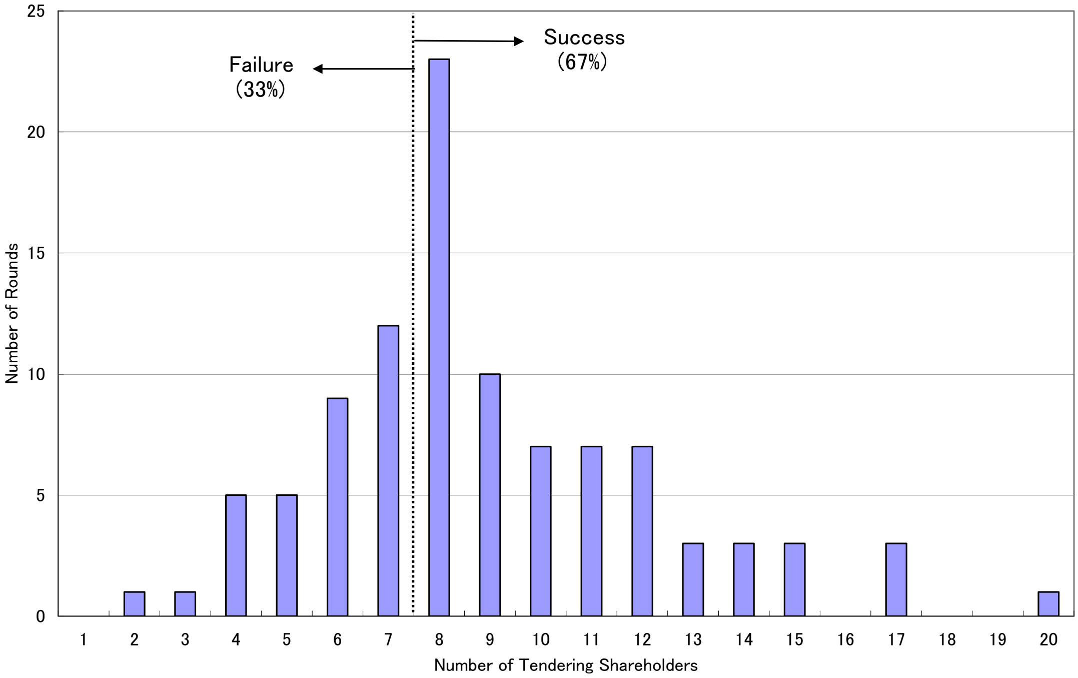
The distributions of the number of tendering shareholders under the symmetric information with toehold are illustrated. The data counts how many times (rounds) each number of shareholders tendered in all sessions under the symmetric information with toehold.

Figure 3 The Distribution of the Rounds Classified by Number of Tendering Shareholders
Experiment AN (Asymmetric information and No toeholds)



The distributions of the number of tendering shareholders under the asymmetric information with no toehold are illustrated. The data counts how many times (rounds) each number of shareholders tendered in all sessions under the asymmetric information with no toehold.

Figure 4 The Distribution of the Rounds Classified by Number of Tendering Shareholders
Experiment AT (Asymmetric information and Toeholds)



The distributions of the number of tendering shareholders under the asymmetric information with toehold are illustrated. The data counts how many times (rounds) each number of shareholders tendered in all sessions under the asymmetric information with toehold.

Appendix: Players Instructions for the No Toehold Case[26]

Overview of this Experiment

1. We will begin the explanation of this experiment with a recorded tape. The experimenter will operate the tape. After the explanation, you may ask questions.

2. You will draw an envelope. A piece of paper in the envelope assigns your role in this experiment.

3. If you are assigned to the role of Buyer, move to the seat to which the experimenter will guide you, taking everything on your desk with you.

4. There are both the sheets for the Buyer and the sheets for Sellers on your desk. Make sure that you have the sheets you will use in this experiment. Summary and Explanation, Individual Card, and Overview of this Experiment are on white papers. They are the same for both the Buyer and Sellers. Except for these white papers, the sheets for the Buyer are PINK, and the sheets for Sellers are GREEN. Make sure that you have the appropriate sheets for your role. The experimenter will distribute the Desired Purchasing Price Cards (pink) to the Buyer, and the Selling Decision Cards (green) to Sellers.

Make sure that you have the following:

Buyer

- Summary and Instructions (white)
- Individual Card (white) *Fill in your card before the experiment begins.
- Overview of this Experiment (white)
- Buyer's Record Sheet (pink)
- Desired Purchasing Price Cards (pink)
- Buyer's Payoff Sheet 1 (pink)
- Buyer's Payoff Sheet 2 (pink)
- Receipt (white) *Enter your name and address, and impress your seal before the experiment begins.
- Ballpoint pen.

Sellers

- Summary and Instructions (white)
- Individual Card (white) *Please fill in your card before the experiment begins.
- Overview of this Experiment (white)
- Sellers' Record Sheet (green)
- Selling Decision Cards (green)
- Sellers' Payoff Sheets (green)
- Receipt (white) *Enter your name and address, and impress your seal before the experiment begins.
- Ballpoint pen.

* Even if you are the Buyer (a Seller), you may refer to the sheets for Sellers (the Buyer).

5. Before this experiment begins, you may ask questions. If you have any questions during this experiment, raise your hand without saying a word. The experimenter will come to your seat.

6. We will start the first experiment. **Do not communicate with any other participant during the experiment**.

i. The experimenter will let the Buyer know the value (Z) of a commodity. If you are the

[26] This is a translation from the original Japanese. Instructions for the toehold case are the same except for the information about the buyer's initial commodity holdings. In the following footnotes, we show the places where the instructions are different.

Buyer, record the value on your Record Sheet. You are not to read the value aloud.

ii. If you are the Buyer, enter your desired purchasing price of the commodity in your Desired Purchasing Card for the said round, remove and hand it to the experimenter. You may take your time. If you are a Seller, please wait until the Buyer makes a decision.

iii. The experimenter will announce the commodity's desired purchasing price that the Buyer has decided. If you are a Seller, decide whether to sell your commodity or not. Mark the Selling Decision Card for the said round according to your decision, remove and place it face down on the right edge of your desk in such a way that the face of the card will not be seen by any other participant. The experimenter will collect your card.

iv. The experimenter will announce to all of the participants the value of Z and how many Sellers have sold the commodities. Record the announced value in your Record Sheet.

v. Record your payoff according to your Payoff Sheet(s).

*The experiment will be repeated twenty times.

7. When the twentieth round of the experiment has finished, the experimenter will say "We have finished this experiment," and this experiment will finish. Your Record Sheets will be collected. While the experimenter calculates your monetary reward, fill in our questionnaire.

8. Your reward for this experiment will be paid. Wait until your Individual Number is called.

9. When your Individual Number is called, come to the experimenter's desk with your Individual Card, Receipt and the questionnaire.

10. You will receive your reward. Enter the amount of money that the experimenter will tell you in the price column of your Receipt. Make sure that you have entered your name and address on the Receipt. Impress your seal if you have not done so already, and receive your reward.

Summary and Instructions

(Read the following while listening to the tape)

We will begin the instructions of this experiment from now. See *Summary and Instructions* on your desk.

Summary

This is an experiment in economic decision making. The instructions are simple, and if you follow them carefully and make good decisions, you would earn a considerable amount of money. The experiment will be repeated twenty times. In each repetition, or "round", your payoff will be calculated and the sum of your payoffs in all of the rounds will determine your actual payoff which will be paid in cash at the end of this experiment. Later we will explain how to calculate your payoff.

The experiment will be conducted between one Buyer and twenty Sellers of a commodity. Who is going to be the Buyer and who are going to be Sellers will be decided by lottery.

If you are the Buyer, you will offer the price at which you would like to buy the commodity, or your "desired purchasing price," to twenty Sellers. Each Seller possesses the commodity. He or she will choose "Sell" or "Not Sell", referring to the "desired purchasing price" offered by the Buyer.

During this experiment, neither the Buyer nor the Sellers are allowed to talk to any other participant. If somebody should talk, the experiment will be suspended. Also, you are asked to follow the various instructions given by the experimenter.

Instructions

When you sit down, make sure that the followings are on your desk.

-Summary and Instructions (this sheet) -Individual Card
-Buyer's Record Sheet -Record Sheets (for Sellers)
-Desired Purchasing Price Card and Selling Decision Card

(one small piece of pink paper and one small piece of green paper)
-Overview of this Experiment -Buyer's Payoff Sheet 1
-Buyer's Payoff Sheet 2 -Sellers' Payoff Sheet
-Receipt -Ballpoint pen

Fill in your *Individual Card*, and enter your name and address and impress your seal before the experiment begins.

Sellers' Record Sheet is for recording your information on this experiment, if you are a Seller.

Buyer's Record Sheet is for recording your information on this experiment, if you are a Buyer.

Desired Purchasing Cards are for entering the price at which you would like to buy the commodity (desired purchasing price), when you are a Buyer. Now you have only one Desired Purchasing Card. It makes a pair with the Selling Decision Card. For the experiment you will be given twenty cards. You will use one of them in each round. Remove and hand it to the experimenter.

Selling Decision Cards will be used if you are a Seller. You will enter your decision, "Sell", or "Not Sell" the commodity you have, in the cards considering the Desired Purchasing Price the Buyer will offer. Now you have only one Selling Decision Card. It makes a pair with the Desired Purchasing Card. For the experiment you will have twenty cards. For each round you will fill in one of them, remove and turn it over on the right hand side of your desk. The experimenter will collect it.

Overview of this Experiment is the summary of what the participants are to do in this experiment. Refer to it when necessary.

Next we will give you the instructions of this experiment.

Before we begin this experiment, we assign one of the participants to the role of Buyer and twenty to the role of Seller by lottery. In this experiment, whether you will be the Buyer or a Seller does not matter for the opportunity of earning money. The amount of the reward depends only on your decision and luck.

<u>Buyer (one person)</u>

Let us give the instructions to the Buyer. To begin with, put on your desk the Buyer's Record Sheet, Buyer's Payoff Sheet 2, and the Desired Purchasing Card (The pink one in a pair of small pieces of paper). The Buyer will use the pink sheets.[27]

Now you do not have any units of a commodity, and you are thinking of purchasing 10 units.[28] The value (Z) of the commodity per 1 unit varies from 0 to 200, at intervals of every 10 (0, 10, 20, 30, …, 180, 190, 200). From among these values, Z will be determined completely at random. At the beginning of each round, the experimenter will let you know the value of Z with a piece of paper. The value of Z will be revealed only to you, the Buyer, and you are not to show it to anyone. The value of Z may be different in each round.

The value (Z) of the commodity is realized, however, only when you can purchase 10 units, that is, only when you can get the offers of "Sell" from <u>10 Sellers or more</u> out of 20. If you can get the offers only from <u>9 Sellers or less</u>, the commodity has no value for you, and you are to stop purchasing it.[29]

Looking at the value of Z revealed by the experimenter, you will enter your "desired

[27] The color of the Buyer's materials is yellow in the toehold case.
[28] In the toehold case, the Buyer has 5 units of a commodity initially, and his or her goal is to purchase 8 more units.
[29] In the toehold case, the value (Z) of the commodity is realized only when 8 sellers or more agree to sell their units of commodity at the Buyer's offering price, while the Buyer stops purchasing any units when 7 sellers or less agree to sell.

purchasing price" or the price at which you would like to purchase one unit of the commodity, in your Desired Purchasing Price Card. Then you will show the card to the experimenter. You can offer the value from 0 to 200, at intervals of every 10 (0, 10, 20, 30, …, 280, 290, 300). Referring to your offer, each Seller will choose either "Sell" or "Not Sell". And your payoff will depend on whether 10 Sellers or more would choose "Sell" or "Not Sell".[30]

The way the Buyer's (your) payoff will be determined is summarized in the Buyer's Payoff Sheet on your desk. Let us explain how to use it. Suppose that more than eight Sellers agreed to "sell", and let this case be "Case 1". Then your payoff will be:

(Z – desired purchasing price) × 10.[31]

For example, if Z is 150 and the desired purchasing price you offer is 100, then your payoff will be:

(150 – 100) × 10 = 500.[32]

Your payoff in this "Case 1" is shown in Buyer's Payoff Sheet 2 as well. Looking at Buyer's Payoff Sheet 2, you will find your payoff 500 at the box where the column of Z 150 and the row of the desired purchasing price 100 intersect.

On the other hand, suppose only 9 Sellers or less agreed to "sell", and let this case be "Case 2". In this case, the commodity will have no value for you. Therefore you will stop purchasing the commodity. You can see in Buyer's Payoff Sheet 1, your payoff will be zero.[33]

We will explain the Buyer's payoff patterns with some simple examples.

Example 1 Suppose that the value of Z you were shown (the value of the commodity for you) was 130, that then you offered 90 as your desired purchasing price, and that 15 Sellers agreed to "sell" referring to your offer. This case is "Case 1", since 10 Sellers or more agreed to sell the commodity. Therefore your payoff would be, according to Sellers' Payoff Sheet 1,

(130 – 90) × 10 = 400.

This can also be confirmed with Buyer's Payoff Sheet 2. On Buyer's Payoff Sheet 2, you will find your payoff 400 at the box where the column of Z 130 and the row of the desired purchasing price 90 intersect.[34]

Example 2 Similarly, suppose that the value of Z was 130 and that you offered 90 as your desired purchasing price. Then, suppose also that 10 Sellers agreed to "sell". This case is "Case 1" as well, since 10 Sellers or more agreed to sell the commodity. Therefore your payoff would be 400, as in *Example 1*. The result is recorded at Example 2 on the Sellers' Record Sheet.[35]

Example 3 Next, suppose that the value of Z was 80, that your desired purchasing price was 140 and that 11 Sellers agreed to "sell". This case is also "Case 1", since 10 Sellers or more agreed to sell. Then your payoff would be, according to Buyer's Payoff Sheet 1,

(80 – 140) × 10 = –600,

so that you would lose 600. This can be confirmed with Buyer's Payoff Sheet 2. On the Payoff

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30 In the toehold case, the Buyer's payoff depends on whether 8 sellers or more sell their units of commodity or not.

31 In the toehold case, the Buyer's payoff formula is Z × 5+(Z – desired purchasing price) × 8.

32 In the toehold case, this example was written as 150×5+(150–100)×8=1150.

33 In the toehold case, this case is when 7 sellers or less agree to sell.

34 In example 1 in the toehold case instructions, 12 sellers agree to sell. The value of Z and the buyer's purchasing price are the same. Therefore the buyer's payoff in this example is 130× 5+(130 – 90) × 8=970.

35 In example 2 in the toehold case instructions, 8 sellers agree to sell. The value of Z and the buyer's purchasing price are the same.

Sheet of Buyer 2, you will find your payoff – 600 at the box where the column of Z 80 and the row of the desired purchasing price 140 intersect. The result is recorded at Example 3 on the Sellers' Record Sheet.[36]

Example 4 Suppose that the value of Z was 190, that your desired purchasing price was 100 and that 7 Sellers agreed to "sell". [37]This case is "Case 2", since 9 Sellers or less agreed to sell. Therefore, according to Buyer's Payoff Sheet 1, your payoff would be zero. As an exercise, record the result of *Example 4* in the Sellers' Record Sheet.

Taking these things in to account, in each round you will decide at what price you would like to purchase the commodity or your "desired purchasing price". Then you will enter it into the Desired Purchasing Card, and hand the card to the experimenter.

The above are the instructions for the Buyer in one round. You may see the sheets for the Sellers as well. However, make sure that you do not confuse the sheets for the Buyer with those for the Sellers.

<u>Sellers (20 persons)</u>

Now let us give the instructions to the Sellers. To begin with, put on your desk the Sellers' Record Sheet, Sellers' Payoff Sheet, and the Selling Decision Cards (the small green pieces of paper). The Sellers will use the green sheets.[38]

If you are a Seller, you have one unit of a commodity. You will choose either "Sell" or "Not Sell", referring to the "desired purchasing price" offered by the Buyer.

Your payoff depends not only on your decision whether to "Sell" or "Not Sell", but also on those of <u>the other Sellers</u>. However, you will not know <u>the other Sellers'</u> decisions when you make your own decision.

As for how your payoff will be determined, see the Sellers' Payoff Sheet. Now we will explain how to use this sheet. If 10 Sellers or more <u>other than you</u> agreed to "sell" ([Case A] in the Sellers' Payoff Sheet), your payoff will be determined as follows.[39] If you choose "Sell", your payoff will be the "desired purchasing price" offered by the Buyer. Instead, if you choose "Not Sell", your payoff will be "the value of Z for the Buyer". At the beginning of this experiment, the experimenter will reveal the value of Z to the Buyer, but not to you. At the end of each round, however, the experimenter will announce the value of Z to all of the participants.

Next, if 9 Sellers or less <u>other than you</u> agreed to "sell" ([Case B] in the Sellers' Payoff Sheet), your payoff will be zero, regardless of your choice of "Sell" or "Not Sell".[40]

In order to make sure, we will explain the payoff patterns of Sellers with three simple examples.

Example 5 Suppose that you chose "Sell" at the desired purchasing price 130 offered by the Buyer, and that 15 Sellers agreed to "sell" at the same time.[41]In this case, the number of Sellers <u>other than you</u> who sold the commodity is 14. This is [Case A], since 10 Sellers or more <u>other than you</u> agreed to "sell". Since you chose "Sell", according to the Sellers' Payoff Sheet, your payoff would be the "desired purchasing price offered by the Buyer", that is, 130. The result is recorded at Example 5 of the Sellers' Record Sheet. There "the value of Z announced by the

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[36] In example 3 in the toehold case instructions, 10 sellers agree to sell. The value of Z and the buyer's purchasing price are the same. Therefore the buyer's payoff in this example is 80×5+(80 – 140) × 8 = –80.

[37] In example 4 in the toehold case instructions, 5 sellers agree to sell.

[38] The color of the seller's materials is blue in the toehold case.

[39] In the toehold case, this is the case when 8 sellers or more other than the seller agree to sell.

[40] In the toehold case, this is the case when 7 sellers or less other than the seller agree to sell.

[41] In example 5 in the toehold case instructions, 14 sellers agree to sell. The value of Z and the buyer's purchasing price are the same.

experimenter" is 80, but it has nothing to do with your payoff in the case of Example 5.

Example 6 Suppose that you chose "Not Sell" at the desired purchasing price 120 offered by the Buyer, and that 12 Sellers agreed to "sell". In this case, the number of Sellers other than you who sold the commodity is 12. This is [Case A], since 10 Sellers or more other than you agreed to "sell". However, your payoff would be, according to the Sellers' Payoff Sheet, Z (the value of the commodity for the Buyer), because you chose "Not Sell". The value of Z will be announced at the end of each round. If Z is 100 then your payoff would be 100, and if Z is 150 then your payoff would be 150. The result is written at Example 6 of the Sellers' Record Sheet.

Example 7 Suppose that you chose "Sell" at the desired purchasing price 80 offered by the Buyer, and that 6 Sellers agreed to "sell". In this case, the number of Sellers other than you who sold the commodity is 5. This is [Case B], since 9 Sellers or less other than you agreed to "sell". Therefore, according to Sellers' Payoff Sheet, your payoff would be 0. Suppose the value of Z announced at the end of the round was 140. However, in this *Example*, the value of Z has nothing to do with your payoff. As an exercise, record the result of Example 7 in the Sellers' Record Sheet.[42]

Taking into account the instructions mentioned so far, in each round the Sellers will choose either "Sell" or "Not Sell", referring to the desired purchasing price offered by the Buyer that the experimenter will announce, and fill in the Selling Decision Card with a circle.

The above are the instructions for the Sellers in one round. You may see the sheets for the Buyer as well. However, make sure that you will not confuse the sheets for Sellers with those for the Buyer.

These are the instructions for one round. At the end of each round, the experimenter will announce to all the participants the value of Z and the number of the Sellers who agreed to "sell" the commodity. Based on the announcement, confirm your payoff and record it in the Record Sheet.

How to fill in the Record Sheet

Buyer

- i. Enter the value of Z revealed by the experimenter in the Buyer's Record Sheet.
- ii. Choose your desired purchasing price from 0 to 300 at intervals of every 10 (0, 10,20, …, 280, 290, 300).
- iii. Enter the desired purchasing price in the Desired Purchasing Price Card, remove, and hand it to the experimenter.
- iv. Enter the desired purchasing price also in the Buyer's Record Sheet.
- v. Enter the number of the Sellers who agree to "sell" the commodity, which will be announced by the experimenter, in the Buyer's Record Sheet.
- vi. Enter your payoff in the Buyer's Record Sheet (see Buyer's Payoff Sheet 1 and Buyer's Payoff Sheet 2).

Sellers

- i. Enter the Buyer's desired purchasing price announced by the experimenter in the Sellers' Record Sheet.
- ii. Choose either "Sell" or "Not Sell" and enter it in the Sellers' Record Sheet and the Selling Decision Card.
- iii. Remove the completed Selling Decision Card, and hand it to the experimenter.
- iv. Enter the value of Z and the number of the Sellers who agree to sell the commodity, which will be announced by the experimenter, in the Sellers' Record Sheet.
- v. Enter the number of the Sellers other than you who sold the commodity in the Sellers' Record Sheet.
- vi. Enter your payoff in the Sellers' Record Sheet (see Sellers' Payoff Sheet).

[42] In example 7 in the toehold case instructions, the buyer's purchasing price is 180.

*In the Sellers' Record Sheet, how your payoff will be determined is mentioned on the right hand side of the column in which you will fill in each round. This is the same as the Sellers' Payoff Sheet. Refer to it when you record your payoff.

Finally, we will explain how the amount of money you receive is determined. The amount of money depends on "Your Payoff" in each round. It is calculated as follows.

The Buyer's monetary reward is:

1,000 + (the sum of "Your Payoff") yen.[43]

For example, if the sum of "Your Payoff" in all of the rounds is 3,000 you will receive:

1,000 + 3,000 = 4,000 yen.

Next, a Seller's monetary reward is:

1,000 + 3× (the sum of "Your Payoff") yen.[44]

For example, if the sum of "Your Payoff" in all of the rounds is 3,000 you will receive:

1,000 + 3× 1,000 = 4,000 yen.

This is the end of the instructions of this experiment. If you have any questions, raise your hand without speaking. The experimenter will come to your desk.

[43] The buyer's monetary reward formula in the toehold case is (1000+0.5× (the sum of payoffs throughout the experiment)) yen.

[44] The monetary reward formula for a seller in the toehold case is (1000+2×(the sum of payoffs throughout the experiment)) yen.