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Abstract

We explore experimentally whether the free-rider problem occurs in corporate takeovers. While Grossman and Hart's (1980) classical proposition states that due to the free-rider problem takeovers never succeed, we observe a considerable number of successful takeovers in real capital markets. To solve this paradox, we conducted an experimental study by constructing simple laboratory markets of atomistic shareholders. We found the following. First, free-rider problems did occur in our laboratory; only 20% of takeovers were successful and consequently 80% of social value disappeared. Second, a bidder's initial shareholdings significantly mitigated the free-rider problem; the probability of takeover success rose to 71.3% when a bidder initially held the shares of the target firm. Based on these experimental results, we argue that the free-rider problem potentially exists in real takeover markets as well, but that the bidder's initial shareholdings may make takeovers successful in reality.

I. Introduction

In a widely held firm, the separation of ownership and control is a serious matter for shareholders. Corporate managers do not necessarily pursue shareholders' wealth. To cope with this matter, shareholders have two alternatives, "voice" and "exit" (Hirschmann (1970)). Even if a small shareholder cannot take the former option, she can take the latter (much easier) route by selling her shares. If the buyer purchases progressively more shares from these shareholders and succeeds in holding half of the company's shares, the buyer obtains control and can improve the management of the firm. Thus, small shareholders do not have to worry about the risk of incurring loss due to bad management.

This is the well-known story of the takeover mechanism. About twenty years ago, however, Grossman and Hart (1980) challenged this "optimistic story". They suggest that this type of corporate takeover *never* succeeds. The reason is that if a small shareholder knows that her share value will rise due to the improvement in management after the takeover success, she prefers to hold on to her shares rather than selling them. That is, no shareholder sells her own shares when she expects others to sell. In other words, the shareholder attempts to free-ride on the benefit of a successful takeover. This selfish behavior of shareholders, however, results in the socially inefficient outcome that takeovers will never be successful. This is the free-rider problem in corporate takeovers that Grossman and Hart (1980) discuss.[1]

Grossman and Hart's (1980) story is widely known, and their theoretical conclusion seems to have already become a classical proposition.[2] It is accepted as a starting point for a considerable number of theoretical models of corporate takeovers (e.g., Shleifer and Vishny (1986), Bradley, Desai, and Kim (1988), Bagnoli and Lipman (1988), Bebchuk (1989), Hirshleifer and Titman (1990), Holmstrom and Nalebuff (1992), etc.).[3] However, turning to real takeover markets, we have to be skeptical of this proposition. We observe that a significant number of corporate takeovers have been successful over the past few decades. Hoffmeister and Dyl (1981) find that among 84 cash tender offers made during 1976 and 1977 in the U.S., 73.8% of them (62 offers) were successful. Walking (1985) reports that using his U.S. sample of 108 takeover offers during 1972-76, 66.7% of them (72 offers) succeeded. Duggal and Millar (1994) examine 287 tender bids involving firms listed on the New York Stock Exchange or the American Stock Exchange during the period 1984-1987, and show that the probability of takeover success is

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[1] Bradley (1980) presents a similar idea. He also suggests that synergy gains from consolidating the two firms make a takeover successful even if the free-rider problem exists.

[2] For example, Bebchuk (1989) states in the introduction to his paper, "In an already classical paper, Grossman and Hart (1980) advanced the proposition … ".

[3] Hirshleifer (1995) presents a good survey of various takeover models.

55.4% (159 of 287 succeeded). Also, Jensen (1993) convincingly shows that the market for corporate control was especially active in the U.S. during the 1980s and suggests that a lot of successful takeovers play roles in improving corporate efficiencies and raising social welfare. These results and views, at first glance, seem to support the “optimistic story” of takeovers rather than Grossman and Hart’s classical proposition: the takeover mechanism actually works and there is no serious free-rider problem preventing takeover success[4].

Observing this reality, people outside the economics would criticize Grossman and Hart’s result. In particular, among other things, they would insist that the assumption of rational shareholders is unrealistic. Some would say, “I do not agree with Grossman and Hart. I would guess that some shareholders sell their shares and takeovers may be successful, because shareholders are not as rational as economists say.” Others would say, “In reality, shareholders do not know how high their share values will rise after the takeover, so they would choose to sell shares if the price offered by the bidder (buyer) is higher than the current market price.” We consider that these critics should not be ignored, since recent developments in experimental economics indicate that people do not necessarily behave rationally (see, for example, Thaler (1992)).

Against these critics, financial economists would argue as follows, “Grossman and Hart’s proposition is right. But in real capital markets there are several economic factors or institutional environments that do not appear in Grossman and Hart’s model. These factors or environments must mitigate the free-rider problem and produce a successful takeover”. Indeed, subsequent takeover models give some theoretical foundations for this argument. Shleifer and Vishny (1986) and Hirshleifer and Titman (1990) suggest that a bidder’s initial shareholdings may overcome the free-rider problem. Bradley, Desai, and Kim (1988) also show 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 the number of shareholders is finite, the free-rider problem is alleviated and successful takeovers are possible. Also, Grossman and Hart (1980) themselves suggest that a dilution opportunity for a bidder may make takeovers successful. Thus, it is possible that we may observe successful takeovers in real capital markets even if free-rider problems in the Grossman and Hart’s sense potentially exist.

Therefore, from our casual observations, it is not clear whether Grossman and Hart’s story

[4] Interestingly, the well-known corporate finance textbooks, Brealey and Myers (1991) and Ross, Westerfield, and Jaffe (1996) do not mention the free-rider problem in corporate takeovers although they discuss mergers and acquisitions and present empirical evidence on the effects of takeovers. Also, in a survey article for corporate takeovers in the *Journal of Economic Perspectives*, Jarrell, Brickley, and Netter (1988) do not cite Grossman and Hart (1980) either. Do these imply that the free-rider problem is less important in actual takeover markets?

applies to corporate takeover markets. We consider it necessary to examine the appropriateness of Grossman and Hart's model by presenting empirical evidence, because the results of such an examination would have important implications for real takeover markets and financial economics. Let us suppose that we find Grossman and Hart's model rejected in reality. Then, we can believe the optimistic story of takeovers, and investors do not have to worry about bad management. At the same time, however, we must question the value of recent takeover models since these models have evolved from Grossman and Hart's model. Next, let us suppose the opposite case, that is, we find that Grossman and Hart's model is accepted in reality. Then, bidders must be serious about the free-rider problem and need to find ways to mitigate this problem. In this case, we recognize the significance of takeover models that show bidders how to succeed in takeovers and give us insights into appropriate public policies to prevent the free-rider problem.

Numerous empirical studies on corporate takeovers[5], however, have made few contributions to testing Grossman and Hart's model. This must be because empirical research uses field data affected by many different factors in complicated real takeover markets (some of which may be the factors pointed out by subsequent takeover models), and hence it is difficult to test Grossman and Hart's model directly. On the other hand, experimental studies, in general, have an advantage in controlling factors that do not appear in the model and testing the model directly. For this reason, we adopt an experimental approach in this paper. We construct simple laboratory markets for corporate takeovers comparable to Grossman and Hart's model, and examine how severe the free-rider problem is in our laboratory markets.[6]

In addition, we explore the effect of a bidder's initial shareholdings on takeover success. The bidder's initial shareholdings are regarded by financial economists as one of the means of solving the free-rider problem. As we briefly mentioned above, Shleifer and Vishny (1986) and Hirshleifer and Titman (1990) argue that when a bidder initially holds the shares of the target firm, she can internalize the benefits of the takeover, thus overcoming the free-rider problem (takeovers may be successful). We examine whether their story is actually supported in our laboratory. In real U.S. capital markets, Walking's (1985) empirical study finds a positive effect of the bidder's initial shareholdings on takeover success, which is in line with the prediction of the above two models. This positive effect, however, may stem from various other factors in reality, such as the bidder's influence on the target management or the shareholders' fear of becoming inactive minorities, as Walking (1985) suggests. Our experiment gives an opportunity

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[5] See, survey articles by Jensen and Ruback (1983) and Jarrell, Brickley, and Netter (1988).

[6] As for the free-rider problem in the provision of public goods, there have been a huge number of experimental studies and several interesting findings are reported (see survey articles by Davis and Holt (1993) and Ledyard (1995)). We will mention them later.

to test Shleifer and Vishny's (1986) and Hirshleifer and Titman's (1990) models directly. Also, conducting experiments in this initial shareholdings case as well as in the Grossman and Hart case (with no initial shareholdings), we can check whether the Grossman and Hart case shows a severer free-rider problem than the initial shareholdings case, as theory suggests.

In attaining our aim, we must confront one problem with experimental settings: how to construct an atomistic shareholders world in the laboratory. The models we test (Grossman and Hart (1980), Shleifer and Vishny (1986), and Hirshleifer and Titman (1990)) all assume that each shareholder is *atomistic* in the sense that she ignores her impact on the outcome of the takeover in making her tender decision. We should notice that the results of these models (e.g. Grossman and Hart's proposition) crucially depend on this atomistic shareholders assumption, as Bagnoli and Lipman (1988) point out. The atomistic shareholders assumption is naturally satisfied in the case where there are an infinite (or a very large) number of shareholders, each of whom owns a negligible (very small) proportion of the firm. In conducting experiments, however, we cannot gather an infinite number of participants, and hence it seems difficult to create the atomistic shareholders' world in the laboratory. We deal with this difficulty by developing an original experimental device where each shareholder takes her decision as if she were an atomistic shareholder even in the finite-participant laboratory. We believe that this device is innovative and can be applied to other experiments dealing with atomistic agent markets.

To our knowledge, there have been two experimental studies of corporate takeovers. One is Kale and Noe's (1997) study which compares the predictions of finite (*non-atomistic*) shareholder models (Bagnoli and Lipman (1989) and Holmstrom and Nalebuff (1992)) with the outcomes of laboratory experiments. Their experimental results support these models in some designs, but do not in other designs. Also, Cadsby and Maynes (1998) test Holmstrom and Nalebuff's (1992) model in a laboratory environment where shareholders own more than one share, and find that their experimental results are inconsistent with that model's predictions. Our study differs from Kale and Noe (1997) and Cadsby and Maynes (1998) in four respects. First, most importantly, we test the takeover models of *atomistic* shareholders as discussed by Grossman and Hart (1980), whereas the previous two studies test the models of *non-atomistic* (finite) shareholders. Second, as we mentioned above, we also investigate the effect of a bidder's initial shareholdings on mitigating the free-rider problem. Third, our experiments involve a bidder's bidding behavior as well as shareholders' tendering decisions following the story of the takeover models, while the previous two studies only involve the latter. Fourth, we introduce informational asymmetry about the share value after a successful takeover (only a bidder knows it) because this setting seems more realistic in corporate takeover markets.

From our laboratory, we find the following. First, the free-rider problem is severe in our laboratory markets: only 20% of takeovers are successful when a bidder has no initial shares (Grossman and Hart's case). This result indicates that corporate takeovers tend to fail and consequently most of the potential social value from successful takeovers disappears due to the free-rider problem. In this sense, we can say that Grossman and Hart's model contains valuable message in understanding the nature of takeover markets. Second, the initial shareholdings by a bidder considerably mitigate the free-rider problem in corporate takeovers: about 70% of takeovers succeed when a bidder initially holds shares in the target firm. This result is consistent with the theoretical predictions presented by Shleifer and Vishny (1986) and Hirshleifer and Titman (1990). It also suggests that the initial shareholdings held by the bidder may be one reason for the successful takeovers observed in real takeover markets.

This paper is organized as follows. Section II reviews theoretical models of corporate takeovers that analyze the free-rider problem in atomistic shareholders markets. Section III describes our laboratory takeover markets and explains experimental procedures. Section IV presents the hypotheses to be tested. Section V discusses our experimental results. Section VI analyzes each participant's behavior and points out some anomalies observed in our laboratory. Finally, Section VII summarizes our findings and examines their implications.

II. Theoretical Overview

In this section, we briefly review three takeover models that analyze the free-rider problem under the atomistic shareholder assumption. First, we illustrate Grossman and Hart's (1980) classical proposition that corporate takeovers *never* succeed. We show that their proposition holds under both symmetric and asymmetric information. Second, we discuss the results of Shleifer and Vishny (1986) and Hirshleifer and Titman (1990) in which initial shareholdings by the bidder play the crucial role in solving the free-rider problem.

A. Corporate Takeovers and the Free-rider Problem

Suppose that one bidder (raider) attempts to take over the firm by purchasing the firm's shares from atomistic shareholders. The bidder does not initially hold any shares of the target firm, and she offers a bid price per share x to the shareholders. The shareholder observes x and decides whether to tender her shares. If the bidder can successfully purchase 50% of the total number of the firm's shares, S, then she succeeds in the takeover, gains control of the firm, and improves the value of the firm by the amount $z > 0$ per share. If she cannot acquire 0.5 of the shares, then she fails in the takeover, does not purchase any shares (the bidder makes a conditional offer)[7],

[7] In this paper, we explore Grossman and Hart's (1980) model under a conditional offer. This seems

and cannot realize the increase in firm value. We assume, for simplicity, that the pre-takeover value of the firm under the incumbent management is zero[8]. Since z is positive, it is obvious that the success of the takeover produces social benefits. Then, the important point to explore is whether or not such a value-increasing takeover can succeed in a world of rational bidders and shareholders.

Grossman and Hart (1980) argue that this type of takeover *never* succeeds. They deduce this striking result by pointing out there is a free-rider problem among shareholders as follows.

If the takeover is successful, the bidder's profit is 0.5S (z - x). Therefore, to obtain some gain from this takeover, the bidder must make the bid x smaller than the post-takeover value of the share z, i.e., $x < z$. In Figure 1-A, this bidder-profitability condition is shown as the area under the $x = z$ line.

Next, let us consider the shareholders' decisions. First, suppose that the takeover is successful. Then, the shareholder can obtain the bid price x per share if she has chosen to tender shares whereas she obtains z per share if she rejects the offer and holds on to her shares. On the contrary, suppose that the takeover is unsuccessful. Then, no transactions occur between the bidder and shareholders, and hence the shareholder earns zero profits whether or not she has chosen to tender her shares. This shareholder's payoff is summarized in Table 1. In addition, since each shareholder is atomistic, her tender decision has no impact on the outcome of the takeover. Under these conditions, the (weakly) dominant strategy for the shareholder is to accept the offer if $x \geq z$, and to reject the offer if $x < z$. This shareholder-acceptability condition ($x \geq z$) is indicated by the area above the $x = z$ line in Figure 1-A.

Observing Figure 1-A, we realize that there is no x which satisfies both the bidder-profitability and the shareholder-acceptability conditions for any z, that is, takeovers which benefit the bidder can never succeed. To understand this impossibility result, suppose that the bidder makes the bid, $x_0 < z_0$, to earn the profits 0.5S (z_0 - x_0). Shareholders, however, will reject this offer. Each shareholder, while on the one hand holding his shares, on the other hand expects other shareholders to accept the offer and make the takeover successful, and attempts to obtain the post-takeover value z_0 which is greater than the bid price x_0. That is, she does not contribute to the success of the takeover, but seeks to free ride on the benefit of its success. This self-interested behavior of each shareholder, however, leads to the socially inefficient outcome that a value-increasing takeover always fails. This is Grossman and Hart's (1980) classical

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to be standard among recent treatments of the free-rider problem in takeovers, although Grossman and Hart themselves assume an unconditional offer (an offer committing the bidders to purchase tendered shares whether or not takeovers succeed). See, Hirshleifer (1995) and Grinblatt and Titman (1998).

[8] This assumption is the same as that in Hirshleifer and Titman (1990).

proposition.

Grossman and Hart (1980) show this proposition under the assumption that the post-takeover value of the target firm z is known to both the bidder and the shareholders. In our paper, however, we wish to explore whether this proposition holds under the assumption that there is information asymmetry regarding z between a bidder and the shareholders. We assume that the bidder, who attempts to takeover the firm and to earn considerable profits, knows z, but atomistic shareholders do not. The reason why we examine this asymmetric information case is that it is closer to real-world capital markets. In actual takeover markets, it is plausible that shareholders do not know the post-takeover value (z), and hence whether they can predict z is a disputable issue. Indeed, subsequent theoretical models of corporate takeovers, such as Shleifer and Vishny (1986), Hirshleifer and Titman (1980), and Chowdhry and Jegadeesh (1994), assume asymmetric information regarding the post-takeover value and examine how shareholders formulate their expectations of that value. Therefore, throughout this paper, we explore the free-rider problem and the possibility of takeover success under this information asymmetry setting.

Does Grossman and Hart's (1980) proposition still hold in the world of asymmetric information? The standard answer of modern economics would be "Yes". In the world where z is private information for a bidder, a shareholder must have some prediction of z in order to determine her action. However, as long as the shareholder is *rational*, she realizes that the bidder makes the offer $x < z$ to earn profits, and hence the shareholder predicts that x is lower than z. Thus, the shareholder prefers to reject the offer, hoping to free ride and obtain z if the takeover is successful. Therefore, even under asymmetric information, the free-rider problem among rational shareholders means that takeovers never succeed.[9]

This prediction that takeovers never succeed also implies that there is no relation between the probability of takeover success and the bid price x. Whatever x the bidder chooses, rational shareholders expect that x is lower than z. Hence shareholders reject the offer and takeovers always fail. Therefore a high bid price offered by a bidder does not increase the probability of takeover success at all.

From the above discussion, we restate Grossman and Hart's (1980) proposition under the asymmetric information setting.

Proposition 1 (Grossman and Hart (1980))

When the post-takeover value z is unknown to atomistic shareholders and the bidder has no initial shareholdings,

1-1. takeovers can never be successful, and

[9] Shleifer and Vishny (1986) show this result as a special case of their model.

1-2. no relation exists between a bid price x and the probability of success.

Proposition 1 implies that "the free-rider problem remains when asymmetric information is introduced" (Hirshleifer (1995), pp.845). We believe that this proposition is persuasive for most academic economists, since the model is based on the usual assumption of economics that "people are both rational and selfish" (Dawes and Thaler (1988), pp.187). In the above model, in deriving the proposition, we assume that shareholders (i) maximize their own profits, (ii) fully understand that they gain x by accepting the offer and z by rejecting it in a successful takeover, and (iii) rationally predict that x is lower than z.

This presumption, however, is not without its critics. People outside the economics profession may consider that human beings do not behave as economists assume, but that they sometimes choose irrational or altruistic behavior. If this is true, some shareholders may not satisfy the above conditions, (i), (ii), or (iii), and might indeed sell shares to the bidder if offered a positive bid (x). Considering the possibility of such behavior, it is probable that takeovers sometimes succeed and that the probability of success is increasing with the bid level x. In addition, as we mentioned in the introduction, we observe a considerable number of successful takeovers in real financial markets. This evidence also makes us skeptical of whether there exists a severe free-rider problem in corporate takeover markets, motivating our experiments.

B. The Bidder's Initial Holdings and the Takeover Success.

Next, consider the case where the bidder initially holds some shares of the target firm. Let α represent the proportion of the firm's shares owed by the bidder (we assume $0 < \alpha < 0.5$). Then, the bidder's profits from the successful takeover can be written as

$$[\alpha z + (0.5 - \alpha)(z - x)]\, S \qquad (1)$$

Notice that the bidder obtains some gains (αz) from her initial holdings if takeovers are successful. In other words, the bidder can internalize a part of the increase in firm value generated by successful takeovers. This means that the bidder with initial holdings has a greater incentive to make the takeover succeed and can also afford to offer a higher bid to facilitate shareholders' acceptance. In fact, the bidder-profitability condition (which assures the bidder of positive profits from successful takeovers) in this case can be written as

$$x < [0.5/(0.5-\alpha)]z. \qquad (2)$$

As $[0.5/(0.5-\alpha)]$ is greater than 1, (2) implies that the bidder can make the bid x greater than z. This bidder-profitability condition is shown in Figure 1-B.

Noting that the shareholders'position is the same as in the previous case, we also show the shareholder-acceptability condition ($x > z$) in Figure 1-B is exactly the same as that in Figure 1-

A. The point to observe is that there are x's which satisfy both the bidder-profitability and the shareholder-acceptability conditions for all z. This suggests that when both the bidder and the shareholders know z (information is symmetric), the bidder can always make a bid which is accepted by the shareholders. For example, as shown in Figure 1-B, to succeed in a takeover, the bidder has only to offer $x = x_0^*$ when $z = z_0$, and $x = x_1^*$ when $z = z_1$. Therefore, under symmetric information regarding z, the bidder who initially holds the shares of the target firm can succeed in value-increasing takeovers. In other words, the free-rider problem in corporate takeovers can be solved by the bidder's initial holdings.

However, under the more realistic assumption of information asymmetry between a bidder and shareholders, the story is not as simple. When z is private information for a bidder, the bidder has an incentive to pretend that her z is low, to make a lower bid x, and to extract larger profits. For example, in Figure 1-B, a z_0-bidder (a bidder whose z is z_0) may dishonestly say that his z is z_1, and offer x_1^* instead of x_0^*. If the shareholders believed that this bidder's statement ($z = z_1$) was true and accepted a lower offer x_1^*, they would lose profits of ($x_0^* - x_1^*$) per share. Therefore, when shareholders do not know the bidder's z, they have to predict the true value of z by themselves, compare its expectation with x, and decide whether to accept the offer. How do shareholders formulate expectations for the unknown z in this case?

The answer to this question from economic theory is that *rational* shareholders predict z by observing the bid price x offered by a bidder; shareholders use the bid price as a signal which reveals the bidder's private information about z. This logic is employed in the following two papers.

First, Shleifer and Vishny (1986) claim that shareholders predict z by using the bidder-profitability condition (2). They argue that rational shareholders would recognize that the bidder must make a profitable bid and hence the bid satisfies (2). Then after observing the bid x, shareholders would rationally expect that $z > [(0.5-\alpha)/0.5]\ x$ from (2). Given this expectation formation, Shleifer and Vishny (1986) show that when the bid x is greater than a critical value x_c, x becomes larger than the shareholders' expected value of z.[10] Thus, with a bid greater than x_c,

[10] Let us develop this point in more detail. For expositional simplicity, assume that z's prior distribution is uniform on [0, z_{max}]. Then, from (2), the shareholders' conditional expected value of z, E(z | x), is

$$E(z \mid x) = [\ [(0.5-\alpha)/0.5]x + z_{max}\ ]/2. \qquad \text{(N-1)}$$

For the shareholder to accept an offer, the bid x must be larger than this expected value of z. Hence, we can state the shareholder's acceptability condition as

$$x \quad > \quad [\ [(0.5-\alpha)/0.5]x + z_{max}\ ]/2. \qquad \text{(N-2)}$$

Notice that as a bidder makes the bid x (the left-hand side) higher, shareholders' expectation of z (the right-hand side) becomes higher, but the latter increase is not as large as the former (dE(z | x)/dx is positive but less than one). Therefore, we know that there exists an x which satisfies (N-2).

shareholders accept offers and takeovers are successful. That is, Shleifer and Vishny's (1986) model suggests that takeovers by an initial shareholder may be successful and that there is a positive relationship between a bid price and the probability of takeover success (more precisely, the probability of success is an increasing step function of the bid price). These results are in sharp contrast with Proposition 1 presented earlier.

Hirshleifer and Titman (1990) obtain similar results by using the same setting as Shleifer and Vishny (1986), but employing a more sophisticated equilibrium concept, the perfect Bayesian equilibrium. They show that in a perfect Bayesian equilibrium of the takeover game, the takeover succeeds probabilistically and the probability of takeover success P(x) is continuously increasing in the bid price x (i.e., $P'(x) > 0$). They obtain these results by introducing the assumption that shareholders have some personal costs of tendering, c, which are unknown to the bidder.

To understand their model, suppose that shareholders predict the post-takeover value z correctly. Then, the shareholder tenders her shares if $x-c > z$. The bidder, however, does not know c, and hence is uncertain whether or not shareholders will accept the bid. Consequently, takeovers succeed probabilistically. The bidder, however, knows that the larger x she offers, the greater the likelihood that $x-c > z$ (shareholders accept the bid), and hence the probability of success increases with the bid x ($P'(x) > 0$). On the other hand, perceiving $P'(x) > 0$, a high z bidder, who has more to gain from a successful takeover, is willing to bid higher (i.e., $dx/dz > 0$) to increase the probability of success. This bidding behavior, however, fully reveals the bidder's private information on z to shareholders. That is, shareholders perfectly infer z by observing a bid x, which is consistent with the initial supposition of the shareholder's correct prediction of z. Thus, we confirm here that the above story is consistent with the perfect Bayesian equilibrium.[11]

Hirshleifer and Titman's (1990) paper makes two important contributions. One is to present

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Rearranging (N-2), we get

$$x \;>\; [z_{max} / (1+2\alpha)] \;\equiv\; x_c . \qquad \text{(N-3)}$$

(N-3) says that shareholders accept an offer if the bid x is greater than the critical value x_c. A bidder whose z is greater than $[(1-2\alpha)\, z_{max} / (1+2\alpha)]$ can obtain positive profits with these bids. That is, takeovers succeed when a high-z-bidder makes a high bid.

[11] In their paper, Hirshleifer and Titman (1990) also show another perfect Bayesian equilibrium where the bidder sets the optimal bid x^* exactly equal to z. In this equilibrium, shareholders are indifferent about whether or not to tender, so that any mixed strategies are optimal for shareholders. Therefore, shareholders can choose the mixed tendering strategy such that the probability of success (P(x)) is strictly increasing in x and also supports the proposed bid $x^* = z$. Hirshleifer and Titman (1990) claim that this mixed-strategy equilibrium may be viewed as a metaphor for the equilibrium shown in the text; when shareholders' unknown tendering costs c are arbitrary small, from the bidder's perspective, shareholders seem to randomly choose whether or not to tender, i.e., they seem to use mixed tendering strategies (see, Harsanyi (1973)).

an equilibrium in which takeovers succeed probabilistically. This stochastic success of takeovers coincides with our casual observations. The other is to indicate that a high level of a bidder's initial shareholdings (α) increases the probability of takeover success in two ways. One is that with a higher α a bidder can make a greater bid x and consequently shareholders are more likely to tender. We call this the *tendering effect*. The other is that a high α reduces the number of shares needed to complete takeovers ($0.5-\alpha$) and hence the probability of takeover success rises given shareholders' tendering decisions.[12] We call this latter effect the *pure number effect.*

To summarize, from Shleifer and Vishny (1986) and Hirshleifer and Titman (1990), we can derive the following proposition about the possibility of takeover success under atomistic shareholder markets when the bidder has some initial shareholdings.

Proposition 2 (Shleifer and Vishny (1986), Hirshleifer and Titman (1990))

When the post-takeover value z is unknown to the atomistic shareholders and the bidder initially holds the shares of the target firm,

2-1. takeovers succeed with positive probability, and

2-2. a positive relation exists between the bid price x and the probability of success.

Proposition 2-1 indicates that initial shareholdings by a bidder can produce successful takeovers, and that such shareholdings thus improve social efficiency. This outcome stems from the bidder internalizing a part of the benefits from successful takeovers. On the other hand, Proposition 2-2 tells us that takeovers are more likely to succeed under high bids than low ones. This relation stems from either the method used by shareholders to predict z (Shleifer and Vishny (1986)) or from shareholders' personal tendering costs or benefits (Hirshleifer and Titman (1990)). In addition, we should note that these two theoretical predictions (Proposition 2-1, 2-2) are not observed when a bidder has no initial shareholdings as we saw in section II-A.

III. Experimental Design and Procedures

To test these theoretical propositions (Propositions 1 and 2), we construct takeover markets in a laboratory and conduct some experiments. In this section, we discuss our experimental design and procedure.

Our experiments were conducted in January and May 1998 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

[12] This is true as long as shareholders have some personal costs of tendering that are unknown to the bidder or they use some mixed tendering strategy.

the experiment was about takeovers.[13] 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”).[14]

In the experiments, a group consists of one bidder and twenty shareholders. Before the experiment, the experimenter assigns roles to each participant by lottery. These roles are fixed during the experiment. The experiment consists of 20 rounds for each group. One round of the experiment proceeds as follows.

1) The experimenter lets the bidder know the post-takeover value z. z varies from 0 to 200 at intervals of every 10 (0, 10, 20, … 180, 190, 200), and z may be different in each round. z is revealed only to the bidder, but not to the shareholders (asymmetric information).
2) Looking at the value of z revealed by the experimenter, the bidder offers a bid price x.
3) Observing the bid price x, 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 accepted the offer, and the value of z for this round.

This is one round of the experiment. It is repeated 20 times. The 20-round length is common knowledge to all participants. Also, no communication is allowed throughout the experiment. Each participant sits at her desk with side-board blinders to ensure as much privacy and anonymity as possible.

We conducted two kinds of experiments, [Experiment A] and [Experiment B]. These two differ according to whether or not the bidder initially holds the shares of the target firm. In [Experiment A], a bidder initially has no shares, and each shareholder owns one share (i.e., shareholders as a whole have 20 shares). We call this case the *no shareholdings case* or the *Grossman and Hart case*. In this case, 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 the offer (tendered) obtain the offer price x while the shareholders who have rejected the offer (not tendered) obtain the post-takeover value z.[15] [16]

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

[14] For details, see the instruction sheet in the appendix.

[15] In fact, in determining each shareholder’s payoff, we judge the takeover outcome by the numbers of shareholders to accept the offer *other than her*. We will explain this point later.

[16] 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

When 9 shareholders or less accept the offer, the takeover fails. Then, no transaction occurs,[17] and both the bidder's and shareholders payoffs are zero.[18]

In [Experiment B], the bidder initially holds 5 shares, while each shareholder holds one share as in [Experiment A]. That is, the bidder's initial holdings are 20% (5/25) of the shares (α=0.2 in section II-B). We call this case the *initial shareholdings case*. In this case, 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' payoff is 5z + 8(z – x), while the shareholders' payoffs are the same as in [Experiment A]. When 7 shareholders or less accept the offer, the takeover fails, and all the participants' payoffs are zero.

In our experimental procedure, we must tackle the problem of how to reproduce atomistic markets in the laboratory. As we stated earlier, we wish to test the propositions for corporate takeovers developed by Grossman and Hart (1980), Shleifer and Vishny (1986), and Hirshleifer and Titman (1990) which were discussed in the last section. We should note that these propositions hold under the *atomistic* shareholder assumption; there are many small shareholders, none of whom can affect the outcome of a takeover. Under this assumption, each shareholder makes her tendering decision viewing the probability of takeover success as given. On the other hand, as Bagnoli and Lipman (1988) point out, when there are only limited number of shareholders, some shareholders must be pivotal in the sense that they may affect the outcome of a takeover. In this case, each shareholder determines her tendering decision by recognizing its impact on the probability of success, and consequently she may have more incentive to tender. Under this *non-atomistic* shareholders assumption, Bagnoli and Lipman (1988) and Holmstrom and Nalebuff (1992) show that Grossman and Hart (1980)'s classical proposition does not hold and successful takeovers are possible even in the no initial shareholding case. From the results of these theoretical models, we know that the takeover outcome with non-atomistic shareholders is quite different from that with atomistic shareholders.

Kale and Noe (1997) and Cadsby and Maynes (1998) test non-atomistic shareholder models

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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.

[17] We consider conditional offers. See footnote 7.

[18] Monetary rewards for participants are related to payoffs in the experiment. For details, see the instruction sheet in the appendix.

in laboratory takeover markets. In contrast to their experiments, we test atomistic shareholders models such as Grossman and Hart (1980), Shleifer and Vishny (1986), and Hirshleifer and Titman (1990). However, we cannot gather a huge number of participants for experiments and hence it is not easy to create the atomistic shareholder setting in the laboratory. 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 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 (she does not tender with probability of 0.494); (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.

Therefore, to test the atomistic shareholder model, we need to construct some experimental device that makes each shareholder choose her decision as if she were an atomistic shareholder, i.e., she determines her tendering decision without considering its effect on the probability of takeover success. Our solution to this problem is that we additionally define *a takeover outcome for each shareholder* which is not affected by her own tendering decision. That is, we judge the takeover outcome (success or failure) for each shareholder by the number of shareholders to tender *other than herself,* and determine each shareholder's payoff according to this definition. To be specific, in [Experiment A] ([Experiment B]), if 10 (8) or more shareholders *other than her* tender, we say that the takeover is successful *for her*, and 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* to determine her payoff. Thus, she is expected to decide whether to tender without considering the effect of her choice on the probability of takeover success. On the other hand, for the bidder (and for us, experimenters), we follow the usual rule, i.e., takeovers succeed if 10 (8) or more shareholders accept the offer in [Experiment A] ([Experiment B]).

We expect that our experimental device will create an atomistic shareholder market in the laboratory. At the same time, however, we recognize some limitations of our device in replicating real atomistic markets. First, in our laboratory markets, if some shareholders are altruistic or kind enough to others, their decisions may be biased toward more tendering compared to those in real atomistic markets. In our markets, each shareholder's decision does not affect the outcome of takeovers *for herself*, but it does affect the outcome of takeovers *for the bidder and for other shareholders*. Thus, an altruistic shareholder may be willing to tender her share for others in our markets,[19] while she would not do so in real atomistic markets where her decision does not affect any takeover outcome.[20] Second, 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 [Experiment A]. 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.

In spite of these limitations, we believe that our experimental device does create an atomistic world in a finite participant laboratory and is an innovation of our paper. It is worth noting that our device may be useful in other experiments where atomistic agents make decisions facing some threshold for the aggregate outcome. For example, we can conduct experiments on the provision of step-level public goods[21] under atomistic agents, while this issue has already been explored in the laboratory under non-atomistic agents by Offerman, Sonnemans, and Schram (1996). Another application of our device might be in experiments on the majority voting behavior of atomistic agents.

For more details about our experimental procedures, see the players instruction sheets used in our experiments that are shown in the Appendix. We conducted [Experiment A] and [Experiment B] for four groups each. As one group consists of 21 persons (one bidder and 20 shareholders), 168 students participated the experiments. All students were inexperienced in the sense that they had not participated in such an experiment before. We paid the participants monetary rewards related to the payoffs they gained in the experiment. Average monetary rewards of participants were \$ 25.31 (3,290 yen if \$1.00 = 130 yen) for sellers and \$ 29.35 (3,816 yen) for bidders. It took about 110 minutes to conduct one experiment.

IV. Hypotheses

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[19] We cannot ignore the effects of altruistic behavior. For example, Andreoni (1995) reports that kindness or altruism can induce voluntary contributions in public goods experiments.

[20] Note that, in real atomistic markets, each shareholder's decision does not affect the takeover outcome for others as well as for her, since both definitions of the takeover outcome are the same.

[21] Step-level public goods are specific kinds of public goods that are only provided if a certain minimum level of money (contribution) is raised. This minimum-contribution requirement (threshold) is also called a provision point (see Issac, Schmidtz, and Walker (1989)). Offerman, Sonnemans, and Schram (1996) provide as examples of step-level public goods, bridges, lighthouses, dikes, laws in parliament, and restoration of a public building.

Using this experimental setting, we test the theoretical predictions of the atomistic takeover models outlined in section II. We present six hypotheses derived from Propositions 1 and 2.

Hypothesis 1: Takeovers never succeed when a bidder has no initial shares of the target firm.

This hypothesis is a restatement of Proposition 1-1. This is a strong hypothesis in the sense that it predicts that takeovers *never* succeed when a bidder initially has no shareholdings ([Experiment A] in our laboratory). We would observe this result if shareholders are always as rational as economic theorists assume, i.e., if shareholders know that they can gain the post-takeover value z by rejecting the offer and also rationally predict that z is larger than a bid x.

Hypothesis 2: Takeovers succeed with positive probability when a bidder initially has shares of the target firm.

As Proposition 2-1 says, when a bidder has initial shareholdings ([Experiment B] in our laboratory), she may overcome the free-rider problem and succeed in takeovers since she can internalize a part of post-takeover benefits z. Furthermore, comparing this Hypothesis 2 with Hypothesis 1, we also predict that

Hypothesis 3: The probability of takeover success is lower in the no shareholdings case than in the initial shareholdings case.

This Hypothesis is a weak version of Hypothesis 1. Even if Hypothesis 1 is not supported (i.e., takeovers are sometimes successful in the no shareholdings case), we expect from the theory that a takeover is less likely to succeed in the no shareholdings case (Grossman and Hart's case) compared to the initial shareholdings case because of the severity of the free-rider problem.

Next, we measure the economic efficiency of takeovers for each group. As we mentioned in section II, the takeovers we examine in the present paper are all value-increasing because they realize the positive post-takeover value z if they are successful. Hence, from a social point of view, it is desirable that all takeovers succeed, but they may not, due to the free-rider problem of shareholders. In order to find to what degree these post-takeover values z are realized by successful takeovers, we define the *efficiency* of each group as

efficiency = (the sum of z realized by successful takeovers over the 20 rounds / the sum of z over the 20 rounds)

Thus, *efficiency* represents the percentage of the post-takeover values actually realized by successful takeovers compared to post-takeover values given by the experimenter for one group. When takeovers succeed in fewer rounds, efficiency decreases. Hence, considering Hypothesis 3, we predict that

Hypothesis 4: Efficiency is lower in the no shareholdings case than in the initial shareholdings case.

Finally, the following two hypotheses are restatements of Propositions 1-2 and 2-2 which indicate the relation between the bid price x and the probability of takeover success.

Hypothesis 5: The probability of takeover success is not related to the bid price x in the no shareholdings case.

Hypothesis 6: The probability of takeover success is increasing in the bid price x in the initial shareholdings case.

Grossman and Hart's (1980) proposition predicts that when a bidder has no initial shares ([Experiment A] in our laboratory), rational shareholders would expect that a bid x must be lower than a post-takeover value z, so that a high bid would not induce shareholders to tender their shares. On the other hand, theoretical predictions by Shleifer and Vishny (1986) and Hirshleifer and Titman (1990) suggest that when a bidder initially hold shares ([Experiment B] in our laboratory), a high bid induces shareholders to accept the offer, and raises the probability of takeover success.

V. Experimental Results

A. Overview

We present the experimental results in Table 2-A ([Experiment A]) and Table 2-B ([Experiment B]). These tables indicate information about the value of z presented by the experimenter[22], the bid price x offered by the bidder, and the numbers of shareholders who accepted the offer for each round. In the bottom three rows of the tables, we can also observe the average bid price, the acceptance rate (the sum of the number of shareholders who accept the offer / total number of shareholders (20×20)), the number of rounds of successful takeovers, and efficiency (defined in the last section) for each group.

These two tables show the main results that the formal analysis will confirm. First, the probability of successful takeovers is lower in the no shareholdings case (Grossman and Hart's case, [Experiment A]) than in the initial shareholdings case ([Experiment B]). The numbers of successful takeovers are 3, 4, 1, 8 for groups of [Experiment A], whereas they are 13, 17, 14, 13 for groups of [Experiment B]. Second, as a result of this, the efficiency is also lower in the no shareholdings case than in the initial shareholdings case. In [Experiment A], the efficiency

[22] The value of z was determined by the experimenter with dice. To make comparisons easily, we use the same stream of z for all the groups.

remains at a low level (2.19% - 41.67%), while in [Experiment B], it is fairly high (66.67% - 92.54%). These results seem to support Hypothesis 3 and Hypothesis 4 in the last section. This indicates that a severer free-rider problem occurs in the no shareholdings case (Grossman and Hart's case) than in the initial shareholdings case. In addition, we also observe that the average bid is larger in the initial shareholdings case than in the no shareholdings case. This reflects the fact that a bidder can afford to make a higher bid in the initial shareholdings case because she can obtain more profits by internalizing part of post takeover gain in successful takeovers (see, the bidder's profitability condition in Figure 1-B).

Next, let us look at Figure 2-A and Figure 2-B. These two figures show the relationships among the post-takeover value z, the bid price x, and the probability of takeover success. The height of each bar shows the probability of takeover success for a specific z and x range. For example, in Figure 2-A, the probability of success is 0.364 (36.4%) in the 130-160 z and 90-120 x range. This probability of success is calculated from Table 2-A where we find that 4 out of 11 takeovers succeeded in this z and x range. An empty square indicates no offers are made in that cell (e.g. in the 130-160 z and 50-80 x range) and a bar with no depth indicates offers were made but no takeovers were successful (e.g. in the 90-120 z and 50-80 x range). In addition, in the figures, to exclude extreme probability values due to small samples, we consider a cell with only one offer (where the probability of success must be either 0 or 1) as that with no offers.

Figures 2-A and 2-B highlight the relations between a bid price x and the probability of takeover success for each experiment. In Figure 2-A ([Experiment A], the no shareholdings case), we do not find an obvious relationship between the bid price x and the probability of success. If anything, there may be a positive relation because cells with zero probability of success (a bar with no depth) can be seen in only the lower x range (0-40, 50-80, 90-120), but this positive relationship seems to be very weak. On the other hand, in Figure 2-B ([Experiment B], the initial shareholdings case), there seems to be a fairly clear positive relationship between the bid x and the probability of success. There, we observe a higher probability of takeover success in higher ranges of x, although we do see a conspicuous exception in that the probability of success is high (0.8) in the cell of the 0-40 z and 0-40 x range (we know that 4 out of 5 takeovers succeeded in this cell from Table 2-B).

The above observations seem to be consistent with Hypotheses 5 and 6. We will later confirm whether our impression is right by conducting formal statistical analyses. A further finding in Figures 2-A and 2-B is that there is a positive relation between z and x in both figures. This positive relation presumably reflects the bidder's profitability condition illustrated in Figures 1-A and 1-B.

B Tests of Hypotheses

In this subsection, we test the hypotheses listed in Section IV. We discuss to what degree our experimental data support the hypotheses and examine the appropriateness of the takeover models such as Grossman and Hart (1980), Shleifer and Vishny (1986), and Hirshleifer and Titman (1990). Results 1-6 shown below correspond to the results of tests on Hypotheses 1-6, in order.

Result 1: The probability of takeover success is 0.2 (20%) in the no shareholdings case.

Table 3 summarizes the results of the probability of takeover success, acceptance rates, and efficiency for each experiment. From the first column of Panel A, we find that in [Experiment A] (the no shareholdings case), takeovers are successful in 16 out of 80 rounds. Thus the probability of success is 0.2 (20%). This result does not support Hypothesis 1, the strong hypothesis that takeovers never succeed when a bidder has no initial shareholdings. In Panel B, we also observe the acceptance rate, i.e., the proportion of shareholders who accepted the offer. The first column shows that in [Experiment A], 639/1600 shareholders choose to accept the offer and hence the acceptance rate is 0.399 (39.9%) Thus, we recognize that the two-fifths of the participants who play shareholders' roles decide to tender their shares, while Grossman and Hart (1980) predict that no shareholders tender at all. In Section VI, we examine the possible reasons why these participants did not behave as the theory predicted.

Thus, our experimental evidence contradicts Hypothesis 1 which is originally derived from Grossman and Hart's (1980) classical proposition. We should not, however, dismiss the basic insight of Grossman and Hart that corporate takeovers fail due to the free-rider problem among shareholders. Our evidence indicates that in the no shareholdings case, only 20% of takeovers succeed (80% of takeovers fail), which means that most of the post-takeover values which would be realized by successful takeovers (z) disappear. In fact, in Panel C of Table 3, we observe that average efficiency over groups of [Experiment A] is only 21.38%, that is, about 80% of social values are lost in [Experiment A]. These results suggest that the optimistic story of corporate takeovers is doubtful. We observed fairly severe free-rider problems in our laboratory and consequently takeovers tended to be unsuccessful. In this sense, we can say that Grossman and Hart (1980)'s classical proposition contains a valuable message to help us understand the nature of takeover markets.

Result 2: The probability of takeover success is about 0.7 (70%) in the initial holdings case.

This result can be seen in the middle column ([Experiment B]) of Panel A of Table 3. We find that in [Experiment B] (the initial shareholdings case), 57 out of 80 takeovers are successful, and thus the probability of success is 0.713 (71.3 %). This result supports Hypothesis 2 that takeovers succeed with positive probabilities when a bidder initially has shares. In Panel C of Table 3, we also notice that the average efficiency over groups of [Experiment B] is 76.54%. From these results, we conclude that the initial shareholdings of a bidder can substantially mitigate the free-rider problem in corporate takeovers and greatly improve social welfare.

Result 3: The probability of takeover success is significantly lower in the no shareholdings case than in the initial shareholdings case.

Result 4: The efficiency is significantly lower in the no shareholdings case than in the initial shareholdings case.

Result 3 can be easily deduced from Results 1 and 2. As the lowest row of Panel A of Table 3 shows, the difference in the probability of success between [Experiment A] and [Experiment B] is 0.513, and this difference is statistically significant (p-value <0.001) by Fisher's exact test. Therefore, our experimental data support Hypothesis 3. Also, as predicted from Result 3, Hypothesis 4 is supported as well. Panel C of Table 3 shows that the average efficiency in [Experiment A] (21.38%) is much lower than that in [Experiment B] (76.54%). The difference between the two amounts to 55.16% and this difference is statistically significant at 0.3% level by Welch's t-test. Results 3 and 4 indicate that the free-rider problem is more serious in the no shareholdings case (Grossman and Hart's case) than in the initial shareholdings case.

The approximately 50% (51.3%) point increase in the probability of success in the initial shareholdings case compared to the no shareholdings case may stem from two effects, according to the theoretical arguments in Section II-B. One is the *tendering effect* which states that in the initial shareholdings case, the bidder can offer a bid x higher than z so that shareholders tend to tender their shares. Another is the *pure number effect* such that initial shareholdings by a bidder reduce the number of shares needed to succeed in takeovers. To make a takeover successful, a bidder has to purchase only 8 shares or more in [Experiment B], whereas she has to purchase 10 shares or more in [Experiment A]. To grasp the magnitude of each effect, we calculate the probability of takeover success in [Experiment B] assuming that takeovers succeed when a bidder purchases 10 (not 8) shares or more. This hypothetically calculated probability of success in [Experiment B] can be interpreted as the probability of success in the initial shareholdings case without the pure number effect, since the number of the shares required (10) is the same as that in the no shareholdings case. We find that this calculated probability of success is equal to 0.375 (37.5%). Thus, we can say that out of the 51.3% point rise in the probability of success gained by the initial shareholdings, 17.5% (37.5% minus 20%) comes from the tendering effect[23] and 33.8% (71.3% minus 37.5%) stems from the pure number effect.

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[23] Panel B of Table 3 shows that shareholders are more likely to tender in the initial shareholdings

It is worth noting that Walking's (1985) empirical study also finds a positive relationship between the bidder's initial shareholdings and the probability of takeover success, using data from the U.S. capital markets over 1972-76. It is not clear from his study, however, what factor gives rise to this positive relation, although he did present some hypotheses concerning this issue.[24] This may be partly because in empirical studies (in general) it is not necessarily easy to isolate one specific factor from naturally occurring phenomena in a complex reality. In contrast, our experimental research has made it clear why the bidder's initial shareholdings increase the probability of success by testing the takeover models directly in the laboratory. This positive relation comes from the tendering effect and the pure number effect.

Result 5: The probability of takeover success is not related to the bid price x in the no shareholdings case.

Result 6: The probability of takeover success is increasing in the bid price x in the initial shareholdings case.

Results 5 and 6 support Hypotheses 5 and 6, respectively. To obtain Results 5 and 6, we conducted the following logit analyses for both experiments.

Model 1: $\text{Prob} = F\,(a + b\,x)$ (3)

Model 2: $\text{Prob} = F\,(a + b\,x + c_1\,\text{ROUND} + c_2\,\text{GROUP2} + c_3\,\text{GROUP3} + c_4\,\text{GROUP4})$ (4)

where Prob equals 1 if the takeover is successful and equals 0 otherwise. $F(k) = 1/(1 + e^{-k})$ is the logit function, and x is the bid price offered by a bidder. To control for the group effect and monotonic trends in the probability of success over time, we add in Model 2 group dummies (GROUP2-GROUP4) and the variable ROUND which equals 1 for the 1st round, equals 2 for the 2nd round, and so on[25]. From Hypotheses 5 and 6, we expect b = 0 for the groups in the no shareholdings case ([Experiment A]), and b > 0 for the groups in the initial shareholdings case ([Experiment B]).

Table 4 reports the regression results for each experiment. In [Experiment A], the coefficients of the bid price x are positive but they are not statistically significant in both

case ([Experiment B]) than in the no shareholdings case ([Experiment A]); the acceptance rate in [Experiment B] is 0.4575 while that in [Experiment A] is 0.3994, and its difference (0.058) is statistically significant at 0.1% level by Fisher's exact test.

[24] Walking (1985) discusses two hypotheses on why the bidder's initial shareholdings raise the probability of takeover success. One is the strong influence of the bidder on the target management, and the other is the increased shareholder fear of becoming inactive minorities.

[25] We also used the round dummies (RDQ2 takes the value of 1 for the 6th – 10th rounds, RDQ3 takes the value of 1 for the 11th – 15th rounds, and RDQ4 takes the value of 1 for the 16th – 20th rounds) instead of ROUND to control the round effect. However, the results did not change.

Models 1 and 2. This result is in line with Hypothesis 5; the probability of takeover success is not related to the bid price in the no shareholdings case. On the other hand, in [Experiment B], we observe statistically significant positive coefficients on the bid price x in both models (p-values are less than 1% in both models). This suggests that Hypothesis 6 is also supported; the probability of takeover success is increasing in the bid price x in the initial shareholdings case. In addition, we do not find any group effects or round effects on takeover success, since the estimated coefficients of group dummies and round variables are not statistically significant.

In Figure 3, we predict the probability of takeover success for each bid price x by the estimation results of Model 2 in Table 4.[26] To compare the predicted values to the observed ones, the figure includes the actual probability of success for each x range depicted in Figures 2-A and 2-B. First, in the no shareholdings case, the predicted probability of takeover success does not seem to increase significantly with a bid price x (the dotted line). The predicted probability of success is 0.10 (10%) for a bid of 20, and it is only 0.25 (25%) for a bid of 180. That is, the probability of takeover success remains low at a higher bid price. This evidence is consistent with Grossman and Hart's (1980) theoretical prediction that shareholders rationally expect that a bid price x is lower than z and they are not induced to accept the offer at any bid level.

On the other hand, in the initial shareholdings case (the solid line), the graph obviously shows that the probability of success increases with the bid price x. For example, while the predicted probability of takeover success is only 0.26 (26%) when the bid x is 20, it rises to 0.94 (94%) when the bid x is 180. Thus the difference between two predicted probabilities amounts to 0.68 (68% points).[27] This suggests that the positive effect of the bid price x on the probability of success in the initial shareholdings case is economically significant.

These results give us an insight into the importance of the bid premium in influencing the outcomes of takeovers, an issue that some researchers have empirically investigated. Hoffmeister and Dyl (1981) report that the bid premium has no effect on success or failure of a takeover, using a U.S. sample from 1976-77. Walking's (1985) study, however, shows that the bid premium has a positive effect on the probability of takeover success during 1972-76. Compared to these empirical studies, our experimental evidence suggests more general results; the bid does not affect the takeover outcome in the no shareholdings case, but it does affect the outcome in the initial shareholdings case. In other words, we have shown that the effect of the bid premium on the takeover success is different, depending upon whether the bidder initially

[26] Figure 3 assumes that ROUND equals 10 and the intercept term is at the mean of four groups.

[27] In Figure 3, it may seem odd that the actual probability of success in the initial shareholdings case ('Initial Shareholdings: Actual', depicted as a circle) for 0-40 x range (0.67) is not in the neighborhood of the predicted probability line (the solid line). But this can be understood once we recognize that the number of rounds for the 0-40 x range is only 6, which is a relatively small number compared to the number of total rounds 80.

holds the shares of the target firm or not.

To summarize our observations, (i) the free-rider problem is severe in Grossman and Hart's world, but (ii) initial shareholdings by a bidder significantly mitigate the free-rider problem. On the whole, our experimental evidence supports the messages from takeover models such as Grossman and Hart (1990), Shleifer and Vishny (1986), and Hirshleifer and Titman (1990). From these results, we conjecture that the free-rider problem potentially exists in real takeover markets as well, and that the bidder's initial shareholdings may make takeovers successful in reality.

VI. Discussion

In this section, we present two kinds of analyses. First, we analyze the individual bidders' and shareholders' behavior in our laboratories. Does each participant (bidder or shareholder) behave as the theory suggests? In experimental research, just as in other empirical research, we sometimes observe some evidence that is not consistent with the theoretical prediction. In this sense, our experiment is no exception. We point out some anomalies in participants' decisions in our laboratory and explore how to interpret them. Second, we focus on the results for the later rounds in each session in order to examine the robustness of our conclusions.

A. Bidders' Behavior

It is important to examine bidders' behavior because it could affect shareholders' behavior and takeover outcomes. The theory suggests that a bidder determines a bid price x so as to gain positive profits from a successful takeover. Thus, a bid is expected to satisfy the bidder-profitability conditions that are shown in Figure 1-A and 1-B. Is this the case in our experiments?

Using the data on bid prices shown in Table 2-A and 2-B, we confirm that a bidder usually offers a bid satisfying the bidder-profitability condition. At the same time, however, we also notice that there are some rounds in which a bidder overpays, that is, a bidder offers too high a bid to gain profits even if a takeover succeeds. In [Experiment A], for example, in the 8th round of Group A-1, the bidder offers 60 which is higher than the post-takeover value z of 50. In this round, the bidder would incur losses of 10 per share if the takeover succeeded. Excessively high bids of this kind occur in four rounds in Group A-1, one round in Group A-3, and seven rounds in Group A-4, as can be seen in Table 2-A. We also find bidder overpayments in [Experiment B], violating the bidder-profitable condition (2), in two rounds (the 2nd and 18th rounds) in Group B-2 and in three rounds (8th, 10th, and 18th rounds) in Group B-4.

Why did some bidders overpay in our experiments? We consider two possibilities. The first one is confusion; a bidder misunderstood or could not calculate her payoffs and unconsciously offered too high a bid. To explore this possibility, we checked the bidder's (buyer's) record sheets, and examined whether bidders made any mistakes in calculating their payoffs. However, no mistakes were found on the bidder's record sheets throughout our experiments. We therefore conjecture that overpaying bidders did not confuse their payoffs, rather they *consciously* overpaid.

Another possibility is that bidders overpay to establish a reputation for offering higher bids and induce shareholders to tender in later rounds. If this were the case, the bidder's overpaying behavior would be observed less in later rounds than in earlier rounds; in our experimental setting with a finite number of rounds (20 rounds), the value of reputation must decrease as the session approaches its end. To examine whether this reputation effect motivates bidders to overpay, we run regressions on the bid price x. We use as explanatory variables, z (post-takeover value), ROUND (which equals 1 for the 1st round, equals 2 for the 2nd round, and so on) or round dummies (RDQ2 takes the value of 1 for the 6th – 10th rounds, RDQ3 takes the value of 1 for the 11th – 15th rounds, and RDQ4 takes the value of 1 for the 16th – 20th rounds), and group dummies (GROUP2, GROUP3, and GROUP4). If a bidder decides her bid based on the reputation effect, ROUND or the round dummies (RDQ2, RDQ3, and RDQ4) should have negative effects on a bid price.

Table 5 reports regression results using Ordinary Least Squares. Model 1 represents the estimation results of the equations using the variable ROUND, whereas Model 2 shows results using the round dummies (RDQ2, RDQ3, and RDQ4) instead of ROUND. First, we notice that the post-takeover values z have significant positive effects on the bid prices in both experiments ([Experiment A] and [Experiment B]). This is a natural result emanating from the bidder-profitability condition; a higher-z-bidder can afford to offer a higher bid.[28] Next, let us examine the reputation effect. The results of Model 1 show that ROUND is not significant in either experiment. The results of Model 2 also indicate that the round dummies are not significant in either experiment, except that RDQ2 is significant but positive in [Experiment A]. In addition, in Model 2, we also confirm (not reported in the table) that neither the difference between the coefficient of RDQ2 and that of RDQ3, nor the difference between the coefficient of RDQ3 and that of RDQ4, was significant in either experiment. Therefore, we do not find any evidence suggesting that the bid level becomes lower as the session approaches its end. This result contradicts the hypothesis that bidders consider their reputation for later rounds, and suggests

[28] Walking and Edmister (1985) report that the bid premium is a positive function of potential acquisition-related benefits using the data from 158 cash tender offers for 1972-1977. This *empirical* result is consistent with our *experimental* result that a bid price (x) is positively related to potential post-takeover benefits (z).

that overpayment is not due to reputation concerns.

Thus overpayment remains an anomaly and seems to represent irrational behavior by a bidder. However, it is worth noting that although we sometimes observed bidders overpaying in our laboratory, the messages of the theoretical takeover models are supported by our experimental results as shown in the last section. This suggests that the takeover models are appropriate for predicting the phenomena of takeover markets even if there exist some irrational bidders.

B. Shareholders' Behavior

In Section V-B, we observed that about 40% of shareholders sell their shares in [Experiment A], while Grossman and Hart (1980)'s classical proposition predicts that no shareholders tender at all in the no shareholdings case. How can we interpret this gap between the experimental result and the theoretical prediction? In this sub-section, we examine three possible reasons why a considerable proportion of shareholders sell their shares in [Experiment A]: pivotal confusion, implicit cooperation among shareholders, and response to a bidder's excessive bid.

1. Pivotal Confusion

Pivotal confusion may be one reason for some shareholders to tender. As we explained in Section III, in our experimental setting each shareholder's tendering decision *does not* affect the outcome of a takeover for her. However, if a participant (a shareholder) does not understand this rule, she may incorrectly perceive that she may be a *pivotal* shareholder to affect a takeover outcome that determines her payoff. In this case, as the non-atomistic shareholder models (Bagnoli and Lipman (1988) and Holmstrom and Nabeluff (1992)) suggest, the shareholder is more likely to tender the share expecting that her tendering raises the probability of a takeover success. We call this confused shareholder behavior pivotal confusion.

To explore to what degree such pivotal confusion occurs, we checked the shareholders' (sellers') record sheets. On this sheet, each shareholder enters her decision (sell or not sell), the number of shareholders who agree to sell their shares, the number of shareholders other than her who sell their shares, and her payoff. By inspecting the mistakes on these items in each shareholder's record sheet, we can specify for whom and in what round the pivotal confusion occurs. Suppose, for example, that in one round on one shareholder's record sheet, we find that *her decision* = 'sell', *the number of the shareholders who agreed to sell their shares*' = '8', and *the number of the shareholders other than her who sold their shares* = '8'. This shareholder clearly makes a mistake in this round; since her decision is 'sell', 'the number of shareholders other than her who sold their shares' must be '7' (8 minus 1). Then, we judge that pivotal confusion occurs in this round for this shareholder.

In Group A-1, we find 5 pivotal confusions out of a total of 400 selling opportunities (20 shareholders times 20 rounds). We also find 2, 2, and 10 pivotal confusions in Group A-2, A-3, and A-4, respectively. Therefore, for four groups in [Experiment A], the number of pivotal confusions is 19 out of a total of 1600 selling opportunities (20 shareholders × 20 rounds × 4 groups), and the proportion of pivotal confusion is thus only 1.19% (19/1600). This suggests that pivotal confusion hardly occurs throughout [Experiment A][29], judging from shareholders' (sellers') record sheets. For reference, we re-calculate the acceptance rate (the proportion of shareholders who tendered their shares) shown in Panel B of Table 3, assuming that the shareholders with pivotal confusion do not tender in those rounds. Then, the acceptance rate in [Experiment A] declines to 0.3875, which is only slightly lower than the 0.3994 figure in Table 3.[30]

This suggests that pivotal confusion cannot be a major reason that about 40% of shareholders tender their shares in [Experiment A]. At the same time, the above observation of little pivotal confusion also means that almost all shareholders (participants) understand our experimental setting and thus know that each shareholder's decision *does not* affect a takeover outcome for her. In this sense, we can say that our original device is fairly successful in making the finite participant laboratory close to the atomistic shareholder world.

2. Implicit cooperation among shareholders

The second possible reason for shareholder tendering is that some shareholders implicitly may cooperate with one another. That is, even without communication, they may accept the offer jointly to realize social gains from a takeover success, rather than attempting to free ride by rejecting the offer. Does this cooperative behavior occur in our experiments?

From game theory, the standard answer to this question would be 'No'. In the finite repeated game framework, based upon a backwards induction argument, a subgame perfect equilibrium strategy is that everyone takes a one-shot Nash equilibrium strategy ('reject the offer' in our game) in every round, rather than taking the cooperative strategy ('accept the offer' in our game).[31] Thus, there is no possibility that shareholders implicitly cooperate and tender their

[29] Throughout [Experiment B], the number of pivotal confusions is 42 out of 1600. Thus, the fraction of the pivotal confusion is 2.63% (42/1600), which is also at a fairly low level.

[30] On the assumption that the shareholders with pivotal confusion do not tender, the probability of success and the average efficiency in [Experiment A] decline to 0.1750 (17.5%) and 17.98%, respectively. These figures, however, are only slightly lower than those in Table 3 and hence do not basically change our results.

[31] On the other hand, it is also well known that cooperation among agents can be an equilibrium in an *infinitely* repeated game through the use of threats. A typical example of this is the infinitely repeated Prisoners' Dilemma. There cooperation is a subgame perfect equilibrium using the Tit-for-

shares jointly, as long as the number of rounds is finite (20 in our experiment).

However, there is also an alternative to this standard view in game theory. Kreps, Milgrom, Roberts, and Wilson (1982) present a reputation model showing that cooperation can occur even in a *finitely* repeated Prisoners' Dilemma. They suggest that when the players are uncertain about their rivals' rationality, each player chooses to cooperate to establish a reputation for an irrational (cooperative) behavior, and doing so results in higher payoffs to her. In addition, Kreps, et al. (1982) also predict that the degree of cooperation decreases over time because the reputation value becomes lower in later periods.

A considerable number of public goods experiments with a finite number of rounds typically show that cooperation (contributions to public goods) occurs and that the cooperation rate (the contribution rate) declines as the session approaches close to its end.[32] This evidence is consistent with the above prediction of Kreps, et al. (1982). Thus, with the Kreps, et al. (1982) story, our evidence of shareholders' tendering may also be considered as cooperative behavior among shareholders.

To explore this possibility, we examine whether the degree of shareholder tendering declines over time as Kreps, et al. (1982) suggest. To put it more concretely, in the logit regression of tendering probability we run later, we see whether the round number (ROUND) or the round dummies (RDQ2, RDQ3, and RDQ4) have negative effects on the probability of tendering.[33]

3. Response to the bidder's excessive bids

In Section VI-A, we saw that bidders sometimes overpay in our experiment. We could not specify the reason for this behavior. However, whatever the reason may be, it is possible that shareholders are induced to tender their shares by the bidders' excessive bids. Suppose that a shareholder observes that bidders overpay (i.e., $x > z$ in [Experiment A]) in one round. Then, she may expect that the bidder will overpay again for some reason and choose to sell the share to gain a bid price x (that may be larger than z). Therefore, the shareholder tendering observed in [Experiment A] may be a response to bidders overpaying in previous rounds.

To examine this effect, we employ a logit regression of shareholders' probabilities of tendering, adding one of two variables representing overbidding, OPAYAVG or OPAYDUM. OPAYAVG is the average of overpayments (x-z) from the 1st round to the previous round. OPAYDUM is a dummy variable that takes a value of 1 if overpayment has occurred at least once prior to the previous round, and 0 otherwise. If shareholders' tendering stems from bidders

Tat strategy.

[32] See, for example, Dawes and Thaler (1988) and Davis and Holt (1993, Chapter 6).

[33] For the variable ROUND and the round dummies, see Section VI-A.

historical overpayments, the coefficient of OPAYAVG or OPAYDUM must be positive.

4. Logit regression analysis

We perform the following logit regression of shareholders' probabilities of tendering for [Experiment A].

$$\text{Model 1:} \quad \text{Prob (tender)} = F\,(\,a + b\,x + c_1\,\text{ROUND} + c_2\,\text{OPAYAVG} + c_3\,\text{PIVOTAL} + \text{group dummies}) \qquad (5)$$

where Prob (tender) equals 1 if a shareholder tenders the share (accepts the offer) and equals 0 if she does not tender (rejects the offer). F is the logit function as before (see eqs. (3) and (4) in Section V-B), and x is the bid price offered by a bidder. ROUND and OPAYAVG are the round number and the average of overpayments, respectively, as defined above. PIVOTAL is a dummy variable that takes a value of 1 if pivotal confusion is observed for that shareholder in that round. If pivotal confusion induces shareholders to be more likely to tender, PIVOTAL has positive effects on tendering probability. Model 2 differs from the above Model 1 in that the former uses the round dummy (RDQ2, RDQ3, and RDQ4) instead of ROUND. Model 3 and Model 4 are different from Model 1 and Model 2, respectively, in that the former models include OPAYDUM instead of OPAYAVG.

The logit regression results are presented in Table 6. We first notice that the round number (ROUND) and the round dummies (RD2, RD3, and RD4) are not significant in any of the regressions. In addition, in Model 2 and Model 4, we also confirmed (not reported in the table) that neither the difference between the coefficient of RDQ2 and that of RDQ3, nor the difference between the coefficient of RDQ3 and that of RDQ4, was significant. That is, we do not find that the tendering probability declines over time in our experiments. This contradicts the prediction of Kreps et al. (1992). Therefore, the shareholder tendering observed in our experiment *cannot* be interpreted as implicit cooperation among shareholders as in Kreps, et al's (1982) story. Second, OPAYAVG and OPAYDUM, the variables for historical overpayments, do not have significant effects on tendering probability either.[34] Hence, a bidder's overpayment does not seem to induce shareholders to tender their shares, that is, the bidder's overpayment cannot be a reason for the shareholder tendering observed in our experiments. Third, PIVOTAL has a significant positive effect on tendering probability in all regressions.[35] This suggests that

[34] We also use as independent variables the average of overpayments during the previous 5 (and 3) rounds, the overpayment in the previous round, and the number of the overpayment rounds prior to the previous round instead of OPAYAVG or OPAYDUM. None of these variables are significant.

[35] This marginal effect (not reported in the table) equals 0.23. Thus, the tendering probability of a shareholder with this confusion is 23 percentage points higher than those without this confusion, *ceteris paribus*.

shareholders with pivotal confusion are more likely to sell their shares, as expected.[36] However, since pivotal confusion occurs so rarely, it cannot play a major part in determining tendering decisions.

Overall, although we presented three possible reasons for shareholders to tender in [Experiment A] (pivotal confusion, implicit cooperation among shareholders, and response to bidders'excessive bids), none of them were supported by our results. Thus, the observation of less than perfect free-riding still remains an anomaly. We now point out some other hypotheses which may explain this anomaly.

One possibility is shareholder misperception; perhaps some shareholders did not notice the advantage of free-riding behavior. As we mentioned earlier, our experiments were conducted under *asymmetric* information settings, which is more realistic than the *symmetric* information settings of Grossman and Hart's original paper. In addition, our experiment is not a simple repetition of the same game since the values of z differ from round to round. Therefore, it was possible that some shareholders could not rationally predict that z is larger than x, and hence they chose to tender their shares. Another possibility is shareholder altruism. In our experiments, as we explained earlier, each shareholder's decision affects the takeover outcome for the bidder and for other shareholders while it does not affect her own takeover outcome. Thus, if a shareholder was sufficiently altruistic, she might choose to tender in order to contribute to a takeover success for others. We cannot ignore this possibility because we recognize that in public goods experiments voluntary contributions can be induced by kindness or altruism.

To explore these possibilities, it seems useful to conduct additional experiments. First, to examine whether tendering arises from shareholder misperception, we could conduct our experiments under *symmetric* information settings and/or use experienced participants, and compare the results with those we obtained. Second, to figure out whether altruism motivates tendering decisions, we could run an experiment where the takeover outcome is determined by some completely random process.[37] In this setting, a shareholder could not affect others' payoffs by her actions, and therefore there would be no scope for altruism. If we observe less tendering behavior in this setting than in our experiments, we could conclude that altruism or kindness is one reason for shareholder tendering in our experiments. We leave these additional experiments

[36] We also use the variable, PIVOTAL-ALL, which equals 1 for all of her rounds if a shareholder experiences pivotal confusion in at least one round during the experiment, and equals 0 otherwise. We find that PIVOTAL-ALL also has a significant positive sign on shareholder tendering probabilities in all regressions. Thus, the shareholders who experience pivotal confusion are more likely to tender during the whole session. In addition, we recalculate the acceptance rate (panel B of Table 3) in [Experiment A], dropping these shareholders. It equals 35.91%, which is only slightly lower than that of Table 3.

[37] This idea was suggested by Bram Cadsby and Elizabeth Maynes.

for future research.

Also, it should be added that non-free-riding behavior is typically observed in public goods experiments (Dawes and Thaler (1988) and Davis and Holt (1993, Chapter 6)). The reason why some people do not free ride in the provision of public goods has been the subject of controversy over the last few decades, however, it still remains an anomaly. Explaining this anomaly would help understand the non-free-riding behavior observed in our takeover experiments.

Before ending this sub-section, we note in Table 6 that the bid price x has a significant positive effect on tendering probability, that is, a high bid induces shareholders to tender. This result seems to contradict the result in Section V-B which suggested that a high bid does not significantly increase the probability of takeover success in [Experiment A]. Calculating the marginal effects from the logit regressions in Table 6, however, we find that the effect of x on tendering probability is relatively small. The average of the marginal effects for Model 1 - Model 4 is 0.000763 (not reported in the table), which indicates that when a bid price x increases from 0 to 200, the tendering probability increases by only 15.26%. This is considerably smaller than the 45.96% which we obtain for [Experiment B][38]. In addition, as we will show later, the effect of a bid x on tendering probability is no more significant in the analyses for the final 10 or 15 rounds. That is, in the no shareholdings case (i.e., [Experiment A]), shareholders are not induced to tender by a high bid price after experiencing several rounds of the experiment. This result seems to suggest that shareholders' behavior approaches the theoretical prediction of Grossman and Hart (1980) (Proposition 1-2 in Section II-A) as participants learn more about our takeover game.

C. Analyses for Later Rounds

Finally, we report the results of our analyses for the final 15 and 10 rounds of each session. If there is some learning process taking place, the results for the final rounds may be different from those for the whole session. To explore this possibility, we conduct the same analyses for the final 15 (6^{th} – 20^{th}) and final 10 (11^{th} – 20^{th}) rounds. As shown below, we find that our basic conclusions remain largely unchanged.

Table 7 summarizes the probability of takeover success, the acceptance rates, and the average efficiency for the final 15 and 10 rounds. We notice that the results are very similar to those for the whole session reported in Table 3. First, in [Experiment A], the probability of success and average efficiency is low; the probability of success is 0.1833 for the last 15 rounds

[38] We run the same regressions (Model 1 – Model 4) for [Experiment B], obtain the average of the marginal effects of x on the tendering probability for Model 1 – Model 4, and calculate the increase in tendering probability when x rises from 0 to 200.

and 0.1500 for the 10 rounds, and the average efficiency is 19.08% for the 15 rounds and 16.49% for the 10 rounds. Therefore, our result for the whole session that a valuable takeover tends to fail due to the free-rider problem in the no shareholdings case is also supported in the final rounds. Second, in [Experiment B], the probability of success and the average efficiency are high for both the final 15 and 10 rounds (for example, for the final 15 rounds, the probability of success is 0.700 and the average efficiency is 77.08%). Thus, we confirm our result that initial shareholdings held by the bidder mitigate the free-rider problem also holds for the final rounds. Third, the acceptance rates are lower in [Experiment A] than in [Experiment B] for both the final 15 and 10 rounds. This result is the same as that for the whole session (in Table 3) although the difference is not highly significant (the p-value is 0.075 for the 15 rounds and 0.093 for the 10 rounds).

Next, we examine the relation between the bid price x and the probability of takeover success. We run the same regressions for the final 15 and 10 rounds as those for the whole session presented in Table 4 (the detailed results are not reported to save space). In the [Experiment A] regressions, we obtain exactly the same results for both the final 15 and 10 rounds as those in Table 4; a bid price x does not significantly affect the probability of success. In the [Experiment B] regressions for the final 15 and 10 rounds, we observe the positive effects of x on the probability of success, as we did for the whole session in Table 4, although this effect is significant only for the final 15 rounds (for the final 10 rounds, the p-values for the x coefficients are 0.25 in Model 1 and 0.21 in Model 2). Thus, we can say that the results on the relation between the bid price and the probability of success for the final rounds are almost the same as those for whole session.

In addition, as for the individual participants' (the bidder's and shareholders') behavior, most of the findings observed for the whole session are robust for the final 15 and 10 rounds. We run the same regressions for the final 15 and 10 rounds as those in Table 5 (the bidder's behavior) and Table 6 (the shareholders' behavior). The results are very similar to those for the whole session (the detailed results are not reported to save space); in the regressions on bidder behavior, ROUND and the round dummies are not significant; in the regressions on the shareholder tendering decision, the variables for the round number and the variables for overpayments do not seem to affect the probability of tendering. Therefore, conducting the analyses for the later rounds, we still cannot explain the anomalies pointed out earlier (why a bidder sometimes overpays and why some shareholders tender their shares in [Experiment A]). Finally, we find that a bid price does not significantly affect the shareholders' probability of tendering in [Experiment A] in both the final 15 and 10 rounds. This result is different from that for the whole session (in Table 6) and consistent with the theoretical prediction by Grossman and Hart (1980), as we stated in the previous sub-section.

VII. Concluding Remarks

Our research started with the observation of the gap between the well-known proposition by Grossman and Hart (1980) and the practical evidence from real takeover markets. While Grossman and Hart's classical proposition states that corporate takeovers fail due to the free-rider problem, such a problem is not readily apparent in real capital markets. This conflict gave rise to our question, "Does the free-rider problem actually occur in corporate takeover markets?"

To answer this question, we conducted an experimental study by constructing laboratory takeover markets comparable to Grossman and Hart's model. In contrast to earlier experiments on corporate takeovers by Kale and Noe (1997) and Cadsby and Maynes (1998), we attempted to create a world of atomistic shareholders in the laboratory. To realize this, we developed an original experimental device such that the takeover outcome for each shareholder was to be judged by the number of tendering shareholders other than herself. We believe that this device is an innovation of our paper and can be easily applied to other experiments with atomistic agents such as those on step-level public goods and majority voting.

In our laboratory, free-rider problems did occur; only 20% of takeovers were successful and consequently most (80%) of the potential social value from takeover success disappeared. This result suggests that Grossman and Hart's (1980) classical proposition provides valuable insight into the nature of takeover markets. Their proposition denies the 'optimistic story' of takeovers and argues that takeovers should fail even if they were socially valuable. This is what we actually observed in our laboratory.

From our laboratory evidence, we naturally conjecture that the free-rider problem potentially exits in real takeover markets as well. If this conjecture is true, why do we often observe successful takeovers in reality? One possible answer from financial economics would be that "(bidders) find ways to get around the free-rider problem" (Grinblatt and Titman (1998), pp.696). Subsequent takeover models show that under some conditions, Grossman and Hart's classical proposition does not hold and takeovers may be successful. In particular, Shleifer and Vishny (1986) and Hirshleifer and Titman (1990) predict that initial shareholdings by a bidder mitigate the free-rider problem and may allow a takeover to succeed. This prediction was supported in our laboratory; when a bidder initially holds shares of the target firm, about 70% of takeovers are successful. This experimental result indicates that the bidder's initial shareholdings may overcome the free-rider problem in real takeover markets and can be considered one reason for the successful takeovers observed in reality.

While we demonstrated the importance of Grossman and Hart's classical proposition, we should also note that their proposition does not perfectly explain our evidence. Specifically, the observed probabilities of takeover success (20%) and that of shareholder tendering (40%) in our laboratory were far in excess of the 0% predicted by Grossman and Hart. We examined several possible reasons why some shareholders did not free ride, but this finding remains an anomaly. To explain this anomaly, we need to conduct experiments in slightly different settings. Also, the future development of research exploring the provision of public goods would help us to better understand our anomaly, since non-free-riding behavior is also observed in public goods experiments.[39]

Overall, our experimental evidence supports economists' views of real takeover markets; the free-rider problem exists, but it can be mitigated by factors such as a bidder's initial shareholdings. This result has important implications for capital markets, public policy, and financial economics. First, we should not believe the "optimistic story of takeovers". Takeover mechanisms do not necessarily work well. Thus, shareholders have to care about how to discipline bad management, and bidders need to find ways to get around the free-rider problem. Second, institutional environments that limit bidders' initial shareholdings may prevent takeover success and lower social welfare. For example, under U.S. regulations, potential bidders cannot freely accumulate initial shares in the target firm, because they are required to file schedule 13-D with SEC disclosing holdings and intentions after purchasing 5% of target shares. This regulatory environment may discourage valuable takeovers. Third, a considerable number of takeover models may be useful in explaining reality. We showed that Grossman and Hart's (1980) model, the starting point for various takeover models, and two subsequent models regarding the bidder's initial stakes (Shleifer and Vishny (1986) and Hirshleifer and Titman (1990)) were supported in our laboratory. Therefore, it is also possible that other takeover models based on Grossman and Hart (1980) show us remedies for the free-rider problem and explain successful takeovers in reality. In exploring this possibility, experimental research seems particularly effective.[40]

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[39] Dawes and Thaler (1988, pp.196) summarizes the general result of public goods experiments, "It is certainly true that there is a free-rider problem. . . . On the other hand, the strong free-rider prediction is clearly wrong — not everyone free-rides all of the time".

[40] Kale and Noe's (1997) and Cadsby and Maynes' (1998) experiments are two examples of this.

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Table 1 Shareholders' Payoffs

The Outcome of a Takeover / Shareholder's Decision	Successful	Not Successful
Tender (Accept)	x	0
Not Tender (Reject)	z	0

Table 2-A The Results of [Experiment A]

(The no shareholdings case)

Round Number	The Value of Z	Group A-1 Bid Price	Group A-1 # of sellers to accept	Group A-2 Bid Price	Group A-2 # of sellers to accept	Group A-3 Bid Price	Group A-3 # of sellers to accept	Group A-4 Bid Price	Group A-4 # of sellers to accept
1	150	110	**12**	110	9	90	6	110	9
2	100	40	6	80	6	80	3	90	9
3	190	120	4	130	6	130	4	100	6
4	170	110	6	150	**13**	150	9	180	**11**
5	150	90	9	120	**12**	130	8	150	**12**
6	140	130	9	120	9	120	6	130	8
7	180	160	9	130	7	170	9	150	**13**
8	50	60	5	30	**10**	50	**10**	70	**14**
9	150	100	**10**	130	9	130	9	150	8
10	30	40	8	30	6	10	5	40	9
11	70	50	6	50	7	50	7	70	**12**
12	90	90	7	60	7	70	9	80	5
13	160	130	**10**	120	7	140	8	100	**10**
14	120	120	6	110	**10**	110	7	130	**11**
15	120	100	6	100	9	110	7	120	5
16	50	80	9	40	9	40	8	60	**11**
17	90	80	6	70	6	80	8	100	7
18	30	60	7	20	6	40	8	40	7
19	180	190	7	140	9	170	9	80	8
20	60	50	7	50	5	60	8	40	5
Average Bid	Acceptance Rate	95.50	0.373	89.50	0.405	96.50	0.370	99.50	0.450
# of Rounds of Successful Takeovers		3		4		1		8	
Efficiency		20.18 %		21.49 %		2.19 %		41.67 %	

Table 2-B The Results of [Experiment B]

(The initial shareholdings case)

Round Number	The Value of Z	Group B-1		Group B-2		Group B-3		Group B-4	
		Bid Price	# of sellers to accept	Bid Price	# of sellers to accept	Bid Price	# of sellers to accept	Bid Price	# of sellers to accept
1	150	120	**13**	160	**15**	130	**12**	140	**12**
2	100	100	**8**	180	**17**	70	5	110	7
3	190	120	**8**	140	**11**	170	**12**	140	**8**
4	170	90	5	160	**17**	140	6	150	**15**
5	150	160	**8**	140	**14**	140	7	140	**9**
6	140	160	**9**	120	**11**	160	**8**	140	7
7	180	150	**11**	130	**9**	190	**15**	150	**8**
8	50	10	4	70	**10**	80	6	100	7
9	150	170	**17**	120	**10**	140	**12**	130	**9**
10	30	40	4	40	**8**	40	**10**	110	**9**
11	70	90	7	50	**8**	70	6	100	6
12	90	110	**8**	60	**9**	110	**8**	100	**8**
13	160	160	**12**	120	**8**	150	**11**	130	5
14	120	130	**8**	120	**10**	130	**10**	100	**13**
15	120	130	6	100	**12**	130	6	100	**14**
16	50	80	6	50	3	60	**11**	80	**10**
17	90	110	**11**	90	7	100	**9**	90	**8**
18	30	40	**8**	50	5	40	**8**	80	**8**
19	180	150	**9**	130	**14**	180	**13**	90	7
20	60	60	7	70	**8**	60	**8**	70	4
Average Bid	Acceptance Rate	100.90	0.423	105.00	0.515	114.50	0.458	112.50	0.435
# of Rounds of Successful Takeovers		13		17		14		13	
Efficiency		75.88 %		92.54 %		71.05 %		66.67 %	

Table 3

The Probability of Takeover Success, Acceptance Rates, and the Efficiency

Panel A. The Probability of Success

	[Experiment A] No Shareholdings	[Experiment B] Initial Shareholdings	Difference
# of Total Rounds	80	80	
# of Success Rounds	16	57	
# of Failure Rounds	64	23	
The Probability of Success	0.2000	0.7125	0.5125*** (0.000)

Note: ***, **, * indicates p<0.001, p<0.01, p<0.05. p-values are shown in parentheses.

Panel B. Acceptance Rates

	[Experiment A] No Shareholdings	[Experiment B] Initial Shareholdings	Difference
# of Total Shareholders	1600	1600	
Shareholders who accepted	639	732	
Shareholders who rejected	961	868	
Acceptance Rate	0.3994	0.4575	0.0581** (0.001)

Panel C. The Efficiency

	[Experiment A] No Shareholdings	[Experiment B] Initial Shareholdings	Difference
Average Efficiency	21.38 %	76.54 %	55.16% **(0.003)

Table 4

Logit Regression Results: The Probability of Takeover Success

	[Experiment A] No Shareholdings				[Experiment B] Initial Shareholdings			
	Model 1		Model 2		Model 1		Model 2	
Intercept	- 2.2437**	(0.004)	- 1.8220	(0.152)	- 1.0904	(0.135)	- 2.2167	(0.091)
X (Bid Price)	0.0086	(0.214)	0.0068	(0.402)	0.0191**	(0.005)	0.0240**	(0.004)
ROUND			- 0.0600	(0.285)			0.0321	(0.541)
GROUP2			0.3750	(0.660)			1.3668	(0.110)
GROUP3			- 1.2649	(0.297)			0.1854	(0.805)
GROUP4			1.3395	(0.090)			- 0.1656	(0.817)
# of observations	80		80		80		80	
Log Likelihood	-39.24		-34.50		-43.60		-41.30	

Note: ***, **, * indicates $p<0.001$, $p<0.01$, $p<0.05$. p-values are shown in parentheses.

Table 5

OLS Regression Results: Bid Price Offered by the Bidder

	[Experiment A] No Shareholdings		[Experiment B] Initial Shareholdings	
	Model 1	Model 2	Model 1	Model 2
Intercept	3.1481 (0.742)	- 1.3212 (0.889)	46.845***(0.000)	40.573***(0.001)
Z	0.7420***(0.000)	0.7570***(0.000)	0.6052***(0.000)	0.6130***(0.000)
ROUND	0.7399 (0.088)		- 0.6509 (0.200)	
RDQ2		15.796* (0.019)		3.2463 (0.682)
RDQ3		12.282 (0.065)		- 0.9797 (0.901)
RDQ4		13.993 (0.053)		- 8.0895 (0.347)
GROUP2	- 6.0000 (0.344)	- 6.0000 (0.340)	- 4.0000 (0.591)	- 4.0000 (0.595)
GROUP3	1.0000 (0.874)	1.0000 (0.873)	5.5000 (0.461)	5.5000 (0.734)
GROUP4	4.0000 (0.528)	4.0000 (0.524)	3.5000 (0.639)	3.5000 (0.642)
# of observations	80	80	80	80
Adjusted R^2	0.771	0.776	0.661	0.655

Note: ***, **, * indicates p<0.001, p<0.01, p<0.05. p-values are shown in parentheses.

Table 6

Logit Regression Results: Shareholders' Probabilities of Tendering

	[Experiment A] No Shareholdings			
	Model 1	Model 2	Model 3	Model 4
Intercept	- 0.7199 (0.206)	- 0.9686 (0.077)	- 0.9041***(0.000)	- 1.0283***(0.000)
X (bid)	0.0033* (0.013)	0.0034* (0.011)	0.0030* (0.021)	0.0032* (0.017)
ROUND	- 0.0065 (0.715)		- 0.0116 (0.356)	
RDQ2		0.2083 (0.254)		0.1563 (0.346)
RDQ3		0.0404 (0.866)		- 0.0360 (0.841)
RDQ4		0.0374 (0.892)		- 0.0600 (0.761)
OPAYAVG	0.0029 (0.774)	0.0004 (0.965)		
OPAYDUM			0.2432 (0.210)	0.1877 (0.328)
PIVOTAL	0.9699* (0.044)	0.9783* (0.043)	0.9864* (0.041)	0.9905* (0.041)
GROUP2	0.1980 (0.235)	0.2172 (0.195)	0.3706 (0.055)	0.3373 (0.079)
GROUP3	0.0342 (0.842)	0.0542 (0.753)	0.1848 (0.311)	0.1560 (0.390)
GROUP4	0.3200 (0.162)	0.3625 (0.116)	0.3192* (0.039)	0.3308* (0.032)
# of observations	1520	1520	1520	1520
Log Likelihood	-1012.51	-1011.40	-1011.77	-1010.92

Note: ***, **, * indicates p<0.001, p<0.01, p<0.05. p-values are shown in parentheses.

Table 7

Results for Later Rounds

	[Experiment A] No Shareholdings	[Experiment B] Initial Shareholdings	Difference
Panel A. The Final 15 Rounds (6^{th} – 20^{th} rounds)			
The Probability of Success	0.1833	0.7000	0.5167*** (0.000)
Acceptance Rates	0.3992	0.4358	0.0366 (0.075)
Average Efficiency	19.08%	77.08%	58.00%** (0.002)
Panel B. The Final 10 Rounds (11^{th} – 20^{th} rounds)			
The Probability of Success	0.1500	0.6750	0.5250*** (0.000)
Acceptance Rates	0.3825	0.4238	0.0413 (0.093)
Average Efficiency	16.49%	69.07%	52.58%** (0.005)

Note: ***, **, * indicates p<0.001, p<0.01, p<0.05. p-values are shown in parentheses.

Figure 1-A The Free-rider Problem in Corporate Takeovers

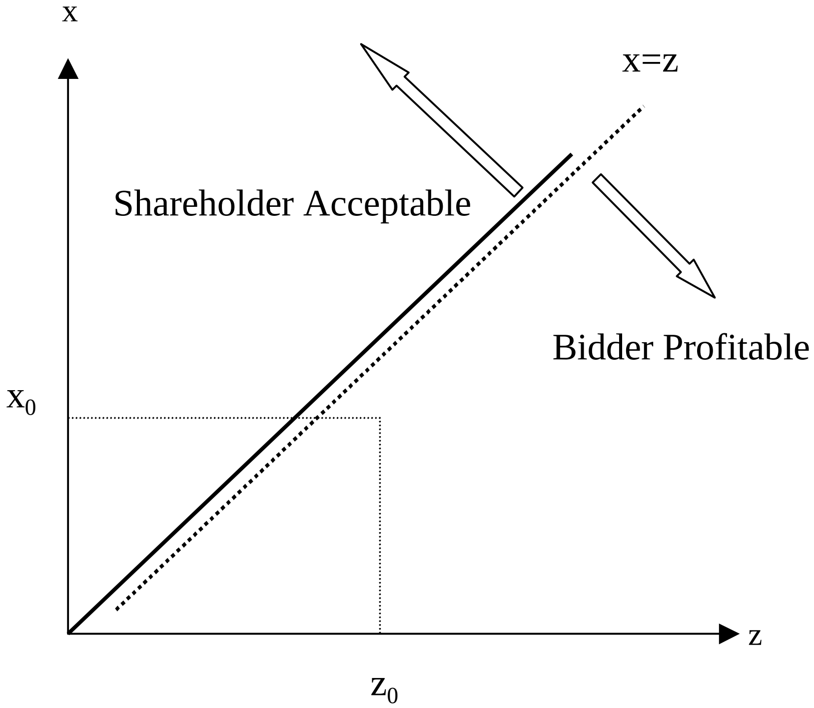


Figure 1-B The Bidder's Initial Holdings and Takeover Success

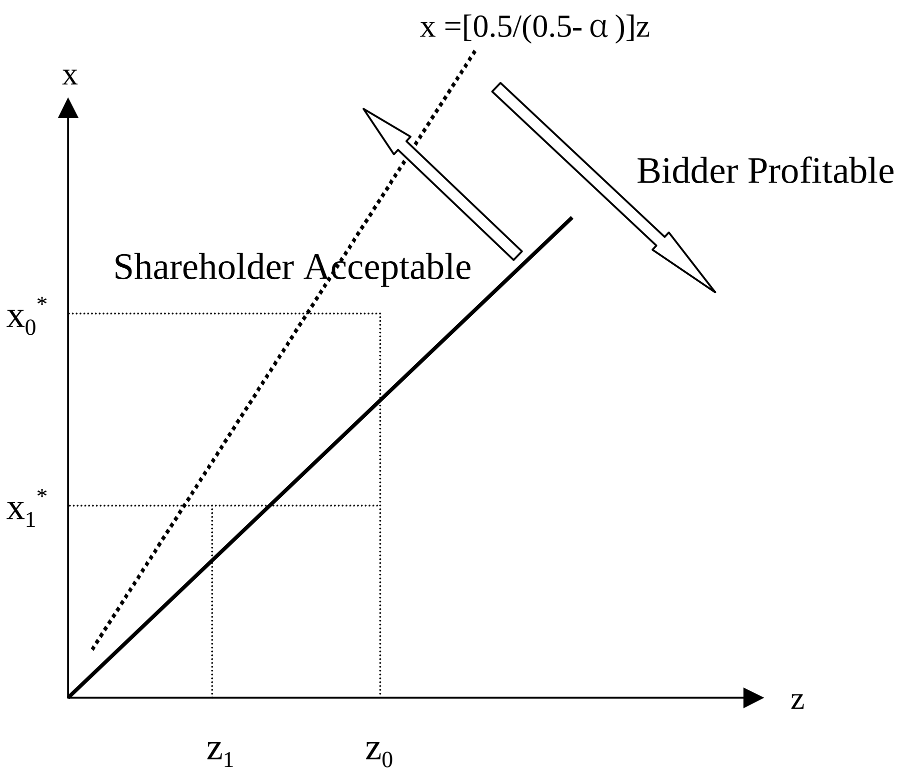


Figure 2-A [Experiment A] (No Shareholdings)

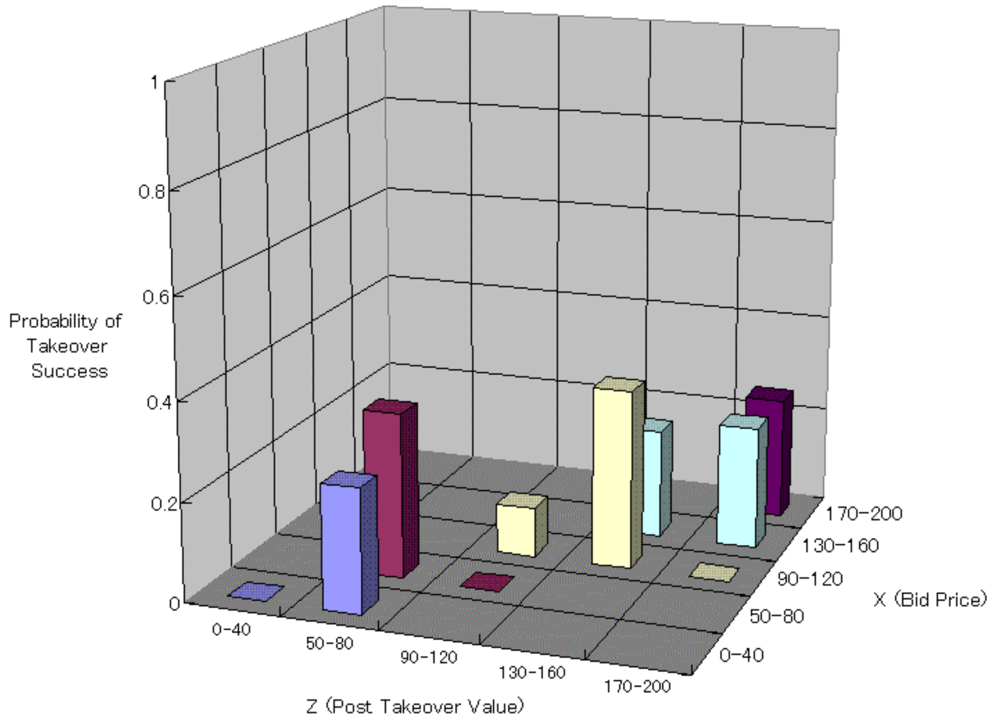


Figure 2-B [Experiment B] (Initial Shareholdings)

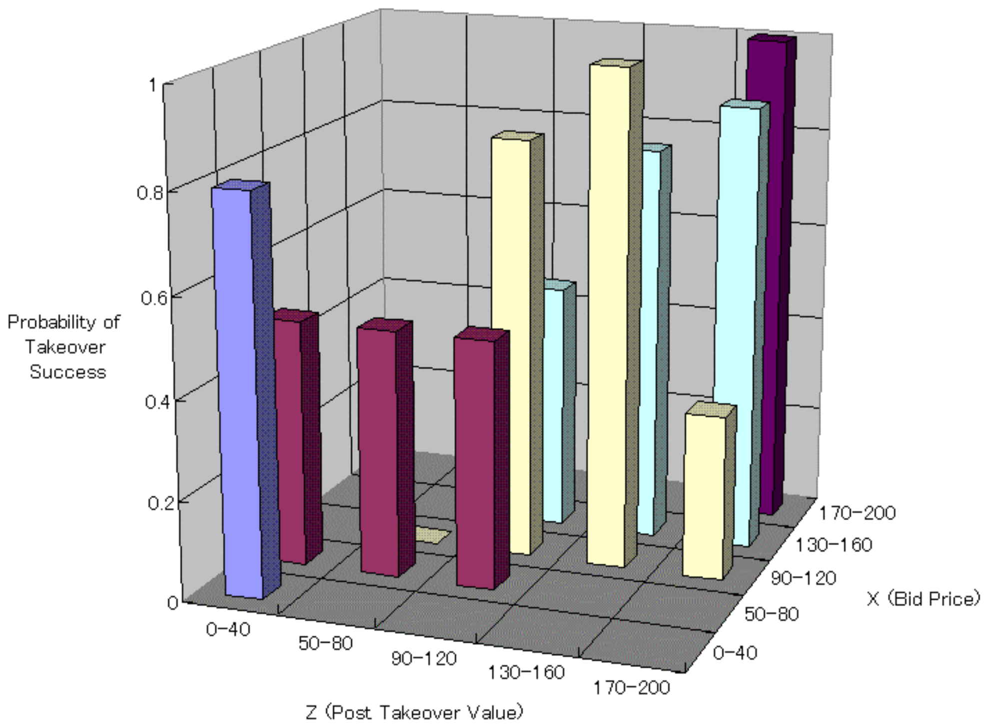
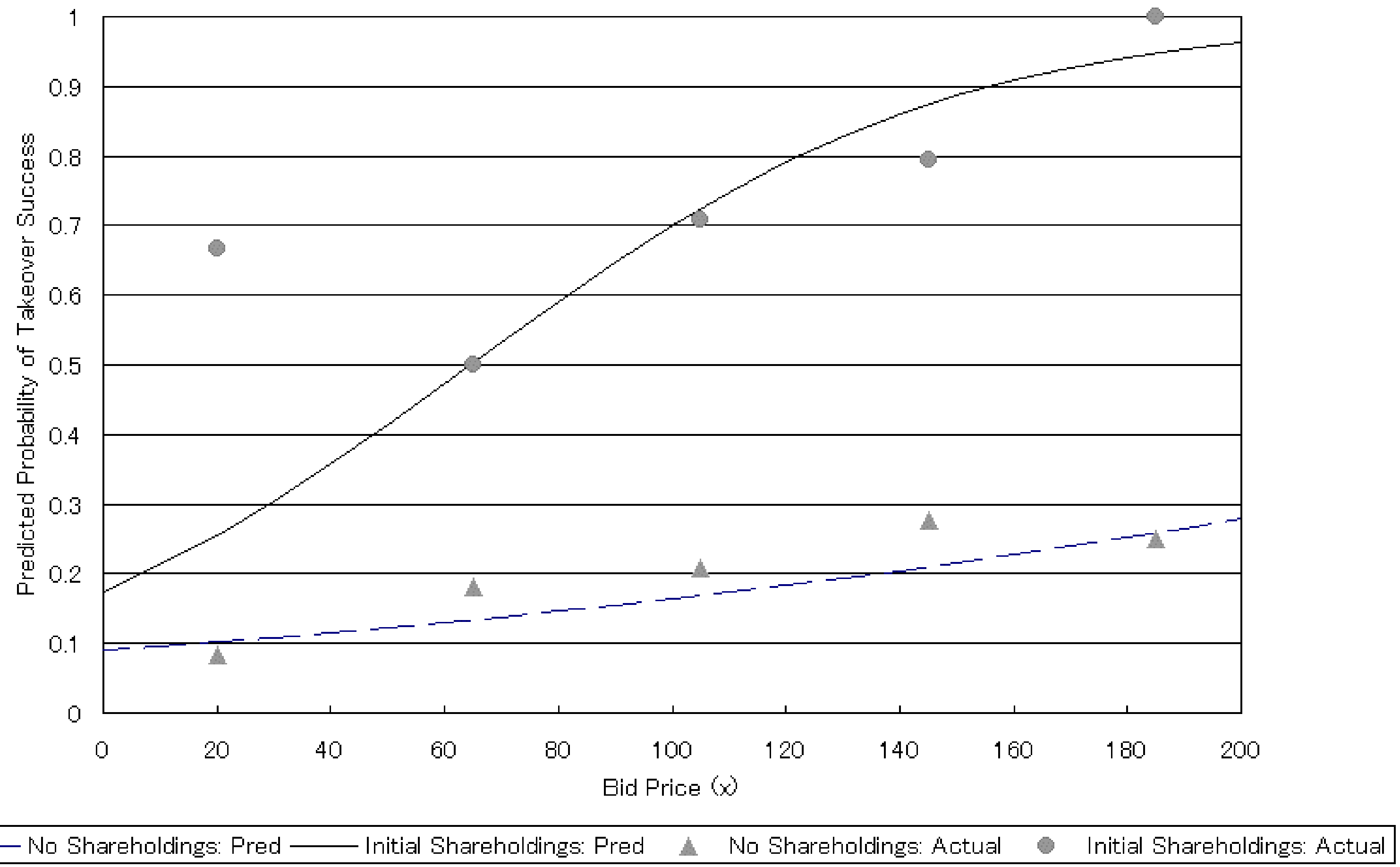


Figure 3 Predicted Probability of Takeover Success
(from regression model 2)



Appendix: Players Instructions for [Experiment B][41] (Exact Transcript)

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 Buyer, move to the seats to which the experimenter will guide you, with everything on your desk.

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 common to both the Buyer and Sellers. Except for these white papers, the sheets for the Buyer are YELLOW, and the sheets for Sellers are BLUE. Make sure that you have the appropriate sheets for you. The experimenter will distribute the Desired Purchasing Price Cards (yellow) to the Buyer, and the Selling Decision Cards (blue) 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 (yellow)
- Desired Purchasing Price Cards (yellow)
- Buyer's Payoff Sheet 1 (yellow)
- Buyer's Payoff Sheet 2 (yellow)
- Receipt (white) *Enter your name and address, and impress your seal before the experiment begins.
- Ballpoint pen.

[41] Player instructions for [Experiment A] are similar except for the bidder's initial holdings and things related to them.

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 (blue)
- Selling Decision Cards (blue)
- Sellers' Payoff Sheets (blue)
- 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 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 consider slowly. If you are a Seller, please wait for a while.

iii. The experimenter will announce the commodity's desired purchasing price that each Buyer will have decided. If you are a Seller, decide whether to sell your commodity or not. Enter 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 also 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 of this experiment will be paid. Wait until your Individual Number is called.

9. If 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 in the Receipt. Impress your seal if not, and receive your reward. Then the whole experiment will finish.

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 the 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 there are the follows 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 (on pieces of yellow and papers)

-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.

From now on we will give you the instructions of this experiment.

Before we begin this experiment, we assign one of the participants to the Buyer and twenty to Sellers 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.

Buyer (one person)

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

Now you have 5 units of a commodity, and you are thinking of purchasing 8 more units. 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 8 more units, that is, only when you can get the offers of "Sell" from 8 Sellers or more out of 20. If you can get the offers only from 7 Sellers or less, the commodity has no value for you, and you are to stop purchasing it. And in that case, the value of 5 units of the commodity you originally have will also be zero.

Looking at the value of Z revealed by the experimenter, you will enter your "desired 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 300, 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 8 Sellers or more would choose "Sell" or "Not Sell".

The way the Buyer's (your) payoff will be determined is summarized in Buyer's Payoff Sheet on your desk. Let us explain how to use it. Suppose that more than 8 Sellers agreed to "sell", and let this case be "Case 1". Then your payoff will be:

$$Z \times 5 \quad + \quad (\text{ Z} - \text{desired purchasing price}) \times 8.$$

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

$$150 \times 5 \quad + \quad (150 - 100) \times 8 = 1150.$$

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 1150 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 7 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 and the value of 5 units of the commodity you originally have will also be zero, so that as you can see in Buyer's Payoff Sheet 1, your payoff will be 0.

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 12 Sellers agreed to "sell" referring to your offer. This case is "Case 1", since 8 Sellers or more agreed to sell the commodity. Therefore your payoff would be, according to Sellers' Payoff Sheet 1,

$$130 \times 5 \quad + \quad (130 - 90) \times 8 = 970.$$

This can also be confirmed with Buyer's Payoff Sheet 2. On Buyer's Payoff Sheet 2, you will find your payoff 970 at the box where the column of Z 130 and the row of the desired purchasing price 90 intersect.

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 8 Sellers agreed to "sell". This case is "Case 1" as well, since 8 Sellers or more agreed to sell the commodity. Therefore your payoff would be 970, as in *Example 1*. The result is recorded at Example 2 on Sellers' Record Sheet.

Example 3 Next, suppose that the value of Z was 80, that your desired purchasing price was 90 and that 10 Sellers agreed to "sell". This case is also "Case 1", since 8 Sellers or more agreed to sell. Then your payoff would be, according to Buyer's Payoff Sheet 1,

$$80 \times 5 \quad + \quad (80 - 140) \times 8 = -80,$$

so that you would lose 80. This can be confirmed with Buyer's Payoff Sheet 2. On the Payoff Sheet of Buyer 2, you will find your payoff – 80 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 Sellers' Record Sheet.

Example 4 Suppose that the value of Z was 190, that your desired purchasing price was 100 and that 5 Sellers agreed to "sell". This case is "Case 2", since 7 Sellers or less agreed to sell. Therefore, according to Buyer's Payoff Sheet 1, your payoff would be 0. As an exercise, record the result of *Example 4* in 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 is the instructions for the Buyer in one round. You may see the sheets for the Sellers as well. However, make sure that you will not confuse the sheets for you with those for the Sellers.

Sellers (20 persons)

Now let us give the instructions to the Sellers. To begin with, put on your desk Sellers' Record Sheet, Sellers' Payoff Sheet, and the Selling Decision Card (the blue one in a pair of small piece of paper). The Sellers will use the blue sheets.

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 as to "Sell" or "Not Sell", but also on those of the other Sellers. However, you will not know the other Sellers' decisions when you make your own decision.

As for how your payoff will be determined, see Sellers' Payoff Sheet. Now we will explain how to use this sheet. If 8 Sellers or more other than you agreed to "sell" ([Case A] in Sellers' Payoff Sheet), your payoff will be determined as follows. 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 7 Sellers or less other than you agreed to "sell" ([Case B] in Sellers' Payoff Sheet), your payoff will be 0, regardless of your choice of "Sell" or "Not Sell".

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 14 Sellers agreed to "sell" at the same time. In this case, the number of Sellers other than you who sold the commodity is 13. This is [Case A], since 8 Sellers or more other than you agreed to "sell". Since you chose "Sell", according to 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 Sellers' Record Sheet. There "the value of Z announced by the 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 8 Sellers or more other than you agreed to "sell". However, your payoff would be, according to 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 Sellers' Record Sheet.

Example 7 Suppose that you chose "Sell" at the desired purchasing price180 offered by the Buyer, and that 6 Sellers agreed to "sell". In this case, the number of Sellers <u>other than you</u> who sold the commodity is 5. This is [Case B], since 7 Sellers or less <u>other than you</u> 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 Sellers' Record Sheet.

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 is 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 you 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.

<u>How to fill in Record Sheet</u>

<u>Buyer</u>

i. Enter the value of Z revealed by the experimenter in Buyer's Record Sheet.

ii. Choose your desired purchasing price from 0 to 300 at the 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 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 Buyer's Record Sheet.

vi. Enter your payoff in Buyer's Record Sheet (see Buyer's Payoff Sheet 1 and Buyer's Payoff Sheet 2).

<u>Sellers</u>

i. Enter the Buyer's desired purchasing price announced by the experimenter in Sellers' Record Sheet.

ii. Choose either "Sell" or "Not Sell" and enter it in Sellers' Record Sheet and the Selling

Decision Card.

iii. Remove the entered 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 Sellers' Record Sheet.

v. Enter the number of the Sellers other than you who sold the commodity in Sellers' Record Sheet.

vi. Enter your payoff in Sellers' Record Sheet (see Sellers' Payoff Sheet).

*In 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 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:

$$1{,}000 + 0.5 \times (\text{ the sum of "Your Payoff" }) \text{ yen.}$$

For example, if the sum of "Your Payoff" in all of the rounds is 4,000 you will receive:

$$1{,}000 + 0.5 \times 4{,}000 = 3{,}000 \text{ yen.}$$

Next, a Seller's monetary reward is:

$$1{,}000 + 2 \times (\text{ the sum of "Your Payoff" }) \text{ yen.}$$

For example, if the sum of "Your Payoff" in all of the rounds is 1,000 you will receive:

$$1{,}000 + 2 \times 1{,}000 = 3{,}000 \text{ yen.}$$

This is the end of the instructions of this experiment. If you have questions, raise your hand quietly. The experimenter will come to your desk.

Buyer's Record Sheet

Your Individual Number ___________

Example 1

The value of Z (enter the value of Z revealed by the experimenter)	Your desired purchasing price (a value from 0 to 300 at the interval of every 10)	The number of Sellers announced by the experimenter	The way your payoff is determined (see Buyer's Payoff Sheet 1 and 2)		Your Payoff
130	90	12	"Case 1" The number of Sellers announced is <u>8 or more</u> →	See Buyer's Payoff Sheet 2	970
			"Case 2" The number of Sellers announced is <u>7 or less</u> →	0	

Example 2

The value of Z (enter the value of Z revealed by the experimenter)	Your desired purchasing price (a value from 0 to 300 at the interval of every 10)	The number of Sellers announced by the experimenter	The way your payoff is determined (see Buyer's Payoff Sheet 1 and 2)		Your Payoff
130	90	8	"Case 1" The number of Sellers announced is <u>8 or more</u> →	See Buyer's Payoff Sheet 2	970
			"Case 2" The number of Sellers announced is <u>7 or less</u> →	0	

Example 3

The value of Z (enter the value of Z revealed by the experimenter)	Your desired purchasing price (a value from 0 to 300 at the interval of every 10)	The number of Sellers announced by the experimenter	The way your payoff is determined (see Buyer's Payoff Sheet 1 and 2)		Your Payoff
80	140	10	"Case 1" The number of Sellers announced is <u>8 or more</u> →	See Buyer's Payoff Sheet 2	−80
			"Case 2" The number of Sellers announced is <u>7 or less</u> →	0	

Example 4 (Record the result by yourself)

The value of Z (enter the value of Z revealed by the experimenter)	Your desired purchasing price (a value from 0 to 300 at the interval of every 10)	The number of Sellers announced by the experimenter	The way your payoff is determined (see Buyer's Payoff Sheet 1 and 2)		Your Payoff
			"Case 1" The number of Sellers announced is <u>8 or more</u> →	See Buyer's Payoff Sheet 2	
			"Case 2" The number of Sellers announced is <u>7 or less</u> →	0	

Sellers' Record Sheet

Your Individual Number _______________

Example 5

The desired purchasing price offered by the Buyer	Your choice (put a circle around either of them)	The number of Sellers announced	The number of Sellers other than you who sold the commodity
130	Sell Not Sell	14	13
The value of Z announced by the experimenter		Your payoff	
80		130	

The way your payoff is determined (see Seller's Payoff Sheet)			
		The number of Sellers other than you who chose "Sell"	
		[Case A] 8 or More	[Case B] 7 or less
Your Choice	Sell	The desired purchasing price offered by the Buyer	0
	Not Sell	Z	0

Example 6

The desired purchasing price offered by the Buyer	Your choice (put a circle around either of them)	The number of Sellers announced	The number of Sellers other than you who sold the commodity
120	Sell Not Sell	12	12
The value of Z announced by the experimenter		Your payoff	
100 (150)		100 (150)	

The way your payoff is determined (see Seller's Payoff Sheet)			
		The number of Sellers other than you who chose "Sell"	
		[Case A] 8 or More	[Case B] 7 or less
Your Choice	Sell	The desired purchasing price offered by the Buyer	0
	Not Sell	Z	0

Example 7

The desired purchasing price offered by the Buyer	Your choice (put a circle around either of them)	The number of Sellers announced	The number of Sellers other than you who sold the commodity
	Sell Not Sell		
The value of Z announced by the experimenter		Your payoff	

The way your payoff is determined (see Seller's Payoff Sheet)			
		The number of Sellers other than you who chose "Sell"	
		[Case A] 8 or More	[Case B] 7 or less
Your Choice	Sell	The desired purchasing price offered by the Buyer	0
	Not Sell	Z	0

Buyer's Payoff Sheet 1

The number of Sellers who agreed to sell	
"Case 1" **8 or More**	"Case 2" **7 or Less**
$Z \times 5 + (Z -$ your desired purchasing price$) \times 8$	0

Sellers' Payoff Sheet

		The number of Sellers other than you who chose "Sell"	
		[Case A] 8 or More	[Case B] 7 or Less
Your Choice	Sell	The desired purchasing price offered by the Buyer	0
	Not Sell	The value of Z	0

Buyer's Payoff Sheet 2

		The value of Z revealed by the experimenter																				
		0	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**	**110**	**120**	**130**	**140**	**150**	**160**	**170**	**180**	**190**	**200**
	0	0	130	260	390	520	650	780	910	1040	1170	1300	1430	1560	1690	1820	1950	2080	2210	2340	2470	2600
	10	-80	50	180	310	440	570	700	830	960	1090	1220	1350	1480	1610	1740	1870	2000	2130	2260	2390	2520
	20	-160	-30	100	230	360	490	620	750	880	1010	1140	1270	1400	1530	1660	1790	1920	2050	2180	2310	2440
	30	-240	-110	20	150	280	410	540	670	800	930	1060	1190	1320	1450	1580	1710	1840	1970	2100	2230	2360
	40	-320	-190	-60	70	200	330	460	590	720	850	980	1110	1240	1370	1500	1630	1760	1890	2020	2150	2280
	50	-400	-270	-140	-10	120	250	380	510	640	770	900	1030	1160	1290	1420	1550	1680	1810	1940	2070	2200
	60	-480	-350	-220	-90	40	170	300	430	560	690	820	950	1080	1210	1340	1470	1600	1730	1860	1990	2120
	70	-560	-430	-300	-170	-40	90	220	350	480	610	740	870	1000	1130	1260	1390	1520	1650	1780	1910	2040
	80	-640	-510	-380	-250	-120	10	140	270	400	530	660	790	920	1050	1180	1310	1440	1570	1700	1830	1960
	90	-720	-590	-460	-330	-200	-70	60	190	320	450	580	710	840	970	1100	1230	1360	1490	1620	1750	1880
	100	-800	-670	-540	-410	-280	-150	-20	110	240	370	500	630	760	890	1020	1150	1280	1410	1540	1670	1800
	110	-880	-750	-620	-490	-360	-230	-100	30	160	290	420	550	680	810	940	1070	1200	1330	1460	1590	1720
	120	-960	-830	-700	-570	-440	-310	-180	-50	80	210	340	470	600	730	860	990	1120	1250	1380	1510	1640
Your desired purchasing price	**130**	-1040	-910	-780	-650	-520	-390	-260	-130	0	130	260	390	520	650	780	910	1040	1170	1300	1430	1560
	140	-1120	-990	-860	-730	-600	-470	-340	-210	-80	50	180	310	440	570	700	830	960	1090	1220	1350	1480
	150	-1200	-1070	-940	-810	-680	-550	-420	-290	-160	-30	100	230	360	490	620	750	880	1010	1140	1270	1400
	160	-1280	-1150	-1020	-890	-760	-630	-500	-370	-240	-110	20	150	280	410	540	670	800	930	1060	1190	1320
	170	-1360	-1230	-1100	-970	-840	-710	-580	-450	-320	-190	-60	70	200	330	460	590	720	850	980	1110	1240
	180	-1440	-1310	-1180	-1050	-920	-790	-660	-530	-400	-270	-140	-10	120	250	380	510	640	770	900	1030	1160
	190	-1520	-1390	-1260	-1130	-1000	-870	-740	-610	-480	-350	-220	-90	40	170	300	430	560	690	820	950	1080
	200	-1600	-1470	-1340	-1210	-1080	-950	-820	-690	-560	-430	-300	-170	-40	90	220	350	480	610	740	870	1000
	210	-1680	-1550	-1420	-1290	-1160	-1030	-900	-770	-640	-510	-380	-250	-120	10	140	270	400	530	660	790	920
	220	-1760	-1630	-1500	-1370	-1240	-1110	-980	-850	-720	-590	-460	-330	-200	-70	60	190	320	450	580	710	840
	230	-1840	-1710	-1580	-1450	-1320	-1190	-1060	-930	-800	-670	-540	-410	-280	-150	-20	110	240	370	500	630	760
	240	-1920	-1790	-1660	-1530	-1400	-1270	-1140	-1010	-880	-750	-620	-490	-360	-230	-100	30	160	290	420	550	680
	250	-2000	-1870	-1740	-1610	-1480	-1350	-1220	-1090	-960	-830	-700	-570	-440	-310	-180	-50	80	210	340	470	600
	260	-2080	-1950	-1820	-1690	-1560	-1430	-1300	-1170	-1040	-910	-780	-650	-520	-390	-260	-130	0	130	260	390	520
	270	-2160	-2030	-1900	-1770	-1640	-1510	-1380	-1250	-1120	-990	-860	-730	-600	-470	-340	-210	-80	50	180	310	440
	280	-2240	-2110	-1980	-1850	-1720	-1590	-1460	-1330	-1200	-1070	-940	-810	-680	-550	-420	-290	-160	-30	100	230	360
	290	-2320	-2190	-2060	-1930	-1800	-1670	-1540	-1410	-1280	-1150	-1020	-890	-760	-630	-500	-370	-240	-110	20	150	280
	300	-2400	-2270	-2140	-2010	-1880	-1750	-1620	-1490	-1360	-1230	-1100	-970	-840	-710	-580	-450	-320	-190	-60	70	200

Your Individual Number ____________
Desired Purchasing Price Card **1st round**

You are the Buyer. Put a circle around one of the values below.
0 10 20 30 40 50 60 70 80 90 100 110
120 130 140 150 160 170 180 190 200
210 220 230 240 250 260 270 280 290 300

Your Individual Number ____________
Desired Purchasing Price Card **2nd round**

You are the Buyer. Put a circle around one of the values below.
0 10 20 30 40 50 60 70 80 90 100 110
120 130 140 150 160 170 180 190 200
210 220 230 240 250 260 270 280 290 300

Your Individual Number ____________
Desired Purchasing Price Card **3rd round**

You are the Buyer. Put a circle around one of the values below.
0 10 20 30 40 50 60 70 80 90 100 110
120 130 140 150 160 170 180 190 200
210 220 230 240 250 260 270 280 290 300

Your Individual Number ____________
Desired Purchasing Price Card **4th round**

You are the Buyer. Put a circle around one of the values below.
0 10 20 30 40 50 60 70 80 90 100 110
120 130 140 150 160 170 180 190 200
210 220 230 240 250 260 270 280 290 300

Your Individual Number ____________
Desired Purchasing Price Card **5th round**

You are the Buyer. Put a circle around one of the values below.
0 10 20 30 40 50 60 70 80 90 100 110
120 130 140 150 160 170 180 190 200
210 220 230 240 250 260 270 280 290 300

Your Individual Number ____________
Desired Purchasing Price Card **6th round**

You are the Buyer. Put a circle around one of the values below.
0 10 20 30 40 50 60 70 80 90 100 110
120 130 140 150 160 170 180 190 200
210 220 230 240 250 260 270 280 290 300

Your Individual Number ____________
Desired Purchasing Price Card **11th round**

You are the Buyer. Put a circle around one of the values below.
0 10 20 30 40 50 60 70 80 90 100 110
120 130 140 150 160 170 180 190 200
210 220 230 240 250 260 270 280 290 300

Your Individual Number ____________
Desired Purchasing Price Card **12th round**

You are the Buyer. Put a circle around one of the values below.
0 10 20 30 40 50 60 70 80 90 100 110
120 130 140 150 160 170 180 190 200
210 220 230 240 250 260 270 280 290 300

Your Individual Number ____________
Desired Purchasing Price Card **13th round**

You are the Buyer. Put a circle around one of the values below.
0 10 20 30 40 50 60 70 80 90 100 110
120 130 140 150 160 170 180 190 200
210 220 230 240 250 260 270 280 290 300

Your Individual Number ____________
Desired Purchasing Price Card **14th round**

You are the Buyer. Put a circle around one of the values below.
0 10 20 30 40 50 60 70 80 90 100 110
120 130 140 150 160 170 180 190 200
210 220 230 240 250 260 270 280 290 300

Your Individual Number ____________
Desired Purchasing Price Card **15th round**

You are the Buyer. Put a circle around one of the values below.
0 10 20 30 40 50 60 70 80 90 100 110
120 130 140 150 160 170 180 190 200
210 220 230 240 250 260 270 280 290 300

Your Individual Number ____________
Desired Purchasing Price Card **16th round**

You are the Buyer. Put a circle around one of the values below.
0 10 20 30 40 50 60 70 80 90 100 110
120 130 140 150 160 170 180 190 200
210 220 230 240 250 260 270 280 290 300

Your Individual Number _____________
Desired Purchasing Price Card **7th round**

You are the Buyer. Put a circle around one of the values below.
0 10 20 30 40 50 60 70 80 90 100 110
120 130 140 150 160 170 180 190 200
210 220 230 240 250 260 270 280 290 300

Your Individual Number _____________
Desired Purchasing Price Card **8th round**

You are the Buyer. Put a circle around one of the values below.
0 10 20 30 40 50 60 70 80 90 100 110
120 130 140 150 160 170 180 190 200
210 220 230 240 250 260 270 280 290 300

Your Individual Number _____________
Desired Purchasing Price Card **9th round**

You are the Buyer. Put a circle around one of the values below.
0 10 20 30 40 50 60 70 80 90 100 110
120 130 140 150 160 170 180 190 200
210 220 230 240 250 260 270 280 290 300

Your Individual Number _____________
Desired Purchasing Price Card **10th round**

You are the Buyer. Put a circle around one of the values below.
0 10 20 30 40 50 60 70 80 90 100 110
120 130 140 150 160 170 180 190 200
210 220 230 240 250 260 270 280 290 300

Your Individual Number _____________
Desired Purchasing Price Card **17th round**

You are the Buyer. Put a circle around one of the values below.
0 10 20 30 40 50 60 70 80 90 100 110
120 130 140 150 160 170 180 190 200
210 220 230 240 250 260 270 280 290 300

Your Individual Number _____________
Desired Purchasing Price Card **18th round**

You are the Buyer. Put a circle around one of the values below.
0 10 20 30 40 50 60 70 80 90 100 110
120 130 140 150 160 170 180 190 200
210 220 230 240 250 260 270 280 290 300

Your Individual Number _____________
Desired Purchasing Price Card **19th round**

You are the Buyer. Put a circle around one of the values below.
0 10 20 30 40 50 60 70 80 90 100 110
120 130 140 150 160 170 180 190 200
210 220 230 240 250 260 270 280 290 300

Your Individual Number _____________
Desired Purchasing Price Card **20th round**

You are the Buyer. Put a circle around one of the values below.
0 10 20 30 40 50 60 70 80 90 100 110
120 130 140 150 160 170 180 190 200
210 220 230 240 250 260 270 280 290 300

Questionnaire

Your Individual Number ________

Your role in this experiment (put a circle around the appropriate one) Seller Buyer

The experiment has finished. Finally, please answer the questions below.
This questionnaire is used in order for us to understand how the participants of this experiment made decisions. You have plenty of time to answer the questions. Whenever you have anything unclear, ask the experimenter. When you have finished answering these questions, wait quietly until the other participants finish.

This questionnaire is anonymous, so that you do not have to enter your name. Please answer all the questions below. If you do not answer any one of these questions, we cannot use your questionnaire sheets as proper data. How to answer the questions is as follows. Put a × mark according to your answer.

Example Question:

Was this experiment easy, or difficult?

Very Easy ____ ____ ____ ____ ____ ____ ____ Very Difficult

If you feel the experiment was very easy,

Very Easy _×_ ____ ____ ____ ____ ____ ____ Very Difficult

put × in the most left box. If you feel the experiment was very difficult,

Very Easy ____ ____ ____ ____ ____ ____ _×_ Very Difficult

put × in the most right box. If you feel the experiment was easy,

Very Easy ____ _×_ ____ ____ ____ ____ ____ Very Difficult

put × as above. If you feel the experiment was somewhat easy,

Very Easy ____ ____ _×_ ____ ____ ____ ____ Very Difficult

put × as above. If you feel the experiment was difficult,

Very Easy ____ ____ ____ ____ ____ _×_ ____ Very Difficult

put × as above. If you feel the experiment was somewhat difficult,

Very Easy ____ ____ ____ ____ _×_ ____ ____ Very Difficult

put × as above. If you feel the experiment was neither easy nor difficult,

Very Easy ____ ____ ____ _×_ ____ ____ ____ Very Difficult put × in the center box as above.

Thank you in advance for your assistance.

Questions on the Instructions of this Experiment

First, we will ask questions about the instructions of this experiment given at the beginning of this experiment. Check (×) one box that applies.

We distributed *Summary*, *Overview of this Experiment* and payoff sheets (*Buyer's Payoff Sheet 1, Buyer's Payoff Sheet 2, Sellers' Payoff Sheet*). Did you refer to them during this experiment?

Never ____ ____ ____ ____ ____ ____ ____ Very Frequently

Did you have anything unclear in the instructions of this experiment?

Yes ____ No

If your answer is Yes, please specify where in the instructions were unclear.

If you have any idea to improve the instructions of this experiment, please write it down below.

Did anything out of the instructions occur in this experiment?

Yes ____ No ____

If your answer is Yes, what was out of the instructions?

Did you understand the procedure of this experiment before it actually started?

Yes ____ No ____

If No, at which round did you come to understand the procedure?

Questions on Your Decision Making

When you make decisions (your desired purchasing price if you were the Buyer, or whether you would sell or would not sell if you were a Seller), what did you take into account? Explain briefly.

Did your decision making change as this experiment proceeded?

Yes ____ No ____

If Yes, how did your decision making change?

- In general, was your decision making difficult, or easy?

  Very Easy ____ ____ ____ ____ ____ ____ ____ Very Difficult

- As this experiment proceeded, did your decision making become easier, or more difficult?

Decision making:

Became Much Easier ____ ____ ____ ____ ____ ____ ____ Became much more Difficult

- To what degree do you think your decision influenced your payoff?

  Never ____ ____ ____ ____ ____ ____ ____ Very Much

- To what degree do you think your decision influenced the other participants' payoffs?

  Never ____ ____ ____ ____ ____ ____ ____ Very Much

- To what degree do you think the other participants' decisions influenced your payoff?

  Never ____ ____ ____ ____ ____ ____ ____ Very Much

- If this experiment had been such that your decision would be known to the other participants, how do you think your decision making would have changed?

  Your decision making would have been:

  Completely the Same ____ ____ ____ ____ ____ ____ ____ Completely Different

- What would your decision making have been like?

- To what degree did you consider the influence that your decision would give to the other participants' payoffs?

  Never ____ ____ ____ ____ ____ ____ ____ Very Much

- To what degree do you think the other participants' consider the influence that their decisions would give to your payoff?

  Never ____ ____ ____ ____ ____ ____ ____ Very Much

- Did the past results influence your next decision making?

  Never ____ ____ ____ ____ ____ ____ ____ Very Much

- If the results in the past rounds influenced your decision making, please specify what.

General Questions on this Experiment

- Next, we will ask general questions about this experiment. To what degree do the following sentences fit the impressions you have.

*This experiment was boring.

Completely False ____ ____ ____ ____ ____ ____ ____ Very True

*My purpose in this experiment was to earn money as much as possible.

Completely False ____ ____ ____ ____ ____ ____ ____ Very True

*I came to think about my decision making less, as the experiment proceeded.

Completely False ____ ____ ____ ____ ____ ____ ____ Very True

*I am satisfied with my payoff.

Completely False ____ ____ ____ ____ ____ ____ ____ Very True

*My purpose in this experiment was to earn more money than other participants.

Completely False ____ ____ ____ ____ ____ ____ ____ Very True

*The experiment was carried out smoothly.

Completely False ____ ____ ____ ____ ____ ____ ____ Very True

*The value of Z was chosen at random.

Completely False ____ ____ ____ ____ ____ ____ ____ Very True

*This experiment was enjoyable.

Completely False ____ ____ ____ ____ ____ ____ ____ Very True

*I did not fully understand the procedure of this experiment until the experiment actually started.

Completely False ____ ____ ____ ____ ____ ____ ____ Very True

*My purpose in this experiment was to earn money as much as possible, together with the other participants.

Completely False ____ ____ ____ ____ ____ ____ ____ Very True

*(Sellers) I did not find it worthwhile to sell the commodity, because not many Sellers were willing to sell the commodity.

Completely False ____ ____ ____ ____ ____ ____ ____ Very True

*I was looking forward to the result in each round.

Completely False ____ ____ ____ ____ ____ ____ ____ Very True

*I thought the experiment was too long.

Completely False ____ ____ ____ ____ ____ ____ ____ Very True

*I did not take this experiment as a whole seriously.

Completely False ____ ____ ____ ____ ____ ____ ____ Very True

- Had you heard of this experiment before the experiment began?

  Yes ____ No ____

- If Yes, what did you hear.
- If you have any comments or opinions for future experiments, please write them down below.