If at First You Don't Succeed: The Effect of the Option to Resolicit on Corporate Takeovers

Ann B. Gillette
Michael J. Coles College of Business, Kennesaw State University and Federal Reserve Bank of Atlanta

Thomas H. Noe
A.B. Freeman School of Business, Tulane University

This article models, and experimentally simulates, the free-rider problem in a takeover when the raider has the option to "resolicit," that is, to make a new offer after an offer has been rejected. In theory, the option to resolicit, by lowering offer credibility, increases the dissipative losses associated with free riding. The outcomes of our experiment support this prediction and produce losses from free riding even higher than theoretically predicted. These dissipation losses reduce raider gains to less than 3% of synergy value of the acquisition

Financial economists have established that, in corporate control contests, individual shareholders have an incentive to *free ride*, that is, to reject the offer in the hope that enough other shareholders accept the offer. Grossman and Hart (1980) have shown that, if shareholders behave nonstrategically, that is, do not take into account the effect of their tendering decision on the aggregate outcome, free riding prevents successful takeovers at prices below post-acquisition value. In contrast, Bagnoli and Lipman (1988) have shown that, when the number of shareholders is finite, strategic shareholder behavior supports equilibria in which free riding is not universal. In fact, even in some formulations of "infinite agent" models, universal free riding is not the only outcome [see Noe (1995)]. However, even in these strategic settings, some value is dissipated through free

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riding. Financial economists, such as Kale and Noe (1997), Cadsby and Maynes (1998), and Hamaguchi et al. (2002), have experimentally studied free riding in takeovers. Our research extends their research by investigating two new questions: the effects of resolicitation and dynamic raider-offer behavior.

Resolicitation in takeover contest is quite common. There are a myriad of examples of bid revisions, such as Oracle's contentious hostile bid for PeopleSoft. Oracle made a series of bids for PeopleSoft ranging from \$16 per share to the final offer of \$26.50. This practice of bid revision has been studied empirically in financial economics. In fact, Betton and Eckbo (2000) found in their comprehensive sample of tender offer contests between 1971 and 1990 that 62% of the contests were single bid and of the 38% that contained multiple bids, 41% of those involved only a single bidder. They conclude that competition, even implicit competition from rumored bidding competitors, cannot be an important explanation for these bid revisions.

In principle, the option to resolicit could either increase or reduce the economic losses from free riding. The argument that resolicitation will reduce economic losses is captured by the aphorism, "If at first you don't succeed, try, try again." In other words, because a deal is struck if an offer is accepted even once, the more often offers can be made the more likely that some offer will be accepted. We call this effect of increased opportunities to tender the *direct effect* of the resolicitation option. However, an argument can also be made that the option to resolicit will increase the economic losses from free riding. This argument can be summarized by Samuel Johnson's aphorism, "Depend upon it, sir, when a man knows he is to be hanged in a fortnight, it concentrates his mind wonderfully." In other words, only the looming threat of losses leads offers to be taken seriously. Attenuating this threat increases an agent's willingness to free ride so much that dissipation losses from free riding actually increase in response to the introduction of an option to resolicit. We term this effect of reduced commitment from resolicitation the *credibility effect.*

This article attempts to determine which of these effects, the direct effect or the credibility effect, dominates in actual takeovers. We first develop a simple model of takeovers with resolicitation.[1] In the model, a raider attempts to take over a firm and implement an improvement in the firm's operations. We abstract from competition between raiders in our formal analyzes and experiments. This limits the applicability of our analysis to many takeover situations. However, as we explain in Section 4, many of our insights extend to a setting with raider competition. The takeover game features (i) a conditional tender offer, (ii) a simple, stationary Markovian structure, and (iii) symmetric share endowments for all shareholders. By

[1] As we explain later, our takeover model is isomorphic to a public-goods provision problem and thus the article also has some implications for this literature.

conditional, we mean that the payments to tendering shareholders are conditional on the raider's receiving enough shares to take control of the firm. If insufficient shares are tendered, the raider returns all tendered shares and prepares a new offer. The game is *stationary* in that, after each offer failure, there is a time-stationary probability that the improvement gain generated by the raider will evaporate, and the takeover game will end. We call the complement of this probability, that is, the probability that the gains do not evaporate, the *continuation probability*.[2]

Our theoretical analysis shows that this game has a symmetric Nash equilibrium. In this equilibrium all shareholders follow stationary-tendering strategies and the raider follows a stationary-offer strategy of making the same offer in each period. A numerical investigation of this equilibrium shows that it has the following properties:

(i) The bid price offered by the raider decreases, at a moderate rate, as the continuation probability increases.
(ii) The shareholders' probability of tendering into the offer falls, at a more substantial rate, as the likelihood of continuation increases.
(iii) The likelihood that the game will end in dissipation and a loss of value actually increases in the continuation probability.
(iv) The raider's payoff first falls and then increases in the continuation probability.

In short, in our theoretical model, the credibility effect trumps the direct effect of resolicitation; the dissipative losses from free riding are increased by the resolicitation option.

Using this model as a benchmark, we performed a series of laboratory experiments. We simulated share tendering with seven shareholder firms, using an experimental design that controls for the effect of behavioral variability in subjects across treatment outcomes. The two treatments we implemented featured continuation probabilities of 0.01 and 0.75. We refer to the rounds featuring a 0.01 continuation probability treatment as "nonresolicitation rounds" and the rounds featuring a 0.75 continuation probability treatment as "resolicitation rounds."[3]

Our experiments produced results that were qualitatively consistent with the predictions of theory, in that, in the experiments as in theory, the

[2] Thus, if raider behavior is fixed and resolicitation is ruled out, our game reduces to the standard takeover free-riding game used in the experimental finance literature. At the same time, if the coordination problem is eliminated, by assuming a single shareholder, then our game reduces to a dynamic bargaining game. Such games have been examined by Roth, Murnigham, and Schoumaker (1988), Weg, Rapoport, and Felsenthal (1990), Bolton (1991), and Bornstein and Yaniv (1998).

[3] Although using the term "nonresolicitation" for referencing the 0.01 continuation probability is not entirely accurate since continuation, although very unlikely, is possible, we use this term for readability and continuity with the earlier discussion. The reason for using the 0.01 continuation probability instead of a 0.00 continuation probability and the rationale for the choice of the 0.75 continuation probability in the continuation treatment is discussed in detail in the experimental section.

credibility effect dominates the direct effect. Quantitatively, both with resolicitation and without resolicitation, shareholders undertendered significantly relative to theory and raider-initial offers were somewhat but not significantly higher than predicted by theory. In subsequent periods in the rounds featuring resolicitation, average-raider offers significantly exceeded the Nash equilibrium prediction. Nevertheless, shareholder-tendering intensities remained significantly less than the Nash equilibrium prediction and, a fortiori, less than the predicted response to the overly generous observed raider offers. The net effect of raider and shareholder behavior was to engender large dissipation losses and low shareholder and raider payoffs. The magnitude of excess dissipation relative to theory was similar in the rounds with and without resolicitation. However, the negative variation of raider profits from theoretical predictions was much greater with resolicitation. In fact, under resolicitation, raiders captured less than 3% of takeover value, more than 70% less than their predicted share. Thus, the article provides strong evidence that the option to resolicit increases the dissipative costs of free riding; that is, the credibility effect of the resolicitation option swamps the direct effect. The resolicitation option has a particularly detrimental effect on raider profits, even more than theory suggests.

Our experimental analysis of the effect of dynamics on free riding is unique, to our knowledge, in the corporate finance literature.[4] However, in the theoretical corporate finance literature, Harrington and Prokop (1993) have analyzed the effect of the option to resolicit on the free rider problem in takeovers. They show in an unconditional-offer framework that in the limit, as the cost of resolicitation converges to zero, free riding eliminates the social gain from takeovers. On the one hand, our theoretical results show that their theoretical results depend on the assumption that the takeover offer is unconditional. When offers are conditional, the social gain from takeovers does not converge to zero as the cost of resolicitation converges to zero. On the other hand, the very high levels of free riding we actually observe experimentally in our conditional offer experiments are consistent with the theoretical predictions of their unconditional offer model.

The rest of the article is organized in the following manner. Section 1 derives and specifies the dynamic model studied. Section 2 lays out the experimental design and Section 3 reports and analyzes the results. Conclusions and extensions of the analysis are provided in Section 4.

1. The Model

In this section, we develop the analytical theory that forms the basis for subsequent experimental investigations. This theory fits two isomorphic

[4] However, the experimental public-goods literature has considered the interaction between free riding and offer sequencing in the context of a very different extensive form model of free riding, see Dorsey (1992).

economic situations: a profit-maximizing corporate raider making a conditional-tender offer to a group of shareholders and a revenue-maximizing public agency soliciting contributions from a group of citizens for a public good. For clarity, we follow the takeover interpretation throughout the analysis. At the end of this section, we outline and reinterpret the model in a public-goods setting.

Consider a firm with N shareholders; let $[N] = \{1, 2, 3,...N\}$ represent the set of shareholders. Each shareholder, $i \in [N]$, holds one indivisible share of the firm's stock. We assume an infinite set of discrete dates, d, indexed by the natural numbers $\{0, 1,...\}$. At the start of each date d, a raider makes a bid b_d, $d = 0, 1,...$ for the firm's shares. To gain control the raider must acquire K shares. K is constant over time and satisfies the condition that $0 < K < N$. We assume that the takeover offer is conditional. Therefore, if the bid is accepted by K or more shareholders, control of the firm is transferred to the raider and the game terminates. In this case, nontendering shareholders earn a payoff equal to the post-takeover value of the firm, \$1; tendering shareholders earn a payoff equal to the bid price, b_d; the raider earns a payoff equal to the number of shares tendered times the difference between the post-takeover value of the shares, \$1, and the bid price he offers, b_d. If fewer than K shares are tendered, the takeover attempt fails and tendered shares are returned to shareholders.

After each failed takeover bid, there is a probability, $1 - \delta$, that the improvement gains which the raider generates evaporate. In this case, the raider and the shareholders earn payoffs of 0, and the takeover game terminates. If evaporation does not occur, the raider will be able to make another bid at the start of the next period. We call δ the "continuation probability" for the game. The comparative statics developed below will focus on the effect of shifts in δ on the equilibrium strategies of the shareholders, the division of gains, and the social costs of free riding. The model assumptions closely resemble the conditional offer model Ferguson developed in Ferguson (1994) and to a lesser extent to the unconditional offer model of Harrington and Prokop (1993). However, these authors do not extract from their Markovian models the specific comparative statics we need to form the null hypotheses for our experiment.

We next identify the Markovian equilibria of this game. In this Markovian game, shareholders condition their actions on a "state" variable, which summarizes the current state of the system, and on the actions of the other players that they can observe in the current period.[5] In our game, the choice or "action variable" for each shareholder is the probability with which he will tender his share. We represent the probability with which shareholder i tenders by π_i, $\pi_i \in [0, 1]$. A vector of choices for all

[5] For further analysis of Markovian games, see Friedman (1986). For an application of Markovian-game approach to the analysis of repeated unconditional tender offers, see Harrington and Prokop (1993).

shareholders is represented by $\pi = (\pi_i, \ldots \pi_N) \in [0, 1]^N$ A Markovian strategy for the shareholder is a map from the "state variable" of the system and the observed current actions of the other players, into his actions. Since this choice is made only in the state of the world where the improvement gains from the takeover have not evaporated, and because failed conditional offers have no effect on subsequent agent payoffs, the Markov assumption implies that there is only one nontrivial "state" of the system. Thus, this tendering probability is independent of the date and depends only on the current offer made by the raider, $b \in [0,1]$. Thus, a tendering strategy for a shareholder is a map, i^*, from possible current period raider bids, b, to tendering probabilities, $\pi_i \in [0, 1]$. A vector of strategies for all shareholders is represented by π^*.

Next consider Markovian strategies for the raider. At each date, the action for the raider consists of a bid price, $b \in [0,1]$. The raider makes offers only in one state of the world—the state in which evaporation has not occurred. Moreover, the raider never observes any actions of the shareholders in the current period before he makes his offer. Thus, a Markovian strategy for the raider is a constant function mapping the single state into the interval [0,1]; we identify this constant function with a number in the interval [0,1]. Thus, the raider's equilibrium strategy can be thought of simply as an element b in the interval [0, 1].

To solve this game, first consider shareholder actions for a fixed raider strategy of playing b. Let w_i^T, $\left(w_i^{NT}\right)$ be the expected payoff to shareholder i if evaporation has not occurred and i follows the strategy of tendering (not tendering) her share. Let $\tilde{S}$ represent the total number of shares tendered in equilibrium and let $\tilde{S}^{-i}$ represent the total number of shares tendered conditioned on shareholder i's tendering 0 shares. Let $nt_i(\pi)$ represent the probability that the takeover succeeds given that shareholder i does not tender and all other shareholders tender with the probabilities specified by $\pi \in [0, 1]^N$. That is, $nt_i(\pi) = P_\pi(\tilde{S}^{-i} \geq K)$. Let $t_i(\pi)$ represent the corresponding probability that the takeover succeeds given that i tenders; that is, $t_i(\pi) = P_\pi(\tilde{S}^{-i} + 1 \geq K)$. The payoff to a shareholder from tendering, given that the raider offers b and the probability that other shareholders tender is given by π, can be expressed as follows:

$$w_i^T = t_i(\pi)b + \delta[1 - t_i(\pi)]w_i^T.$$

The above equation represents the two sources of shareholder payoffs. The first source is the expected payoff in the current round from tendering, the probability the offer will succeed in the current round if shareholder i tenders $t_i(\pi)$ times the bid price, b. The second source of gain is the value of continuation, w_i^T, times the likelihood of continuation. Continuation can only occur if the offer fails, which occurs with probability

$1 - t_i(\pi)$ and evaporation does not occur, which happens with probability δ. Rearranging the expression for shareholder payoff from tendering given above yields

$$w_i^T(\pi, b) = \frac{b\ t_i(\pi)}{1 - \delta[1 - t_i(\pi)]}. \tag{1}$$

To understand Equation (1), note that if the takeover is sure to succeed [that is, $t_i(\pi) = 1$], then the shareholder payoff from tendering reduces to the bid price, b. In contrast, if the offer is sure to fail, then the shareholders payoff reduces to 0, which is expected given that the offer is conditional on success and the pre-takeover value of the firm is 0. In general, the payoff represented by Equation (1) is just the per period payoff divided by the probability that the game will not continue into the next round given that the shareholder tenders.

Similarly, the expected payoff from not tendering is given by

$$w_i^{NT}(\pi, b) = \frac{nt_i(\pi)}{1 - \delta[1 - nt_i(\pi)]}. \tag{2}$$

Thus, under the Equation (2) for the shareholders payoff conditioned on not tendering, if the offer is sure to succeed even when shareholder i does not tender ($nt_i(\pi) = 1$) the payoff from not tendering equals 1, which is higher than the payoff from tendering. At the same time, as is the case for the tendering strategy, the payoff if the offer is sure to fail equals 0.

We will say that tendering is a best reply for shareholder i to π given b if

$$w_i^T(\pi, b) \geq w_i^{NT}(\pi, b).$$

We will say that that not tendering is a best reply for shareholder i given π and b if

$$w_i^{NT}(\pi, b) \geq w_i^T(\pi, b).$$

The raider's expected profit, V, for a bid of b, if shareholders follow tendering strategy π^*, is given by

$$V(\pi^*, b) = \frac{(1 - b)\, \mathrm{E}_{\pi^*(b)}(\tilde{S} \mid \tilde{S} \geq K) P_{\pi^*(b)}(\tilde{S} \geq K)}{1 - \delta[1 - P_{\pi^*(b)}(\tilde{S} \geq K)]}.$$

Definition. *A stationary, perfect, subgame-perfect Markovian equilibrium consists of an ordered pair $[b^*, \pi^*(\cdot)]$, where $b^* \in [0,1]$ and $\pi^*(\cdot)$ is a function mapping $[0,1]$ into $[0,1]^N$, which satisfies the following conditions:*

(a) *For all* $b \in [0,1]$ *and* $i \in [N]$, *whenever* $\pi_{i^*}(b) \geq 0$, *tendering is a best reply for i given* $\pi^*(b)$ *and b, and whenever* $\pi_{i^*}(b) \leq 1$, *not tendering is a best reply for i given* $\pi^*(b)$ *and b.*

(b) $b^* \in \underset{b \in [0,1]}{\mathrm{Arg\,max}}\ V[\pi^*(b), b]$.

(c) *The equilibrium in the subgame starting with each raider bid b satisfies the perfection refinement of Selten (1975).*

These conditions have a natural interpretation. Condition (a) simply says that shareholders are sequentially rational. In other words, in response to every possible bid price, shareholders tender with positive probability only if their payoff from tendering is at least as high as their payoff from not tendering and refrain from tendering with positive probability only if their payoff from refraining from tendering at least equals the payoff from tendering. Condition (b) simply says that given the shareholder-response functions, the raider picks the equilibrium bid price that maximizes his payoff. Condition (c) says that, for each raider offer, some small perturbations of shareholder tendering probabilities produce best responses that are close to the subgame equilibrium responses. Henceforth, we will simply call a stationary, perfect, subgame-perfect Markovian equilibrium, an "equilibrium."

This game has many equilibria. However, for each fixed $b \in (0,1)$, all symmetric subgame equilibria feature mixed strategies. To see this, consider the two symmetric pure strategy candidate subgame equilibria: $\pi = 1$ and $\pi = 0$. First consider $\pi = 1$. Note that tendering is never a best response to all other shareholders tendering. If all other shareholders tender, then the payoff from not tendering to any individual shareholder is 1, which exceeds the payoff from tendering, b. Thus, $\pi = 1$ is never a subgame equilibria. Next consider $\pi = 0$. If no other shareholder tenders, then regardless of what any individual shareholder does, the offer will fail. Because the offer fails and the offer is conditional, the individual shareholder's payoff equals 0 regardless of her own strategy. Hence, if other shareholders never tender, each shareholder is indifferent between tendering and not tendering. Thus, not tendering is indeed a best response for each shareholder to strategy vector $\pi = 0$ under which no shareholder tenders, and thus condition (a) for a subgame equilibrium is satisfied. However, condition (c) is not satisfied because the best response for an individual shareholder to any tendering vector with $\pi > 0$ but sufficiently close to 0 is to tender with probability 1. Thus the perfect equilibrium condition of Selten (1975), condition (c), is not satisfied.

The analysis above implies that all symmetric equilibria involve mixed strategies. In such equilibria, sequential rationality requires each shareholder to be indifferent between tendering and not tendering. As we see from the analysis above, this argument implies that the following equilibrium condition must be satisfied:

$$b\left(\frac{\overline{B}_{K-1}(\pi)}{1-\delta\left[1-\overline{B}_{K-1}(\pi)\right]}\right)=\frac{\overline{B}_{K}(\pi)}{1-\delta\left[1-\overline{B}_{K}(\pi)\right]}, \tag{3}$$

where, for all $k \in \{0, 1, \ldots N-1\}$ and $\pi \in [0,1]$, $\overline{B}_k$ is defined by

$$\overline{B}_k(\pi)=\sum_{j=k}^{N-1}\binom{N-1}{j}\pi^j(1-\pi)^{(N-1)-j}.$$

Next, note that for each offer $b \in (0,1)$ there is a unique associated probability of tendering. This result is recorded below.

Lemma 1. *For each raider offer $b \in [0, 1]$ there exists a unique probability, $\pi^*(b) \in [0,1]$, such that $\pi^*(b)$ solves Equation (3).*

Proof. See Appendix A.

Equilibrium responses by shareholders also exist which are not symmetric. Associated with each fixed bidding strategy, $b^* \in (0, 1)$, there exist a number of asymmetric best response vectors for shareholders. First, any pure strategy vector in which exactly K shareholders tender and the remaining shareholders do not tender is a best response for shareholders. In addition, there are asymmetric mixed-strategy best responses. In all such shareholder best responses, as we show in Appendix B, all shareholders who play a mixed strategy use the same randomization probability. This result should not be surprising since it is the same characterization for single-shot takeover games and is derived in the Appendix of Holmstrom and Nalebuff (1992). Thus, in any mixed strategy response to a raider offer, a subset of shareholders tender, a subset randomize, and a subset do not tender, and each tendering shareholder has a positive probability of being marginal.

Like earlier researchers, who analyzed static takeover settings, we focus our analysis on the symmetric shareholder best response. There are three reasons for our focus on the symmetric solution. First, this focus facilitates comparisons between our work and other experimental and theoretical research on takeovers and public goods. These papers all focus on the symmetric equilibria [see Holmstrom and Nalebuff (1992), Kale and Noe (1997), and Marks and Croson (1998)]. Second, we believe that the symmetric outcome is focal because the identically endowed student subjects playing the target shareholders have no reason to conjecture or coordinate toward an asymmetric outcome for the game that will produce nonuniform payoffs. Third, the important qualitative comparative static of the asymmetric equilibria, the relationship between the continuation probability and the severity of the free-rider problem, has the same sign in all of the asymmetric mixed strategy equilibria as in the symmetric equilibrium we formally analyze below. Thus, the interpretation of the differences between our experimental results and Nash predictions is the same under the asymmetric equilibria as it is under the symmetric equilibria.

Theorem 1. *In a symmetric equilibrium of the game, the raider's bid* $b^* \in (0,1)$ *is a solution to*

$$\mathrm{Max}_{b\in(0,1)} = \frac{(1-b)E_{\pi^*(b)}\,(\tilde{S}|\tilde{S}\geq K)P_{\pi^*(b)}(\tilde{S}\geq K)}{1-\delta\,[1-P_{\pi^*(b)}\,(\tilde{S}\geq K)]} \tag{4}$$

where all shareholders tender in each round and $\pi^*(b)$ *is implicitly defined, for each* $b \in (0,1)$*, as the solution to (3).*

Proof. Given Lemma 1, the only thing that remains to be established is that the raider will not make an extremal offer of 0 or 1. Because rejecting an offer of 0 is a dominant strategy, any equilibrium must feature all shareholders rejecting an offer of 0. Thus, the raider's profit from a 0 offer will be 0. Similarly, even if an offer of 1 is accepted, it will provide the raider with a 0 payoff. By Lemma 1, any raider offer strictly between 0 and 1 will be accepted with positive probability. Thus, such an offer produces a higher payoff than any extremal offer. This contradicts the optimality of extremal offers and establishes the result.

Theorem 1 and Lemma 1 do not tell us how to compute the tendering probability generated by the unique symmetric equilibrium of the game. No closed-form solutions exist. However, numerical calculation of the roots of Equation (3) is straightforward and will be performed for the parameters of the experiment. We also do not have an analytical formula for the raider's optimal bid price. However, for the parameterizations of the model used in the experiment, we compute the optimal raider-bidding strategies and compare them with the bids actually made by raiders in the experiments.

1.1 Comparative statics

In this model, the three exogenous parameters are the continuation probability, δ, the number of shares required for the offer to succeed, K, and the total number of shareholders, N. The outcome of the game is described by three variables—the equilibrium bid price, the equilibrium probability of tendering, and the final division of value between the parties. The division of value between the parties is as follows: total value equals N, the number of shares times their per-unit value of one. Some of this value will be lost because an agreement is not reached before evaporation occurs. By a simple recursive argument, the expected proportion of this total value lost through dissipation, which we represent by D^*, is given by

$$D^* = \frac{(1-\delta)(1-P^*)}{1-(1-P^*)\,\delta}, \quad \text{where} \quad P^* = P_{\pi*(b*)}(\tilde{S} \geq K).$$

The fraction of the gain captured by the raider, which we represent by R^*, is given by the optimized value of the raider's payoff function given by Equation (4), divided by the total value, N. Because the equilibrium is symmetric, the fraction of gain captured by the shareholders is the expected payoff to an individual shareholder times the number of shareholders, N, divided by the total value, which is also N. Thus, the fraction of the gain captured by shareholders is just the equilibrium shareholder payoff. Moreover, because in equilibrium shareholders randomize between tendering and not tendering, shareholder payoffs are the same under both of these choices. For this reason, the fraction of the total gain captured by shareholders, which we represent by S^*, equals the equilibrium payoff to any individual shareholder from not tendering.

In the experiments, the only exogenous parameter varied is δ, the continuation probability. The values of N and K were fixed at 7 and 4, respectively. Thus, the numerical comparative statics presented below in Table 1 are focused on the effect of varying δ.

Table 1
Numerical Comparative Statics

δ	b^*	$\pi^*(b^*)$	S^*	R^*	D^*
0.00	0.622894	0.571421	0.485224	0.167860	0.346916
0.01	0.622699	0.569975	0.484762	0.167628	0.347610
0.05	0.621836	0.564011	0.482817	0.166699	0.350484
0.10	0.620561	0.556126	0.480158	0.165539	0.354303
0.15	0.619039	0.547720	0.477221	0.164385	0.358393
0.20	0.617258	0.538757	0.474017	0.163243	0.362741
0.25	0.615161	0.529167	0.470489	0.162117	0.367394
0.30	0.612726	0.518901	0.466646	0.161017	0.372337
0.35	0.609898	0.507883	0.462454	0.159951	0.377595
0.40	0.606630	0.496036	0.457902	0.158933	0.383164
0.45	0.602862	0.483269	0.452982	0.157978	0.389041
0.50	0.598531	0.469478	0.447691	0.157104	0.395205
0.55	0.593556	0.454531	0.442034	0.156338	0.401628
0.60	0.587852	0.438271	0.436039	0.155713	0.408248
0.65	0.581289	0.420475	0.429723	0.155274	0.415003
0.70	0.573720	0.400847	0.423150	0.155085	0.421765
0.75	0.564918	0.378934	0.416391	0.155241	0.428368
0.80	0.554530	0.354006	0.409553	0.155893	0.434554
0.85	0.541935	0.324749	0.402800	0.157310	0.439890
0.90	0.525836	0.288386	0.396419	0.160056	0.443525
0.95	0.502530	0.236927	0.391109	0.165761	0.443131

Shows the numerical simulations for different continuation probabilities (δ), the equilibrium raider bid (b^*), the equilibrium shareholder response to the equilibrium raider bid [$\pi^*(b^*)$], and the fraction of total value expected to be captured by the shareholders (S^*), the raider (R^*), and dissipation (D^*). All of the results assume that there are seven shares outstanding and that the raider requires four shares to obtain control.

These comparative statics indicate that, as the continuation probability increases, a shareholder's probability of accepting any given offer falls, as does the optimal raider offer. Dissipation losses from failed tender offers increase, and the fraction of the total takeover gain captured by shareholders falls. The effect of increasing the continuation probability on the fraction of surplus captured by the raider, R^*, is not monotone—initially, increasing the continuation probability decreases the ability of the raider to capture takeover gains, but the direction of the effect reverses for higher probabilities of continuation.

The intuition behind these comparative statics is as follows. As the continuation probability increases, the responsiveness of shareholders to any fixed raider-offer falls. In addition, the elasticity of the tendering probability with respect to the offer falls. This effect is illustrated in Figure 1. Thus the amount that the raider must pay to increase his odds for immediate acceptance increases; at the same time, the cost of evaporation associated with delayed acceptance falls. For this reason, the raider lowers his bid in response to an increase in the continuation probability. This reduction in the bid is recorded in column 2 of Table 1.

As we have seen, increasing the continuation probability both (a) lowers the raider's equilibrium bid and (b) reduces a shareholder's probability of accepting any fixed bid. The effects (a) and (b) reinforce each other. Thus,

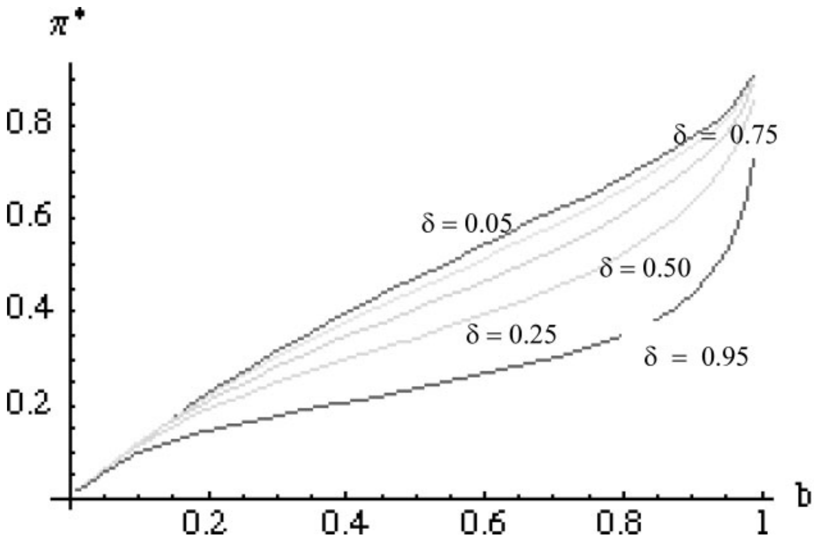

Figure 1
Optimal bid responses and the continuation probability
The optimal bid response and associated shareholder tendering probability given that bid, for each continuation probability is presented. The horizontal axis, b^*, represents the equilibrium bid. The vertical axis, π^*, represents the equilibrium fraction of shares tendered to any fixed raider offer, given the continuation probability.

an increase in the continuation probability induces a substantial reduction in the probability that a shareholder will tender into the equilibrium offer. This effect is recorded in column 3 of Table 1. The negative effects from a reduction in the probability of acceptance, combined with the lower raider-offer price, more than offset the direct positive effect of an increased probability of continuation. Thus, shareholder gains (S^*) fall and the probability of dissipation (D^*) increases with an increase in the continuation probability. This effect is evidenced by columns 4 and 6 of Table 1.

1.2 The equivalent public-goods contribution game

Consider a public good that will be provided only if K out of N "beneficiaries" of the good contribute c dollars: In other words, the provision point is $K \times c$. The benefit from the provision of the public good to each of the beneficiaries is 1.00. A "provider" provides the public good at no cost and will reap revenues equal to the sum total of the contributions from the beneficiaries. At the start of each period, the provider makes a solicitation for c; if fewer than K beneficiaries contribute, then the offer fails and contributions are returned. At this point there is a δ probability that the public good does not evaporate and a probability of $1 - \delta$ that the public good evaporates; thus, the provider has the option of making another solicitation in the next period. If at least K beneficiaries contribute, the provider pockets the contributions, the good is provided, and the game ends.

Note that, in this game, if at least K beneficiaries pay the contribution, the payoff to the paying beneficiaries is $1 - c$, the payoff to the nonpaying or "free-riding" beneficiaries is 1, and the payoff to the provider is $c \times$ number of contributors. If evaporation occurs all parties receive 0. Thus, the payoffs in the public-goods game to the beneficiaries, both paying and free riding, for a solicited contribution of c are identical to the payoffs in the tender offer game associated with a bid of $1 - b$. The provider's payoff for a contribution of c also always equals the raider's payoff for a bid of $1 - b$. Thus, the public-goods game described here is isomorphic to the takeover game described above.

2. Experimental Design

The share-tendering game of the experiments involves indivisible shareholdings, one share for each shareholder. The experiment is a within-subject crossover design that implements two continuation probability treatments. The participants in this experiment were undergraduate and graduate business majors. These students were told they would have an opportunity to earn money in a research experiment involving group decision-making. We ran both inexperienced and experienced sessions. Appendix C is a copy of the instructions.

Each experimental session consisted of three rounds, and this was told to the participants in the instructions.[6] A round is a complete play of the game modeled in the theoretical section above. In the laboratory, a round always starts with an initial raider offer and ends by either (i) an accepted raider offer or (ii) a draw from the urn that forces noncontinuation. At the beginning of each round it was announced which continuation-probability treatment was in effect for that particular round. A nonresolicitation treatment share tendering game was implemented with a 0.01 continuation probability while a resolicitation treatment game was implemented with a 0.75 continuation probability. The number of periods within a round varies as a function of a group's decisions and the actual continuation probability draw for failed-takeover offers. Across the sessions, the actual continuation draws did not afford failed-takeover groups any additional resolicitation periods in the 0.01 treatment, where as a total of 28 additional resolicitation periods resulted from the draws in the 0.75 treatment.

Our choice of the continuation-probability treatments was motivated by discriminatory power and parsimony. The 0.75 probability was chosen for the resolicitation treatment because this continuation probability is both close to the continuation probability that minimizes raider payoff and has a very simple fractional representation. The choice of a continuation probability that produces low raider profits increases the discriminatory power of our experiment for raider profit under the null hypothesis that shareholder-tendering probabilities and raider offers are determined by the symmetric stationary Nash equilibrium. By choosing a continuation probability that has a very simple fractional representation, we make the costs of rejecting the offer easy for the subjects to mentally represent. The 0.01 continuation probability for the nonresolicitation treatment was chosen because we wished to include the case where, theoretically, continuation effects should be absent (payoffs and strategies are identical with the 0.00 treatment up to the third decimal place), yet allow for a simple, physically observable randomization procedure such as the bucket of 100 chips. Using smaller continuation probabilities would require even more chips.[7]

In the data, the 0.01 continuation probability is referenced as Treatment X while the 0.75 continuation probability is referenced as Treatment Y.

[6] We thank an anonymous referee for pointing out the importance of making the total number of rounds fixed and common knowledge among the subjects. This prevents shareholders from trying to manipulate total session earnings by speeding up the number of total rounds in a session.

[7] If we had set a 0.00 continuation probability, then the instructions would have been more complicated and time consuming to administer since we would have had to issue new instructions at the beginning of each round to describe the continuation draw process or lack of it. In addition, the different instruction sets might engender framing bias. Alternatively, we could have performed a draw with a predetermined outcome (drawing from an urn of 100 chips, all with the same color), but this would seem strange to participants and may have introduced noise into participants decision-making with regards to the true motivations for the experiment.

The crossover design systematically varies the sequence of the continuation probability treatments across the three rounds in a given session: we ran both the XYX and the reverse YXY treatment configuration sequences. We choose this design because it allows the experimenter to test for learning effects and to control for such effects. By comparing the first and last rounds, the experimenter can test for learning. If the results of the tests suggest that learning effects are important, then the experimenter can control for learning effects by dropping the first round of both the XYX and YXY configurations. At the same time, because the average subject experience across the remaining rounds is the same in the reduced YX and reverse XY treatment configurations, we can control for sequencing bias. Of course, the cost of dropping the first round is a loss of test power due to the loss of observations if learning effects are not present. To reference rounds associated with a given treatment across the two configuration sequences, we categorize treatment rounds according to the round in a session for which they fall: For example, X1 is the first and X3 is the third treatment round in the XYX configuration while X2 is the second treatment round in the reverse YXY configuration, and treatment Y rounds are similarly categorized.

Across the sessions there are a total of eighteen groups, nine groups for each of the treatment configurations sequence (Table 2). Eight of the eighteen groups were experienced.[8] Each group consisted of seven shareholders and one raider. Although participants were informed with regards to the size of their group, they never knew nor could they find out, who the other members of their group were. Each round participants were privately randomized into a different group. Randomizing group assignments each round along with keeping offer prices and number of shares tendered private information which is an important design feature that facilitates the perception of a series of one-shot games. Alternatively, participants could have been assigned to the same group for the entire experiment facilitating the perception of a finitely repeated game. Since tender offers with a given raider are typically a one-time event, we chose the one-shot mode of repetition.

In each session, to ensure that participants understood the rules of the game and how their earnings would be generated, the experimenter read the instructions aloud and the subjects worked through the attached worksheets. Part 1 of the instructions explained that the participants with the highest scores on a "Trivial Pursuit" questionnaire would be selected to be the raiders for that session. The purpose of the questionnaire was to facilitate aggressive bargaining by allowing the raiders to earn the property

[8] Participant experience means that the subjects had participated in one of the previous inexperienced sessions. Because a majority of the participants in the XYX session 3 and the YXY session 7 were experienced, we classify these session as experienced.

Table 2
Experimental Design

	X = nonresolicitation (0.01) and Y = resolicitation (0.75)				
	Subject experience	Number of subjects	Round 1 periods (X1)	Round 2 periods (Y2)	Round 3 periods (X3)
			Panel A: XYX (0.01/0.75/0.01) configuration		
Session					
1	No	24	1	4	1
2	No	16	1	1	1
3	Yes	16	1	1	1
4	Yes	16	1	1	1
			Y1	X2	Y3
			Panel B: YXY (0.75/0.01/0.75) configuration		
Session					
5	No	24	9	1	1
6	No	16	7	1	2
7	Yes	16	7	1	1
8	Yes	16	3	1	3

A session consists of three rounds of either the XYX or reverse YXY design configuration, where X represents the 0.01 nonresolicitation treatment and Y represents the 0.75 resolicitation treatment. The design aspects are reported in Panel A for the XYX (0.01/0.75/0.01) configuration and in Panel B for the YXY (0.75/0.01/0.75) configuration. Subject experience reflects whether subjects in that session had previously participated in an inexperienced session. Number of subjects is the total number of individual subjects in that session. The remaining columns titled, round "N" periods, reflect the number of periods before the respective round ended by either a successful takeover by all groups or by the draw.

right of their position [see Hoffman et al. (1992)]. The remaining participants were designated shareholders. Participants remained the same agent type throughout a session. The instructions use neutral language in describing the game. In particular, raiders were always referred to as Type A participants and shareholders as Type B participants.

At the beginning of each period, the raiders sent private-offer slips to the members of their group, designating the offer price for which they were willing to buy their group's shares. Before distribution, a monitor checked to make sure that all offer slips by a given raider had the same offer price. After receiving the offer slip, each shareholder privately circled on their tendering slip whether or not they wanted to tender their share. The monitor collected the tendering slips and counted the number of shares tendered for each group. If at least four of the seven shares were tendered in a group, then the raider of that group was required to purchase all shares offered at his specified offer price. If fewer than four shares were tendered within a group, a drawing was held to determine whether the round could continue for another period.

The drawing was administered in the following fashion: A draw was made from the bucket of chips with the designated continuation probability at the beginning of the round. If the draw allowed for another offer to be made, then the process repeated itself. If not, the round was terminated. The monitor never revealed the offer price nor the number of shares tendered for any group, but simply announced whether or not there would be another period to the round. To preserve anonymity of group membership, offer slips were distributed each period to all shareholders. For those groups who had a successful tender offer in a previous period of a round, the respective raider was privately told to write the word "end" on that period's offer slips which were distributed to the respective shareholders, who then returned tendering slips with the word "end" to signify that they understood that the round was over for them. After every round raiders and shareholders were re-randomized into different groups by a drawing from a bucket at the front of the room, which was far enough that the subjects could not observe the participant numbers allocated to the respective groups.

The experimental sessions lasted between 1.25 and 1.75 hours. Subjects were paid $5.00 for showing up on time in addition to their session earnings. Payoffs in the experiment were denominated in a fictional currency called francs; the conversion rate was 0.06 dollars for each franc. The range of actual earnings paid is $14.00–37.50, with a mean of $20.30. To maintain saliency of incentives, we designed the experiment so that most subjects would receive payoffs at least equaling the opportunity cost of their time. Because free-riding behavior can lead to zero payoffs for subjects, experimental researchers typically supplement the subject rewards with an endowment. Recently, both experimental economics and psychology literatures have begun to question whether subjects behave differently when they are "endowed" with these upfront payments. This problem has been referred to as "house money" or "small unexpected windfall gains" effect. In particular, quasi-hedonic editing, a modification of prospect theory proposed by Thaler and Johnson (1990), suggests that initial gains may promote subsequent risk-seeking behavior. Clark (2002) notes that the relevance of house-money effects in public-good settings should induce subjects to pursue "public-spiritedness" and thus contribute more to the public good. In a standard voluntary contribution experiment, Clark (2002) finds no support for a "house-money" effect.

In our experiments, all subjects earned a base payment of 50 francs if the takeover was unsuccessful and up to an additional 100 francs if it was successful. This design was motivated by the takeover problem we modeled—shareholders in unsuccessful conditional offers keep their shares which are still valued at the pre-takeover price. If subjects view the pre-takeover value of the share as an endowment and contrary to the results of Clark (2002) a house-money effect is present, then the house-money effect should increase tendering and thus reduce free riding. Hence, if our results are biased by the house-money effect, which we view as unlikely, they are biased in a conservative direction.

3. Results

In this section, we present the results of the experimental sessions described in Section 2. First, we examine the raiders' behavior and compare their offers to the theoretical predictions for each continuation-probability treatment. The degree of offer escalation in response to rejected offers is then investigated to gain insight into the strategic behavior of raiders. Next, the actual behavior of shareholders is compared with the predicted behavior. At the end of the section, we examine the effect of changes in the continuation probability on the success and efficiency of takeovers.

3.1 Raider behavior

Before comparing raider behavior with equilibrium predictions, we investigate in Table 3 whether there are significant differences in raider offers across rounds, treatments, and by subject experience level. Examining Panels A–C, we do not reject the null hypothesis that the mean offer between and for a given conditional probability treatment is the same across rounds at the 0.05 significance level, except in the case of the average of all period offers in the Y1 and Y3 resolicitation rounds, a p-value of 0.036. When we investigate in Panels D and E whether previous participation in the experiment matters, we do not reject that experienced and inexperienced session offers are the same. However, when we look more deeply at individual raider-learning behavior in Panels F and G, in the resolicitation treatment we find that first-period behavior by raiders has a p-value of 0.038 in the paired t-tests, between the first-period offers in round one (Y1) and first-period offers in round three (Y3). The offers in the first period of round Y1 are significantly lower than the first period offers in round Y3. Given this finding, we believe that the evidence for learning effects is sufficiently strong to warrant reporting aggregate results for only rounds two and three (X2, Y2 and X3, Y3). As noted previously, one of the strengths of the crossover design with three rounds is that it can control for learning effects by repeating the same treatment in both rounds one and three, which then allows for a cleaner comparison of the treatment effect differences in the second and third rounds. Except where noted, our qualitative results are the same as they would have been if we had included the first rounds.

The basic characteristics of raider behavior are presented in Table 4. Two features of raider behavior stand out: First, the raiders' initial offers in the resolicitation treatments and in the nonresolicitation treatments were higher (but not significantly) than predicted by theory, 11.2 and 1%, respectively. In contrast, raider offers in subsequent periods of the resolicitation treatment are 22.5% (significantly) higher than theory predicts. Second, despite the upward drift in average offer, the most common raider action was, consistent with the theory, to submit the same bid after a failed offer. Thus, the average offer upward drift after a failed offer was produced by fairly large

Table 3
***T*-test for differences**

	Average (standard deviation)	*p*-value	
		X2	X3
Panel A: nonresolicitation (0.01)—all periods			
Round			
X1			
Offers	0.499 (0.290)	0.177	0.453
Proportion shares tendered	0.381 (0.237)	0.613	0.329
X2			
Offers	0.657 (0.167)		0.636
Proportion shares tendered	0.429 (0.143)		0.479
X3			
Offers	0.603 (0.286)		
Proportion shares tendered	0.508 (0.296)		
	Average (standard deviation)	Y2	Y3
Panel B: resolicitation (0.75)—all periods			
Round			
Y1			
Offers	0.577 (0.181)	0.350	0.036
Proportion shares tendered	0.257 (0.201)	0.184	0.264
Y2			
Offers	0.627 (0.204)		0.311
Proportion shares tendered	0.325 (0.128)		0.946
Y3			
Offers	0.694 (0.135)		
Proportion shares tendered	0.330 (0.221)		
	Average (standard deviation)	Y2	Y3
Panel C: resolicitation (0.75)—first period only			
Round			
Y1			
Offers	0.556 (0.151)	0.797	0.105

Proportion shares tendered	0.286 (0.202)	0.852	1.000

Table 3
(continued)

	Average (standard deviation)	*p*-value Y2	*p*-value Y3
Y2			
Offers	0.581 (0.251)		0.347
Proportion shares tendered	0.302 (0.151)		0.839
Y3			
Offers	0.674 (0.142)		
Proportion shares tendered	0.286 (0.175)		

Nonresolicitation (0.01)	Average (standard deviation)	X1, X2, and X3	X2 and X3
Panel D: Experienced and inexperienced raider offers			
Round			
X1, X2, and X3			
Inexperienced ($N = 15$)	0.581 (0.250)	0.912	
Experienced ($N = 12$)	0.593 (0269)		
X2 and X3			
Inexperienced ($N = 10$)	0.671 (0.180)		0.413
Experienced ($N = 8$)	0.579 (0.284)		

Resolicitation (0.75)	Average (standard deviation)	All periods (Y1, Y2, and Y3)	First period (Y1, Y2, and Y3)	All periods (Y2 and Y3)	First period (Y2 and Y3)
Panel E: experienced and inexperienced raider offers					
Round					
Y1, Y2, and Y3					
Inexperienced ($N = 50$)	0.580 (0.198)	0.052			
Experienced ($N = 25$)	0.667 (0.137)				
First period (Y1, Y2, and Y3)					
Inexperienced ($N = 15$)	0.571 (0.206)		0.317		
Experienced ($N = 12$)	0.645 (0.162)				
Y2 and Y3					
Inexperienced ($N = 20$)	0.621 (0.195)			0.153	
Experienced ($N = 11$)	0.717 (0.132)				
First period (Y2 and Y3)					

Inexperienced ($N = 10$)	0.581 (0.239)	0.290
Experienced ($N = 8$)	0.686 (0.144)	

Table 3
(continued)

Paired sample t-test	Average (standard deviation)	p-value: All periods (Y2 and Y3)	p-value: First-Period (Y2 and Y3)
Panel F: raider offers *across* treatment			
Round			
X2 and X3	0.630 (0.229)	0.538	0.976
Y2 and Y3	0.665 (0.144)		
First Period (Y2 and Y3)	0.628 (0.204)		

Paired sample t-test	Average (standard deviation)	X3	All periods Y3	First period (Y3)
Panel G: raider learning within a treatment				
Round				
X1	0.499 (0.290)	0.391		
X3	0.603 (0.286)			
Y1				
All offers	0.605 (0.129)		0.232	
First period offers	0.556 (0.151)			0.038
Y3				
All offers	0.680 (0.145)			
First period offers	0.674 (0.142)			

upward revisions by a minority of raiders. Theory predicts higher offers in the nonresolicitation treatment than in the resolicitation treatment. However, the paired t-tests in Table 3 do not find that individual raiders made significantly different offers between the resolicitation and nonresolicitation rounds. Although raider offers are similar in the resolicitation and nonresolicitation rounds, the total number of rejected offers in the first period of a round is higher in the resolicitation rounds, 16 of 18 (88.89%) relative to 10 of 18 (55.56%) in the nonresolicitation rounds.

Insight into the raiders' strategic behavior can be gained by examining the percentage of offers, conditional on the opportunity to resolicit, that

Table 4
Raider behavior

	Non-resolicitation (0.01)	Resolicitation (0.75)
Panel A: actual versus Nash equilibrium offers		
Nash equilibrium offer	0.623	0.565
All offers		
Mean (p-Value)	0.630	0.655
	(0.898)	(0.009)
Standard Deviation	0.229	0.179
N	18	31
First period offers		
Mean (p-value)		0.628
		(0.209)
Standard deviation		0.204
N		18
After first period offers		
Mean (p-Value)		0.692
		(0.006)
Standard deviation		0.137
N		13

Period	N	Mean	Median	Minimum	Maximum	Interquartile range
Panel B: characteristics of offers by period						
Nonresolicitation (0.01)						
1	18	0.630	0.725	0.150	0.850	0.488–0.800
Resolicitation (0.75)						
1	18	0.628	0.675	0.040	0.850	0.500–0.800
2	6	0.667	0.675	0.500	0.800	0.538–0.800
3	4	0.725	0.775	0.500	0.850	0.563–0.838
4	3	0.700	0.750	0.500	0.850	0.500–0.850
All offers						
1–4	31	0.655	0.700	0.040	0.850	0.500–0.800
After first-period offers						
2–4	13	0.692	0.750	0.500	0.850	0.525–0.800

	Non-resolicitation (0.01)	Resolicitation (0.75)
Panel C: Raider Response to Rejected Offers		
Total number of offers	18	31
Total number of rejected offers	10 (55.6%)	27 (87.1%)
Subsequent offer		
Higher		5
		(38.5%)
Same		7
		(53.8%)
Lower		1
		(7.7%)

Table 4
(continued)

	Non-resolicitation (0.01)	Resolicitation (0.75)
Offer escalation		
Geometric average percentage change		32.8%
p-value		0.312
Median change		2.4%
Mode		0.0%
Range of geometric percentage change		–8.3–177.1%

The table summarizes the results for rounds 2 and 3. Panel A compares the average offer price to the theoretical Nash equilibrium price for both the nonresolicitation (0.01) and resolicitation (0.75) treatments and reports the standard deviations and the number of observations for the experiment observations. The *p*-values are for a two-tailed test of the null hypothesis that the predicted and actual means are the same. All offers include offers made during all periods of a given round but in the nonresolicitation treatment all offers are effectively first-period offers since the draw always ended the round after the first period. First-period offers include only the first offer made in a given round to a new group. Panel B provides information on the characteristics of offers in different periods of a round. For each period, the number of observations in the period (i.e., number of groups facing resolicitation), and the offer mean, median, minimum, maximum, and interquartile range are reported. Panel C investigates how the raiders respond to rejected offers. Total number of rejected offers represents all offers rejected in the respective treatment. The number of rejected offers where the subsequent offer was higher, the same, or lower is reported. Percentage numbers are conditional on the opportunity of a subsequent offer. The degree of escalation in offers after an offer was rejected is highlighted by the geometric average percentage change in offers, which is calculated for all groups for a given round and across all rounds. The *p*-value is for a two-tailed test of the null hypothesis that the change in offers, measured by the geometric average, equals 0. Also reported is the median, the mode, and range of change in offers for the geometric percentage change in offers.

are higher, lower, or the same, as the preceding rejected offer. An examination of these conditional percentages in Panel C reveals that after a rejected offer, 38.5%of the raiders' offers were higher than their previous offers, 53.8% were the same, and 7.7% were lower.[9] Raiders displayed a positive average percentage change in offers of 32.8%, with a positive median percentage change of 2.45% with a mode of 0%. Although, in the vast majority of cases, raiders either held fast or escalated, sometimes raider offers fell. The range of percentage changes was –8.3–177.1%. This variability in offers is captured graphically in Figures 2: two of the six raiders made the same offer, three tended to first escalate their offers before making the same offer, and one reduced his offer.[10]

[9] In the Y1 rounds, after a rejected offer, 54.3 percent of the raider offers were higher, 11.4 percent were the same, and 34.3 percent were lower than the preceding offer.

[10] In the Y1 rounds, most of the individual raider's strategic offer patterns can be characterized as switching between lowering and raising the offer relative to their preceding offer. A total of eight groups faced resolicitation. The four groups that achieved a successful takeover did so by the fourth period of the round. Of the unsuccessful groups, three faced seven periods of resolicitation and the other group nine periods, before the draw ended the round.

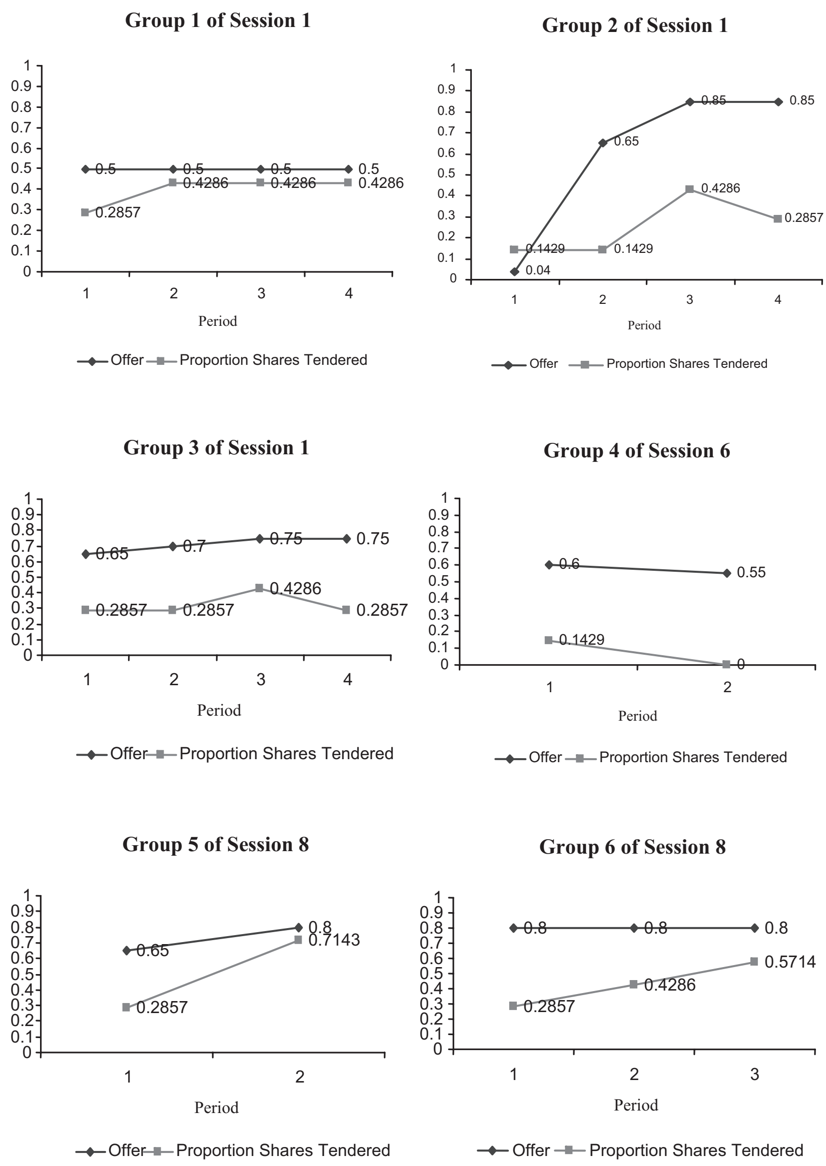

Figure 2
Individual group resolicitation play
For rounds 2 and 3, group play by period, raider offers, and group tendering response, is presented for the six groups that experienced resolicitation.

3.2 Shareholder behavior

In our experiments, just as "overbidding" characterizes raider behavior in the resolicitation treatment, we find that "undertendering" on average characterizes shareholder responses in both resolicitation and nonresolicitation rounds. Less obvious is the extent to which undertendering is a response to raiders' dispersed offers around the Nash prediction. We investigate these issues in Tables 5 and 6, and in Figure 2.

Panel A of Table 5 compares the shareholders' tendering proportions across resolicitation and nonresolicitation sessions to the Nash equilibrium expected proportion of shares tendered. The proportion of shares tendered is reported for (i) the average for all periods, (ii) the average for the first periods, and (iii) the average for periods after the first period. In keeping with the theoretical predictions, the average proportion of shares tendered fell as the continuation probability rose. In both the nonresolicitation and resolicitation treatments, shareholders on average tendered fewer shares than predicted by theory, although not significantly different at standard levels of significance. However, in the first period of the resolicitation rounds, shareholder tendering was significantly less, in both economic and statistical terms, than predicted by theory.

To examine whether the average undertendering by shareholders is a response to raiders' deviations from theory, we present data on conditional-tendering proportions. For each offer in the experimental treatment, we calculate the difference between the actual proportion of

Table 5
Shareholder behavior

	Non-resolicitation (0.01)	Resolicitation (0.75)
Panel A: actual versus Nash equilibrium proportion of shares tendered		
Nash equilibrium proportion of shares tendered		
Mean	0.569	0.379
Standard deviation	0.495	0.485
Average proportion of shares tendered		
All period shares		
Mean (p-value)	0.468 (0.079)	0.327 (0.100)
Standard deviation	0.229	0.170
N	18	31
First period shares		
Mean (p-value)		0.294 (0.036)
Standard deviation		0.159
N		18
After first period shares		
Mean (p-value)		0.374 (0.916)
Standard deviation		0.180
N		13
Conditional proportion of shares tendered		
Average undertendering	–0.101	–0.111

Table 5
(continued)

Period	N	Mean	Nonresolicitation (0.01) Median	Minimum	Maximum	Interquartile Range
Panel B: proportion of shares tendered by period						
1	18	0.468	0.429	0.000	0.857	0.393–0.571

Period	N	Mean	Resolicitation (0.75) Median	Minimum	Maximum	Interquartile Range
1	18	0.294	0.286	0.000	0.571	0.143–0.428
2	6	0.333	0.357	0.000	0.714	0.107–0.500
3	4	0.464	0.429	0.429	0.571	0.429–0.536
4	3	0.333	0.286	0.286	0.429	0.286–0.429
All periods						
1–4	31	0.327	0.286	0.000	0.714	0.143–0.429
After first period						
2–4	13	0.374	0.429	0.000	0.714	0.286–0.429

The table summarizes the results for rounds 2 and 3. Panel A compares the proportion of shares tendered to the respective Nash equilibrium expected proportion of shares tendered. The proportion of shares tendered is used instead of actual shares to facilitate comparisons with the theoretical predictions. The p-values are for a two-tailed test of the null hypothesis that the predicted and actual means are the same. All period shares are tendered shares during all periods but in the nonresolicitation treatment the draw did not allow for any subsequent offers to be made after the first period. Also reported is only the first period shares tendered in a given round and shares tendered in periods after the first period in a round. Conditional proportion of shares tendered is the average difference between the actual tendering proportions and the Nash equilibrium expected proportion of shares tendered, conditioned on the actual raider offer price. Average undertendering is the sum of all the individual differences for every offer divided by the number of observations. Panel B provides for both the nonresolicitation and resolicitation treatments, group tendering characteristics by period. N is the number of observations in the period, and the mean, median, minimum, maximum, and interquartile range are reported for the proportion of shares tendered.

shares tendered and the Nash equilibrium expected proportion of shares tendered, conditioned on the raider's using that offer as his stationary-equilibrium strategy. The differences proved to be –0.101 in the nonresolicitation rounds and –0.111 in the resolicitation rounds. Thus, conditional on the raider's offer, shareholders in both resolicitation and nonresolicitation rounds undertendered on average.

Interestingly, from period to period, the mean and median group-tendering response in the resolicitation rounds at first rose, in periods 1-3, but then declined in the fourth period. Figure 2 also highlights this variability in group tendering behavior. One question of interest is how many shareholders played a pure tendering strategy. It is important to recognize that the researcher cannot observe tendering strategies, only actions or action patterns of the outcomes of shareholders strategies. An examination of the individual level data shows that approximately 33% of the shareholders played the same action pattern across both the nonresolicitation and resolicitation treatment rounds while a higher percentage, approximately

Table 6
Action patterns and profits

Raider offers	Group identity	Successful takeover	Tendering shareholders	Nontendering shareholders	Tender's average francs	Nontender's average francs	Raider's francs earned
Panel A: Nonresolicitation (0.01)							
15	3.3.2	No	1	6	0	0	0
17	4.3.1	No	0	7	0	0	0
30	6.2.1	Yes	4	3	30	100	280
45	7.2.2	No	1	6	0	0	0
50	1.3.1	No	3	4	0	0	0
	1.3.2	Yes	4	3	50	100	200
70	6.2.2	No	3	4	0	0	0
	7.2.1	No	3	4	0	0	0
	5.2.1	No	2	5	0	0	0
75	8.2.1	No	3	4	0	0	0
	5.2.2	Yes	4	3	75	100	100
76	5.2.3	Yes	4	3	76	100	96
80	8.2.2	No	3	4	0	0	0
	3.3.1	Yes	6	1	80	100	120
	2.3.1	Yes	4	3	80	100	80
81	4.3.2	Yes	6	1	81	100	114
85	1.3.3	No	3	4	0	0	0
	2.3.2	Yes	5	2	85	100	75
Panel B: resolicitation rounds (0.75)—lasting one period							
40	5.3.2	No	0	7	0	0	0
42	4.2.1	No	2	5	0	0	0
50	2.2.2	No	3	4	0	0	0
55	7.3.1	No	2	5	0	0	0
70	7.3.2	No	3	4	0	0	0
72	4.2.2	Yes	4	3	72	100	112
	5.3.3	No	1	6	0	0	0
75	2.2.1	No	1	6	0	0	0
80	5.3.1	No	3	4	0	0	0
	3.2.1	No	3	4	0	0	0
85	6.3.1	Yes	4	3	85	100	60
	3.2.2	No	1	6	0	0	0

Raider offers	Group identity	Successfull takeover	Shareholder action patterns TT	NN	TN	NT	Raider's franc earned
Panel C: resolicitation rounds (0.75)—lasting two periods							
60, 55	6.3.2	No	0	6	1	0	
Action pattern average francs			0	0	0	0	0
65, 80	8.3.1	Yes	2	2	0	3	
Action pattern average francs			80	100	100	80	100

Raider offers	Group identity	Successfull takeover	Shareholder action patterns TTT	NNN	TTN	TNT	TNN	NTT	NTN	NNT	Raider's franc earned
Panel D: resolicitation rounds (0.75)—lasting three periods											
80, 80, 80	8.3.2	Yes	2	3	0	0	0	1	0	1	
Action pattern average francs			80	100	100	80	100	80	100	80	80

Raider offers	Group identity	Successfull takeover	Shareholder action patterns								Raider's franc earnings
			TTTT	NNNN	TNNN	TNTT	NNTT	NTNN	NTTT	NNTN	
Panel E: resolicitation rounds (0.75)—lasting four periods											
50, 50, 50, 50	1.2.1	No	2	3	0	0	1	1	0	0	
Action pattern average francs			0	0	0	0	0	0	0	0	0
4, 65, 85, 85	1.2.2	No	0	3	1	0	1	0	1	1	
Action pattern average francs			0	0	0	0	0	0	0	0	0
65, 70, 75, 75	1.2.3	No	1	3	0	1	0	1	0	1	
Action pattern average francs			0	0	0	0	0	0	0	0	0

The table summarizes information on shareholder action patterns and profits for rounds 2 and 3. Average francs reported are "in addition to" the 50 francs participants earned in each round. In all panels, raider offers are for the designated group, group identity is by session, round, and group, successful takeover is yes if more than four shareholders tendered and no if fewer than four tendered. Groups whose round ended in period 1, either to the draw or a successful takeover, appear in Panels A and B while groups whose round ended after period 1 appear in Panels C–E. Rows in Panels A and B are organized by raider offers in ascending order. Column headings represent the number of tendering shareholders, the number of nontendering shareholders, the francs earned for each tendering shareholder, the average francs earned for each nontendering shareholder, and the francs earned by the raider. In Panels C–E, rows are organized in ascending order by group identity. The column headings for shareholder action patterns are presented by period for the resolicitation treatment sessions with continuation, where the action represented by *T* is tendering and action represented by *N* is not tendering. Shareholders can play a total of sixteen action patterns in the four periods. Only the eight action patterns that are listed were played. To maintain conformity across panels in the table, the other eight action patterns (TTTN, TTNN, TNTN, TTNT, TNNT, NNNT, NTNT, and NTTN) are not shown. Action pattern average francs is a shareholder's profit who followed that action pattern.

64% of the shareholders in the resolicitation rounds, when resolicitaion occurred, played the same action throughout the periods of that round. Those shareholders who did switch actions did so infrequently.

Given the structure of the XYX crossover design, looking at the profitability of action patterns across rounds is not very meaningful because in each round the continuation probability treatment varied and shareholders were re-randomized into different groups. However, Table 6 details, by group, the action and action patterns within a round and the associated profitability for each action pattern. Considering only the first period of a round, comparing the resolicitation rounds with the nonresolicitation rounds, one sees that fewer shareholders tender in the resolicitation rounds, 32.1% versus 46.8% of the shareholders in the nonresolicitation rounds. Since there are more successful takeovers in the nonresolicitation rounds than in the first periods of the resolicitation rounds, it is not surprising that raider average profits are higher. In the rounds in which resolicitation took place, 16.7% of the shareholders always tendered while 47.6% never tendered.

3.3 Successful takeover

Table 7 examines the characteristics of a successful takeover. Panel A shows that the average successful takeover offers within a treatment are

Table 7
Successful takeovers

	Offers and proportion of shares tendered	
	Nonresolicitation (0.01)	Resolicitation (0.75)
Panel A: successful versus unsuccessful takeovers		
Average price		
Successful Takeover	0.696	0.793
Unsuccessful Takeover	0.577	0.634
p-values	0.286	0.100
Average proportion shares tendered		
Successful Takeover	0.661	0.607
Unsuccessful Takeover	0.314	0.286
p-values	0.000	0.000
Panel B: takeover characteristics		
Average number of periods for a takeover	1	1.75
Percentage of first period takeovers	44.4%	11.0%
Percentage of takeovers before round ended	44.4%	22.2%

The table summarizes successful takeovers in rounds 2 and 3. Panel A compares and provides *p*-values for the average offer price and tendering proportion of successful takeovers to unsuccessful takeovers for the nonresolicitation (0.01) and resolicitation (0.75) treatments, respectively. The *p*-values are for a two-tailed test of the null hypothesis that means are the same. Panel B examines the characteristics of successful takeovers. Average number of periods for a takeover is a simple average of the period numbers in which a successful takeover occurred in any round, the percentage of first period takeovers is the frequency with which a successful takeover occurred in the first period of a round, and the percentage of takeovers before the round ended is the frequency with which a successful takeover occurred relative to the total number of opportunities (number of groups times number of rounds).

not significantly different from the unsuccessful takeover offers. In contrast, the proportion of shares tendered within a treatment is significantly higher for the successful relative to the unsuccessful takeovers. Looking across the treatments, one sees that the average offers are higher for both the successful and unsuccessful takeovers in the resolicitation treatment while the proportion of shares tendered is lower. The higher offers in the resolicitation treatment did not induce shareholders to increase their tendering probabilities accordingly. Thus, it is not surprising that Panel B provides evidence in support of the theory that the credibility argument dominates the direct effect. The percentage of total successful takeovers in the nonresolicitation treatment is twice that found in the resolicitation treatment. In addition, because theory predicts stationary-raider offers and random-(albeit stationary) shareholder responses, it also predicts that tendering will be higher when the takeover succeeds, but that offers will not be higher. Furthermore, the raider action pattern that yielded the highest percentage of successful takeovers in the resolicitation treatment is where the raider made the same offer in each subsequent period. Across all three rounds, the action pattern of constant offers found a 67% success rate, the action pattern of increasing offers found a 60% success rate, the action pattern of declining offers found a 0% success rate, and the action pattern of variable offers found a 20% success rate. Thus, the results here are qualitatively consistent with the predictions of theory.

3.4 Dissipation and the division of value

How do differences between theory and experimental results affect the welfare of the shareholders? Raider overbidding, for any fixed shareholder response, unambiguously increases shareholder welfare. The effect of undertendering on shareholders' welfare is more subtle. Ceteris paribus, undertendering could have either a positive or a negative effect on shareholder payoffs. Until enough shares are captured to ensure control, more tendering increases shareholder welfare. After this point is reached, however, more tendering lowers shareholder welfare.

Table 8 compares the normalized takeover gains observed in the resolicitation and nonresolicitation rounds with the Nash equilibrium distribution of gains. In our computation of the effect that resolicitation has on the Nash equilibrium distribution of gains, we conditioned on the actual realized value of the continuation draw. For example, if a session ended with a noncontinuation draw after a single rejected offer, we conditioned the expected Nash equilibrium payoffs for that session on the fact that the first draw from the urn was discontinuation. Were there sufficient number of repetitions of the experiment, the Law of Large Numbers would ensure that our conditional and unconditional expected payoffs converge. However, it is doubtful that we can rely on the convergence given that the number of draws from the urn was less than thirty in both the

Table 8
Division of gains

	Average shareholder gain	Average raider gain	Average dissipation
Continuation probability			
Nonresolicitation (0.01)			
Actual	0.360	0.085	0.556
Nash	0.485	0.168	0.348
Resolicitation (0.75)			
Actual	0.194	0.028	0.778
Nash	0.318	0.094	0.588

The table summarizes the average normalized takeover gains disbursed among the shareholders, raiders, and dissipation in rounds 2 and 3. A comparison is made to the Nash equilibrium distribution of gains for each continuation probability. The Nash predictions are calculated by summing over the predicted outcomes for each group and then dividing by the eighteen groups. The predicted outcomes for each group are the Nash gain distributions predictions conditional on whether the round ended by a successful takeover or by the draw and conditional on the period in which the round ended. The shareholders' gain is 0 if the takeover is unsuccessful. When the takeover is successful, the shareholder gain is calculated for each group in each round as [(nontendered shares × post-takeover value) + (tendered shares × tender price)]/(total shares × post-takeover value). The raider's gain is also 0 if the takeover is unsuccessful; but, if it is successful, then the gains are calculated for each group in each round as (1 – shareholder gains). For each group in each round, dissipation is credited a 0 when the takeover is successful, but credited a 1 when it is unsuccessful. The gains are averaged over each group for all rounds in each session.

resolicitation and nonresolicitation sessions. For this reason, we decided to compute the conditional statistics. To illustrate the advantage of computing-expected outcomes using conditioning information, consider the following counterfactual but illustrative example. Suppose that all agents always followed the stationary Nash equilibrium strategy vector and that, in all resolicitation periods dissipation draws were never realized, even though some agreements were reached after 99 rejected offers. Having 99 or more consecutive nondissipation draws after rejected offers is unlikely, given that there is a 25% chance of dissipation with each draw, but it is not impossible. Because agents, in this example, were very lucky in the resolicitation draws, the Nash equilibrium probability of each offer succeeding (about 25%) will, after 99 offers, produce an almost 100% chance of success. Thus, if we ignored the very lucky draws from the state of nature, we would conclude that takeover efficiency was much higher than theoretical predictions in the resolicitation treatments. Note that even in this example, because agents themselves do not know that they will experience such good fortune, their strategies are unaffected by the luck of the draw. In summary, if we ignored conditioning on the actual draws, we would estimate, in this illustrative example, that agent strategies matched the Nash equilibrium predictions but that takeover gains greatly exceeded predictions. To mitigate this problem, when computing theoretically predicted profit and welfare, we condition on the actual state of nature draws from the experiment. However, our conclusions are robust to this decision to condition on actual draws. Although the divergence of our experimental results from predictions would have been a bit larger if we had simply used unconditional Nash payoffs, our directional conclusions would have been identical.

The normalized gain to the shareholders is determined in the following way: When the takeover is unsuccessful, a 0 is assigned, and when the takeover is successful, the shareholder gain is calculated as [(nontendered shares $\times$ post-takeover value) + (tendered shares $\times$ tender price)]/(total shares $\times$ post-takeover value). The raiders' gain is also 0 if the takeover is unsuccessful, but when it is successful, then the gain is determined to be (1 – the shareholder gain). The dissipation of value is computed by crediting a 1 when a takeover fails and crediting a 0 when a takeover succeeds. Normalized gains represent the proportion of synergy gains captured by the parties to the takeover. Normalized dissipation losses represent the proportion of gains lost because of takeover failure.

The Nash equilibrium prediction (Table 1) is that as the continuation probability increases, dissipation increases, the average gain to shareholders decreases, and the average gain to the raider first decreases and then increases. The point predictions of the experiment contrast sharply with the equilibrium predictions: However, the qualitative theoretical predictions were consistent with the experimental results that resolicitation increases dissipation and lowers raider and shareholder gains. Overbidding by raiders in the resolicitation rounds did not induce shareholders to increase their tendering probabilities accordingly. Therefore, dissipation losses were much larger than predicted by theory. The effect of continuation on raider profit is even more striking. In the resolicitation rounds, the raider's normalized gains were, on average, less than 3% of the synergy value. Thus, despite the fact that the number of shareholders is not very large, and the resolicitation probability is not unreasonable, actual raider gains are very small, probably less than the typical takeover transactions costs.

It is interesting to note that the experimental results for dissipation losses are close to being consistent with the predictions of the atomistic shareholder model [see Grossman and Hart (1980)], which predicts no tendering and thus complete dissipation. The results are actually closer to the prediction of complete dissipation than the predictions of the finite shareholder model. This fit seems surprising because it is clear that shareholders are not following the no tendering strategy dictated by the atomistic model. Shareholders are, in fact tendering with reasonable frequency. However, the nature of the Nash conditional takeover equilibrium is that the equilibrium aggregate probability of tendering induces a significant probability that each shareholder is pivotal for the success of the offer. Thus, a small reduction in the shareholder tendering probabilities below the Nash equilibrium level can lead to a large reduction in the likelihood of takeover success. This effect perhaps partially accounts for the excessive dissipative losses.

4. Extensions

This article modeled, and experimentally simulated, the free-rider problem in a takeover when the raider has the option to "resolicit," that is, to make a new offer after an offer has been rejected. There were three major implications of our analysis. First, when the option to resolicit is present, shareholders free ride, behaving atomistically and tendering much less than the strategic finite shareholder Nash equilibrium predicts. Second, the option to resolicit lowers both shareholder and raider welfare to a degree that exceeds theoretical predictions. Third, to some extent, bidders attempt to compensate for shareholders' lower than anticipated tendering by increasing their bids. These results have consequences relevant to both current research into corporate takeovers and to future experimental research. First, they suggest that shareholder behavior will fit the strategic model much better in situations where the option to resolicit is either very costly or absent. As Hirshleifer (1996) points out, the strategic and atomistic models of shareholder tendering make radically different predictions regarding the utility and efficacy of many standard takeover defenses. For example, the strategic model predicts that supermajority rules will, by making the remaining outside shareholders more pivotal, increase the likelihood of takeover success. Atomistic models like Hirshleifer and Titman (1990) make the opposite prediction. For similar reasons, atomistic and strategic models differ in their predictions regarding toehold stakes and regarding takeover defenses involving debt/equity recapitalization (Israel, 1991).

The second key implication of our experimental results is that empirical tests for the effects of takeover defenses control for the costs and likelihood of resolicitation. Such tests would require empirical proxies for the likelihood of resolicitation, for which some variables appear to be obvious candidates. First, the likelihood of resolicitation will fall with the number of alternative target firms. Thus, the number of potential targets in the same industry should be negatively associated with the likelihood of resolicitation. Another obvious candidate for proxy variable is the degree of industry regulation. In regulated industries, for example, defense and telecommunications, new bids may require new approvals from regulatory authorities, such approvals would raise the cost of resolicitation. Thus, in regulated industries we expect to see less resolicitation, and as a consequence, higher raider profits and a more efficient takeover market.

The third key implication of our analysis—that the option to resolicit is costly to both shareholders and to bidders—has implications for the design of takeovers. First, it implies that transaction costs associated with launching a takeover, by making resolicitation less likely, may be welfare improving. In addition, anti-takeover provisions of the corporate charter which delay shareholder responses to takeovers, for example, provisions that require board evaluation of offers, by lowering the present value of a resolicitation offer, increase shareholder welfare. A number of researchers have already recognized that these sorts of defensive strategies can increase firm value through their effect on bidder's behavior or the behavior of potential rivals to the bidder. This article shows that some defensive actions can improve shareholder welfare through their effect on shareholders' own behavior.

How robust is this conclusion to a world with bidding competition? In our model, the increase in takeover value from charter provisions that raise the cost of resolicitation (and thus lower the likelihood of resolicitation) is derived from two sources. The first source is bid increase—when resolicitation costs are high, raiders increase their bids. The second source is reduced free riding—increases in resolicitation cost make shareholders less likely to free ride. When the strongest raider's bid is already forced by competition above that bidder's optimal noncompetitive bid, the first source of gain is lost. Only the second source, reduced shareholder free riding, remains. In theory, bidding competition lowers but does not eliminate shareholder gains from increased resolicitation costs. Thus, our model predictions extend to a competitive bidding situation. Whether our experimental results would be confirmed in such a setting can only be answered by further investigation.

A perhaps more novel implication of this work is that bidders, ex ante, can gain by increasing their own cost of resoliciting offers. A fairly simple way for acquirers to increase the costs of resoliciting is for acquirers to restrict their own bidding behavior by agreements with third parties. In practice such restrictions are frequently engendered by loan covenants. As Bharadwaj and Shivdasani (2003) show, such covenants frequently require bank approval for the terms and structure of any acquisition. Because bank interests and shareholder interests diverge, and shareholder have private information regarding the nature of the gains from the acquisition, negotiations between the bank and shareholder to undo covenant restrictions may engender value dissipation. Thus, these restrictions increase the cost of bid revision, which should increase raider gains. Similarly, a firm that must obtain outside financing for an increase in its takeover bid will also, under asymmetric information, find that bid revision generates adverse selection costs. Again, these costs make revision more costly and thus should increase raider gains.

Because of overbidding, the effect of shareholder undertendering is concentrated on raider profits. This experimental result is roughly consistent with the empirical evidence that documents large total gains from successful takeovers combined with very small bidder profits. Our results, in a setting where post-takeover value is common knowledge, indicate that higher raider bids might be explained by raiders rationally conjecturing that shareholders will only tender into very high offers. Thus, we provide an explanation for high raider bids that contrasts with the hubris theory based on the overestimation of post-takeover value developed in Roll (1986). Thus, an important empirical implication of our laboratory experiments is a strong negative correlation between the likelihood of resolicitation and the bidder takeover gains.

In addition to producing implications for the behavior of the corporate control markets, our analysis also provides directions for extension. One direction for extension would be to incorporate rival raiders into our analysis. Each raider would be endowed with a (different) takeover improvement gain. In this setting, the following questions could be addressed. First, does the best (highest improvement gain) raider always win the bidding competition, do shareholders coordinate to tender into the best offer? Second, relative to theoretical predictions, how is the winning bidder's profit affected by rival raiders?

Another direction for extending this article is to examine the effect of offer designs and charter provisions on the free-rider problem. Theoretically, such mechanisms can make tendering into a takeover at any price above pre-takeover value, a dominant strategy for shareholders. Thus, these amendments, at least in theory, have two effects: eliminating the free-rider problem and stripping shareholders of any bargaining leverage over the takeover gain. From an experimental viewpoint, one interesting question is how the interplay of these two effects would affect total shareholder takeover gains. A second question is whether inefficient equilibria, which exist in theory, and support value reducing takeovers would be supported by subject behavior in experiments.

A third direction of extension for this article is to incorporate asymmetric information by allowing the target firm to have private information regarding the size of the synergy-related takeover gain. Theoretically, shareholders should use the size of the bidders bid as a signal of the size of the bidder's synergy gain. Because larger synergy gains make failure more costly, high synergy bidders would be willing to pay more to avoid failure. Thus, in a fashion reminiscent of Hirshleifer and Titman (1990), high bids would lead shareholders to revise their estimates of synergy gains upward upon observing a high bidder bid. This, in turn, would increase the shareholders willingness to free ride and reap post-takeover value. In response, bidders should shade their bids downward. Thus, asymmetric information would produce even more dissipation-associated with takeover attempts. However, if bid shading were sufficiently large, higher bidder profits might emerge. The interesting question experimentally is how these predictions would be verified in the data.

Although each of the extensions to our analysis discussed above is interesting, and may yield new implications of its own for the behavior of corporate control markets, we are confident that the results of such extensions are unlikely to reverse the central conclusion from our experiments regarding the option to resolicit. Even if resolicitation is not costless, the raiders' ability to commit to an offer is so weakened that a large fraction of the socially optimal takeovers will either fail or not be attempted. Moreover, even with fairly costly resolicitation and a small number of shareholders, almost all gains from the successful takeover will be captured by shareholders.

Appendix A

Proof of Lemma 1. We need to show that Equation (3) has a unique solution. To this end, define

$$h(\pi) = \frac{\binom{N-1}{K-1}\pi^{K-1}(1-\pi)^{N-K}}{\overline{B}_K(\pi)}.$$

Next, note that through simple algebra we can rearrange (3) to obtain the equivalent equality

$$\left\{b - \frac{\delta\overline{B}_K(\pi)}{1-\delta[1-\overline{B}_K(\pi)]}\right\}h(\pi) - (1-b) = 0.$$

Because the left-hand side of Equation (2) is strictly positive for all π sufficiently small, strictly negative for all π sufficiently large, and continuous in π, a root must exist. Multiple roots are impossible by the following argument. First, note that

$$b - \frac{\delta\overline{B}_K(\pi)}{1-\delta[1-\overline{B}_K(\pi)]}$$

is strictly decreasing in π and is strictly positive in any sufficiently small neighborhood of a root of Equation (2). Similarly, h is strictly decreasing and positive. This implies that in a neighborhood of any root of Equation (2), the expression on the left-hand side of Equation (2) is decreasing. Thus, no root can cut the horizontal axis from below. This implies that once the left-hand side expression turns negative, it stays negative. Uniqueness follows.

Appendix B: Asymmetric Mixed Strategy Equilibria

Lemma 1. In every asymmetric mixed strategy equilibria, all shareholders who play mixed strategies use the same mixed strategy.

Proof. Consider an asymmetric mixed strategy equilibrium. Let i and j be two shareholders who are playing mixed strategies in this equilibrium. Equations (1) and (2) imply that the following equalities hold:

$$b^* \frac{t_i(\pi^*)}{1-\delta[1-t_i(\pi^*)]} - \frac{nt_i(\pi^*)}{1-\delta[1-nt_i(\pi^*)]} = 0 \tag{A1}$$

$$b^* \frac{t_j(\pi^*)}{1-\delta[1-t_j(\pi^*)]} - \frac{nt_j(\pi^*)}{1-\delta[1-nt_j(\pi^*)]} = 0. \tag{A2}$$

Simple algebra shows that Equations (A1) and (A2) are equivalent to

$$t_i(\pi^*) = \frac{(1-\delta)nt_i(\pi^*)}{b^*(1-\delta) - nt_i(\pi^*)\delta(1-b^*)}, \tag{A3}$$

$$t_j(\pi^*) = \frac{(1-\delta)nt_j(\pi^*)}{b^*(1-\delta) - nt_j(\pi^*)\delta(1-b^*)}. \tag{A4}$$

Next let, $Q = P_{\pi^*}\left(\tilde{S}^{-ij} \geq K-2\right)$, $R = P_{\pi^*}\left(\tilde{S}^{-ij} \geq K-1\right)$, $S = P_{\pi^*}\left(\tilde{S}^{-ij} \geq K\right)$, where $\tilde{S}^{-ij}$ represents the total number of shares tendered by shareholders other than i and j. Next define the function T for $\pi \in$ [0,1]R by

$$T[\pi] = \pi Q + (1-\pi)R, \tag{A5}$$

$$NT[\pi] = \pi R + (1-\pi)S. \tag{A6}$$

Note that $t_i(\pi^*) = T(\pi_j^*), nt_i(\pi^*) = NT(\pi_j^*); t_j(\pi^*) = T\left(\pi_i^*\right), nt_j(\pi^*) = NT\left(\pi_i^*\right)$. Define the following function of π:

$$F(\pi) = (b^* T(\pi)\{1-\delta[1-NT(\pi)]\}) - (NT(\pi)\{1-\delta[1-T(\pi)]\}). \tag{A7}$$

Note that F is quadratic in π and that $F(\pi_j^*)$ has the same sign as the left-hand side of Equation (A1) and $F(\pi_i^*)$ has the same sign as the left-hand of Equation (A2). Thus, there exists a mixed strategy equilibrium in which two shareholders randomize using different probabilities if and only if F has two distinct roots on the interval [0, 1].

Because i is indifferent to tendering when j tenders with a positive probability, it must be the case that i prefers tendering to not tendering if j is tendering with probability 0; for the same reason, i must prefer not tendering if j tenders with probability 1. These arguments imply that $F(0) > 0$ and that $F(1) < 0$. However, a quadratic function that is below the x-axis at 0 and above the x-axis at 1 crosses the x-axis at exactly one point between 0 and 1; thus, the root of F is unique, implying that $\pi_i^* = \pi_j^*$.

Appendix C: Instructions

General

You are about to participate in an experiment of group decision-making. There are two parts to this experiment. If you understand the instructions and make careful decisions, you may earn a considerable amount of money. These earnings will be paid to you, in cash, at the end of the experimental session.

Part I

The first part of this experiment involves answering a questionnaire that will be used to designate participant types for the second part of the experiment. The participants with the top scores on the questionnaire will be designated type A participants while the other participants will be designated type B. If there is a tie among the needed number of type A participants then a drawing will be held to determine who will be a type A participant. (Stop and please answer the questionnaire.)

Part II

There will *only* be *three* rounds in this experiment. At the beginning of each round, you will be randomly assigned by a drawing to a different group. There will be eight participants in each group, of which one member will be a randomly assigned type A participant. You will not know or be able to find out the identities of the members in your group.

Within each round there *may or may not* be multiple decision periods. The outcome of your group decision and a draw will determine whether there will be multiple periods to a given round. Your individual payoffs in each round will be determined by your decision and the decisions made by the other members in your group. There will be no interaction between groups nor will any member's choices in another group affect your payoffs.

At the start of every round, each type B participant will be given a token. The type A participant for each group will send a private *offer slip* to the seven type B members of *his/her group*. The offer slip will designate a price, in whole numbers, for which the type A participant will purchase their tokens; the offer price must be the *same* to all type B members in his group. Each type B participant will privately respond with a *sales slip*; marking *Accept*, if they want to accept the offer, or *Reject*, if they want to reject the offer.

If at least four tokens in total within a given group are offered for sale then the round is over for that group. The type A participant must purchase *all* tokens offered for sale within his group at his designated offer price. If less than four tokens are offered for sale within a given group, none of the tokens in that group will be sold in that period. In this case, a drawing will be held to determine whether there will be another decision period in this round. If the outcome of the draw allows for another decision period, then the type A participant will make a new offer, which can be the same, lower or higher than the previous offer. The drawing for another decision period in a given round will affect *only* those groups who do not have at least four tokens offered for sale. However, to keep anonymity of group members, all type A participants will send offer slips each period and all type B participants will respond with sales slips. But in those groups were the round is already over, the type A participants will send offer slips with the words "End" instead of an offer price.

The drawing will be held from one of two buckets. Before each round starts, the bucket that the draw will come from will be announced. Each bucket contains 100 poker chips: in the bucket labeled 75% there are 75 red chips and 25 white chips, and in the bucket labeled 1% there is 1 red chip and 99 white chips. If a white chip is drawn the round is over but if a red chip is drawn there will be another decision period in that round.

Thus, a draw from the 75% bucket yields a 75% chance of another decision period in that round and a 25% chance the round will be over. While a draw from the 1% bucket yields a 1% chance of another decision period and a 99% chance that the round will be over. If a red chip is drawn indicating another decision-making period in that round, then this drawing process repeats, until either at least four tokens are offered for sale within that group or a white chip is drawn.

Earnings

The experiment uses fictional currency called francs. All transactions are denominated in this currency as are the individual payoffs. The total number of francs you earn in each round will convert to your real dollar payoff at the end of the experiment. The conversion factor is 0.06. That is, one hundred francs of earnings will equal six dollars and thus, ten francs of earnings equal 60 cents.

Type A participants' earnings

At the end of each *round*, if total tokens offered for sale ≥ 4 then, earnings = 50 francs + [(100 francs – offer price) $\times$ (total tokens offered for sale)]. If total tokens offered for sale <4 then, earnings = 50 francs.

Type B participants' earnings

At the end of each *round*, if total tokens offered for sale ≥ 4 then, earnings if you accept offer = 50 francs + offer price and earnings if you reject offer = 50 francs + 100 francs. If total tokens offered for sale <4 then, earnings if you accept or reject offer = 50 francs.

Worksheet I

Please work through the following worksheet. Please raise your hand if you have any questions, and a monitor will come by to help you.

If a type B's decision is	If the other type Bs in his group decisions are accept; reject	The *total* tokens offered for sale in this group are?	Is it the *"end"* of the round or will there be a *"draw"* for another period?
Accept	3; 3		
Accept	1; 5		
Reject	3; 3		
Reject	6; 0		
Accept	2; 4		
Reject	4; 2		

Worksheet II

Please work through this worksheet to make sure you understand how to calculate your *round* earnings. For this worksheet, *assume the round has ended*; either at least four tokens were offered for sale or a white chip was drawn.

Offer price	Total tokens offered for sale in a given group	The type B's earnings *that accepted the offer*	The type B's earnings *that rejected the offer*	The type A's earnings *who made the offer*
45	4			
85	5			
6	4			
100	7			
5	3			
100	4			

Record keeping procedures

The type A and B participants have slightly different record sheets. Please look at your record sheet now. Each round the type B participants must fill in round, group number, period, your decision, offer price, group accept or reject offer, your round earnings in francs, and your cumulative earnings in francs. After each round the type A participants must fill in round, group number, period, your offer price, accept or reject offer, your round earnings in francs, and your cumulative earnings in francs. It is important that you keep accurate records throughout the experiment. Once the experiment begins, remember the following: .

(i) Do not talk, signal, or make noises to others in the class.
(ii) Do not show anyone else your offer slip, sales slip, or record sheet.
(iii) Try to ensure that you will not need to leave the room until the exercise is over.

Questionnaire (Note that a different questionnaire was given each experimental session, this is one example.)

(1) The last Triple Crown Winner in horse racing was
- (A) Seattle slew
- (B) Citation
- (C) Winning colors
- (D) Affirmed

(2) Pearl Harbor was attacked on
- (A) December 7, 1941
- (B) December 7, 1942
- (C) May 7, 1941
- (D) May 7, 1942

(3) The book *Alice's Adventures under Ground* (*Alice in Wonderland*) was written by
- (A) C. S. Lewis
- (B) E. B. White
- (C) Carolyn Keene
- (D) Lewis Carroll

(4) A colon punctuates the salutation in formal correspondence.
- (A) True
- (B) False

(5) Who was the first wife of Napoleon Bonaparte?
- (A) Josephine
- (B) Marie Louise
- (C) Hortense
- (D) Joan

(6) Who is credited with naming May 30, 1868, as the first Memorial Day?
- (A) Ulysses S. Grant
- (B) William Smith
- (C) John Logan
- (D) Abraham Lincoln

(7) Who was the main actor in the movie, "It's a Wonderful Life"?
- (A) Tom Hanks
- (B) John Wayne
- (C) Rock Hudson
- (D) James Stewart

(8) In the 2000 Olympics who won the gold metal in the Woman's 10-meter platform diving?
   (A) Natalie Williams
   (B) Lauren Jackson
   (C) Laura Wilkinson
   (D) Marion Jones

(9) In the Bible, which disciple betrayed Jesus.
   (A) Judas
   (B) John
   (C) Peter
   (D) Daniel

(10) The minimum hourly wage was raised from $1.00 to 1.25 in
   (A) 1937
   (B) 1966
   (C) 1954
   (D) 1961

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