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A Model of Dynamic Takeover Behavior

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ABSTRACT

Several observed features of takeover contests appear to be inconsistent with value-maximizing behavior on the part of the agents involved. For instance, managers occasionally resist takeover bids, presumably in order to facilitate competition among bidders. However, counterbids do not always materialize, suggesting that management resistance was not in the best interests of the firm's shareholders. On the other hand, a successful takeover is sometimes accompanied by a *decrease* in the value of the acquirer's shares. In addition, valuable combinations are occasionally not consummated.

We present a simple illustration of sequential takeover bidding in which all managers act in the best interests of their respective shareholders. Within the context of this model, we provide an explanation of the type of behavior described above.

TAKEOVERS AND MERGERS SERVE an important role in the process by which resources are efficiently allocated within a perfectly competitive economic system. For example, synergistic gains due to operating economies of scale are sufficient justification for organizational combinations, accomplished either by negotiation of a merger or by a direct offer to shareholders (takeover). In a world of perfect markets, all valuable combinations would be completed either with simple negotiations or a single bid takeover offer; the distribution of the synergistic gain between the combining firms would be a function of their relative contributions to the combination and their bargaining power.

However, much observed behavior in mergers or takeovers is inconsistent with the behavior implied by perfect markets models. For instance, resistance by the target management of a takeover offer above the prebid market price of the target is not easily explainable in perfect markets; but of the 86 multiple bid contests studied by Eckbo [5], management of the target firm opposed the first bid in 50 cases. This behavior is undoubtedly related to the fact that the market price of the target does not fall immediately back to its prebid value when a takeover bid fails, although when a subsequent bid is not forthcoming, the price does fall after some time (Bradley, Desai, and Kim [3]). This market reaction is also not easily justified in perfect markets. In addition, in a perfect market we would not expect the value of the shares of a successful bidder to decline following an acquisition; however, overbidding "mistakes" do occur.

Understanding takeover behavior and the circumstances surrounding such behavior is important, for example, to regulators considering legislative limitations to takeover activity. There is a growing body of literature (e.g., Bebchuk

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[2], Gilson [7, 8], and Easterbrook and Fischel [4]) which at least partially views observed takeover behavior as suboptimal for the shareholders of the firms involved. One of the main purposes of this paper is to show that such activity might in fact be value-maximizing in an environment characterized by asymmetric information among the participants. Regulatory efforts to remove the asymmetries rather than to limit behavior might be more appropriate and efficient.

One or more forms of market imperfection undoubtedly lie behind observed takeover behavior, and previous works have examined some of these. Grossman and Hart [9] examine the takeover mechanism as a discipline on inefficient management and recognize the incentives that exist which could lead individual target shareholders to not tender their shares in a takeover bid, leading to failure of the takeover. A charter amendment to limit minority shareholder rights is suggested as a solution to the problem. Baron [1] relies on asymmetric information and a positive value to the target management of retaining control to justify resistance by target management.

More recently, the role of asymmetric information has been expanded by Fishman [6], Khanna [10], and P'ng [11] to justify takeover behavior. Khanna assumes that bidders sequentially discover bidder-specific synergy gains and that they may submit bids for the target. The initial bidder submits a high "pre-emptive" bid to try to convince other potential bidders that the initial bidder's specific synergy gain is large, thus discouraging subsequent bids. Khanna shows that target management resistance is justified as a tactic designed to delay the process and thereby allow time for more bidders to enter the contest, and raise the expected value of the target. In a somewhat related model, Fishman [6] also examines "pre-emptive" bidding strategies and in addition examines the use of cash or shares as the medium of exchange in the merger. Fishman assumes that the target has some special information about the merger synergy, and the resulting equilibrium shows that the use of shares as the medium of exchange will be more attractive to a target that knows the merger is very valuable; however, this medium also attracts more aggressive bidder competition. P'ng [11] builds a model in which potential synergy gains possess both common and bidder-specific elements. P'ng also justifies high initial offers as the first bidder attempts to discourage potential subsequent bidders from undertaking costly investigation into their synergy gains with the target.

An element common to all these models is the concept of the initial bid as a signal of *that bidder's* possible synergy gains; potential subsequent bidders infer the initial bidder's possible synergy gains from the size of the initial bid. In contrast to this view, our model assumes that the possible synergy gain is entirely common to all bidders; thus, potential subsequent bidders learn about *their own* valuations of the merger from the initial bid. The initial bidder, who possesses potentially superior information about the target, understands that his or her bid is a signal to both the target and the uninformed bidder and, in equilibrium, the informed bidder will choose a bidding strategy designed to protect that informational advantage. The key assumptions in our model are: (i) there is a synergy gain common to all bidders, and (ii) one bidder has potentially superior information about the gain while both the target, and another bidder (that could also capture the same synergies with the target) have no special information about the synergy gain. Thus, the (potentially) informed bidder has an informational advantage over both the target and the uninformed bidder in attempting to acquire the target. This information asymmetry leads to equilibria in which the target may rationally reject a first bid, valuable mergers may not be consummated, and the uninformed bidder may sometimes acquire the target at a cost in excess of the realized synergy gains.

The model analyzed here is highly structured, and this structure is important to the form of the resulting equilibria. The structure, involving restrictions on the order of the bidding and the levels of bids, is described in Section I. At this point, we offer some justification for the imposition of the bidding restrictions used. The informational advantage held by the informed bidder minimizes the expected payoffs to the uninformed bidder: one would expect that an uninformed agent could only be made worse off by competing against a better informed rival, and therefore that an informational asymmetry of the type with which we deal would eliminate competition. However, we show that if the uninformed bidder is provided with some tactical advantage to overcome the informational disadvantage, the uninformed bidder may enter the bidding and provide some competitive discipline on the informed bidder. The tactical advantage which we employ results from the specific structure imposed on the bidding process. The target, of course, benefits from the competitive discipline provided by the uninformed bidder because larger initial bids may be forthcoming from the informed bidder, as well as possibly higher bids coming from the uninformed bidder.

Sections I and II set out the structure of the model. This is followed in Section III by a presentation of the results. A summary of the implications of the model and concluding remarks complete the paper.

I. A Model of Takeover Bids

We consider the behavior of a target firm, T, an informed bidder, I, and an uninformed bidder, U. All agents are assumed to be risk-neutral value maximizers who apply a zero discount rate to future cash flows. The informed bidder is assumed to have studied the operations of the target firm and has identified a way in which a combination would raise the target's value above its current prebid standardized value of 0. The uninformed bidder is also capable of generating the synergistic gain but is unable to identify the target until the informed has presented a bid.

All agents (I, U, T, and the market, i.e., investors who determine market values) know that *if* a merger is synergistic, in that it will result in a positive net gain, then the set of possible synergy gains is $\{G_1, G_3\}$ with $G_3 > G_1 > 0$. We assume that only I first learns of a possible synergy gain. However, U, T, and investors learn of the synergistic possibility as soon as a tender offer is made.

We also assume that it is common knowledge that bidder I is better informed than bidder U. Specifically, once the target is identified, all agents are aware that the firm is worth $G_1 = 1$ or $G_3 = 3$ with probabilities $p_1 + p_2$ and $p_3 + p_4$, respectively. It is also known that I receives a signal, Y, from the set $\{1, 2, 3\}$. Signal $Y = 1$ is received with probability p_1 and informs I that the value of the firm is G_1. Signal $Y = 3$ is received with probability p_4 and informs I that the value is G_3. Finally, signal $Y = 2$ is received with probability $p_2 + p_3$ and indicates that the firm is worth G_1 with probability $\phi = p_2/(p_2 + p_3)$ or is worth G_3 with probability $(1 - \phi) = p_3/(p_2 + p_3)$. Thus, the expected merger value to I when $Y = 2$ is $G_2 = \phi G_1 + (1 - \phi)G_3$. To summarize, the set of possible information/value states is: $\{s\} = \{1, 2, 3, 4\}$ with

$$
\begin{aligned}
s = 1 &\Rightarrow \text{Value} = 1,\ Y = 1,\\
s = 2 &\Rightarrow \text{Value} = 1,\ Y = 2,\\
s = 3 &\Rightarrow \text{Value} = 3,\ Y = 2,\\
s = 4 &\Rightarrow \text{Value} = 3,\ Y = 3.
\end{aligned}
$$

Finally, we make the assumption that

$$\text{Assumption (A1): } p_2 = p_3.$$

Assumption (A1) is for simplicity and provides that $G_2 = 2$ and $\phi = ½$. Thus, signal 1 or 3 provides the informed with perfect information about the true value of the post-takeover firm while signal 2 contains imperfect information.

Thus, the game is one in which asymmetrically informed agents enter into a bidding contest for a target firm. If the contest was completely unrestricted, in that I and U could make as many offers and counteroffers as they wished, and the offers could be of any magnitude, it is easy to show that the resulting equilibrium is one in which I bids 1 and T accepts the bid.[1] This result reflects the fact that an uninformed bidder can at best break even and overall will expect to lose from competition with a better informed agent. Since U has no incentive to enter the bidding, T will obtain only the minimum possible synergy gain from the takeover contest. Consequently, T would actually favor some form of restricted bidding which would provide U with enough of a tactical advantage to offset the informational disadvantage which it faces.

We impose the following sequential structure on the bidding process to provide a tactical advantage to the uninformed bidder:

1. I submits a bid from the set $\{G_1, G_2, G_3\}$;
2. T accepts or rejects the bid—acceptance ends the game;
3. If T rejects I's bid, U may either pass by bidding zero or counterbid with a bid that is strictly greater than the rejected bid.

The payoffs from the game are:

(i) T receives the accepted bid or receives zero if a bid is rejected and a counterbid is not made;
(ii) the winning bidder receives the true merger value, G_i, $i = 1, 2, 3$, less the amount of the winning bid;
(iii) the losing bidder receives zero.

[1] To see this result, assume that U considers countering a bid of 1 with a bid of $1 + \varepsilon$, $0 < \varepsilon < 1$. If I has received $Y = 2$ or $Y = 3$, then a second bid by I will follow U's counterbid. In fact, the only time that I will not counter a bid by U is when U has paid as much or more than the firm is actually worth. Consequently, U will not bid more than 1 for the firm, allowing I to preempt U with a bid of 1. Recognizing that a counterbid is not forthcoming, T will accept a bid of 1.

I's original bid is contingent upon the signal $Y \in \{1, 2, 3\}$; U and T must act on the basis of their prior beliefs and any information in I's original bid. The two restrictions that provide U with a tactical advantage to offset I's informational advantage are the restriction that bids be selected from the set $\{G_1, G_2, G_3\}$ and the fact that U is allowed to make the final bid.[2] T's accept/reject decision is nontrivial since U's equilibrium strategy may include not counterbidding a rejected bid;[3] in this case, we assume that the synergistic opportunity is lost.

A strategy for player I is a probability measure on the set $\{1, 2, 3\}$. The notation $b_i^j = \text{pr}(I \text{ bids } i \mid Y = j)$ will be used to indicate the probability with which the informed bids i given that signal j has been received.

A strategy for player U is a probability measure on the set $\{0, 2, 3\}$, where a bid of 0 designates a pass (no bid) by the bidder. The notation $c_k^i = \text{pr}(U \text{ bids } k \mid I \text{ bids } i)$ will indicate the probability with which the uninformed will bid k in response to a bid of i made by the informed.

The strategy for player T, $a_i = \text{pr}(T \text{ accepts } i)$, is the probability with which the target firm accepts a bid of i made by the informed.

The expected game payoffs derived below are simplified by including the constraint that probabilities sum to 1 in the conditional value function. Thus,

- player U chooses: c_0^1, c_2^1, and c_0^2, with

$$c_3^1 = 1 - c_0^1 - c_2^1$$

$$c_3^2 = 1 - c_0^2.$$

- player T chooses: a_1 and a_2, where $0 \le a_1, a_2 \le 1$.
- player I chooses: b_1^1, b_2^1, b_1^2, b_2^2, b_1^3, and b_2^3, with

$$b_3^1 = 1 - b_1^1 - b_2^1$$

$$b_3^2 = 1 - b_1^2 - b_2^2$$

$$b_3^3 = 1 - b_1^3 - b_2^3.$$

U, T, and the market revise their beliefs about the true state based upon the

[2] Small fixed costs per bid might also reduce the problem of intermediate bids, although the ultimate result is the exclusion of U from bidding, as discussed in footnote 1. Fixed bidding costs could be included in the restricted bidding model without changing the resulting equilibrium. Neither bidders' behavior at any stage in the game would be affected by prior bids since the costs incurred would be sunk. The synergistic gains in the presence of bidding costs would then be the gain net of the cost of making the successful bid.

[3] The first bid made by I can be thought of as a secret merger offer made to the managers of the firm. If accepted, the merger is announced to the market. If rejected, the offer becomes a public tender offer which is resisted by management.

bid made by I:

$Q_s^i = \mathrm{pr}(s \mid I \text{ bids } i)$ will denote the Bayesian revised state probabilities

$$Q_1^i = \frac{b_i^1 p_1}{\Delta_i},$$

$$Q_2^i = \frac{b_i^2 p_2}{\Delta_i},$$

$$Q_3^i = \frac{b_i^2 p_3}{\Delta_i},$$

$$Q_4^i = \frac{b_i^3 p_4}{\Delta_i},$$

where

$$\Delta_i = b_i^1 p_1 + b_i^2 (p_2 + p_3) + b_i^3 p_4.$$

II. Assumptions, Notation, and Solution Technique

In this section, we discuss the technique used to derive the equilibria of the game described in Section I. We make use of the concept of a Bayesian Nash equilibrium; thus, all actions in the game are optimally chosen, with all players correctly anticipating the optimal strategies of the others, and beliefs of imperfectly informed agents are rationally determined, based upon the optimal strategies.

In deriving the equilibrium, we make the additional assumption about the prior beliefs, p_s:

$$\text{Assumption (A2): } p_1 < p_4.$$

Assumptions (A1) and (A2) together imply that if there is synergy in the combination, there is a higher prior likelihood of it having value $G_3 = 3$ rather than value $G_1 = 1$. Reversing the inequality in assumption (A2) leads to a simple pure strategy equilibrium discussed in Section V.

The solution procedure consists of the following steps. First, we derive each player's expected game payoffs, contingent upon the player's observations and responses; these expected payoffs are also functions of the opponents' strategies. We then search for strategies, and beliefs consistent with those strategies, such that none of the players can be made better off by defecting from the equilibrium set of strategies. Finally, we consider the consistency of the equilibrium strategies with reasonable off-equilibrium-path beliefs.

Denote the players' contingent expected game payoffs by:

V_Y^I is I's expected payoff given that signal Y has been received.
V_i^T is T's expected payoff given that I has made a bid of i.
V_i^U is U's expected payoff given that I has made a bid of i.

These expected payoffs are calculated by working backwards through the sequential game in the following way:

(a) *The counterbid of U.* If I bids 1 and T rejects this, U will either pass (with probability c_0^1), bid 2 (with probability c_2^1), or bid 3 [with probability $(1 - c_0^1 - c_2^1)$]. If I bids 2 and this is rejected by T, U can either pass or bid 3. Appendix A derives the expected payoffs to U, contingent on I bidding 1 or 2, respectively:

$$V_1^U = (1 - a_1)[c_2^1(- Q_1^1 - Q_2^1 + Q_3^1 + Q_4^1) + (1 - c_0^1 - c_2^1)(-2)(Q_1^1 + Q_2^1)] \quad (1)$$

$$V_2^U = (1 - a_2)[(-2)(1 - c_0^2)Q_2^2]. \quad (2)$$

(b) *T's response to I's bid.* The derivation of the expected payoffs to T, contingent upon I's offer and T's response is provided in Appendix B. Thus, T's expected payoffs, contingent upon I's bid of 1 and 2, respectively, are:

$$V_1^T = a_1(1) + (1 - a_1)[2c_2^1 + 3(1 - c_0^1 - c_2^1)] \quad (3)$$

$$V_2^T = a_2(2) + (1 - a_2)(1 - c_0^2)(3). \quad (4)$$

(c) *I's bid.* The expected payoffs to I contingent upon the inside information, Y, and I's bid are derived in Appendix C:

$$V_1^I = b_1^1(0) = 0 \quad (5)$$

$$V_2^I = b_1^2a_1(1 - \phi)(2) + b_2^2a_2(1 - 2\phi) + (1 - b_1^2 - b_2^2)(-2\phi) \quad (6)$$

$$V_3^I = b_1^3a_1(2) + b_2^3(a_2). \quad (7)$$

Equation (5) follows from the fact that if $Y = 1$ then any bid by I in excess of 1 is weakly dominated by a bid of 1. Thus,

$$b_1^1 = 1 \quad b_2^1 = 0 \quad b_3^1 = 0.$$

Note that the expected payoffs in Equations (1) through (7) describe each player's payoffs in terms of the other players' strategies, either directly or through revised beliefs, Q_s^i.

The basic tradeoffs contained in these expected payoffs have simple economic interpretations. When player I knows the merger is of high value ($Y = 3$), there is the obvious incentive to underbid. However, this incentive must be balanced against the possibility of rejection of the offer: player T recognizes player I's incentive to bluff and so may reject a low bid in the hope that U will offer a higher bid. Of course, in deciding whether or not to reject, T recognizes that if no counteroffer is forthcoming the gain from the first bid is lost. Finally, player U also recognizes player I's incentive to bluff and so may counter with a higher bid. Since U is bidding on the basis of incomplete information, the possibility of overbidding exists.

An important characteristic of the game structure is that I's informational advantage has been partially offset in two ways: (i) by restricting admissible bids to the set {1, 2, 3}, and (ii) by giving U the tactical advantage of submitting the last bid. Since I has incentives to underbid for a valuable T, giving U the last bid may allow U to obtain T for less than the total synergistic gain.[4]

Taking the derivatives of Equations (1) through (7) with respect to the appropriate choice variables yields the set of First-Order Conditions. Since the expected value functions are linear in the relevant choice variables, the resulting First-Order Conditions are independent of those choice variables. Equilibrium in this model is characterized by a set of strategies, b_t^i, c_k^i, and a_i, and beliefs, Q_s^i as defined in the previous section, that are consistent with Equations (8) through (16) and with reasonable off-equilibrium-path beliefs.

$$\partial V_1^U/\partial c_0^1 = 2(1 - a_1)(Q_1^1 + Q_2^1) \tag{8}$$

$$\partial V_1^U/\partial c_2^1 = 1 - a_1 \tag{9}$$

$$\partial V_2^U/\partial c_0^2 = 2(1 - a_2)Q_2^2 \tag{10}$$

$$\partial V_1^T/\partial a_1 = 1 - (2c_2^1 + 3(1 - c_0^1 - c_2^1)) \tag{11}$$

$$\partial V_2^T/\partial a_2 = (Q_2^2 + Q_3^2 + Q_4^2)(3c_0^2 - 1) \tag{12}$$

$$\partial V_2^I/\partial b_1^2 = 1 + a_1 \tag{13}$$

$$\partial V_2^I/\partial b_2^2 = 1 \tag{14}$$

$$\partial V_3^I/\partial b_1^3 = 2a_1 \tag{15}$$

$$\partial V_3^I/\partial b_2^3 = a_2. \tag{16}$$

For a set of strategies to be consistent, the assumed behavior must obtain in the First-Order Conditions. For example, if beliefs are such that Equation (12) equals zero, then T is indifferent to his or her choice of a_2. Alternatively, suppose that $0 < Q_2^2 + Q_3^2 + Q_4^2 < 1$ and $1/3 < c_0^2 \leq 1$; since Equation (12) is positive, $a_2 = 1$ is optimal. However, a positive First-Order Condition will not *always* require that the appropriate strategy variable equal 1; some First-Order Conditions are linked by the constraint that strategy variables sum to 1. For example, Equations (8) and (9) are linked by the constraint $c_0^1 + c_2^1 + c_3^1 = 1$. Suppose $Q_1^1 + Q_2^1 = 1/2$ and $0 < a_1 < 1$ so that Equations (8) and (9) are both positive and equal. Since bidding 3 has at best a zero marginal benefit and Equations (8) and (9) imply a positive, equal marginal benefit to U from either passing or bidding 2, then U is indifferent to these two actions, but prefers either to bidding 3. Thus, $c_3^1 = 0$ and $c_0^1 + c_2^1 = 1$ with both variables having equal marginal benefits. So, the consistent strategy can have any $0 \leq c_0^1 \leq 1$, $c_2^1 = (1 - c_0^1)$, $c_3^1 = 0$.

III. Equilibria

The model generates two distinct equilibria which differ due to a particular assumption about the manner in which U behaves when indifferent between presenting a counteroffer or passing. In the first equilibrium, the relevant assumption is that U will not present a counterbid when the expected payoffs from countering and passing are equal. This is referred to as the *passive compe-*

[4] Alternative behavior is discussed in Section V.

tition case. This assumption is most important when I has bid 2, revealing in this equilibrium that the firm is worth 3. Since U will have to bid 3 for a firm worth 3, U is indifferent between bidding and passing and will therefore pass. This behavior is significant since it allows I to obtain a firm worth 3 with a bid of only 2. Thus, despite his or her indifference, U's decision determines whether I or T is to receive the additional unit and, in this case, U favors I.

In the second *white knight* equilibrium, U is assumed to always counter a bid of 2 by I with a bid of 3. This behavior by U implies that T receives a higher payoff at the expense of I.

THE PASSIVE COMPETITION EQUILIBRIUM. The following strategies characterize a sequentially rational Nash equilibrium under the *passive competition* assumption described above:

$$
\begin{array}{lll}
b_1^1 = 1 & b_2^1 = 0 & b_3^1 = 0 \\
b_1^2 = 1 & b_2^2 = 0 & b_3^2 = 0 \\
b_1^3 = p_1/p_4 & b_2^3 = 1 - p_1/p_4 & b_3^3 = 0 \\
a_1 = 1/2 & a_2 = 1 & a_3 = 1 \\
c_0^1 = 1/2 & c_0^2 = 1 & \\
c_2^1 = 1/2 & c_3^2 = 0 & \\
c_3^1 = 0 & &
\end{array}
$$

and result in the following revised beliefs:

$$Q_1^1 = Q_4^1 = p_1/2(p_1 + p_2) \quad Q_2^1 = Q_3^1 = p_2/2(p_1 + p_2)$$

$$Q_1^2 = Q_2^2 = Q_3^2 = 0 \quad Q_4^2 = 1$$

$$Q_1^3 = Q_2^3 = Q_3^3 = 0 \quad Q_4^3 = 1.$$

The equilibrium has I making an initial bid of 1 whenever bad news ($Y = 1$) or a noisy signal ($Y = 2$) is received; when I knows the merger is most valuable ($G_3 = 3$) he or she will bid 1 with probability p_1/p_4 [less than 1 by assumption (A2)] and he or she will bid 2 with probability $1 - (p_1/p_4)$. Given these strategies, it is optimal for T to always accept a bid of 2, but to reject a bid of 1 with probability 1/2. It is rational for T to occasionally reject a bid of 1 since there is a 0.5 probability that U will counter with a bid of 2. U finds it optimal to sometimes counter a bid of 1 by I because the value of the combination may actually be 3. As shown in Appendix D, only $c_0^2 \geq 1/3$ is necessary; we assume $c_0^2 = 1$ by the passive competition assumption. Given this behavior by U, T will accept an offer of 2. The expected game payoffs in this equilibrium are:

$$E(V^I) = p_3 + p_4 \quad E(V^U) = 0 \quad E(V^T) = 2(p_3 + p_4).$$

Only two information sets will not be reached in equilibrium, and off-equilibrium-path behavior in these cases is straightforward. First, if I makes an unexpected offer of 3, it will be accepted by T regardless of how T believes this unlikely event came to be; since no higher value is possible, T will accept that "mistaken" offer. Thus, neither I nor U have any incentive to make this "mistake." Second, if I bids 2 and for some reason T rejects that offer, U is indifferent to withdrawing or countering with a bid of 3; by setting $c_3^2 = 0$, we assume that U would not counter with a bid of 3. Thus, T has no incentive to make the "mistake" of rejecting a bid of 2.

THE WHITE KNIGHT EQUILIBRIUM. The following strategies also constitute a sequentially rational Nash equilibrium with the same revised beliefs as in the previous equilibrium:

$$\begin{array}{lll} b_1^1 = 1 & b_2^1 = 0 & b_3^1 = 0 \\ b_1^2 = 1 & b_2^2 = 0 & b_3^2 = 0 \\ b_1^3 = p_1/p_4 & b_2^3 = 1 - p_1/p_4 & b_3^3 = 0 \\ a_1 = 0 & a_2 = 0 & a_3 = 1 \\ c_0^1 = 0 & c_0^2 = 0 & \\ c_2^1 = 1 & c_3^2 = 1 & \\ c_3^1 = 0 & & \end{array}$$

This equilibrium has the same strategies by I as in the previous case, but T now rejects any bid by I that is less than 3, and U always counterbids after T rejects I's first offer. Appendix D shows that only $c_0^2 \leq 1/3$ is necessary. In this equilibrium we assume that U, although indifferent, will always counter any bid made by I; thus, T will always reject that first offer. This *white knight* behavior leads to a higher expected game payoff to T, a lower payoff to I, and no change to U's payoff compared to the *passive competition* equilibrium:

$$E(V^I) = 0 \quad E(V^U) = 0 \quad E(V^T) = p_1 + p_2 + 3(p_3 + p_4).$$

IV. Implications of the Model

Two Bayesian Nash equilibria have resulted from the above characterization of a takeover contest. While the two equilibria differ in important ways, they are similar in that they explain the characteristics of takeover contests set out in the introduction. We illustrate this with the passive competition equilibrium.

First, rejection of an initial takeover offer by management may be in the best interests of the target shareholders. The motive, of course, for T to reject the initial offer of 1 by I is to allow a higher counteroffer.[5]

[5] In our stylized model of takeovers, the roles of T and U are intertwined. If T did not accept or reject the initial offer (i.e., passively waited for a counter offer), the forms of equilibria we found above recur: U's actions discipline I's bidding strategy, and I's strategy effects U's revised beliefs. We include T because, in fact, initial offers are not open for an unlimited length of time, and the timing of a counterbid by U may be uncertain with the result that T may have to respond to the offer before it is known whether or not a counterbid is forthcoming. Also, including T demonstrates that target management resistance to an offer that is above the prebid market price may be an appropriate action for value-maximizing managers.

Next, our model indicates that we will observe takeover contests involving sequential bidding; in this simple formulation, the probability of I bidding 1, T rejecting the offer, and U countering with a bid of 2 is $(1/2)(p_1 + p_2)$. I would like to acquire T at below the true value, and U imposes some discipline on I with the implicit threat of a counteroffer.

Also, the market price of the target responds to an offer from I. Since the target and the market share the same beliefs, the market value of the target at each point in the contest will correspond to the conditional expected value of the target, V_i^T. From Equations (3) and (4) with the equilibrium strategies, we see that $V_1^T = 1$ and $V_2^T = 2$; the uninformed market moves the price of T up to the value of the offer, although, when the bid is 1, the offer may be rejected. Even when T rejects the initial offer of 1, the market price stays at 1 until it is known that a counterbid by U is not forthcoming; this follows from there being a 0.5 probability that U will counter with a bid of 2, so that the expected target value is $(1/2)(0) + (1/2)(2) = 1$. This result is consistent with the empirical evidence provided by Bradley, Desai, and Kim [3]. Of course, if that rejection does not prompt a counteroffer from U (and there is a probability of $c_0^1 = 1/2$ that it will not), then the synergistic gain is assumed to dissipate, and the target value will fall back to the standardized value of zero.

Finally, our model indicates that the pricing and allocation of resources through the takeover mechanism is imperfect. One instance of this imperfection is mistaken overbidding by U who will bid 2 for a firm worth $G_1 = 1$ with probability $(1/4)(p_1 + p_2)$. The other imperfection is that valuable synergistic mergers may be foregone in the passive competition case; the probability of I bidding 1, T rejecting the bid, and U not countering is $(1/2)(p_1 + p_2)$.

The impact of asymmetric information on asset allocation can be seen by comparing the ex ante value of the merger without a tender contest to the sum of the values of the game to the players involved. If agents could bid for the firm based only upon their prior beliefs, they would pay

$$1(p_1 + p_2) + 3(p_3 + p_4).$$

However, the total value of the game under asymmetric information is

$$E(V^I) + E(V^U) + E(V^T) = \begin{cases} p_1 + p_2 + 3(p_3 + p_4), & \text{in the white knight case;} \\ 3(p_3 + p_4), & \text{in the passive competition case.} \end{cases}$$

The value loss in the passive competition case due to asymmetric information is $(p_1 + p_2)$; it is easy to show that this is the expected loss that occurs when I bids 1, T rejects, and U does not make a counteroffer so that the valuable synergy opportunity is lost. There is no such loss in the white knight equilibrium since U always successfully acquires the firm. In fact, the white knight equilibrium has the same distribution of ex ante expected values as a game in which I does not receive a signal Y: T captures all of the expected benefits.

As is true of most models with multiple equilibria, it is difficult to specify which equilibrium will obtain. If binding contracts between U and either I or T could be entered into prior to bidding, T could offer U a maximum sidepayment of 1 to act as a white knight while I could at most offer a sidepayment of $(p_3 + p_4)$ to be a passive competitor. However, there are a number of reasons which suggest that the passive competition case is more likely to obtain. The first is that since $E(V^I) = 0$ in the white knight equilibrium, I might decide to pass if allowed to do so since passing and making an initial bid have the same expected payoff; but if no bid is made, T receives no synergistic benefits at all. Thus, precommitting to a white knight might not be in T's best interests. Beyond these problems, the enforceability of a prior white knight contract is questionable. Moreover, T would actually hide the fact that a white knight existed if, in fact, one did.

In addition, further restrictions on the equilibrium would eliminate the white knight case. Recall that, in equilibrium, when I bids 2, U believes that the firm is worth 3 with probability 1. U is, therefore, indifferent to countering with a bid of 3 or passing and, according to the white knight assumption, makes a counterbid. However, while countering and passing generate the same payoffs in equilibrium, passing dominates countering in that it is as good in equilibrium but better if, for some reason, I had bid 2 following receipt of the signal $Y = 1$ or $Y = 2$. As a result, the white knight equilibrium would be destroyed if strategies which were dominated in this way were eliminated.

V. Concluding Comments

Within a simple bidding game under asymmetric information, we are able to explain many observed takeover/merger phenomena. These include sequential bidding, mistaken overbidding, managerial resistance, including the use of a *white knight*, and the reluctance of the market to reduce the price of the target following a rejected takeover offer. Importantly, these phenomena occur under the assumption of rational value-maximizing behavior and are not the result of managerial self-interest as has been suggested by Easterbrook and Fischel [4] and Gilson [7].

The key factor that provides the results of our model is the presence of an uninformed bidder who, despite an informational disadvantage, has incentives to sometimes counter a low initial offer by the informed bidder. In our model, the incentive for the uninformed bidder to enter follows from the tactical advantage provided by the structure of the contest.

The game structure could be changed somewhat without destroying the informational and tactical asymmetries between the bidders. For example, I could be allowed to submit a second bid to counter a bid by U provided that I's actions favor U when I is indifferent. The only circumstance in our model in which I might counter a bid by U is the sequence: I receives the signal $Y = 3$, I bids 1, T rejects, and U bids 2. In this circumstance, I is *indifferent* to bidding 3, or letting U acquire the firm with a bid of 2. If I does not counter with a bid of 3, or randomizes with a sufficiently small chance of bidding 3, then U's tactical advantage is not lost, and our equilibria still hold. If (when $Y = 3$) I always counters U's bid of 2 with a bid of 3, then U can never "win" in this game, and so U will never bid; in this case, the only equilibrium is characterized by I bidding 1 and T accepting the offer. Thus, it is in T's best interest to discourage a second bid by I so that U has a reason to enter the contest, thereby raising T's expected payoff. Indeed, T would like to convince U that a second bid by I will not be considered. Bitter (and sometimes personal) criticism of the management of the bidding firm by the management of the target firm is often observed in a takeover battle and could be interpreted as T not only rejecting an initial bid by I but precommitting to not consider another bid by I.[6]

Within our game structure a key assumption concerns the prior probabilities: $p_1 < p_4$. It is not difficult to show that if this assumption is reversed, then the unique equilibrium has I bidding 1 with probability 1 and T accepting the offer with probability 1. The important feature of this equilibrium is that, since the merger is a low-valued one in terms of U's initial expectations, U has no incentive to become involved in the bidding. As a consequence, I is able to acquire the firm for a price which is consistent with the lowest possible synergy gain.

Extensions of our model in several directions may generate interesting results in future work. For instance, recent models have been developed which allow for bidder-specific values to be placed on the target firm (Fishman [6], Khanna [10]). Including this feature within the present structure would generate a model in which bidders learn about two relevant characteristics of the target through the offers being presented. In a similar manner, it may prove interesting to allow the target to have private information about the value of the firm, opening up the possibility that bidders may learn something from the target's rejection of an offer (see Fishman [6]). Also, the existence of multiple bidding equilibria suggests that precommitment activities by T might be value-maximizing. The growing number of "defensive tactics" employed by potential takeover targets might prove justifiable in a world of asymmetric information.

Appendix A

Table A

Deriving U's Payoffs

I's Bid	T's Response	U's Move	With Probability	Expected Payoff
1	reject	pass	c_0^1	0
		bid 2	c_2^1	$-(Q_1^1 + Q_2^1) + (Q_3^1 + Q_4^1)$
		bid 3	c_3^1	$-2(Q_1^1 + Q_2^1)$*
2	reject	pass	c_0^2	0**
		bid 3	c_3^2	$-2Q_2^2$

* If I bids 1 and T rejects, then "U bid 3" is weakly dominated by "U pass."
** If I bids 2 and T rejects "U pass" weakly dominates "U bid 3."

[6] Alternatively, since I will obtain a zero payoff by countering U's bid with a bid of 3, I may withdraw from the battle for T and search for another target. This would then allow U to acquire a firm worth 3 with a bid of 2.

Appendix B

Table B

Deriving T's Payoffs

I's Bid	T's Move	With Probability	Expected Payoff
1	accept	a_1	1
	reject	$1 - a_1$	$2c_2^1 + 3(1 - c_0^1 - c_2^1)$
2	accept	a_2	$2(Q_2^2 + Q_3^2 + Q_4^2)$
	reject	$1 - a_2$	$(1 - c_0^2)(3)(Q_2^2 + Q_3^2 + Q_4^2)$*
3	accept	1	3

* Note that since $Q_1^2 = 0$, $Q_2^2 + Q_3^2 + Q_4^2 = 1$.

Appendix C

Table C

Deriving I's Payoffs

Signal	I's Bid	With Probability	Expected Payoff
$Y = 1$	1	b_1^1	0*
$Y = 2$	1	b_1^2	$a_1(1 - \phi)(2) = a_1$
	2	b_2^2	$a_2(1 - 2\phi) = 0$
	3	b_3^2	$-2\phi = -1$**
$Y = 3$	1	b_1^3	$2a_1$
	2	b_2^3	a_2
	3	b_3^3	0***

* "I bid 1" dominates any alternative strategy.
** "I bid 3" with $Y = 2$ is strongly dominated by "I bid 1."
*** "I bid 3" with $Y = 3$ is weakly dominated by either alternative.

Appendix D: Deriving the Equilibria

We develop the *passive competition* and *white knight* equilibria by systematically applying possible strategies to the First-Order Conditions (8) through (16) and eliminating those strategies which are inconsistent within this equation system. The first major strategy assumption is that $a_1 = 0$; given this constraint, we show that only $a_2 = 0$ is consistent. Then, given these requirements, limits are obtained for b_1^3 and c_0^2, providing the *white knight* equilibrium.

The second major case tested is $a_1 = 1$. Using arguments about off-equilibrium-path beliefs, we show that there is no Bayesian Nash equilibrium which satisfies assumption (A2); reversing (A2) leads to a degenerate pure strategy equilibrium.

Finally, assuming $0 < a_1 < 1$, the *passive competition* equilibrium is derived.

For convenience, we reproduce the system of First-Order Conditions:

$$\partial V_1^U/\partial c_0^1 = 2(1 - a_1)(Q_1^1 + Q_2^1) \tag{8}$$

$$\partial V_1^U/\partial c_2^1 = 1 - a_1 \tag{9}$$

$$\partial V_2^U/\partial c_0^2 = 2(1 - a_2)Q_2^2 \tag{10}$$

$$\partial V_1^T/\partial a_1 = 1 - (2c_2^1 + 3(1 - c_0^1 - c_2^1)) \tag{11}$$

$$\partial V_2^T/\partial a_2 = (Q_2^2 + Q_3^2 + Q_4^2)(3c_0^2 - 1) \tag{12}$$

$$\partial V_2^I/\partial b_1^2 = 1 + a_1 \tag{13}$$

$$\partial V_2^I/\partial b_2^2 = 1 \tag{14}$$

$$\partial V_3^I/\partial b_1^3 = 2a_1 \tag{15}$$

$$\partial V_3^I/\partial b_2^3 = a_2. \tag{16}$$

Case 1: Assume $a_1 = 0$. Equation (11) requires $c_2^1 \geq 1/2$; to allow $c_2^1 \geq 1/2$, Equation (9) must equal or exceed Equation (8): $Q_1^1 + Q_2^1 \leq 1/2$. Note that any $a_2 > 0$ implies by Equations (15) and (16) that $b_2^3 = 1$ and $b_1^3 = 0$; however, these values violate the necessary condition $Q_1^1 + Q_2^1 \leq 1/2$. Thus, $a_2 = 0$.

If we allow $b_2^2 > 0$, so that $Q_2^2 > 0$, then Equation (10) is non-negative, requiring $c_0^2 = 1$; however, $c_0^2 = 1$ in Equation (12) requires $a_2 = 1$, which violates the condition $a_2 = 0$; thus, $b_2^2 = 0$ and $b_1^2 = 1$.

For $a_2 = 0$, Equation (12) requires $c_0^2 \leq 1/3$. Since Equations (15) and (16) are equal, we can choose b_1^3 and b_2^3 freely, and we set $b_1^3 \geq p_1/p_4$ to satisfy $Q_1^1 + Q_2^1 \leq 1/2$; thus, $b_2^3 \leq (1 - (p_1/p_4))$.

Choosing the limits $b_1^3 = p_1/p_4$, $c_2^1 = 1$ and $c_0^2 = 0$ provides the white knight equilibrium described in Section III.

Case 2: Assume $a_1 = 1$. Using this assumption in Equations (13) and (14) implies $b_1^2 = 1$ and $b_2^2 = 0$, and Equations (15) and (16) imply $b_1^3 = 1$ and $b_2^3 = 0$. Thus, if $a_1 = 1$, I will always bid 1, regardless of his or her signal. Also, for $a_1 = 1$, Equation (11) requires $c_2^1 \leq 1/2$.

However, assumptions (A1) and (A2) in the text imply that, based upon priors, U will counter I's uninformative bid of 1 with a bid of 2, if T "mistakenly" rejects I's bid of 1. Knowing that U will counter, T *will* reject I's bid of 1, so that $a_1 = 1$ cannot be an equilibrium.

Case 3: Assume $0 < a_1 < 1$. This assumption in Equations (13) and (14) requires $b_1^2 = 1$ and $b_2^2 = 0$. Also, a necessary condition for $0 < a_1 < 1$ is that Equation (11) equal zero: $c_2^1 = 1/2$ and $c_0^1 = 1/2$. To allow this, Equations (8) and (9) must be equal: $Q_1^1 + Q_2^1 = 1/2$. Since $b_1^2 = 1$, this requires $b_1^3 = p_1/p_4$ and $b_2^3 = 1 - (p_1/p_4)$. To allow this choice of b_1^3 and b_2^3, Equations (15) and (16) must be equal: $a_1 = 1/2 a_2$. The free choice of $a_2 > 0$ requires $c_0^2 > 1/3$ in Equation (12). Choosing the limits $a_2 = 1$ and $c_0^2 = 1$ provides the passive competition equilibrium shown in the text.

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