Discussion Paper No. 670

A Theory of Preemptive Takeover Bidding*

by
Michael J. Fishman

Kellogg Graduate School of Management
Northwestern University
Evanston, Illinois 60201

December 1985

Abstract

This paper develops a model of the takeover bidding process. The model is one of strategic bidding among competing bidders, in an environment of asymmetric and costly information. Implications concerning the relationships between bidders' and targets' profits and (1) bidders' initial offers, (2) single and multiple bidder contests, and (3) takeovers which occurred before and after the enactment of takeover legislation are developed. Additionally, the model provides a rationale for bidders to make high premium ("preemptive") initial bids, rather than making low initial bids and raising them if there is competition.

1. Introduction

Takeover bidding, in addition to attracting a great deal of attention from practitioners, has attracted a great deal of attention from researchers. There is now a large empirical literature on takeovers (see Jensen and Ruback (1983)). The most striking of the stylized facts to emerge is the existence of the high premiums offered by bidders. High premiums, in and of themselves, would not be that surprising if they appeared to be the result of competing bidders bidding up the price. This is not always the case though. Rather than offering a low bid and being prepared to raise it if there is competition, bidders frequently offer high premiums on their initial bids. The empirical literature also provides measures of bidder and target profits from takeovers. Among the findings, differences in profits between single and multiple bidder contests, and takeovers which occurred before and after the enactment of takeover legislation, have been documented.

The purpose of this paper is to develop a model of the takeover bidding process, which can provide a useful framework for examining and interpreting these empirical results. The model developed is one of strategic bidding among competing bidders, in an environment of asymmetric and costly information. In addition to providing a framework for understanding the empirical results, the model provides a rationale for high premium, initial bids.

Takeover bidding contests are similar to open (English) auctions. Bidders submit successively higher bids until a high bid stands. One important difference however between takeover bidding contests and open auctions, as typically thought of, lies in the time involved in each. As typically thought of, open auctions, whether for art, real estate, etc., take place over a short period of time. They may last only several minutes.

Takeover bidding contests on the other hand can last weeks, or even months. Bradley, Desai and Kim (1984) report that for a sample of multiple bidder tender offer contests, the ultimately successful offer was made, on average, over five weeks after the initial offer.

Why, though, is time important? Ignoring discounting, why would it matter if an auction ends in several minutes or several weeks? There is one particular action which becomes possible with added time, which will be focused on here. That action is a bidder's acquisition of information. Consider a bidder in an auction which will last several minutes. The bidder may have conducted an outside appraisal of the value of the object for sale, prior to the opening of bidding. However, once the bidding has begun, there is no longer sufficient time to acquire outside information. The bidder must bid with the information it acquired prior to the auction, and with whatever it learns from the bidding. Now consider a bidder which has several weeks to determine whether or not to top the current high bid. Investing in outside information is a real possibility. The importance of being able to determine an optimal information acquisition strategy after (rather than before) observing another bidder's bid, lies in what can be learned from the bid. In general, a bidder will be able to learn something about the other bidder's valuation for the target's assets (at a minimum it learns that the valuation equals or exceeds the bid). This is useful information. First, one bidder's valuation is effectively a minimum acquisition cost facing another bidder. To acquire the target, a bidder must outbid all others. Second, if bidders' valuations are correlated, a bidder can learn about its own valuation. This is information which can be profitably utilized in determining an optimal strategy. So while a bidder may have followed one strategy given its prior beliefs, it may follow another given its updated (on the basis of the observed bidding) beliefs.

The problem modeled allows a bidder to make its information acqusition decision after the bidding has begun.[1] This gives an early bidder the ability, through its bidding, to influence a later bidder's beliefs and thus its actions. This possibility is what underlies a bidder's incentive to make a high premium initial offer. A bidder can use a high premium offer to signal that it has a high valuation. This for the purpose of deterring another potential bidder from competing.

A unique equilibrium is developed for a two-bidder model. It is a signaling equilibrium. A "first" bidder may make a high premium, "preemptive" bid which signals a high valuation and deters a "second" bidder. Otherwise, it will make a low premium bid which signals a low valuation, in which case, a second bidder will compete. Implications concerning the relationships between bidders' and targets' profits, bidders' initial offers, single and multiple bidder contests, and whether the offer was made before or after the enactment of takeover legislation are developed.

There is a growing theoretical literature on takeover bidding. The following is a sample. Grossman and Hart (1980) consider the problem individual shareholders face in determining whether or not to tender their shares into a tender offer. It is demonstrated that even in the absence of competition, a bidder may have to offer a premium over market value in order to induce shareholders to tender. That type of model is not inconsistent with the analysis here. In fact, such a model can be incorporated here to determine the minimum acquisition price of a target. Then, given the minimum acquisition price, the analysis here will determine a bidder's optimal offer price.

There have been several studies with models of competing bidders. Baron

(1983) studies a model in which a second bidder can only bid if the first bidder's offer is rejected. Further, for the purpose of studying the possibility of allowing target management to defeat offers, a first bidder is allowed only one bid.[2] Giammarino and Heinkel (1985) and P'ng (1985) also study models in which a bidder can make only one bid. In these studies, however, the target does not have to reject a first bidder's offer in order to observe a second bidder's offer. Thus a first bidder's initial bid (rather than its valuation, as is the case here) is the acquisition cost facing the second bidder. The model analyzed here allows bidders to make any number of bids. Thus bidding low and then raising the bid, if necessary, is a viable strategy. The incentive behind an initial high premium offer also differs across models. Here, the incentive is to signal information in an attempt to influence the decision of a potentially competing bidder. In Baron (1983), the incentive behind a high premium offer is to induce target management to accept the offer and end the bidding. In Giammarino and Heinkel (1985) and P'ng (1985), the incentive is to deter the competing bidder by making the acquisition cost it faces (i.e., the initial bid) unprofitably high. P'ng (1985) also studies a case where bidders can make any number of bids. The focus there though, is on comparing the outcomes of the different types of auctions (i.e., allowing one or any number of bids).

Khanna (1985) studies a somewhat different model. A first bidder makes an initial offer, and then a second bidder arrives. If the second bidder tops the initial offer, then all remaining bidders arrive. If however, the second bidder cannot top the initial offer, the problem ends with the first bidder acquiring the target. The main difference between that model and the one studied here lies in the entry of competing bidders. Here, since information is costly, a bidder's entry decision is non-trivial, and beliefs concerning the other bidder's valuation are important. In Khanna (1985), whether or not a bidder gets the opportunity to enter is what is determined non-trivially. Since information is costless, bidders will always enter given the opportunity, and beliefs concerning other bidders' valuations are irrelevant. This implies different motivations for high initial offers. Again, the motive here is to signal a high valuation for the purpose of affecting a competing bidders' entry decision. In Khanna (1985), the motive is to lower the probability that competing bidders will be given the opportunity to enter.

The paper is laid out as follows. Section 2 sets out the model. In Section 3, the bidders' problems are discussed in detail, and in Section 4, the equilibrium is developed. In Section 5 the expected profits of bidders and targets are examined. Section 6 discusses the model's implications and compares them to the findings of the empirical literature. Section 7 concludes the paper.

2. The Model

For the purposes of this study, it is presumed that the reason for a takeover is to gain control over the target's operating strategy in order to implement a more profitable strategy than is currently being followed. Also for the purposes of this study, the takeover of a firm is defined to be the purchase of all of the claims held against the firm. In total, an acquirer seeks to purchase the claims against the target at one price, raise the value of the target by changing the operaing stragegy, and profit from the difference. Several issues are not studied here. First, what the change of operating strategy actually involves is not studied. It is simply taken as given that the possibility of implementing a more profitable strategy may exist. Second, whether the claims against a target are acquired with a tender offer or a merger offer is not studied. Finally there is the question of why a takeover (as defined here) is chosen over alternative methods of changing the operating strategy. One alternative is a proxy contest. Rather than purchasing sufficient equity to gain control, one could purchase some lesser fraction of the equity, solicit the votes of other equityholders, and attempt to vote in a board which will implement the proposed strategy. A second alternative is an employment contract. One can implement the proposed strategy in return for a (possibly contingent) wage. While these other issues are both interesting and important, they are beyond the scope of this study.

Consider a firm with market value, v_0, and term this firm the target. If the target is taken over, and a new operating strategy is imposed, the target assets will yield some liquidating cash flow. Assume there are two different management teams which may be able to implement an operating strategy for the target's assets which is more profitable than the current one. Term these two teams bidders 1 and 2. All claims against the target and both bidders are assumed to be equity claims held by risk-neutral investors.[3] Also, the managements of the target and both bidders are assumed to be acting to maximize the expected wealth of their respective shareholders, and it is assumed that there is no collusion among any of the three parties.

Questions of bargaining are ignored throughout. The highest offer which is at or above a known minimum acquisition price is successful. While the analysis will go through with any minimum acquisition price, it is assumed that the minimum acquisition price is equal to v_0, the target's prebid market value.[4] This does serve to highlight the results. Even though a target can be acquired at the market price, it will be demonstrated that some bidders have an incentive to submit initial bids at a positive premium.

The motivation behind a takeover is to raise the productivity of the target's assets. Bidders are not attempting to profit on private information regarding the value of the target as is. This value is assumed to be common knowledge (and equal to v_0).[5] Bidders can however, observe private information regarding their own valuations from controlling the target's assets. Specifically, at a known cost $c_i > 0$, bidder i can privately observe a signal which conveys information on its own valuation but is independent of the other bidder's valuation. The cost c_i includes both out-of-pocket costs, for instance investment banking fees, and also any opportunity costs involved. The bidder could, for example, be working on other projects. It is assumed that bidders' private signals cannot be physically verified. Thus there will be no <u>direct</u> disclosure by bidders, and contracts contingent on the signals cannot be enforced.

Let v_i denote bidder i's expected valuation for the target's assets, conditional on its private signal. Let $F_i(\cdot)$ be the cumulative distribution function of $\tilde{v}_i$, and let $f_i(\cdot)$ be the probability density function of $\tilde{v}_i$, where $f_i(v_i)$ is strictly positive on the interval $[\ell,h]$ (where $\ell < v_0 < h$) and zero elsewhere (for $i = 1,2$). These distributions are common knowledge. It is assumed that $E\tilde{v}_i < v_0$ for $i = 1, 2$. Bidders' unconditional expected valuations are below the minimum acquisition price. The significance of this assumption is that it renders uninformed bidding unprofitable. Bidders will only bid if they have first incurred the cost to observe their private signal.[6] Henceforth we will refer to v_i as bidder i's valuation.

The basic problem unfolds as follows. A bidder, call it bidder 1, exogenously learns of a potentially profitable target for takeover. A firm which is not a potentially profitable target for takeover can be defined as one for which the probability that either bidder could implement a more productive operating strategy is zero. Assume that there is a large enough number of firms for which this is true so that studying random firms is not a profitable strategy.

Once bidder 1 learns of the target, it can incur the cost to observe its private information, and then perhaps, make a takeover bid. Should bidder 1 not make a bid, the problem will end with the knowledge of the target remaining known only to bidder 1.[7] Suppose, though, that bidder 1 does make a bid. The bid will alert bidder 2 to the existence and identity of the target, a potential profit opportunity. Bidder 2 will then determine whether or not to compete for the target. If it does compete, it will incur the cost to observe its private information. Then a competitive open auction (i.e., the bid starts rising from bidder 1's initial offer and continues rising until only one bidder remains) for the target will follow. If bidder 2 does not compete, then bidder 1's offer stands as the high offer. An important point to note is that the target will be able to observe any and all offers before having to accept (or reject) one. In particular, bidder 1's initial offer does not have to be rejected in order to observe an offer (should one materialize) from bidder 2.

Asymmetric and costly information is what drives the results. Offering a premium over v_0 in an initial bid is shown to be a way for bidder 1 to signal to bidder 2 that $\tilde{v}_1$ is "high." This, for the purpose of deterring bidder 2 from becoming a competitor. Bidder 2 can be deterred by such a signal since the higher bidder 2 believes $\tilde{v}_1$ to be, the lower is the expected profit from competing. This is because bidder 1's valuation is the acquisition cost facing bidder 2.[8]

3. The Bidders' Problems

Once a first bidder learns of a potential target for takeover, it must determine whether or not to incur the cost c_1 to learn $\tilde{v}_1$. To determine this, the optimal strategy given that bidder 1 knows $\tilde{v}_1$ must be determined. Therefore the problem which arises once the bidder has observed $\tilde{v}_1$ is solved first.

Consider a first bidder which has already incurred the (now sunk) cost c_1 and has observed $\tilde{v}_1$. Since the minimum price at which the target can be acquired is v_0, if $\tilde{v}_1 < v_0$, no bid will be submitted. If, however, $\tilde{v}_1 \geqslant v_0$, some bid p, such that $\tilde{v}_1 \geqslant p \geqslant v_0$ should be made. Bidder 2 will then observe the bid and will determine whether or not to compete. If bidder 2 decides to compete, it will incur the cost to learn $\tilde{v}_2$. Then there will be an open auction with the higher valuing bidder taking over the target with an offer of $\min\{\max(p, \tilde{v}_2), \tilde{v}_1\}$. That is, if $\tilde{v}_2 \leqslant p$, bidder 2 cannot profitably top the initial bid, and the initial bid will stand as the high bid. If $\tilde{v}_2 > p$, the higher valuing bidder will acquire the target at the other bidder's valuation. If bidder 2 does not compete, then bidder 1 will take over the target at a price of p, the initial bid.[9]

The expected profits of the two bidders can now be computed. Let d denote bidder 2's decision, where d = 1 refers to bidder 2 competing and d = 0 refers to bidder 2 not competing. Denote bidder i's profit as a function of v_1, v_2, p, and d as $\pi_i(v_1, v_2, p, d)$. For a realization of $\tilde{v}_1 \geqslant v_0$ and an offer p such that $v_1 \geqslant p \geqslant v_0$,

$$\begin{aligned} E\pi_1(v_1, \tilde{v}_2, p, 0) &= v_1 - p \\ E\pi_1(v_1, \tilde{v}_2, p, 1) &= v_1 - E\min\{\max(p, \tilde{v}_2), v_1\} \end{aligned} \tag{1}$$

for d = 0 and d = 1. The first important point to note is that $E\pi_1(v_1, \tilde{v}_2, p, 0) \geqslant E\pi_1(v_1, \tilde{v}_2, p, 1)$. Holding p constant, bidder 1's expected profit is higher if bidder 2 does not compete. Competition from bidder 2 may lead to bidder 1 paying a higher price for the target (i.e., realizations of $\tilde{v}_2$ such that $p < \tilde{v}_2 \leqslant v_1$), or may lead to bidder 1 being outbid altogether (i.e., realizations of $\tilde{v}_2$ such that $\tilde{v}_2 > v_1$). The second important point to note is that $E\pi_1(v_1, \tilde{v}_2, p, d)$ is decreasing in p. Holding bidder 2's decision constant, bidder 1's expected profit is decreasing in p, the initial offer.

For an initial offer p such that $\tilde{v}_1 \geqslant p \geqslant v_0$,

$$E\pi_2(\tilde{v}_1, \tilde{v}_2, p, 0) = 0$$

$$E\pi_2(\tilde{v}_1, \tilde{v}_2, p, 1) = E[\tilde{v}_2 - \min\{\tilde{v}_1, \tilde{v}_2\}\,|\,p] - c_2. \tag{2}$$

Notice that for bidder 2's expected profit, the expectation is taken over both $\tilde{v}_1$ and $\tilde{v}_2$. Also notice that bidder 2's expected profit depends on p only through its effect on bidder 2's beliefs, that is, through the updated distribution of $\tilde{v}_1$ conditional on observing the initial offer p. To win the bidding, bidder 2 would have to offer $\tilde{v}_1$ and since $\tilde{v}_1 \geqslant p$, p is otherwise irrelevant. This is an important point. There is only one way for bidder 1's initial offer to have an impact on bidder 2's strategy, and that is through bidder 2's beliefs.[10]

The problem is to determine how much bidder 1 should initially offer for the target. An offer of v_0 has been assumed sufficient (in the absence of a higher offer) to acquire the target. However, there is also bidder 2 with which to contend. Bidder 2 will be able to infer something about $\tilde{v}_1$ from bidder 1's initial offer. In general, the higher the offer, the higher will bidder 2 believe $\tilde{v}_1$ to be, and the higher bidder 2 believes $\tilde{v}_1$ to be, the lower is the expected profit from competing. There is a lower probability of winning the bidding, and given that bidder 2 wins, it will likely pay a higher price. Therefore bidder 2 is less likely to compete if it believes $\tilde{v}_1$ is high. Bidder 1, aware of this, will take bidder 2's response into account when making its offer. For as discussed above, for any initial offer, bidder 1 prefers that bidder 2 not compete.[11] Thus bidder 1 faces the following tradeoff. The higher the initial offer, the higher the expected cost of the takeover (if successful). However, a high offer can be used to signal to bidder 2 that $\tilde{v}_1$ is high, and thus deter bidder 2 from competing.[12]

A few remarks about the model are in order before proceeding. "Entry" costs play a key role in the analysis, particularly for bidder 2. A natural question, therefore, is how important these costs are likely to be in practice. Are such costs high enough to warrant modeling?[13] In answering this question it must be remembered that the relevance of these costs comes down not to a comparison of these costs with the expected value of the target assets to the bidder.[14] It is the likely difference between the expected valuations of the two bidders which is the relevant measure for comparison, as it is this difference on which bidder 2 stands to profit. The less of a difference which is likely between $\tilde{v}_1$ and $\tilde{v}_2$, the more important become entry costs. In the extreme case of $\tilde{v}_1 = \tilde{v}_2$, any positive entry cost is prohibitive.[15]

A remark about the independence assumption is also in order. Independence between $\tilde{v}_1$ and $\tilde{v}_2$ is actually a stronger assumption than is necessary. A sufficient condition for the analysis which follows is that $E[\tilde{v}_2 - \min\{v_1, \tilde{v}_2\}|v_1]$ be decreasing in v_1. Bidder 2's expected profit from competing must be decreasing in bidder 1's valuation. If this condition did not hold, then a first bidder would have no incentive to signal that $\tilde{v}_1$ is high. Such information would not be a deterrent. We now proceed to the development of an equilibrium.

4. Equilibrium

After observing a first bidder's initial offer, a second bidder will update its prior beliefs concerning the first bidder's valuation. Then, based on these updated beliefs, the second bidder will make its decision as to whether or not it will compete for the target. A first bidder, in determining its initial offer, will take the second bidder's updating and decision into account. This is the strategic interaction between bidders which an equilibrium must characterize.

In many models of strategic behavior, multiple equilibria will exist for various equilibrium concepts. The model studied here is no exception. For instance, by arbitrarily specifying beliefs for out-of-equilibrium moves, the restrictions of a Sequential Equilibrium (see Kreps and Wilson (1982)) will allow for the existence of a continuum of equilibria. Therefore a stronger equilibrium concept is required. The concept applied here is that of a Perfect Sequential Equilibrium (see Grossman and Perry (1984)). By combining the requirements of "sequential rationality" (see Kreps and Wilson (1982)) with a requirement of "credible" beliefs (to be defined) this equilibrium concept will lead to the existence of a unique equilibrium.

With bidder 1 following a pure strategy (as is the case studied here), the information which will be conveyed by bidder 1's initial offer will be that $\tilde{v}_1 \in V$, where V is some nonempty subset of the interval $[v_0, h]$ (realizations of $\tilde{v}_1 < v_0$ are henceforth ignored as they result in no bid). For an initial offer p, let V(p) denote this subset. Given V(p), bidder 2 can then use Bayes' formula to compute an updated probability density function for $\tilde{v}_1$. The function V(p) will be termed an updating rule. Let d(V(p)) denote bidder 2's decision rule (as to whether or not to compete) as a function of its beliefs. This specification emphasizes the point displayed by (2), that bidder 2's expected profit depends on p only through its impact on bidder 2's beliefs. Let $p(v_1)$ denote bidder 1's strategy. Its initial offer is a function of its valuation. A condition which is going to be required of the bidders' strategies is that they be sequentially rational with respect to bidder 2's updating rule. This is defined as follows.

The pair of strategies $\{p'(\cdot), d'(\cdot)\}$ is defined to be sequentially rational with respect to an updating rule $V'(\cdot)$ if and only if

(i) $p':[v_0, h] \to [v_0, \infty)$ and $E\pi_1(v_1, \tilde{v}_2, p'(v_1), d'(V'(p'(v_1))))$

$\geq E\pi_1(v_1, \tilde{v}_2, p, d'(V'(p)))$ for all $p \in [v_0, \infty)$ and for all $v_1 \in [v_0, h]$.

and (3)

(ii) $d':\mathbf{V} \to \{0, 1\}$, and $E\pi_2(\tilde{v}_1, \tilde{v}_2, p, d'(V'(p))) \geq$

$E\pi_2(\tilde{v}_1, \tilde{v}_2, p, d)$ for all $d \in \{0, 1\}$ and for all $p \in [v_0, \infty)$

(where $\mathbf{V}$ is the set of all nonempty subsets of $[v_0, h]$).

This definition of sequential rationality corresponds to that of Kreps and Wilson (1982). Taking the updating rule as fixed, each bidder must, at all times, follow an optimal strategy. In particular, bidder 2 must follow an optimal strategy for all initial offers, even for those which would not arise in equilibrium.

We now turn to the requirements to be imposed on bidder 2's updating rule. Continuing to follow Grossman and Perry (1984), a credible updating rule is defined. This notion of credibility is similar to that discussed by Kreps (1984).[16] For any bidder 1 strategy, $p'(\cdot)$, define the set $\hat{V}(p; p') = \{v_1 | p'(v_1) = p\}$. Note that if $p'(v_1) \neq p$ for all $v_1 \in [v_0, h]$, then $\hat{V}(p; p')$ is empty.

An updating rule, $V'(\cdot)$, is defined to be credible with respect to the pair of strategies $\{p'(\cdot), d'(\cdot)\}$ if and only if, $V': [v_0, \infty) \to \mathbf{V}$, and for all $p \in [v_0, \infty)$,

$$\begin{array}{ll} \text{(i)} & \text{If } \hat{V}(p;\, p') \text{ is nonempty then } V'(p) = \hat{V}(p;\, p'). \\ \text{(ii)} & \text{If } \hat{V}(p;\, p') \text{ is empty then} \end{array} \tag{4}$$

a) $V'(p) = V \in \mathbf{V}$.

b) If there exists a $V \in \mathbf{V}$ such that $E\pi_1(v_1, \tilde{v}_2, p, d'(V)) \geqslant E\pi_1(v_1, \tilde{v}_2, p'(v_1), d'(\hat{V}(p'(v_1); p')))$ for all $v_1 \in V$, and strict inequality holding for some $v_1 \in V$, and $E\pi_1(v_1, \tilde{v}_2, p, d'(V)) \leqslant E\pi_1(v_1, \tilde{v}_2, p'(v_1), d'(\hat{V}(p'(v_1); p')))$ for all $v_1 \notin V$, then $V'(p) = V$. If there exists more than one such set, then $V'(p)$ can be set equal to any one of them.

The key to (4) is that credibility requires bidder 2's beliefs to be, <u>if possible</u>, self-fulfilling. Consider $\{p'(\cdot), d'(\cdot)\}$ as a candidate for an equilibrium strategy pair. Condition (4i) is a requirement placed on beliefs for offers which would be made in the proposed equilibrium (i.e., p such that $p'(v_1) = p$ for some v_1). Credibility requires that for such offers, bidder 2's beliefs be consistent with bidder 1's strategy, and thus self-fulfilling. Condition (4ii) is a requirement placed on beliefs for offers which would not be made in the proposed equilibrium (i.e., p such that $p'(v_1) \neq p$ for all v_1). Again, credibility requires that if it is possible, bidder 2's beliefs must be such that they would be self-fulfilling. Suppose there is a set V which satisfies (4iib). Then, first bidders for which $v_1 \in V$, and only those first bidders, would prefer, if it would induce bidder 2 to believe $v_1 \in V$, to deviate from the proposed strategy. In such a case, believing $v_1 \in V$ would be self-fulfilling, and thus credibility requires $V'(p) = V$. Notice that this in turn implies that the proposed equilibrium would be "broken." Also notice that for an updating rule to be credible, it must be specified for all p .[17] A Perfect Sequential Equilibrium (PSE) can now be defined.

A pair of strategies, $\{p'(\cdot), d'(\cdot)\}$, combined with an updating rule, $V'(\cdot)$, constitute a PSE if and only if

(i) $\{p'(\cdot), d'(\cdot)\}$ is sequentially rational with respect to $V'(\cdot)$, and (5)

(ii) $V'(\cdot)$ is credible with respect to $\{p'(\cdot), d'(\cdot)\}$.

A unique PSE for this problem will be developed. The procedure is as follows. First, the updating rule is taken as fixed, and it is shown that there exists a unique pair of strategies which are sequentially rational with respect to the updating rule. Second, an updating rule which is credible with respect to a sequentially rational pair of strategies is characterized. Combining the results yields the unique PSE.

For $v_1 \in [v_0, h]$, define

$$\bar{p}(v_1) = E \min\{\max(v_0, \tilde{v}_2), v_1\}.$$

For a realization of $\tilde{v}_1 > v_0$, it is easily verified (using (1)) that bidder 1 is indifferent between offering $p = \bar{p}(v_1)$ given that it would deter bidder 2, and offering $p = v_0$ given that it would not deter bidder 2. Thus $\bar{p}(v_1)$ determines the maximum price a first bidder with a given v_1 would be willing to offer to deter the second bidder. The alternative anticipates the equilibrium. A first bidder which does not deter the second bidder will offer v_0, the minimum acquisition price. Since $\bar{p}(v_1)$ is increasing in v_1, the following inverse function can be defined. For $p \in [v_0, \bar{p}(h)]$, define $\bar{v}(p)$ such that $\bar{v}(\bar{p}(v_1)) = v_1$. The function $\bar{v}(p)$ determines the minimum value of v_1 for which a first bidder would be willing to offer a given p to deter the second bidder.

Lemma 1: For an updating rule, $V'(\cdot)$, suppose there exists a minimum p for which $p \leq \bar{p}(h)$ and $E[\pi_2(\tilde{v}_1, \tilde{v}_2, p, 1) | \tilde{v}_1 \in V'(p)] \leq 0$, and denote it p_0. Then, the unique pair of strategies which is sequentially rational with respect to $V'(\cdot)$ is given by

$$p'(v_1) = \begin{cases} v_0 & \text{if } v_0 \leq v_1 < \bar{v}(p_0) \\ p_0 & \text{if } \qquad v_1 \geq \bar{v}(p_0). \end{cases} \tag{6a}$$

$$d'(V'(p)) = \begin{cases} 1 & \text{if } E[\pi_2(\tilde{v}_1, \tilde{v}_2, p, 1) | \tilde{v}_1 \in V'(p)] > 0 \\ 0 & \text{if } E[\pi_2(\tilde{v}_1, \tilde{v}_2, p, 1) | \tilde{v}_1 \in V'(p)] \leq 0. \end{cases} \tag{6b}$$ [18]

Taking the updating rule as fixed, if there exist initial offers which will deter bidder 2, bidder 1 will either offer the minimum price which deters bidder 2, or it will offer the minimum acquisition price. All other offers are dominated. Bidder 2's strategy, taking the updating rule as fixed, is simply to compete if the expected profit from doing so is positive, and not to compete otherwise (the convention is adopted that bidder 2 does not compete if its expected profit from doing so is zero). In equilibrium, both bidders' strategies can be fully characterized by p_0, which is determined by the updating rule. Since no first bidder would make an initial offer above $\bar{p}(h)$, we will represent the case of $E[\pi_2(\tilde{v}_1, \tilde{v}_2, p, 1) | \tilde{v}_1 \in V'(p)] > 0$, for all $p \in [v_0, \bar{p}(h)]$, by $p_0 = \bar{p}(h)$.

To restate, taking the updating rule as fixed, the strategies given by (6) are the unique strategies which are sequentially rational with respect to the updating rule. An updating rule which is credible with respect to such strategies will now be characterized.

For $v_0 \leq a \leq b \leq h$, define

$$w(a,b) = E[\tilde{v}_2 - \min\{\tilde{v}_1, \tilde{v}_2\} | a \leq \tilde{v}_1 \leq b] - c_2.$$

This would be bidder 2's expected profit from competing given that it knows $a \leq \tilde{v}_1 \leq b$. It is easily verified that $w(a,b)$ is decreasing in a and b. The higher bidder 2 believes $\tilde{v}_1$ to be, the lower is its expected profit from competing. The following assumption is made:

$$w(v_0, h) > 0. \tag{A1}$$

(A1) posits that if bidder 2 knew only that $\tilde{v}_1 \geq v_0$, then it would find it profitable to compete. Define r such that $w(r, h) = 0$. Using (A1), it follows that $v_0 < r < h$. The value r is the minimum value for which the knowledge that $\tilde{v}_1 \geq r$ would deter bidder 2. The major result concerning a credible updating rule can now be stated.

Lemma 2: Suppose $V'(\cdot)$ is credible with respect to $\{p'(\cdot), d'(\cdot)\}$, and $\{p'(\cdot), d'(\cdot)\}$ is sequentially rational with respect to $V'(\cdot)$. Then there exists a minimum value of p such that $E[\pi_2(\tilde{v}_1,\tilde{v}_2,p,1)|\tilde{v}_1 \in V'(p)] \leq 0$, and it is equal to $\bar{p}(r)$.

Again, the value r is equal to the minimum value for which the knowledge that $\tilde{v}_1 \geq r$ would deter bidder 2. The minimum price which would deter bidder 2, is $\bar{p}(r)$, which is just high enough so that bidders for which $v_1 \geq r$ would offer it, and those for which $v_0 \leq v_1 < r$ would not. If any lower price would deter bidder 2, some bidders for which $v_0 \leq v_1 < r$ would be induced to make the offer, which in turn would induce bidder 2 to compete.

Combining the characterization of sequentially rational strategies with the characterization of a credible updating rule yields the unique PSE. That is, Lemmas 1 and 2 prove

Proposition 1: If the pair of strategies, $\{p^*(\cdot), d^*(\cdot)\}$, combined with the updating rule, $V^*(\cdot)$, constitute a PSE, then

$$p^*(v_1) = \begin{cases} v_0 & \text{if } v_0 \leqslant v_1 < r \\ \bar{p}(r) & \text{if } v_1 \geqslant r \end{cases} \tag{7a}$$

$$d^*(V^*(p)) = \begin{cases} 1 & \text{if } p < \bar{p}(r) \\ 0 & \text{if } p = \bar{p}(r). \end{cases} \tag{7b}$$

While a credible updating rule must be specified for all p, $V^*(p)$ can only be uniquely specified for $p = v_0$, in which case $V^*(p) = [v_0, r)$, and for $p = \bar{p}(r)$ in which case $V^*(p) = [r,h]$. For p such that $v_0 < p < \bar{p}(r)$, the PSE only requires that $V^*(p)$ be such that $E[\pi_2(\tilde{v}_1, \tilde{v}_2, p, 1) | \tilde{v}_1 \in V^*(p)] > 0$. For $p > \bar{p}(r)$, the PSE places no restriction at all on $V^*(p)$. This is because these are offers which would never be made, regardless of the beliefs which they would induce. This nonuniqueness, however, is not crucial. Changing the updating rule (subject to the above requirements) will not change the sequence of choices which would evolve for any given realization of $\tilde{v}_1$. This is what is meant in calling (7) a unique equilibrium. As an example, though, one credible updating rule is

$$V^*(p) = \begin{cases} [v_0, r) & \text{if } p = v_0 \\ [\bar{v}(\min\{p, \bar{p}(h)\}), h] & \text{if } p > v_0. \end{cases}$$

The unique PSE is a signaling equilibrium. The first bidder makes either a preemptive bid, $\bar{p}(r)$, or a zero premium bid, v_0. The former offer signals that $\tilde{v}_1 \geq r$ in which case the second bidder is deterred. The latter offer signals that $v_0 \leq \tilde{v}_1 < r$ in which case the second bidder competes. Rather than offering market value on the initial bid and being prepared to raise the bid if there is competition, a first bidder may bid high on its initial bid.

Signaling itself is costless to the economy. It represents a transfer from bidder 1 to the target. The signaling equilibrium, though, is not fully revealing. Bidder 2 only learns whether $v_0 \leq \tilde{v}_1 < r$ or $\tilde{v}_1 \geq r$, not the precise value of $\tilde{v}_1$. For this reason, the signaling equilibrium is socially inefficient relative to the equilibrium which would obtain if $\tilde{v}_1$ could be observed directly by bidder 2. If such were the case, bidder 1 would make an initial offer of $p = v_0$ (if $\tilde{v}_1 \geq v_0$). Bidder 2 would then compete if $v_0 \leq \tilde{v}_1 < r'$, where r' satisfies $w(r', r') = 0$. This decision rule coincides with the socially efficient decision rule. That $w(r', r') = w(r, h)$, and $w(a, b)$ is decreasing in a and b, implies that $r < r'$. Therefore, for realizations of $\tilde{v}_1$ such that $r \leq \tilde{v}_1 < r'$, bidder 2 is deterred in the signaling equilibrium whereas it would not be if $\tilde{v}_1$ could be observed directly by bidder 2.[19]

5. Bidders and Target Profits and Preemptive Bidding

The above model provides a determination of the bidders' and target's expected profits from a takeover. Bidder 1's expected profit from studying the target is given by (using (7)):

$$
\begin{aligned}
&E\pi_1(\tilde{v}_1,\tilde{v}_2,p^*(\tilde{v}_1),d^*(V^*(p^*(\tilde{v}_1)))) - c_1 \\
&= E[\tilde{v}_1 - \min\{\max(v_0,\tilde{v}_2),\tilde{v}_1\} \,|\, v_0 \leq \tilde{v}_1 < r]\Pr(v_0 \leq \tilde{v}_1 < r) \\
&\qquad + E[\tilde{v}_1 - E\min\{\max(v_0,\tilde{v}_2),r\} \,|\, \tilde{v}_1 \geq r]\Pr(\tilde{v}_1 \geq r) - c_1 \qquad (8) \\
&= E[\tilde{v}_1 - \min\{\max(v_0,\tilde{v}_2),\min(\tilde{v}_1,r)\} \,|\, \tilde{v}_1 \geq v_0]\Pr(\tilde{v}_1 \geq v_0) - c_1.
\end{aligned}
$$

If this expression is nonnegative, then bidder 1 will study the target. Bidder 2's expected profit from competing has already been discussed in detail.

Denote the target's profit as $\pi_0(v_1, v_2, p, d)$. Given that bidder 1 studies the target, the target's expected profit is given by

$$\begin{aligned} &E\pi_0(\tilde{v}_1,\tilde{v}_2,p^*(\tilde{v}_1),d^*(V^*(p^*(\tilde{v}_1)))) \\ &= E[\min\{\max(v_0,\tilde{v}_2),\tilde{v}_1\} - v_0 | v_0 \leqslant \tilde{v}_1 < r]\Pr(v_0 \leqslant \tilde{v}_1 < r) \\ &\quad + [E\min\{\max(v_0,\tilde{v}_2),r\} - v_0]\Pr(\tilde{v}_1 \geqslant r) \\ &= [E\min\{\max(v_0,\tilde{v}_2), \min(\tilde{v}_1,r)\} - v_o | \tilde{v}_1 \geqslant v_0]\Pr(\tilde{v}_1 \geqslant v_0). \end{aligned} \tag{9}$$

How does a change in c_2, bidder 2's information acquisition (entry) cost, impact the equilibrium? By definition, $w(r, h) = 0$. Therefore, since $w(a, h)$ is decreasing in a and in c_2, r is decreasing in c_2. Thus an increase (decrease) in c_2 will lead to more (fewer) realizations of $\tilde{v}_1$ for which bidder 2 is deterred. Further, since $\bar{p}(r)$ is increasing in r, an increase (decrease) in c_2 will lead to a lower (higher) minimum price which deters entry. In total, an increase (decrease) in c_2 will lead to more (fewer) preemptive bids, but such bids will be at a lower (higher) premium. How does a change in c_2 impact the expected profits of the bidders and the target? From (8) it can be seen that bidder 1's expected profit is decreasing in r, and thus increasing in c_2. For bidder 2 the result is trivial. Clearly bidder 2's expected profit must be higher as c_2 is lower. From (9) it can be seen that given that bidder 1 enters, the target's expected profit is increasing in r, and thus decreasing in c_2. So the higher is bidder 2's information acquisition cost, the higher is bidder 1's expected profit, and the lower is the expected profit of bidder 2 and the target.

These results are actually more obvious than the algebra which leads to

(8) and (9) might suggest. Bidder 1's problem is a choice between bidding high ($p = \bar{p}(r)$) and deterring bidder 2, or bidding low ($p = v_0$) and inducing bidder 2 to compete. Making it more costly to deter bidder 2 (by raising $\bar{p}(r)$) can only reduce bidder 1's expected profit. As regards the target, given that bidder 1 chooses to study the target, anything which raises (lowers) the expected profit of bidder 1 must lower (raise) the expected profit of the target. This can be demonstrated as follows. If bidder 1 takes over the target at a price of P, the expected profit of bidder 1 is $v_1 - P - c_1$, and that of the target is $P - v_0$. The total for the two is $v_1 - v_0 - c_1$. If bidder 2 is to outbid bidder 1 for the target, it will have to offer a price of v_1. In this case, bidder 1's profit is $-c_1$ and that of the target is $v_1 - v_0$. So the total of the expected profits of bidder 1 and the target is again $v_1 - v_0 - c_1$. It follows that given that bidder 1 chooses to observe $\tilde{v}_1$, (and holding c_1 and the distribution of $\tilde{v}_1$ fixed), anything which raises (lowers) the expected profit of bidder 1 must lower (raise) the expected profit of the target.

These results provide a clear incentive for targets to take actions which lower the costs of competing bidders. An example might be a target's engaging a first bidder in litigation in an attempt to provide more time for a second bidder (presuming more time would lower bidder 2's costs).[20] Of course the first bidder will anticipate such target actions. If the target has the capability of lowering c_2 so low as to make bidder 1's entry unprofitable, bidder 1 will not enter.[21]

Another action which would lower bidder 1's expected profit, and thus raise the target's expected profit, would be to restrict the strategies available to bidder 1 by eliminating preemptive bidding altogether. If despite the reasoning given above, it seems odd that a target would benefit from the elimination of high initial bids, this result can also be verified directly. For any realization of $\tilde{v}_1 \geq r$ (for realizations of $\tilde{v}_1 < r$, it would not matter), a target would receive $\bar{p}(r) = E \min\{\max(v_0,\tilde{v}_2),r\}$ in a preemptive bid. If such a bid could not be made, bidder 1 would make an initial bid of $p = v_0$ and bidder 2 would compete (by A1). Then, the expected price which the target would receive is $E[\min\{\max(v_0,\tilde{v}_2),\tilde{v}_1\} | \tilde{v}_1 \geq r]$ which is greater than the value of the preemptive bid.

Eliminating preemptive bidding would likely be difficult, though, for publicly traded targets. As long as tender offers can be made, it would seem that preemptive bids can also be made.[22] Note though that this is a general problem faced by any seller of an object for which bidders must incur information acquisition costs of a nontrivial magnitude. So how might any seller eliminate preemptive bidding? This would essentially require that no bids be submitted until after all potential bidders had become informed. In providing a solution, it must be noted that potential bidders will have an incentive to wait and observe early bids before making their own decision. Therefore they may not truthfully disclose when they have become informed. In light of this, one way might be to limit the time period over which bids may be submitted. If information cannot be acquired (at all or at a low enough cost) instantaneously, but rather must be acquired over an extended period of time, then this might work. Time would not allow the observation of other bids before making the information acquisition decision, and potential bidders would be forced to sink the information cost prior to the opening of bidding. Alternatively, the submission of sealed bids over an extended period of time may also work.

6. Implications of the Model

The equilibrium of the model is one in which a first bidder may offer, on its initial bid, a premium over the target's going market price. The premium is offered for the purpose of deterring a potential rival from competing. Consider now the model's implications regarding the expected profits of targets and bidders conditional on the observation of high and low premium bids. Targets' expected profits conditional on observing high and low initial bids are given by

$$E\,\min\{\max(v_0,\ \tilde{v}_2),\ r\} - v_0 \tag{10a}$$

and

$$E[\min\{\max(v_0,\ \tilde{v}_2),\ \tilde{v}_1\}\,|\,v_0 \leq \tilde{v}_1 < r] - v_0 \tag{10b}$$

respectively. These expected profits reflect the fact that the second bidder would not compete following a high bid, and would compete following a low bid. Notice that even though there will be no competition from other bidders, targets' expected profits are higher, conditional on observing high premium initial bids.[23] The expected profits of first bidders conditional on observing high and low initial bids are given by

$$E[\tilde{v}_1 - \min\{\max(v_0,\ \tilde{v}_2),\ r\}\,|\,\tilde{v}_1 \geq r] - c_1 \tag{11a}$$

and

$$E[\tilde{v}_1 - \min\{\max(v_0,\ \tilde{v}_2),\ \tilde{v}_1\}\,|\,v_0 \leq \tilde{v}_1 < r] - c_1 \tag{11b}$$

respectively. Since

$$E[\tilde{v}_1 - \bar{p}(r)\,|\,\tilde{v}_1 \geq r] > E[\tilde{v}_1 - \bar{p}(\tilde{v}_1)\,|\,\tilde{v}_1 \geq r] > E[\tilde{v}_1 - \bar{p}(\tilde{v}_1)\,|\,v_0 \leq \tilde{v}_1 < r],$$

we have that (11a) exceeds (11b). First bidders' expected profits are also higher conditional on observing a high initial bid. Thus the model predicts a positive relationship between the expected profits of first bidders and targets. To my knowledge, there is no empirical work which examines the market's valuations of bidders' expected profits conditional on the initial bid offered, or conditional on the market's valuation of the target's expected profit.

The preemptive bidding model also provides predictions concerning single and multiple bidder contests. The model predicts that a second bidder is less likely to compete following a high premium bid as compared to a low premium bid. Further, as discussed above, the expected profits of targets and first bidders will be higher when a high premium bid is observed. Therefore targets' and first bidders' expected profits will be higher for single as compared to multiple bidder contests.

Testing these predictions is less straightforward than it may at first seem. This is because there is an inherent measurement problem. There is a difference between the distinction which can be made between single and multiple bidder contests in theory, and that which can be made in the data. There will be cases in which a second bidder competes, but observes a low valuation and cannot top the initial offer. These second bidders will not be observed and these cases would be classified as single rather than multiple bidder contests. Thus, of actual multiple bidder contests, the least (most) profitable cases for targets (first bidders) would be classified as single bidder contests.

Consider the measured profits of targets. For a sample of observed single bidder contests, targets' expected profits are equal to

$$\frac{1-F_1(r)}{1 - F_1(r) + (F_1(r) - F_1(v_0))F_2(v_0)} [E \min\{\max(v_0, \tilde{v}_2), r\} - v_0]. \tag{10a'}$$

This is the probability that the first bidder made a preemptive offer given that a single bidder was observed, multiplied by the target's profit from a preemptive offer. For cases in which a first bidder made a zero premium offer and the second bidder observed $\tilde{v}_2 \leq v_0$, the target earns a zero profit. Comparing (10a) and (10a'), we see that the average profits of targets in a sample of observed single bidder contests will be below that of targets in a sample of actual single bidder contests. For a sample of observed multiple bidder contests, targets' expected profits are equal to

$$E[\min\{\tilde{v}_1, \tilde{v}_2\} - v_0 | v_0 \leq \tilde{v}_1 < r, \tilde{v}_2 > v_0]. \tag{10b'}$$

This reflects the fact that the first bidder did not make a preemptive offer (i.e., $v_0 \leq \tilde{v}_1 < r$), the second bidder bid (i.e., $\tilde{v}_2 > v_0$), and the high bid is equal to $\min\{\tilde{v}_1, \tilde{v}_2\}$. Comparing (10b) and (10b'), we see that the average profits of targets in a sample of observed multiple bidder contests will be above that of targets in a sample of actual multiple bidder contests. Whether (10a') or (10b') is larger will depend upon c_2 and on the underlying distributions of $\tilde{v}_1$ and $\tilde{v}_2$. Therefore the model cannot, in general, predict whether targets' profits will be higher in observed single, or observed multiple bidder contests. Empirically, Bradley, et al. (1984) report significantly higher target returns for multiple as compared to single bidder tender offer contests. To test the prediction that targets' expected profits in actual single bidder contests exceeds that of actual multiple bidder contests, one could also control for the initial premium offered.

The measured profits of first bidders can be similarly determined. For a sample of observed single bidder contests, first bidders' expected profits are equal to

$$\frac{[1-F_1(r)]E[\tilde{v}_1 - \min\{\max(v_0, \tilde{v}_2), r\} | \tilde{v}_1 \geq r] + [(F_1(r) - F_1(v_0))F_2(v_0)]E[\tilde{v}_1 - v_0 | v_0 \leq \tilde{v}_1 < r]}{1 - F_1(r) + (F_1(r) - F_1(v_0))F_2(v_0)} \tag{11a'}$$

and for a sample of observed multiple bidder contests, first bidders' expected profits are equal to

$$E[\tilde{v}_1 - \min\{\tilde{v}_1, \tilde{v}_2\} | v_0 \leq \tilde{v}_1 < r, \tilde{v}_2 > v_0] \qquad (11b')$$

While a bias again exists, a comparison of (11a') and (11b') reveals that the model predicts that the average profits of first bidders in observed single bidder contests will exceed those for first bidders in observed multiple bidder contests.[24]

Consider now the impact of takeover legislation. Beginning with the William's Act (enacted in July, 1968), federal and state legislation has slowed the tender offer process considerably. Mandatory preoffer filings (as specified by many states' laws) combined with minimum periods for which offers must remain open (as specified by many states' and federal laws) have served to lengthen the time from the effective announcement of an offer to its consummation (see Aranow, Einhorn and Berlstein (1977)). Competing bidders have been allowed more time to study the target. Interpreting this as a decrease in c_2, a second bidder's cost of becoming informed, should be reasonable. As discussed in Section 5, a target's and second bidder's expected profit would increase, and a first bidder's expected profit would decrease as a result of a decrease in c_2. Additionally, there would be a higher frequency of multiple bidder contests. Empirically, Jarrell and Bradley (1980) and Bradley et al. (1984) both report findings of significantly higher target returns from tender offers since the enactment of the William's Act. Further, Jarrell and Bradley (1980) report a higher frequency of multiple bidder contests since the enactment of the Williams's Act. For bidders, Jarrell and Bradley (1980) and Bradley et al. (1984) both report findings of a (statistically insignificant) decrease in the returns to tender offers since the enactment of the William's Act. These estimates, however, are computed across acquiring bidders. First bidders are not distinguished from later bidders, and in order to estimate the impact of takeover legislation, this is crucial. Takeover legislation would decrease the expected profit of first bidders and increase the expected profit of second bidders, and averaging across all bidders cannot identify such effects.

The effects of takeover legislation can also be considered in further detail. From (10a) and (10b) it can be seen that targets' expected profits are increasing in r, and thus decreasing in c_2, for both high and low initial bids. Thus, the increase in targets' expected profits, following a decrease in c_2, is the result of an increase for both single and multiple bidder contests (as defined by the theory rather than by the data). That this result holds for single bidder contests is particularly interesting. Lowering the cost to a potentially competing bidder will raise a target's expected profit even if this other bidder does not compete. This is because the first bidder will have made a higher initial offer. As for measured profits in observed single and multiple bidder contests, the appropriate question is how (10a') and (10b') vary with r. It can be demonstrated that (10a'), the target's expected profit in observed single bidder contests, can increase or decrease as a result of the increase in r. While the profit from a preemptive bid will increase, the probability that a target received a preemptive bid, given that a single bidder was observed, will decrease. Which effect dominates depends on c_2 and the underlying distributions of $\tilde{v}_1$ and $\tilde{v}_2$. As for observed multiple bidder contests, (10b') can be seen to be increasing in r. Thus there should be an increase in target profits in observed multiple bidder contests. Empirically, Bradley et al. (1984) report significant increases in target returns for both observed single and multiple bidder contests.

Now consider the effect on first bidders' expected profits in single and multiple bidder contests. Using (11a), it can be established that first bidders' expected profits in single bidder contests may increase or decrease. While the increase in r increases the minimum preemptive bid (decreasing the expected profit), it also limits preemptive bidding to even higher valuing bidders (increasing the measured expected profit). From (11b), it can be seen that first bidders' expected profits in multiple bidder contests will increase. This is because the increase in r raises the average valuation of first bidders involved in multiple bidder contests. So while the decrease in c_2 can reduce first bidders' expected profits overall, it can raise their measured profits for both single and multiple bidder contests. As for bidder profits in observed single and multiple bidder contests, the results are similar. The profits of first bidders may increase or decrease in observed single bidder contests, and will increase in observed multiple bidder contests, as a result of a decrease in c_2.[25]

There is also another possible effect of a decrease in c_2. It may be the case (though it is not necessary) that a first bidder's expected profit varies with v_0. Then, since a decrease in c_2 will decrease a first bidder's expected profit for all v_0, some targets may no longer be profitable to study, and fewer firms will be subject to takeover bids. This truncation of the less profitable to study targets would have the effect of increasing the <u>measured</u> profits for all bidders and targets (which are involved in takeover bids).[26] The results from the empirical literature are mixed regarding the existence of a truncation effect. Smiley (1979) and Jarrell and Bradley (1980) both report a decrease in the number of tender offers in states which adopted takeover legislation. With regard to the total measured gain, Jarrell and Bradley (1980) report a statistically insignificant increase, and Bradley et al.

(1984) a statistically insignificant decrease in the total measured gain (bidder gain plus target gain) for tender offer samples of matched bidders and targets.

Conclusion

The takeover bidding process has been modeled within a context of asymmetric and costly information. Key to the results is the ability of a second bidder to make an information acquisition decision after it has observed a first bidder's initial offer. This gives the first bidder the ability, through its initial offer, to affect this decision. A unique equilibrium was developed. It was demonstrated that a first bidder may make a high premium initial offer in order to deter a second bidder from competing (i.e., a preemptive bid).

In addition to providing a rationale for high premium initial bids, the model generated a number of testable implications. Among these implications, are the differences in returns to be expected between single and multiple bidder contests, and the effects of takeover legislation. As for examining these implications empirically, an inherent measurement problem was discussed in detail. Observed single bidder contests consist of cases where (1) a second bidder chose not to compete for the target, and (2) a second bidder chose to compete, but determined that it had a low valuation for the target's assets, and thus did not bid. The importance of taking this into account was demonstrated. For while the two events may appear to be similar outcomes, they have different implications for bidder and target profits. The preliminary comparison of the model's implications with the findings of the empirical literature suggests that the preemptive bidding model may indeed be a useful framework for organizing and understanding the empirical results. Further, the following are among the empirical directions suggested by the model. First, in studying the returns to targets and bidders, conditioning on the first bidder's initial offer may provide useful information. This is particularly true for single bidder contests as it may provide a means for discriminating between the two types of events (discussed above) which lead to the observation of only one bidder. Second, in studying the returns to bidders in multiple bidder contests, it is important to distinguish between first and later bidders rather than simply averaging across ultimately successful bidders. This is particularly true for studying the impact of takeover legislation on bidders.

The model here may also prove to be a useful framework for studying the various tactics which have been employed by target managements. For instance, why, in the interests of shareholders, might target management attempt to defeat an offerer (for instance through the creation of an antitrust problem or through greenmail) rather than simply delaying it (see n. 22 above)? Also, what is the rationale for so-called "antitakeover" amendments to corporate charters?

Footnotes

* This is a revised version of Chapter II of my dissertation submitted to the Department of Economics, University of Chicago. I am grateful to Douglas Diamond, Sanford Grossman and Merton Miller for helpful discussions.

1. This is a departure from the literature on auction and securities markets for which participants can acquire costly information. In these studies, participants make their information acquisition decision prior to the opening of the market. For instance, Milgrom (1981) and Matthews (1984) study the problem in auction market settings, and Grossman and Stiglitz (1980) and Verrecchia (1982) study the problem in securities market settings. These studies model the problem as consisting of two stages. In the first stage, participants make their information acquisition decision, and in the second, the market is opened.

2. The problem is studied within the context of a divergence of interest between target management and shareholders. Target management may defeat an offer because it is "low," or because the benefits from control are "high."

3. This eliminates questions regarding the effects of takeovers on the relative values of equity and non-equity claims. Empirically, Asquith and Kim (1982) study a sample of mergers and find no evidence that the mergers had any impact on the value of the merging firms' traded debt claims.

4. One way to justify this is as follows. Suppose the problem described above is exactly replicated, period after period, until the target is taken over. With an infinite horizon and a stationary environment, the market value of the target, v_0, would be the same at the beginning of every period. Furthermore, the alternative to a takeover bid in any given period is v_0. Now suppose that the target's equity is widely held and the bid is a tender offer, and consider a Grossman and Hart (1980) type model. If it is the case that once a bidder acquires sufficient equity in the target to convey voting control it can buy out the minority at a price no greater than that paid to tendering shareholders, then any offer at or above v_0 would be successful. Any offer below v_0 would be unsuccessful. A competing bid of v_0 could be offered by the target to repurchase its own equity.

5. Grossman and Hart (1981) study a model in which a bidder can profit from both an increase in the productivity of the target's assets, and private information regarding the value of the target's assets as is.

6. Fishman (1986) studies a model in which a bidder's strategy may include uninformed as well as informed bidding.

7. There are other possibilities not modeled here. A bidder could, for instance, purchase target shares and then reveal its information with the resulting possibility that another bidder will make a takeover bid at a premium, thus allowing the first bidder to earn a profit on its investment.

8. Note that if bidders' valuations were correlated, the knowledge that the first bidder's valuation is high may no longer be a deterrent to the second bidder. If the second bidder learns that the first bidder's valuation is high, it not only learns that the acquisition cost it faces is high, but may also learn that its own valuation is likely to be high. The net effect on the bidder's expected profit will depend upon the specific joint distribution of the valuations.

9. A bidder would always (ignoring taxation considerations) make a cash (or riskless debt) offer rather than an offer which includes equity or risky debt. This is because of considerations of adverse selection. An offer which includes equity or risky debt would be perceived as a low-valued offer. In Fishman (1986), the model is extended to allow the target, in addition to the bidders, to observe private information. There, a role for combination cash/equity offers is discussed, and implications regarding the use of cash only vs. cash/equity offers are developed.

10. Bidder 2's problem is equivalent to a decision as to whether or not to purchase an option which has a random exercise price. The cost of the option is c_2, the random exercise price is v_1, and the value of the underlying asset is v_2.

11. It is assumed that bidder 1 cannot precommit to any strategy which specifies actions which bidder 1 would not want to take if and when the time came. This rules out the following. Bidder 1 cannot make an initial offer $p = v_0$ and simultaneously precommit to bidding h if bidder 2 submits a bid higher than v_0. If bidder 1 could precommit to this strategy, then bidder 2 would never pay to observe v_2 and bidder 1 could take over the target at a price of v_0.

12. A similar structure has been used by Milgrom and Roberts (1982) in a study of limit pricing. There, a potential entrant into an industry must incur a fixed cost of entry. An established (current) monopolist may then have an incentive to set a lower price than that implied by the symmetric information monopolist optimum. This, in an attempt to deter the potential entrant. Setting a low price can signal that the established firm is a low-cost producer and thus that the potential entrant's profit is likely to be low if it does choose to enter.

13. As discussed above, opportunity costs as well as direct costs must be included in this calculation, and these costs may include forgoing the expected profit from other projects. An interesting case to study would be one in which the forgone project of a "second" bidder consists of becoming a "first" bidder on a different target. If the direct costs were equal across targets, then the cost of becoming a second bidder would equal the expected profit of becoming a first bidder. In such a case, the opportunity costs would be determined endogenously rather than taken as given.

14. An article in Institutional Investor (January, 1985) reports the ten largest takeovers and the ten takeovers which generated the highest investment banking fees (total paid by acquirer and acquiree) in 1984. Six takeovers were in the intersection of both top ten lists. For these six, the average amount paid for the target was \$6.17 billion and the

average acquirer fee was \$7.59 million. So for these deals, the investment banking fees paid by the acquirer were a small fraction of the total cost of the acquisition. Interestingly, the average fee paid by the acquirees in these six deals was \$18.61 million.

15. Judging from empirical studies which estimate bidder profits from takeovers to be very low, it may be that the likely difference in bidder valuations is indeed very small. See Jensen and Ruback (1984).

16. It is also used by Milgrom and Roberts (1984) to obtain a unique price and advertising signaling equilibrium in a model in which firms are better informed about product quality than are consumers.

17. Illustrating this notion of credibility in the context of a "two-type" signaling model may aid in its understanding. Suppose there are two types of informed agents, g and b, who can take some action to signal their type. Consider a particular action which would (1) be chosen by a type g if the action would induce the uninformed to believe that the agent is a type g, and (2) not be chosen by a type b (whether due to infeasibility or undesirability), irrespective of what the action would induce the uninformed to believe. If a credibility requirement is imposed on the beliefs of the uninformed, then the action would induce the uninformed to believe that the agent is indeed a type g.

18. Proofs of lemmas appear in the Appendix.

19. As an aside, the continuum of sequential equilibria which was mentioned at the beginning of this section can be specified. For a given updating rule, $V(p)$, let p_0 denote the minimum value of p for which

$$E[\pi_2(\tilde{v}_1, \tilde{v}_2, p, 1)|\tilde{v}_1 \in V(p)] \leq 0.$$

It can be verified that any updating rule for which $p_0 \geq \bar{p}(r)$, combined with bidder strategies given by (6), will constitute a Sequential Equilibrium.

20. Jarrell (1985) studies this possibility. The results are consistent with the hypothesis that litigation is undertaken in an attempt to facilitate competing bids. Of a sample of 98 tender offers which were followed by target litigation, 61 (62%) became multiple bidder contests. Of a sample of 197 tender offers which were not followed by target litigation, 19 (10%) became multiple bidder contests.

21. This is essentially the concern of the Easterbrook and Fischel (1982) argument that target management should be required to remain passive during tender offers.

22. Maybe not, though. It may be possible to incorporate this type of an argument in constructing a model in which target management attempts to defeat (in the sense of blocking current and future bids by a given bidder), rather than delay takeover bids. This, in the interests of shareholders. By eliminating a bidder with a high valuation, a target may be able to induce the entry of other bidders. Whether or not such a strategy would be profitable for the target would depend on the

resolution of the problem from that point on. In particular, how many new bidders might enter? Baron (1983) studies this type of question. There, though, it is assumed that more bidders will not arrive until some time after the outstanding offer must be accepted or defeated. Further, targets are not allowed to reject an offer without precluding future bids by the offerer. A model along the lines suggested here would make more of the process endogenous. More bidders will only choose to arrive if the known strong bidder is eliminated (not just delayed). Shleifer and Vishny (1985) study this type of problem.

23. This result should not be confused with the earlier result that the target would earn a higher expected profit if preemptive bidding were eliminated. For any given first bidder valuation, a target earns a higher expected profit if a preemptive bid is not made. However, if preemptive bidding is possible, then since the higher valuing bidders will be the ones making preemptive bids, targets will have higher expected profits from such bids.

24. Bradley et al. (1984) do report higher profits for bidders in observed single bidder contests. There, however, an additional measurement problem (for the theory here) is introduced. For multiple bidder contests, averages are computed across the profits of acquiring bidders without distinguishing between first and later bidders.

25. Bradley et al. (1984) report insignificant decreases in the returns to bidders in single and multiple bidder contests. See, however, n. 24 above.

26. The implications of a truncation effect have also been discussed elsewhere. See for instance Jarrell and Bradley (1980) and Jensen and Ruback (1984).

Appendix

Proof of Lemma 1.

That (6b) is bidder 2's optimal strategy is immediate. Consider now bidder 1's optimal strategy.

For $v_0 < p < p_0$,

$$E\pi_1(v_1, \tilde{v}_2, p, d'(V'(p))) = E\pi_1(v_1, \tilde{v}_2, p, 1)$$
$$< E\pi_1(v_1, \tilde{v}_2, v_0, 1) = E\pi_1(v_1, \tilde{v}_2, v_0, d'(V'(v_0))).$$

For $p > p_0$,

$$E\pi_1(v_1, \tilde{v}_2, p, d'(V'(p))) < E\pi_1(v_1, \tilde{v}_2, p_0, d'(V'(p)))$$
$$\leqslant E\pi_1(v_1, \tilde{v}_2, p_0, 0) = E\pi_1(v_1, \tilde{v}_2, p_0, d'(V'(p_0))).$$

Therefore offers other than $p = v_0$ and $p = p_0$ are dominated. Among these two offers,

$$E\pi_1(v_1, \tilde{v}_2, p_0, d'(V'(p_0))) - E\pi_1(v_1, \tilde{v}_2, v_0, d'(V'(v_0)))$$
$$= E\pi_1(v_1, \tilde{v}_2, p_0, 0) - E\pi_1(v_1, \tilde{v}_2, v_0, 1)$$
$$= (v_1 - p_0) - (v_1 - E\min\{\max(v_0, \tilde{v}_2), v_1\})$$
$$= \bar{p}(v_1) - p_0 \gtreqless 0 \quad \text{as} \quad v_1 \gtreqless \bar{v}(p_0).$$

Q.E.D.

Proof of Lemma 2.

Say $p_0 = \bar{p}(r)$.

Using Lemma 1, $V'(\bar{p}(r)) = \hat{V}(\bar{p}(r); p') = [\bar{v}(\bar{p}(r)), h] = [r,h]$.

Therefore $E[\pi_2(\tilde{v}_1, \tilde{v}_2, \bar{p}(r), 1) | \tilde{v}_1 \in V'(\bar{p}(r))] = w(r, h) = 0.$

Say $p_0 < \bar{p}(r)$

Using Lemma 1, $V'(p_0) = \hat{V}(p_0; p') = [\bar{v}(p_0), h]$.

Therefore $E[\pi_2(\tilde{v}_1, \tilde{v}_2, p_0, 1) | \tilde{v}_1 \in V'(p_0)] = w(\bar{v}(p_0), h)$

$> w(\bar{v}(\bar{p}(r)), h) = w(r, h) = 0,$ which is a contradiction.

Say $p_0 > \bar{p}(r)$.

Using Lemma 1, $\hat{V}(\bar{p}(r); p')$ is empty. Therefore, to determine $V'(\bar{p}(r))$ consider (4ii). It will be shown that there exists a unique set $V \in \mathbf{V}$ for which (4ii) is satisfied for $p = \bar{p}(r)$. There are two cases to consider.

1) V is such that $E[\pi_2(\tilde{v}_1, \tilde{v}_2, \bar{p}(r), 1) | \tilde{v}_1 \in V] > 0$.

For $v_1 \in [v_0, h]$,

$$E\pi_1(v_1, \tilde{v}_2, \bar{p}(r), d'(V)) = E\pi_1(v_1, \tilde{v}_2, \bar{p}(r), 1)$$
$$< E\pi_1(v_1, \tilde{v}_2, v_0, 1) = E\pi_1(v_1, \tilde{v}_2, v_0, d'(\hat{V}(v_0; p')))$$
$$\leq E\pi_1(v_1, \tilde{v}_2, p'(v_1), d'(\hat{V}(p'(v_1); p'))),$$

and there exists no such V which satisfies (4ii).

2) V is such that $E[\pi_2(\tilde{v}_1, \tilde{v}_2, \bar{p}(r), 1) | \tilde{v}_1 \in V] \leq 0$.

For $v_1 \in [r, \bar{v}(p_0))$,

$$E\pi_1(v_1, \tilde{v}_2, \bar{p}(r), d'(V)) = E\pi_1(v_1, \tilde{v}_2, \bar{p}(r), 0)$$
$$> E\pi_1(v_1, \tilde{v}_2, v_0, 1) = E\pi_1(v_1, \tilde{v}_2, p'(v_1), d'(\hat{V}(p'(v_1); p'))).$$

For $v_1 \in [\bar{v}(p_0), h]$,

$$E\pi_1(v_1, \tilde{v}_2, \bar{p}(r), d'(V)) = E\pi_1(v_1, \tilde{v}_2, \bar{p}(r), 0)$$

$$> E\pi_1(v_1, \tilde{v}_2, p_0, 0) = E\pi_1(v_1, \tilde{v}_2, p'(v_1), d'(\hat{V}(p'(v_1); p'))).$$

For $v_1 \in [v_0, r)$

$$E\pi_1(v_1, \tilde{v}_2, \bar{p}(r), d'(V)) = E\pi_1(v_1, \tilde{v}_2, \bar{p}(r), 0)$$
$$< E\pi_1(v_1, \tilde{v}_2, v_0, 1) = E\pi_1(v_1, \tilde{v}_2, p'(v_1), d'(\hat{V}(p'(v_1); p'))).$$

Lastly, for $V = [r, h]$, $E[\pi_2(\tilde{v}_1, \tilde{v}_2, \bar{p}(r), 1) | \tilde{v}_1 \in V]$ $= w(r, h) = 0$, and $V = [r, h]$ uniquely satisfies (4ii). Thus $V'(\bar{p}(r)) = [r, h]$ and $E[\pi_2(\tilde{v}_1, \tilde{v}_2, \bar{p}(r), 1) | \tilde{v}_1 \in V'(\bar{p}(r))] = w(r, h) = 0$, which is a contradiction.

Thus $\bar{p}(r)$ is the minimum p for which $E[\pi_2(\tilde{v}_1, \tilde{v}_2, p, 1) | \tilde{v}_1 \in V'(p)] \leq 0$.

Q.E.D.

References

Aranow, R. A., H. A. Einhorn, and G. Berlstein, 1977, Developments in tender offers for corporate control (Columbia University Press, New York).

Asquith, P. and E. H. Kim, 1982, The impact of merger bids on the participating firms' security holders, Journal of Finance, 37, 1209-1228.

Baron, D. P., 1983, Tender offers and management resistance, Journal of Finance, 38, 331-343.

Bradley, M., A. Desai, and E. H. Kim, 1984, Determinants of the wealth effects of corporate acquisitions, Unpublished manuscript (University of Michigan, Ann Arbor, MI).

Easterbrook, F. H., and D. R. Fischel, 1982, Auctions and sunk costs in tender offers, Stanford Law Review, 35, 1-21.

Fishman, M. J., 1986, Takeover bidding with competing bidders and asymmetric information, Unpublished Ph.D. dissertation (University of Chicago, Chicago, IL).

Giammarino, R. M., and R. L. Heinkel, 1985, A model of dynamic takeover behavior, Unpublished manuscript (University of British Columbia, Vancouver, B.C.).

Grossman, S. J., and O. D. Hart, 1980, Takeover bids, the free-rider problem, and the theory of the corporation, Bell Journal of Economics, 11, 42-64.

Grossman, S. J., and O. D. Hart, 1981, The allocational role of takeover bids in situations of asymmetric information, Journal of Finance, 36, 253-270.

Grossman, S. J. and M. Perry, 1984, Sequential bargaining under asymmetric information, Unpublished manuscript (University of Chicago, Chicago, IL).

Grossman, S. J., and J. E. Stiglitz, 1980, On the impossibility of informationally efficient markets, American Economic Review, 70, 393-408.

Jarrell, G. A., 1985, The wealth effects of litigation by targets: Do interests diverge in a merge?, Journal of Law and Economics, 28, 151-177.

Jarrell, G. A., and M. Bradley, 1980, The economic effects of federal and state regulations of cash tender offers, Journal of Law and Economics, 23, 371-407.

Jensen, M. C., and R. S. Ruback, 1983, The market for corporate control: The scientific evidence, Journal of Financial Economics, 11, 5-50.

Khanna, N., 1985, Optimal bidding for tender offers, Unpublished manuscript (Northwestern University, Evanston, IL).

Kreps, D. M., 1984, Signalling games and stable equilibria, Unpublished manuscript (Stanford University, Stanford, CA).

Kreps, D. M., and R. Wilson, 1982, Sequential equilibria, Econometrica, 50, 863-894.

Matthews, S., 1984, Information acquisition in discriminatory auctions, in: M. Boyer and R. E. Kihlstrom, eds., Bayesian models in economic theory (North-Holland, Amsterdam).

Milgrom, P. R., 1981, Rational expectations, information acquisition, and competitive bidding, Econometrica, 49, 921-943.

Milgrom, P. R., and J. Roberts, 1982, Limit pricing and entry under incomplete information: An equilibrium analysis, Econometrica, 50, 443-459.

Milgrom, P. R., and J. Roberts, 1984, Price and advertising signals of product quality, Unpublished manuscript (Stanford University, Stanford CA).

P'ng, I.P.L., 1985, The information conveyed by a tender offer and the takeover price of a target firm, Unpublished manuscript (UCLA, Los Angeles, CA).

Shleifer, A., and R. W. Vishny, 1985, Greenmail, white knights, and shareholders' interest, Unpublished manuscript (MIT, Cambridge, MA).

Smiley, R., 1979, The effect of state securities statutes on tender offer activity, Unpublished manuscript (Cornell University, Ithaca, NY).