Value-Maximizing Managers, Value-Increasing Mergers and Overbidding*

Evrim Akdoğu†

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†Doctoral Candidate in Finance, John M. Olin School of Business, Washington University in St. Louis, Campus Box 1133, One Brookings Drive, St. Louis, MO 63130-4899, tel: (314) 935-6709, fax: (314) 935-6359, e-mail: akdogu@olin.wustl.edu.

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Abstract

Some acquisitions can be viewed as a means for procuring proprietary technology. For such acquisitions, it may be just as important to block competitors from getting the technology as it is to obtain the technology. If a firm will be adversely affected by a competitor's acquisition, then it can rationally "overpay" for the target to avoid this outcome within a value-maximizing framework. We study the behavior of two bidders that enter a bidding contest for the target where the contest is modelled as a second-price auction with costly losing. In contrast to most of the existing literature, the model supports various outcomes that are consistent with empirical evidence within a rational and value-maximizing framework. The model reconciles two empirical regularities: mergers increase value through synergies, and acquirors earn zero or negative returns on average. It also is consistent with the recent empirical evidence suggesting that mergers come in response to an economic change, and tend to cluster within industries.

1 Introduction

Many researchers have addressed the question of wealth gains from acquisitions. A pervasive empirical finding is the fact that takeovers generate substantial gains. Although alternative motives for the merger and the source of these gains are proposed, most empirical findings are consistent with the premise suggesting that the synergies created by the merging of the two parties are the source of these gains.[1] As for the distribution of these gains, there is substantial evidence that shareholders of target firms, on average, realize large capital gains from corporate takeovers. The magnitude and sign of gains to acquiring firms, however, are mixed. Some studies find that on average acquirors break even, obtaining zero return, while others document that they earn statistically negative returns from their acquisitions.[2] This latter result is interpreted as evidence of overbidding by acquirors in the sense that they apparently pay more than they can achieve after gaining control of the target.

The goal of this paper is to develop a theoretical framework in which all managers are rational and value-maximizing, all mergers are value-increasing, yet acquirors can still earn negative returns.[3] The key to the reconciliation of the empirical regularities noted above can be found in another empirical result that has largely been ignored by the existing theories of corporate acquisitions. Bradley, Desai and Kim (1983) show that when the target rejects the initial bidder and remains independent, there is no significant change in wealth for the shareholders of the losing bidder. However, when the target rejects the first bid and accepts a rival bidder's offer, the initial bidder experiences a significant wealth loss subsequent to the rejection of its bid. They suggest that "when a firm loses the competition for a target firm to a rival bidding firm, the market perceives it to have lost an opportunity to acquire a valuable resource. Perhaps the transfer of control of

[1] More recently, Andrade and Stafford (1999) and Mulherin and Boone (2000) find that their results are inconsistent with the nonsynergistic theories and agree that gains are mainly due to synergies.

[2] Among the studies that find negative average returns to bidders include Asquith, Bruner, and Mullins (1987), Bradley, Desai and Kim (1988). On the other hand, Schwert (1996), Franks, Harris and Titman (1990), Jensen and Ruback (1983) find insignificant positive or zero returns for the acquirors.

[3] In independent work, Molnar (2000) also develops a theory of preemption to similarly explain the puzzle of apparent overbidding in acquisitions. While our conclusions are similar, our modelling approach differs. He uses a Cournot model with three firms where the bidders have complete information about each other's potential cost reductions due to the merger, whereas I use a reduced-form profit function and allow the firms' synergy values to be their private information. In addition, I extend the model to study the bids when there exist multiple targets available sequentially to bidders, which is not present in Molnar's (2000) work.

the target resources to another firm places the firm at a competitive disadvantage vis-á-vis the successful bidding firm." The implication is that the bidders are not indifferent between the target staying independent and it merging with one of its competitors.

Mergers are often modelled as investments in a *static* environment where the investment opportunities of the firms and the industry conditions are assumed to be the same both pre- and post-merger. Here, the decision to invest in a merger and its expected return are independent of the competitors' actions as the returns to the status quo are guaranteed at zero. In this setting, the value of the target is simply the "incremental" revenue increase or cost reduction that it brings to the acquiror with respect to the current profits. The primary modelling difference in this paper is that mergers are interpreted as an efficient reaction to economic change in a *dynamic* corporate world.[4] The world is dynamic in the sense that the investment opportunities available to firms are subject to change and returns to the status quo are not guaranteed. To maintain the current level of profitability and competitiveness, the firms are forced to adopt new strategies in response to these changing market conditions.

In this paper, mergers are thought of as acquisitions of new technologies or resources required to efficiently react to the changing economic conditions. In a dynamic environment where a firm that does not possess the necessary technology cannot compete effectively, acquisition of the technology through another firm is taken here as the quicker and less risky option than developing it internally. The economic rationale for such an assumption can be supported by the following remark[5]

> [Mergers and acquisitions] are the response of choice and the M&A market is plied so assiduously by firms in the throes of change, whether proactively self-generated or dictated by the dynamics of their products and services markets. The acquisition can be quick, it can be cost-efficient, and it can be engineered for big-time versatility to meet several requirements in one shot. A wise acquirer can get someone else's technology, someone else's product line, someone's distribution system, someone else's talent, someone else's customers and put all these advantages to work in a hurry.

[4]Consistent with this interpretation, a recent trend in the empirical takeover literature successfully ties merger activity to industry-wide economic changes. Their findings agree that most of the mergers and acquisitions are associated with technological or regulatory shocks and that industries react to these shocks by restructuring, often via mergers and acquisitions. Most recently, Andrade, Mitchell and Stafford (2001) summarize the findings of this literature.

[5]"Why the M&A Boom Isn't Dying Down; A Plethora of Buyers and Sellers Find An Abundance of Reasons to Do Deals", Mergers & Acquisitions.

The main implication of interpreting mergers in this manner is that an acquisition affects not only the acquiror itself, but also its competitors. Consistent with the intuition of Bradley, Desai and Kim (1983), the acquisition of a firm possessing the necessary resources gives the acquiror a competitive advantage. Furthermore, it hurts its competitors that are not successful in restructuring in response to the changing conditions. In this setup, losing out on acquiring a target is equivalent to losing a competitive edge. Consequently, the value of a target that might alternatively be acquired by a competitor is not simply the "incremental" revenue increase or cost reduction that is attributable to the target, but also the loss a firm will incur in case the competitor acquires the target. If losing the target to a competitor is costly, then it can be rational to try to acquire the target at the expense of receiving a negative payoff, since losing the target might be even more costly.

To fix ideas, consider the following illustration of the railroad industry. "The contest that may best exemplify the critical difference between winning or losing, the primary driver of bitterest battles, is the high-profile, mega-bucks scrap between CSX and Norfolk Southern to win Conrail. To the victor belongs dominance in railroad freight hauling in the easterns U.S.; the loser may face an uncertain future as a competitive also-ran".[6] In the early nineties, railroads were losing business to the trucking industry and high costs were preventing them from lowering prices and competing more effectively. In response to the changing conditions, the railroads started consolidating as a means to cut costs through the elimination of duplicate operations. Following the lead of western railroads, such as the merger of Union Pacific with Southern Pacific and Burlington Northern's with Santa Fe in 1995, the three major eastern railroads, Conrail, Norfolk Southern and CSX, joined in the consolidation wave.[7]

On October 23, 1996, eight days after Conrail announced that it had agreed to a friendly takeover by CSX, Norfolk Southern launched a hostile bid for Conrail, sparking a takeover battle. After an eight month bidding contest, the two companies finally agreed to a joint acquisition of Conrail. By the end of this takeover battle, Conrail's stock which began at $\$69\frac{3}{4}$ was valued at

[6] "Immovable and Irresistible", Mergers & Acquisitions, 1997.

[7] In the eastern United States, there were three major rail systems. Conrail dominated the Northeast, whereas Norfolk Southern and CSX Transportation served roughly the same territory throughout the Southeast and Midwest, with some lines running into the Northeast.

\$115, representing a 64% premium over its pre-announcement stock price. The high premium paid to Conrail reflected not only the incremental value Conrail added to the two railroads, but also the high cost of losing Conrail to the competitor. As is typical, the financial projections of both CSX and Norfolk Southern for the proposed merger with Conrail each included the cost reductions due to the merger as well as the revenues that would come at the expense of the losing competitor.[8] Most importantly, however, they each included the 'cost of losing' which was estimated as the loss in revenues that would be a direct result of losing Conrail to the competitor.[9] This paper seeks to incorporate these ideas formally in an economic framework.

The rest of the paper is structured as follows. Section 2 specifies the model and Section 3 derives the bidders' equilibrium strategies. Section 4 delineates the outcomes that emerge as a result of differing realizations of the synergy values. Section 5 shows how the heterogeneity of returns to acquirors across industries are due to the competitive elements within each industry. Section 6 examines how the presence of multiple targets affect the equilibrium bids. Section 7 extracts the empirical implications of the model and Section 8 concludes. All proofs are contained in the Appendix.

2 The Model

2.1 Basic Setup

The model is formulated as a Bayesian game. There are two potential acquirors, B_i where $i = 1, 2$ of one target firm.[10] The target firm is assumed to be passive and by normalization accepts the best nonnegative bid. Both bidders have privately-observed valuations of own synergy, S_i, to be gained upon acquiring the target. While the realized value of the synergy is private information,

[8] See Esty (1998).

[9] Further support of the intuition that losing a target to a competitor is costly comes from industries where losing a competitive edge is crucial for future competition. In these industries, it is not uncommon to see firms attempting to block competitors' mergers by launching hostile bids. Examples include Carnival's (the top global cruise operator) attempt to wreck a merger between the other top two competitors, Royal Carribean and P&O Princess, and ChevronTexaco's announced intention to bid for either Conoco or Phillips simply to block the proposed union of these two competitors. An interesting case can be found in the airline industry, where under a marketing agreement with Continental Airlines, Northwest Airlines retains veto power over any deal involving the acquisition of Continental.

[10] As the bidders are symmetric B_i will represent both of the bidders where $i = 1, 2$. To represent the opponent, we will use the notation B_j where $j = 1 - i$.

the distribution is common knowledge. Specifically, the synergy valuations $\{S_i\}$ are distributed independently and uniformly on the interval $[0, 1]$.

Each bidder has two choice variables.[11] The first is whether to initiate a merger with the target, where this initiation decision is represented by the binary functions, $\tau_i(S_i)$. If bidder B_i initiates a merger after observing the synergy valuation S_i, then $\tau_i(S_i) = 1$, and if not $\tau_i(S_i) = 0$. The other choice variable for the bidders is the bid price for the target. We let $b_i(\tau_j; S_i)$ represent B_i's bid in a possible auction at $t = 2$ when his opponent chooses $\tau_j \in \{0, 1\}$ as its merger initiation decision. Each player's initiation decision is publicly observed before bids are announced. Thus, B_i is allowed to choose different bids based on the new information about his opponent's initiation decision: $b_i = b_{i1}$ when $\tau_j = 1$, and $b_i = b_{i0}$ when $\tau_j = 0$. Similarly, $b_j(\tau_i; S_j)$ is the opponent's bid when player i chooses $\tau_i \in \{0, 1\}$.

The game is formulated in two stages. At $t = 1$, bidders discover their private synergy types after which they decide simultaneously whether to initiate a contest for the target (i chooses τ_i). If at least one bidder initiates, there is a contest in the form of a second-price auction at $t = 2$. Bidder i chooses b_i, the amount to bid for the target in the auction. When no bidder initiates at $t = 1$, there is no auction and the game ends.

2.2 Payoffs

The payoffs of the players are specified as follows. If there is no initiation by either bidder, the target stays independent and both bidders receive normalized payoffs of zero. If either player initiates a merger, then the bidders compete for the target in the form of a modified second-price auction which is described below.[12] There is no cost incurred by the bidders to observe their synergy values or for bidding in the auction.

Let A_i represent the payoff of B_i in a potential auction at $t = 2$. After the bidders make their initiation decisions simultaneously, there are four possible outcomes that can be realized at $t = 2$: (i) both B_i and B_j initiate a merger, (ii) B_i does not initiate, but B_j does, (iii) B_i initiates, but B_j

[11] We restrict our attention to pure strategies.

[12] We do not model the target formally as a strategic agent; the assumed behavior is consistent with a reservation price of 0 in all contingencies.

does not, and (iv) neither B_i nor B_j initiates. Thus, the total realized payoff of B_i at $t = 1$ before making his initiation decision is:

$$\tau_i\tau_j\{A_i(b_i, b_j)\} + (1 - \tau_i)\tau_j\{A_i(b_i, b_j)\} + (1 - \tau_j)\tau_i\{A_i(b_i, b_j)\} + (1 - \tau_i)(1 - \tau_j)\{0\}$$

which after simplifying becomes:

$$= \tau_i(1 - \tau_j)\{A_i(b_i, b_j)\} + \tau_j\{A_i(b_i, b_j)\}. \tag{2.1}$$

In the auction, the bidder with the higher bid wins and pays the losing bidder's bid. When the bids are equal, the target randomizes with one-half probability between accepting the offers of the two bidders. The losing bidder earns a negative payoff of $-\alpha$ where $\alpha > 0$. Then, with general bid functions given by b_i and b_j, bidder B_i's payoff in an auction is given by,

$$A_i = \left\{ \begin{array}{ll} S_i - b_j, & b_i > b_j; \\ -\alpha, & b_i < b_j; \\ \frac{1}{2}(S_i - b_j - \alpha), & b_i = b_j. \end{array} \right\}$$

There are three relevant terms in this payoff A_i. The first term captures the case in which B_i has the higher bid (i.e., $b_i > b_j$), and thus his payoff is his synergy value S_i net of player B_j's bid price.[13] The second term reflects the outcome in which B_i is outbid by B_j (i.e., $b_i < b_j$), and thus B_i incurs the loss of α as he relinquishes the competitive edge to B_j. The third and final term denotes the case in which B_i and B_j each bid the same price for the target, who then with equal probability selects either B_i or B_j as the winner. Thus, one-half of the time B_i wins and earns $S_i - b_j$, and the other half of the time B_i is not selected and loses α.

The main difference of this game from the traditional second-price auction is that in this game, losing is costly. In the traditional second-price auction, the losing bidder guarantees himself a payoff of zero. Otherwise, the bidders might choose not to participate in the auction at all. In this model, we impose a negative payoff of $-\alpha$ on the losing bidder in order to capture the effect of the winning bidder gaining a competitive advantage over his competitor. This negative payoff is defined as the cost of losing the target and is imposed on the losing bidder even if it chooses to abstain from an

[13] Recall that this is a second-price auction.

auction that is initiated by the competitor. Consequently, the bidders cannot avoid this outcome by simply not participating.

The equilibrium concept we employ for solving the game is pure-strategy Bayesian-Nash equilibrium (BNE) in strategies that survive one-round of elimination of weakly-dominated strategies.

2.3 Robustness of the Auction Mechanism

The bidding contest here is modelled as a second-price auction. A more common form of auction that is used to model takeover contests is an English auction among the bidders (for example, see Burkart (1995)). At the beginning of the acquisition process, each bidder submits an offer which is later matched and perhaps exceeded by the rival bidder. An adjustment to the English Auction to better represent the acquisition procedure is to think of the offers arriving each Δt time period (as opposed to instantenously), where Δt might represent the time elapsed between the two offers. The process goes on until one of the potential acquirors withdraws or expresses an intent of not increasing the final offer price. The winning bidder, therefore, pays the last offer price of the losing bidder and acquires the target.

While an adjusted form of the English Auction better represents the real-life acquisition procedure, a second-price auction is used in this model simply for increased tractability. A bidder's strategy in the English auction does not only depend on his valuation, but is also a function of the previous bidding activities. However, in a private-values model in which both bidders know their exact values for the target and their valuations are statistically independent, the English and second-price auctions are strategically equivalent (see Milgrom and Weber (1982)).

3 Equilibrium Strategies

In this section, we analyze the equilibrium strategies of the bidders with respect to their choice variables, which include their initiation decisions and the bids in the auction. As we show below, the relatively simple framework employed in this paper is sufficiently rich to address two fundamental questions from the takeover literature: 1) why do acquirors apparently overbid in bidding contests?, and 2) why and when do firms initiate mergers? It is, in fact, the two-stage structure of the model and the dynamic features of the industry that allows such an examination.

3.1 Bids and Competition

In a single-unit, second-price auction without without costly losing, it is a weakly-dominant strategy for a bidder to bid up to his valuation for the object. The outcome is analogous in our case. In this model losing is costly, therefore, once a competitor initiates a contest, a bidder's effective valuation of the target is not simply his synergy value. It is the sum of the synergy value and the loss imposed on him if he fails to acquire the target. After the opponent chooses to initiate a merger, both abstaining from and losing the auction guarantee the bidder a negative payoff ($-\alpha$). Therefore, once an auction is initiated, a bidder's updated value for the target becomes $S_i + \alpha$. This intuition is formalized in the following result.

Theorem 1. *When there is only one target available for acquisition and a contest has already been initiated by either B_i, B_j or both bidders, a player (B_i or B_j) always enters the auction and bids an amount equal to the sum of his synergy and the cost of losing. Thus, bidder B_i bids $b_{i1} = b_{i0} = S_i + \alpha$ and bidder B_j bids $b_{j1} = b_{j0} = S_j + \alpha$.*

Now that we know the equilibrium bids, we can solve for the expected payoff of the bidders in the auction and discuss the implications of the model about the competition between bidders. Furthermore, we can study the differences in the implications of this model from those of the previous takeover models that arise from the existence of costly losing for the bidders. One regularity in the empirical literature of takeovers is the fact that competition from additional bidders lowers the initial bidder's stock price (see Bradley, Desai and Kim (1988)). Not surprisingly, the implications of most takeover models about the stock price of the initial bidder subsequent to the arrival of a competing bid are similar. Competition inadvertently implies a higher price to be paid for the target regardless of the existence of a cost for losing, causing a negative reaction for the initial bidder.

The novel implications of the model that arise due to the existence of costly losing are about the returns of the *challenging* bidders. If losing the target is costly, the announcement of a merger by the initial bidder should have a negative impact on the price of the eventually challenging bidder.

By examining the expected price realized in the auction, we can predict that the announcement of the competing bid will always have a positive effect on the price of the challenging bidder. To see this, suppose that B_j has already initiated a merger. If B_i abstains from bidding, he is guaranteed a payoff of $-\alpha$. However, by entering the auction, his expected payoff is $(Pr(S_i > S_j)(S_i - E[S_j|S_i > S_j]) - \alpha)$, where $Pr(S_i > S_j)$ represents the likelihood with which B_i emerges as the winning bidder. As B_i already faces $-\alpha$ after the initial bid, the possibility of a payoff that is at least less negative would be positive news for the competing bidder, and the stock price should increase upon entry if this was not already anticipated.

The existence of costly losing also distinguishes this model from previous models in that it can explain the asymmetric reaction to the *outcome* of a takeover competition (see Bradley, Desai and Kim (1983)). Models in which a cost for losing is absent would predict that both losing the target to the rival bidder and the target staying independent produce symmetric effects on the initial bidder's value. Consistent with the results of Bradley, Desai and Kim (1983), however, if losing is costly the two outcomes should produce asymmetric reactions. In fact, our model predicts that losing a contest should have a negative impact, whereas the event in which the target stays independent should bring the bidders' price back to their original levels.

3.2 The Merger Initiation Decision

With the equilibrium bidding behavior in hand, we now step back to the original decision of whether to initiate a merger. If initiating a merger attracts competition and as such introduces the possibility of realizing a worse payoff than achieved in the initial no-merger equilibrium, why do firms initiate mergers at all? This question also cuts to the heart of the takeover puzzle: If bidders on average lose money from mergers, why do they still invest in them? Thinking of mergers simply as investments in a static corporate environment makes it difficult to address these questions within a rational framework. In such an environment, the outside option of bidders are exogenously specified to be the status quo. Regardless of the opponent's action, a bidder can thereby guarantee himself a payoff of zero by not taking any action at all. To determine whether or not to take on an investment in such an environment, a firm simply looks at the NPV of the project, which in this context corresponds to the synergy of the target. If it is positive, $S_i > 0$, a bidder initiates a merger, if it is negative he does not.

In this model, the expected payoff of not taking any action is not constant and can be negative as it is endogenously determined at each stage by the opponent's actions. Since the appropriate benchmarks are endogenously determined and are different from zero at each stage, an acquisition in this model cannot simply be thought of as being a positive NPV project benchmarked to zero. At $t = 1$, after the opponent initiates, the payoff of no action (or not entering the contest) is $-\alpha$; hence the appropriate benchmark is the state in which a bidder fails to acquire the target whose payoff is $-\alpha$. Similarly, before initiation decisions are made, the expected payoff of not initiating is not zero and is dependent on the probability that the opponent initiates the auction. This feature of the model allows us to endogenize the merger decision and study when a bidder decides to change the current state of the industry by initiating a merger.

Theorem 2. *There are two pure-strategy equilibria each with its own symmetric cutoff points, $S_c = 2\alpha$ and $S_c = 0$, where bidders (B_i or B_j) initiate a merger whenever their synergy values (S_i or S_j) exceed these cutoffs, and do not initiate otherwise.*

The intuition underlying the result is as follows. The only time where B_i's decision of initiation has an impact on the outcome (whether or not an auction occurs) is when the opponent chooses not to initiate. When the opponent chooses to initiate, there is an auction at $t = 2$ regardless of B_i's decision. When the opponent chooses not to initiate, then B_i's decision determines whether the status quo is maintained or an auction occurs. Accordingly, the decision of initiation is based on the expected payoff from initiating conditional on the opponent not initiating a merger. The benchmark is the alternative state which in this case is the status quo profits or normalized profits of zero.[14]

The two different equilibria may be interpreted as corresponding to different types of industries in which the firms interact more aggressively versus more strategically. For example, in an industry where firms initiate whenever they have a positive synergy value, i.e., the cutoff is given by $S_c = 0$, the firms are more aggressive and they ignore the strategic impact of losing a target to a competitor. The intuition is that if a player believes that his competitor will always initiate a merger regardless

[14]Theorem 3 computes the cutoff value of synergy above which the total payoff function of B_i is positive when he initiates, regardless of the opponent's decision.

of his synergy value, the rational best-response for him is simply to do the same. On the other hand, the firms in an industry with the strategic equilibrium take into consideration the competitive environment and the consequences of losing the target to a rival bidder.

The magnitude of the negative payoff is an important factor in determining the aggressiveness of the firms within an industry with respect to their acquisition strategies. In the strategic equilibrium, bidders initiate mergers when their synergy value is above 2α. For industries where α is not particularly high, we are likely to see more aggressive bidders that initiate more often. Such industries are more likely to be highly competitive and diverse, with a lot of growth opportunities. Here, losing a competitive edge to a rival is not as costly. For industries where the magnitude of α is very high, or more concentrated industries in which moving a step ahead of the competitors might be more crucial, we expect to see relatively more conservative firms that do not initiate mergers as often.

4 Merger Initiation under Various Synergies

In the previous section, we discussed the equilibrium strategies of the two potential acquirors of one target firm. In this section, we delineate the possible outcomes arising from different synergy realizations based on these merger initiation strategies. The "aggressive" equilibrium in which the bidders always initiate a merger is trivial and ignored for the next part of the analysis. We focus on the "strategic" equilibrium in which bidders initiate for synergy values $S_i > 2\alpha$. We first show that it is possible for the bidders to initiate mergers even when the expected value of initiating is negative, and second that they might choose to preserve the no-merger equilibrium despite having positive synergy values.

Theorem 3. *If the realized synergy value of bidder B_i is in an intermediate range such that $2\alpha < S_i < \sqrt{2\alpha}$, then he initiates a merger even though the total expected payoff from initiating is negative. An analogous result holds for bidder B_j.*

What Theorem 3 documents is that a bidder's *total* or unconditional expected payoff from initiating a merger is only positive if his synergy value exceeds $\sqrt{2\alpha}$. Recall from Theorem 2 that the initiation decision is based on only a bidder's payoff *conditional* on the opponent not initiating a merger, which results in the cutoff of 2α. Consequently, for intermediate synergy values, ($2\alpha < S_i < \sqrt{2\alpha}$), the bidder's total expected payoff from initiating is negative. However, as his conditional expected payoff is positive, he rationally initiates the merger despite his expectation of losing money on average. This is because not initiating causes him to lose more money in expectation.

Based on this result, we can interpret the market's reaction to the announcement of an acquisition in which the original bidder is expected to be challenged. Accordingly, the abnormal returns due to the announcement represent the market's estimate of the bidder's value with respect to his opponent's, as well as the cost of losing the target. A negative reaction suggests that the market's estimate of the initial bidder's value is not significantly greater than the value of a potential competitor that is expected to challenge the initial bid. Even when he wins the contest, he is expected to overpay for the target. A positive reaction, on the other hand, implies that the market expects the initial bidder to win the contest without overpaying.[15]

Theorem 4. *If the realized synergies of both bidders are such that $S_i, S_j \in (0, 2\alpha)$, then no merger is initiated, even though both bidders can create positive synergies with the target.*

What this result shows is that, although both bidders have positive synergy valuations for the target, their magnitudes are too low. If a bidder were to initiate, it would face a significant risk of having a competitor with a higher valuation step in and steal the target leaving the original bidder with a negative payoff of $-\alpha$. Even if the original bidder wins the contest, it is more likely to gain negative profits by giving away all the value created and more to the target through destructive competition with the rival bidder. Consequently, the bidders avoid starting a bidding war when their synergy values lie in this lower region as preserving the status quo provides a more profitable option.

Another empirical regularity in the takeover literature is that mergers occur in waves.[16] By

[15] In this model, the announcement of a merger leads to a competitive auction with certainty. What is described is the combined price effect due to the announcement of the initial and the competing bids. In reality, the initial announcement of a merger might incorporate some probability of a competing bid that is less than one, in which case the market's reaction will occur in two stages. The reaction to the announcement of the initial bid will be more positive (or less negative) and the announcement of the challenge will further decrease the stock prices of the competing bidders. This interpretation is more likely to apply for the triggering merger of a wave.

[16] Mulherin and Boone (2000) show that acquisitions cluster around some industry-wide shock in the target industry

using the results contained in Theorems 2 and 4, we can explain why mergers cluster within an industry and how a slight perturbation can cause firms to move from a no-merger equilibrium to a merger wave. The payoff of initiating to each bidder with synergy values in this range ($S_i < 2\alpha$) is negative, whereas the payoff of preserving the status quo is less negative. As long as the no-merger state of the industry is maintained, the players are better off not initiating a merger. However, once a bidder draws a synergy value that is greater than the cutoff, initiates a merger and disturbs the industry equilibrium, the outside option of his competitor changes. Now, the expected payoff of not initiating becomes $-\alpha$ and the expected payoff of initiating becomes *less* negative. This causes all the "dormant" mergers to be activated, causing a merger wave in the industry.[17]

One example of how the profitability of the status quo is affected by competitors' mergers and how a wave is triggered can be seen in the consolidation of the airline industry. After the proposed mergers of United Airlines with US Airways and American Airlines with TWA, "[b]oth Delta and Continental have said they prefer to stay independent, but would consider a merger or some other alliance if competitors' mergers are approved". Clearly, Delta and Continental would gain little or no value from merging in a state where the no-merger equilibrium was preserved by all their competitors. However, the potential mergers would allow their competitors to reduce costs and to operate more efficiently, ultimately changing the form of the competition in the industry against them. This would cause their current profits to fall and for the merger to possibly become a more profitable option.

5 Payoffs to Acquirors

In this section, we look at the returns to acquirors measured by the conventional empirical literature. We show that, within this framework, acquirors can earn negative or positive realized payoffs with respect to the original no-merger equilibrium depending on the realized synergy values and α. We also show that acquirors' average realized payoffs, or conditional payoff of successful bidders, range from small and positive to negative values, depending on the equilibrium and parameter regions.

for the period 1990-1999 whereas Mitchell and Mulherin (1996) do the same for the period 1982-1989. Andrade and Stafford (2002) show clustering around the bidder industry during the 1990s.

[17] Note that, in this model, not all positive economic shocks will start a wave of mergers. Here, it is the shocks combined with an initial move from a competitor which is the source of a potential wave.

Theorem 5. (Negative Realized Payoffs) *If the realized synergies of the bidding firms are as such:* $S_j < S_i < S_j + \alpha$ *and* $S_i \geq S_c = 2\alpha$*, then the bidder with the highest valuation,* B_i*, acquires the target. However, he overpays in equilibrium and earns a negative payoff of* $S_i - S_j - \alpha < 0$*.*

The conventional empirical studies take the pre-merger state to be the benchmark in measuring the success of a merger. Any amount paid beyond the synergy is considered overbidding by this conventional definition. In this case, the winning bidder overpays by $(S_j + \alpha) - S_i$. The gains to acquirors do not take into account the changing economic conditions or the strategic impact of the merger. Accordingly, this particular case brings negative returns to the acquiror, and therefore considered to be a bad investment decision by either value-destroying or incompetent managers.

In this model, the *absolute* returns with respect to the original state may be negative even for the successful bidder. The returns *relative* to the state in which a bidder loses the target to a competitor, on the other hand, will always be positive. An unprofitable acquisition in absolute terms can actually be the *more* profitable strategy in relative terms. Any study that is simply measuring the absolute returns to acquirors to determine the performance of a merger without taking into account the changing market conditions would underestimate a merger's relative success. Our model suggests that the relevant measure of success is obtained through benchmarking the winning bidder's performance by the losing bidder's performance, which should show a positive incremental return. That is, the incremental change in value to winning bidder B_i, relative to the losing bidder B_j is $(S_i - S_j - \alpha) - (-\alpha) = S_i - S_j > 0$.

The result of Theorem 5 corresponds to merger completion or the effective date which marks the resolution of the uncertainty about the identity of the successful acquiror. At this time, the winning and losing bidders are identified and the amount paid by the acquiror is public knowledge. According to this model, the stock price reaction for the winning bidder of a takeover battle is expected to be always positive. Despite the fact that the successful bidder may be overpaying and getting negative *absolute* returns, the profit of the acquirer $(S_i - S_j - \alpha)$, is always greater (or less negative) than the profit of the losing bidder, $(-\alpha)$. Consequently, even though the magnitude may differ based on the market's estimate of the difference between the winning and the losing bidders (the *relative* profit of the winner), the sign of the market response is expected to be positive (negative) for the successful (unsuccessful) firms.

Theorem 6. (Conditional Payoffs to Acquirors) *Acquirors in the "aggressive" industry earn negative returns on average for $\alpha > \frac{1}{3}$. Acquirors in the "strategic" industry earn small, but positive returns of $\frac{2\alpha^3}{3} - \frac{\alpha}{2} + \frac{1}{6}$ for $\alpha < \frac{1}{2}$ (see fig. 1, p.20).*

The firms in the "aggressive" industry initiate mergers anytime there is value created through synergies, regardless of its magnitude. They ignore the strategic impact of the possibility of losing the target to a competitor. Consequently, even with a positive shock to the industry, for high enough values of the negative externality, they end up with negative returns on average. In the strategic equilibrium, the positive shock to the industry and the response of the firms to the consequences of the competitive environment help the successful acquirors in this industry to avoid negative returns on average. Conditional on being the successful bidder, a firm in the strategic industry expects to earn positive returns on average.

For the firms in the "strategic" industry, the unconditional returns of a potential merger are affected by the magnitude of the externality in two ways. The first is that, as α increases, the cutoff value above which bidders choose to initiate mergers also increases ($S_c = 2\alpha$). This causes fewer mergers to be initiated. The second effect of an increasing α on the returns is that a higher α leads to a higher price to be paid for the target. This causes the returns to acquirors to be smaller as α increases. The conditional returns of the acquirors, however, are only affected by the second effect of α, in that a higher α leads to higher takeover premia for the target. As the magnitude of the externality gets bigger, the conditional returns to acquirors become smaller.[18]

This model is consistent with the diverse results of the empirical literature about the returns to successful acquirors. The results range from on average negative to small positive returns for acquirors. Based on this framework, the heterogeneity of returns to acquirors across industries occurs in a rational manner and is attributed to the elements of the competitive environment within each industry. Similarly, the model implies that studying the returns to acquirors may be informative of the market's assessment of the competitive environment within each industry.

[18]The only relevant region for comparative statics is when $\alpha < \frac{1}{2}$. For $\alpha > \frac{1}{2}$, the cutoff $S_c = 2\alpha$ exceeds 1 and no mergers are ever initiated.

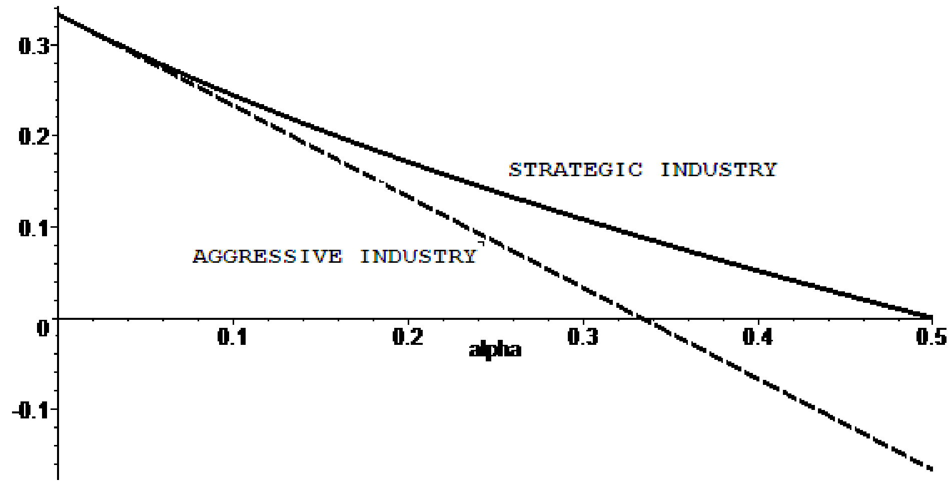

Figure 1: On average returns

6 Bids with Two Targets

In the previous section, we studied the bidding behavior of two players competing for a single target. It is more realistic to believe that the number of "substitutable" targets for the competitors will not always be limited to one. There may be other potential targets that will have similar resources and achieve the same cost-reducing effect for the bidders. In that case, we expect the bidding behavior of the players to be different than that of the single-target case. In this section, we study the effects of having multiple players on the bidding functions. Specifically, we allow for $I > 2$ bidders and two potential targets. The targets are identical in the sense that each bidder has the same synergy value for both targets. Let b_i^1 be B_i's bid for the first target and b_i^2 his bid for the second target. The targets will become available to bidders sequentially as described below.

At $t = 1$, the first target is identified as a potential target and bidders decide whether to initiate a contest or not. If any of the bidders initiate a contest, I bidders compete for the first target in the form of a second-price auction. At $t = 2$, the outcome of the first auction is observed and the winning bidder is identified. Following that, the losing $I-1$ bidders choose their bids for the second target. If no bidder initiates an auction for the first target, there is no auction for the second target either and the no-merger equilibrium is maintained. However, once an auction is initiated for the first target, an auction for the second target will always take place as bidders with no target at the end of the second period end up with the externality, $-\alpha$.

Theorem 7. *In the two-target game with pure-strategies as described above, when an auction is initiated by at least one bidder for the first target, the bid of player i for the first target is,*

$$b_i^1 = S_i - \frac{(S_i)^{I-1}}{I-1} + \alpha,$$

and the bid for the second target is $b_i^2 = S_i + \alpha$, where $b_i^1 < b_i^2$.

The contest for the second target at $t = 2$ is simply the single-target game that is analyzed in the previous sections. Hence, $b_i^2 = S_i + \alpha$, which is the value of the second target for every bidder i who lost out on the first target. The presence of a second target implies that, the effective valuation of a bidder i for the first target is not $S_i + \alpha$. The bidders who choose to enter the auction for the first target submit bids such that $S_i - b_i^1 = E_i[A_{i2}]$, where A_{i2} represents the realized payoff for B_i from the auction for the second target. In other words, B_i submits a bid that equates his profit from winning the first target to his expected payoff of waiting another period for the possibility of acquiring the second target.

The results of this section further characterize part of the dynamics of a merger wave and present some implications as to how the bids should evolve from the beginning to the end. The main result of this section is intuitive; the bid for the first target is always less than the bid for the second target. When there are alternatives available for bidders, overbidding naturally subsides. The interesting implication is that we should expect to see more overbidding towards the end of a wave. In addition, it implies that the more efficient mergers, in the sense that they create the most value, occur earlier in the wave. Finally, as the number of rival bidders increases, the difference between the first and the second bids decreases. This is not a surprising result since it simply confirms the widely-held belief that increased competition among bidders lead to higher takeover premia paid for the targets.

Corollary 1. *Bidders with synergy values, $S_i > ((I-1)\alpha)^{\frac{1}{I-1}}$, underbid for the first target and the ones with $S_i < ((I-1)\alpha)^{\frac{1}{I-1}}$, overbid.*

This is an interesting result since it shows that bidders, even in a very competitive setting, can "underbid" by bidding less than the synergy value for the first target. A bidder with a high enough synergy value – which implies a high enough probability of winning the second-auction – can afford to underbid for the first target. Increased competition or a higher value of the externality, however, causes more firms to overbid for the first target. The intuition is that in an industry where the cost of losing a competitive edge is high and there are a number of competitors, underbidding and running the risk of losing the first target becomes increasingly costly. For high enough values of α, (i.e., $\alpha > \frac{1}{I-1}$), or alternatively a large number of competitors, (i.e., $I > \frac{1+\alpha}{\alpha}$), we can guarantee that bidders never bid less than their synergy values. These conditions force the cutoff above which firms underbid to be greater than 1, which is the upper bound for possible synergy values.

7 Empirical Implications

The starting point of this paper was to reconcile two empirical regularities within a rational framework with value-maximizing managers. We assume that all mergers increase value through positive synergies. Then, we show that acquirors may earn negative (absolute) returns from mergers. The model is also consistent with the common findings of the most recent trend in the empirical literature of takeovers that connects merger waves to industry-wide economic shocks. In addition, we present several new testable implications.

The main contribution of this paper to the empirical studies of takeover literature is its implications about how to interpret the performance of acquirors that earn negative returns from their acquisitions. Traditional studies of takeover performance classify mergers as simple investments in a static economy. The merger's success, therefore, is based on whether or not it is a positive NPV project with respect to the firm's pre-merger environment. The implicit assumption of these studies is that bidders have the same investment alternatives available both pre- and post-merger. A possible regime shift in the industry as well as the strategic impact of a merger is ignored. As such, these studies run the risk of computing a combined measure for the changing economic conditions and the strategic impact of the merger, in addition to the value it adds to the acquiror.

In this model, the returns with respect to a static benchmark can be negative both for the successful and the unsuccessful bidders. The merger can bring negative returns with respect to the original state, however, it will bring positive returns *relative* to what the firm's profits would be if the merger did not go through. The empirical implication is that selecting an appropriate expected performance benchmark in the absence of a merger is crucial. Benchmarking the profits with respect to other competitors who acquire another target, employ some other form of restructuring, and do not take any action will provide meaningful answers to some of the questions about the *relative* gains to acquiring firms.

Another contribution of this paper to the takeover literature is its interpretation of the abnormal returns due to the announcement of a merger. The assumption that a competitor's merger impacts the value of another possible bidder implies that the outcomes of the previous mergers, as well as the expectations about the outcome of the current one, might already be incorporated into the stock price of the potential acquiror. The market's reaction to the announcement of a merger may be interpreted differently based on the previous mergers of the competitors, as well as the expectations of the market about the future mergers. As a result, the reaction due to the announcement would be contaminated by all these expectations and would not be a pure measure of the merger's expected value. The full list of empirically-testable hypotheses generated by the model are given below.

Implication 1: Gains to acquirors *relative* to their industry competitors (or to an industry benchmark) are never negative.

There are a few studies investigating the relative gains to acquirors with respect to their *competitors* by using industry-based benchmarks. The studies involving industry-level analysis often see the underperformance of the acquirors significantly diminish, if not disappear all together. Langetieg (1978) investigates the pre-merger and post-merger stock performance with respect to an industry benchmark, as well as relative to matching firms. His results show that although the bidding firms earn negative returns, the control firms also earn negative excess returns in most post-merger time intervals. The "paired-difference" is *never* significantly different from zero. Healy, Palepu and Ruback (1992) use accounting data to examine post-merger operating performance for the 50 largest mergers between 1979 and 1984. Consistent with this model's predictions, their results show that the operating cash flows of merged firms actually drop from their pre-merger level on average, but that the non-merging firms in the same industry drop considerably more.

More recently, Akdoğu (2003) finds that the *relative* performance of the acquirors, measured by the average cumulative abnormal returns around the announcement of all the acquisitions that took place in the Telecom industry during the years 1996-2001, is better than their unmerging counterparts.

Implication 2: Unsuccessful bidders experience larger negative returns than successful ones.

Despite the vast amount of literature on the empirical studies of takeover literature, very few include the fate of the *unsuccessful* bidders in their analysis. Among the few, Bradley, Desai and Kim (1983), Dodd and Ruback (1977), Dodd (1980) and Fabozzi, Fabozzi, Ferri and Tucker (1988) examine the failed tender offers in an attempt to see the fate of the targets who lost their bids. The main concern of most of these studies is to determine whether the increase in the stock price of the target after the announcement of a bid is permanent or not.[19] With respect to the acquiror returns consistent with the results of this paper, Dodd (1980) finds negative returns for both types of bidders and Bradley, Desai and Kim (1983) find that when an initial bidding firm loses the target to a rival bidder, it experiences a further drop in its stock price.

Implication 3: Unsuccessful bidders eventually acquiring another target or increasing their R&D intensity (or employing some other restructuring process) will experience *less* negative returns than the unsuccessful ones which take no subsequent action.

A firm's performance without the merger after a regime shift is also dependent on the availability of alternative forms of corporate restructuring. Considering the merger as an efficient reaction to an economic shock also raises the issue of the existence of alternate forms of restructuring, such as acquiring another target or increased expenditures on R&D. To the extent that the non-merging competitors also employ alternative forms of restructuring in response to the economic change, the findings of the studies that compare the acquirors to their industry counterparts or to the unsuccessful bidders will be downward biased.

Implication 4: The negative returns are more pronounced in relatively more concentrated bidder industries.

[19] The ultimate goal is to determine whether this increase is to due the target being undervalued, with the announcement revealing extra information about the target's value, in which case the increase is expected to be permanent. Alternatively, the increase in the stock price may be due to an expectation of the value increase through merging with the bidder, in which case it is expected to be temporary because it will not be realized.

The relatively more concentrated industries, such as the railroads, telecommunications and airlines, present a higher cost for losing a competitive edge to a rival, corresponding to higher values of the negative externality. In a concentrated industry, we expect the bidding wars to be relatively more fierce and the bidders to be willing to earn higher negative returns to avoid losing the target. An industry analyst's observation in response to the battle for Conrail, seems to provide some support for this intuition. He suggests that "[t]akeover competitions are very intense when the target is a scarce jewel in a rapidly evolving industry that is populated by relatively few firms".

Implication 5: Higher negative returns should be observed towards the end of a merger wave.

The extent of the cost of losing a competitive edge (or the externality) that gets paid to the target is dependent on the availability of its "substitutes", either in the form of other targets or R&D. As firms get closer to the end of a wave, their alternatives become fewer, forcing them to pay a much higher proportion of the potential loss to the target. If there are no alternatives and the target is the only source of the required resources, then the cost of losing will be even greater. Especially in concentrated industries that are going through a consolidation wave, we expect to see much higher premia to be paid to the targets at the later stages as the number of unmerged firms, hence the potential targets, diminish at a fast pace.

Consistent with this prediction, Harford (2003) finds that the returns to acquiring firms is lower (more negative) at the later stages of a merger wave though he interprets this finding as being due to possible herding behavior by managers. Similarly, Akdoğu (2003) finds that the returns to both the acquirors and the non-merging rivals are lower at the later stages of the recent wave in the Telecom Industry.

8 Conclusion

The primary contribution of this paper is that mergers are interpreted as acquisitions of new technologies or resources in a dynamic corporate world where bidders are not indifferent between the target staying independent and it merging with a competitor. By modelling the mergers as an efficient reaction to an economic change, we are able to address two fundamental questions of the takeover literature within a rational and value-maximizing framework. First, we show that bidders are willing to systematically overpay for the targets in bidding contests. Then, we show why firms choose to invest in mergers even if they may be unprofitable on average.

In addition to the two main puzzles addressed above, the equilibrium strategies and different synergy realizations produce regions in which various interesting outcomes arise. We show that firms may rationally initiate mergers even when they have a negative expected payoff from initiating. Further, we show that they can have a positive expected payoff from initiating, yet still end up with a negative realized payoff from the merger. Finally, we show that there exist regions of synergy values where the firms maintain a no-merger equilibrium despite having positive synergies associated with the acquisition. In addition to these, we study the bids when there exist two targets available for the bidders and characterize part of the dynamics of a merger wave.

The model's predictions are also consistent with many of the stylized facts of the empirical takeover literature. In our model, acquisitions generate substantial gains that are due to synergies, they cluster around a positive industry-wide shock and acquirors may earn negative to small positive returns on average. However, the main contribution of this paper to the empirical studies on takeovers is its implications on the performance measures of the profitability of mergers. We show that the merger can bring negative returns with respect to the original state, however, it will bring positive returns relative to what the firm's profits would be if the merger did not go through.

This suggests that any study that measures the performance of a merger by benchmarking it to the pre-merger return runs the risk of computing a combined measure for the changing economic conditions and the value it adds to the acquiror. The implication is that, when mergers are thought of acquisitions of resources that yield the acquiror a competitive edge over his competitors, future empirical studies that attempt to measure the profitability of mergers should incorporate the appropriate benchmarks. In future studies, benchmarking the profits with respect to other competitors who acquire another target, employ some other form of restructuring, and do not take any action will provide meaningful answers to some of the questions about the *relative* gains to acquiring firms.

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APPENDIX

Formal Specification of the Equilibrium Concept: The equilibrium concept we employ for solving the game is pure-strategy Bayesian-Nash equilibrium (BNE) in strategies that survive one-round elimination of weakly-dominated strategies. In a BNE, each player is maximizing his expected payoff given the type-contingent strategy of the other player. Formally, given a game in which agent i, $i \in \{1, ..., n\}$, chooses a strategy $x_i \in X_i$ and receives an expected payoff $U_i(x_i, x_{-i})$, a BNE $x^* \in \prod_{i=1}^{n} x_i$ is an allocation s.t.

$$\{(\forall i \in \{1, .., n\})\, (\forall (x_i \in X_i))\, U_i(x_i; x_{-i}^*) < U(x^*)\}.$$

A strategy, $x_i' \in X_i$, is weakly dominated if there exists another strategy, $x_i \in X_i$, such that

$$\{(\forall x_{-i} \in X_{-i}) U_i(x_i, x_{-i}) \geq U_i(x_i', x_{-i}) \; and \; (\exists x_{-i} \in X_{-i}) \; s.t. \; U_i(x_i, x_{-i}) > U_i(x_i', x_{-i})\}.$$

Formal Specification of the Strategies: Let X_i be the choice space of player i, then:

$$X_i = \{(\tau_i, b_{i1}, b_{i0}) | \tau_i \in \{0, 1\}, b_{i1}, b_{i0} \in \mathcal{R}_+ \; and \; b_{i0} = 0 \; for \; \tau_i = 0\}.$$

It follows that the strategy, $x_i(S_i) = (\tau_i(S_i), b_{i1}(S_i), b_{i0}(S_i))$, maps the synergy space into the choice space of player i:

$$x_i : [0, 1] \rightarrow X_i.$$

Proof of Theorem 1: In this game, we are looking for a pure-strategy Bayesian-Nash equilibrium (BNE) in strategies that survive iterated elimination of weakly dominated strategies. We show the elimination for B_i only, even though B_j eliminates the same strategies simultaneously. In each round, we eliminate strategies based on the condition specified as follows: If a strategy x_i does at least as well as x_i' for all strategies $x_j \in X_j$ of the opponent and better for some, then x_i weakly dominates x_i'. First round of elimination involves two steps:

<u>**Step 1a :**</u> $x_i(S_i) = (1, b_{i1}', min\{b_{i0}', S_i + \alpha\})$ dominates $x_i'(S_i) = (1, b_{i1}', b_{i0}')$. Let $x_j' = (0, \frac{b_{i0}' + S_i + \alpha}{2}, 0)$. Then,

$$(\forall x_j \in X_j) U_i(x_i, x_j) \geq U_i(x_i', x_j)$$

and $\exists x_j \in X_j$, namely, x'_j, such that

$$U_i(x_i, x_j) > U_i(x'_i, x_j).$$

For all strategies of the opponent where $b'_{i0} < S_i + \alpha$ playing x_i or x'_i brings player i the same outcome and the same payoff. When $b'_{i0} > S_i + \alpha$, however, playing x_i causes B_i to lose the contest and get a payoff of $-\alpha$. Playing x'_i, on the other hand, causes B_i to win the contest but end up with a payoff of $S_i - \frac{b'_{i0}+S_i+\alpha}{2} = \frac{S_i-\alpha-b'_{i0}}{2} < -\alpha$. Similarly,

Step 1b : $x_i(S_i) = (1, min\{b'_{i1}, S_i{+}\alpha\}, b'_{i0})$ dominates $x'_i(S_i) = (1, b'_{i1}, b'_{i0})$. Let $x'_j = (1, \frac{b'_{i0}+S_i+\alpha}{2}, b_{j0})$.

Step 1c : $x_i(S_i) = (0, min\{b'_{i1}, S_i{+}\alpha\}, 0)$ dominates $x'_i(S_i) = (0, b'_{i1}, 0)$. Let $x'_j = (1, b_{j1}, \frac{b'_{i1}+S_i+\alpha}{2})$.

This step shows that strategies involving bids that are higher than $S_i + \alpha$ are dominated.

Step 2a : $x_i(S_i) = (1, b'_{i1}, max\{b'_{i0}, S_i{+}\alpha\})$ dominates $x'_i(S_i) = (1, b'_{i1}, b'_{i0})$. Let $x'_j = (0, \frac{b'_{i0}+S_i+\alpha}{2}, 0)$.

For all strategies of the opponent where $b'_{i0} > S_i + \alpha$ playing x_i or x'_i brings player i the same outcome and the same payoff. When $b'_{i0} < S_i + \alpha$, however, playing x_i causes B_i to win the contest and obtain a payoff of $S_i - \frac{b'_{i0}+S_i+\alpha}{2} = \frac{S_i-\alpha-b'_{i0}}{2}$. Playing $x'_i(S_i)$, on the other hand, causes B_i to lose the contest and end up with a payoff of $-\alpha < \frac{S_i-\alpha-b'_{i0}}{2}$. Similarly,

Step 2b : $x_i(S_i) = (1, max\{b'_{i1}, S_i{+}\alpha\}, b'_{i0})$ dominates $x'_i(S_i) = (1, b'_{i1}, b'_{i0})$. Let $x'_j = (1, \frac{b'_{i0}+S_i+\alpha}{2}, b_{j0})$.

Step 2c : $x_i(S_i) = (0, max\{b'_{i1}, S_i{+}\alpha\}, 0)$ dominates $x'_i(S_i) = (0, b'_{i1}, 0)$. Let $x'_j = (1, b_{j1}, \frac{b'_{i1}+S_i+\alpha}{2})$.

This step shows that strategies involving bids that are lower than $S_i+\alpha$ are dominated. Therefore, the equilibrium bids are $b_i = S_i + \alpha$ and $b_j = S_j + \alpha$. ■

Proof of Theorem 2: To solve for the equilibrium strategy of bidders with respect to the merger initiation decision at $t = 1$, we maximize B_i's total payoff with respect to his choice variable τ_i given his beliefs about the opponent's strategy. As specified in the payoffs section, the total payoff of B_i simplifies to:

$$\tau_i(S_i)(1 - \tau_j(S_j))\,[A_i] + \tau_j(S_j)\,[A_i]\,,$$

where A_i is the payoff of B_i in the auction which is also specified in the payoffs section with general bid functions as:

$$A_i = I\{b_i > b_j\}(S_i - b_j) + I\{b_i < b_j\}(-\alpha) + I\{b_i = b_j\}\frac{1}{2}(S_i - b_j - \alpha).$$

However, after Theorem 1, we know that $b_i = S_i + \alpha$ and $b_j = S_j + \alpha$. This results in the payoff of the auction for B_i to become simply:

$$A_i = I\{S_i > S_j\}(S_i - S_j - \alpha) + I\{S_i < S_j\}(-\alpha) = I\{S_i > S_j\}(S_i - S_j) - \alpha.$$

Substituting $A_i = I\{S_i > S_j\}(S_i - S_j) - \alpha$ in the total payoff, we obtain:

$$\tau_i(S_i)(1 - \tau_j(S_j))[I\{S_i > S_j\}(S_i - S_j) - \alpha] + \tau_j(S_j)[I\{S_i > S_j\}(S_i - S_j) - \alpha]. \quad (8.1)$$

Based on his beliefs about the opponent's strategy ($\tau_j(S_j)$), B_i maximizes his total payoff with respect to his initiation decision, τ_i. Therefore, the only terms we are interested in including in the expression that is to be maximized are the coefficients of τ_i (the first term of equation 8.1). It can easily be seen that the coefficient of τ_i is increasing in S_i. When the coefficient of τ_i is greater than zero, B_i will set $\tau_i = 1$ hence will initiate the bidding and for values less than zero, he will set $\tau_i = 0$. Therefore, we solve for a cutoff value of synergy that sets the coefficient of τ_i equal to zero.

B_i's beliefs about the opponent's strategy:

Now, bidder i has to form some beliefs about the other bidder's strategy to determine his best-response to it. As both players have symmetric information and similar payoffs, the opponent's total payoff should also be increasing in his own synergy, S_j. As a result, B_i believes that B_j initiates whenever his synergy value is greater than some cutoff and does not initiate otherwise.

Let the opponent's cutoff point be S_{cj}. When B_i observes that the other bidder has initiated (or chose $\tau_j = 1$) at the first stage, he believes that the opponent's synergy value is greater than this cutoff, ($S_j > S_{cj}$), and when he sees that he has not initiated ($\tau_j = 0$), then he believes that ($S_j < S_{cj}$). Incorporating his beliefs into the coefficient of τ_i, we get the following expression:

$$\tau_i(S_i)I\{S_j \leq S_{cj}\}[I\{S_i > S_j\}(S_i - S_j) - \alpha].$$

As the two regions ($I\{S_j \leq S_{cj}\}$ and $I\{S_i > S_j\}$) are both conditions on S_j being smaller, we need to split S_i into two regions as $I\{S_i > S_{cj}\}$ and $I\{S_i < S_{cj}\}$ as follows:[20]

$$\tau_i(S_i)I\{S_i > S_{cj}\}I\{S_j < S_{cj}\}\left[I\{S_j < S_i\}(S_i - S_j) - \alpha\right]$$
$$+ \tau_i(S_i)I\{S_i < S_{cj}\}I\{S_j < S_{cj}\}\left[I\{S_j < S_i\}(S_i - S_j) - \alpha\right].$$

First Region ($I\{S_i > S_{cj}\}$): In the first region, the coefficient of τ_i is :

$$I\{S_i > S_{cj}\}I(S_j < S_{cj})\left[I\{S_j < S_i\}(S_i - S_j) - \alpha\right].$$

As $I\{S_i > S_{cj}\}$ and $I\{S_j < S_{cj}\}$ imply that $Pr(S_j < S_i) = 1$, the *expected* value of the coefficient of τ_i in this region is,

$$\{\Pr(S_j < S_{cj})E_i[(S_i - S_j)|S_i, S_j < S_{cj}] - \alpha\} = \left(S_{cj}S_i - \frac{S_{cj}^2}{2} - \alpha S_{cj}\right).$$

Second Region ($I\{S_i < S_{cj}\}$): Similarly, in the second region, we have :

$$I\{S_i < S_{cj}\}I\{S_j < S_{cj}\}\left[I\{S_j < S_i\}(S_i - S_j) - \alpha\right].$$

As $I\{S_i < S_{cj}\}$ and $I\{S_j < S_i\}$ imply $Pr(S_j < S_{cj}) = 1$, the expected value of the coefficient of τ_i in this region becomes:

$$\{Pr(S_j < S_i)E_i[(S_i - S_j)|S_i, S_j < S_i]\} - \{Pr(S_j < S_{cj})(\alpha)\} = \left(\frac{S_i^2}{2} - \alpha S_{cj}\right).$$

Cutoff Functions :

Now, B_i picks his cutoff by looking at the synergy value that sets the expected value of the coefficient of τ_i equal to zero within each region. Let this cutoff value be S_{ci}. Any synergy value above that will make it more profitable for B_i to initiate than not to initiate a merger.

For $S_i > S_{cj}$, S_{ci} is computed by setting $(S_{cj}S_i - \frac{S_{cj}^2}{2} - \alpha S_{cj}) = 0$. Given the opponent's cutoff, S_{cj}, B_i chooses his own cutoff value, S_{ci}, by the best-response function:

$$S_{ci} = \frac{S_{cj}}{2} + \alpha.$$

[20] Note that $Pr(S_i > S_{cj})(A) + Pr(S_i < S_{cj})(A) = A$ as $Pr(S_i > S_{cj}) + Pr(S_i < S_{cj}) = 1$.

For $S_i < S_{cj}$, we compute S_{ci} by setting $(\frac{S_i^2}{2} - \alpha S_{cj}) = 0$. When his synergy value is less than the opponent's cutoff, B_i's best-response function becomes,

$$S_{ci} = \sqrt{2\alpha S_{cj}}.$$

Due to the symmetric nature of the game, similar best-response functions apply to the other bidder. When $S_j > S_{ci}$, B_j's cutoff function is:

$$S_{cj} = \frac{S_{ci}}{2} + \alpha,$$

and when $S_j < S_{ci}$, it is:

$$S_{cj} = \sqrt{2\alpha S_{ci}}.$$

Let S_c be the symmetric cutoff point(s) where the cutoff functions of the two bidders meet. In equilibrium, two symmetric cutoffs are obtained : $S_c = 0$ and $S_c = 2\alpha$. ■

Proof of Theorem 3: In Theorem 2, we solve for the cutoff points that equate the expected value of initiating to the expected value of not initiating. This represents the expected value of initiating a merger conditional on the opponent not initiating. As 2α only guarantees that the conditional expected value of initiating to be positive, the unconditional expected value of initiating can still be negative.

Here, we look for the cutoff point that guarantees a nonzero expected payoff from initiating for B_i. In other words, we solve for the cutoff value of synergy that equates the *total/unconditional expected value of initiating* to zero.

The expected value of initiating for B_i is simply his expected payoff from the auction:

$$Pr(S_i > S_j)E[(S_i - S_j)|S_i, S_i > S_j] - \alpha = \frac{S_i^2}{2} - \alpha$$

Let S_+ be the synergy value that equates the above expression to zero. Then, the expected payoff of initiating is positive when $S_i > S_+$ where $S_+ = \sqrt{2\alpha}$. Based on his equilibrium strategy B_i initiates a merger since $S_i > S_c$ where $S_c = 2\alpha$. However, we have just shown that the expected value of initiating is negative for $S_i < S_+$. For $\alpha < \frac{1}{2}$, which is the region in which mergers are initiated, $S_+ > S_c$.[21] Therefore, there is a region of realized synergies that fall between these cutoffs. ■

Proof of Theorem 4: Given the equilibrium strategies of bidders, neither bidder initiates for synergy values $S_i, S_j < 2\alpha$. In this region, the expected value of initiating is even more negative than the expected value of not initiating. ■

Proof of Theorem 5: Given his equilibrium strategy, B_i initiates a merger as his synergy value is greater than the equilibrium cutoff, $(S_i > 2\alpha)$ and submits a bid of $b_i = S_i + \alpha$ in the auction. After observing that, B_j enters the auction and submits his bid which is $b_j = S_j + \alpha$. Since $(S_i > S_j)$, B_i wins the contest. However, his payoff from winning is $S_i - b_j = S_i - S_j - \alpha$. As $S_j + \alpha > S_i$, the winner's realized payoff from the auction is negative. ■

Proof of Theorem 6: Given that B_i is the successful bidder (acquiror), what should he expect to earn from the merger on average? To address this question, we look at B_i's payoff in the region where he initiated and won the contest in the two respective industries. In the "strategic" industry, this corresponds to the regions, $(S_i > 2\alpha)$ and $(S_i > S_j)$. That represents the numerator of the expression on the left hand side:[22]

$$\frac{\int_{2\alpha}^{1}\int_{0}^{S_i}(S_i - S_j - \alpha)dS_j dS_i}{\int_{2\alpha}^{1}\int_{0}^{S_i} dS_j dS_i} = -\frac{1}{3}\frac{2\alpha^2 + \alpha - 1}{2\alpha + 1},$$

However, when we look at the returns in the data, we get a sample in which the merger has already happened and the ultimate acquiror has already won the contest. As what we observe are the returns conditional on these two events already having happened, we normalize the payoff in the numerator by the probability of these events to get the conditional returns. That represents the denominator of the above expression.

[21]Recall that when $\alpha > \frac{1}{2}$, the cutoff value is greater than 1 which is the upper bound for the synergy values. Hence, no merger is initiated.

[22]Note that B_i can never win unless he initiates a contest in the strategic industry.

Similarly, the conditional returns to acquirors for the "aggressive" industry where ($S_i > 0$) and ($S_i > S_j$) are,

$$\frac{\int\limits_0^1 \int\limits_0^{S_i} (S_i - S_j - \alpha) dS_j dS_i}{\int\limits_0^1 \int\limits_0^{S_i} dS_j dS_i} = \frac{1}{3} - \alpha.$$

Proof of Theorem 7: In a two-target game, the payoff of B_i at $t = 1$ after at least one of the players initiated is:

$$u_i(\cdot) = \max\{\tau_j\}_{j=1}^{I}(A_{i1})$$

The first auction, A_{i1}, brings the following payoffs:

$$A_{i1} = I\{b_i^1 = \max\{b_j^1\}_{j=1}^{I}\}(S_i - \max\{b_j^1\}_{j \neq i}^{I}) + I\{b_i^1 \neq \max\{b_j^1\}_{j=1}^{I}\}(A_{i2})$$

where A_{i2} is the auction for the second target. Then, A_{i2} is:

$$A_{i2} = I\{b_i^2 = \max\{b_j^2\}_{j=1}^{I-1}\}(S_i - \max\{b_j^2\}_{j \neq i}^{I-1}) + I\{b_i^2 \neq \max\{b_j^2\}_{j=1}^{I-1}\}(-\alpha)$$

Note that, in this section, $b_i^1 = b_i^1(\tau_{-i}; S_i)$ where $\tau_{-i} = \{\tau_j\}_{j \neq i}^{I}$ and $b_i^2 = b_i^2(\tau_{-i}; S_i)$, where $\tau_{-i} = \{\tau_j\}_{j \neq i}^{I-1}$. To be consistent with the strategy specification of the previous section, for all 2^{I-1} different combinations of the initiation decisions of the I opponents, we should specify different bids for player i; b_{ik}^1 where $k = 1$ to $2^{(I-1)}$. However, we know from the previous sections that all $2^{(I-1)}$ bid combinations will be equal in equilibrium, so we choose not to complicate the terminology any further.

STEP 1: Prove by elimination of weakly dominated strategies that $b_i^2 = S_i + \alpha$.

The bidding strategy in the auction for the last target is equivalent to that of the single-target game which is analyzed in the previous section, $b_i^2 = S_i + \alpha$.

The expected payoff of waiting for another period, $E_i(A_{i2})$, is calculated as follows. The expected payment of the winning bidder in a second price auction is the second-highest bid. Let S_k be the value of the second-highest bidder for the second target. Then,

STEP 2: Prove that $E[S_k|S_k = \max\{S_j\}_{j\neq i}^{I-1}, S_k < S_i] = S_i - \frac{S_i}{I-1}$.

The expected value of the synergy value of the second-highest bidder, S_k, is

$$E[S_k|S_k = \max\{S_j\}_{j\neq i}^{I-1}, S_k < S_i] = S_i - \frac{\int\limits_{x=0}^{S_i} (F(x))^{I-2}\, dx}{((F(S_i))^{I-2}} = S_i - \frac{\int\limits_{0}^{S_i} (x)^{I-2} dx}{(S_i)^{I-2}}$$

$$= S_i - \frac{1}{(S_i)^{I-2}}\left[\frac{(x)^{I-1}}{I-1}\right]_0^{S_i} = S_i - \frac{S_i}{I-1}.$$

STEP 3: Prove that $E_i(A_{i2}) = \frac{(S_i)^{I-1}}{I-1} - \alpha$.

This gives us,

$$E_i(A_{i2}) = Pr(S_i = \max\{S_j\}_{j=1}^{I-1})\,(S_i - E[S_k|\cdot]) - \alpha = (S_i)^{I-2}\left(\frac{S_i}{I-1}\right) - \alpha = \frac{(S_i)^{I-1}}{I-1} - \alpha.$$

Incorporating this result into player i's payoff in the first auction, A_{i1},

$$A_{i1} = I\{b_i^1 = \max\{b_j^1\}_{j=1}^{I}\}(S_i - \max\{b_j^1\}_{j\neq i}^{I}) + I\{b_i^1 \neq \max\{b_j^1\}_{j=1}^{I}\}\left(\frac{(S_i)^{I-1}}{I-1} - \alpha\right).$$

The value of the first target to B_i becomes: $S_i - \frac{(S_i)^{I-1}}{I-1} + \alpha$.

STEP 4: Prove that $b_i^1 = S_i - \frac{(S_i)^{I-1}}{I-1} + \alpha$ dominates bids higher or lower.

In a second-price auction, bidding your true valuation dominates bidding any amount higher or lower. As a result, the bid for the first target is:

$$b_i^1 = S_i - \frac{(S_i)^{I-1}}{I-1} + \alpha.$$

Proof of Corollary 1: $b_i^1 < S_i$ is the condition for the players to "underbid" for the target in the sense that they pay less than the synergy value target creates for them. The condition is satisfied when:

$$S_i - \frac{(S_i)^{I-1}}{I-1} + \alpha < S_i \Rightarrow S_i > ((I-1)\alpha)^{\frac{1}{I-1}}.$$