Similar Bidders in Takeover Contests

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Abstract
When bidders in a corporate takeover have related resources and post-acquisition strategies, their valuations of a target are likely to be interdependent. This paper analyzes a theoretical model and a laboratory experiment of takeover contests in which similar acquirers have correlated private valuations. The level of similarity affects information content of bids and bidding competition. The model predicts that expected acquisition prices and the probability of multiple-bidder contests are the highest for intermediately similar bidders. Our experiments indicate overbidding and excessive participation compared to the equilibrium. Accounting for acquirers’ additional utility of winning, the experiments provide support for our model’s predictions.

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1. Introduction

Returns in mergers and acquisitions for acquirer and target not only depend on the value that is created, but also on acquisition premium that is paid. Empirical research indicates that, overall, acquisitions do create value (Andrade, Mitchell and Stafford, 2001; Bargeron, Schlingemann, Stulz, and Zutter, 2008; Betton, Eckbo, and Thorburn, 2008) but gains accrue mostly to targets. Acquiring firms’ returns are, on average, close to zero and exhibit large variation (Stulz, Walkling, and Song, 1990; Leeth, and Borg, 2000; Fuller, Netter, and Stegemoller, 2002; Moeller, Schlingemann, and Stulz, 2005). Taken together, the evidence suggests that acquisition prices are determinative for the division of takeover surplus.

The underlying causes of this variation in prices and returns have been subject to continuous scrutiny in the empirical literature. Surprisingly, the level of competition as measured by the number of bidders does not seem to explain this variation (Boone and Mulherin (2008)). However, characteristics of buyers do appear to be successful in explaining returns.

Guided by this evidence, we develop a model of takeover contests in which the characteristics of potential acquirers matter and affect the intensity of competition. We want to take into account that potential acquirers can be similar or dissimilar because they may have very similar or very unique resources, capabilities, and post-acquisition strategies. More specifically,

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1 Boone and Mulherin (2008) use an extensive data set on potential bidders and control for the endogeneity between returns and the level of competition. Some earlier studies using less detailed data sets show either no significant relation (Kale, Kini, and Ryan, 2003; Betton, Eckbo, and Thorburn, 2008) or mixed results (Schwert, 2000).

2 Bidder size is responsible for a large portion of variation in returns (Moeller, Schlingemann, and Stulz, 2004, 2005). Acquirers with more uncertain growth prospects gain less in acquisitions (Moeller, Schlingemann, and Stulz, 2007). Furthermore, the premiums paid to targets depend significantly on the public status of acquirers and whether acquirers are operating firms or private equity funds (Bargeron, Schlingemann, Stulz, and Zutter, 2008). Among operating firms, acquirer returns depend on the strategic objectives of acquiring firms (such as vertical integration, horizontal integration, or diversification) (Walker, 2000).
we analyze a model of two potential bidders that may sequentially enter a takeover contest. If the bidders are similar, their private values of a target are correlated. After observing the initial bid, the second bidder may decide to pay an entry cost to learn its valuation and to participate in the contest. Entering takeover contests is costly since information on target value requires due diligence costs such as fees for consultants, lawyers and investment bankers. The first bidder may offer a high (preemptive) bid in an attempt to deter the competing firm from entering. Alternatively, a low (accommodating) offer by the first bidder may induce entry by the second bidder and start a competitive auction. The signaling effect of an opening offer depends critically on the similarity between bidders.

The interdependence of bidders’ valuations has two opposing effects on contest participation. On the one hand, a bid from a bidder that is similar creates a greater informational externality and thereby encourages entry by a rival. On the other hand, if bidders are more closely related, the bidding contest is expected to be more competitive. The resulting high prices reduce expected payoffs from participation and thus discourage entry. We show that neither of the effects is dominant but their relative strengths depend on the level of similarity and radically affect bidding strategies, price, and bidders’ participation. Our analysis provides several important new insights and implications.

First, conditional on observing a takeover, the probability of single-bidder acquisitions and multiple-bidder contests varies in similarity between potential bidders. Multiple-bidder contests are most likely between intermediately similar competitors, due to the strength of informational externalities of initial bids that attracts followers. Initial bids from very similar bidders promise an even higher expected target value, but also indicate a fierce bidding competition. As a result,
single-bidder contests are expected mostly between dissimilar (when informational externalities are low) and very similar competitors (when potential competition is high).

Second, expected prices for targets demonstrate an inverted U-shape in the level of bidder similarity. This pattern applies for prices in both single-bidder acquisitions and in multiple-bidder contests. The initial bid embeds informational externalities that signal value, making it attractive for competitors to enter. In single-bidder acquisitions, this means that high preemptive bids are required to deter a competitor that shares some of the sources of value. However, if bidders become very similar, the competition effect on prices starts to dominate informational externalities, and deterrence is possible with a relatively low preemptive bid. When multiple-bidder contests occur, competitive bidding yields higher prices when rivals are more similar. However, when rivals are almost identical, the initial bidder will accommodate only if its valuation is low, but this means that the expected price in the contest will be low as well.

Third, our analysis indicates that in an environment with interdependent values, the similarity of potential bidders is an important measure of competition intensity. Targets’ returns are higher in single-bidder acquisitions than in multiple-bidder contests for any given level of similarity because a premium is required to preempt a rival. However, this does not necessarily imply that empirical data should demonstrate higher target returns in single-bidder acquisitions. As discussed above, multiple-bidder contests are most likely at intermediate levels of similarity at which expected prices are the highest. Conversely, single-bidder acquisitions are most likely at very low and very high levels of similarity when expected prices are lower. This implies that, in a cross-section of acquisitions, the relation between the number of bidders and target returns may show either sign if the level of similarity is not controlled for.
The theoretical predictions of the model are difficult to test empirically using historical acquisition data because information about the identity of preempted bidders, and so their similarity with acquirers, is not readily observable by researchers. To overcome this difficulty, we employ a laboratory experiment with financially well-trained subjects. Relative to tests using field data where many relevant factors change simultaneously, controlled environments of laboratory experiments allow for clear comparative static tests. At the same time, laboratory experiments raise questions about external validity—is the behavior of students-subjects informative about investment strategies of firms? We believe that the experiment can inform us about the validity of our theory. First, the academic literature on takeovers shows that individuals play an important role in investment and acquisition decisions. CEOs’, like all other people, have behavioral biases and these biases not only drive takeovers (Roll, 1986; Berkovitch and Narayanan, 1993), but also affect premiums paid in acquisition (Hayward and Hambrick, 1997; Malmendier and Tate, 2008; Levi, Li and Zhang, 2010). Second, human behavior often deviates from theoretical predictions even in simple auctions [see Kagel (1995) for a survey]. People in general demonstrate systematic biases that may intensify some predicted forces and weaken others. The aim of our experiment is to verify if people respond to the tradeoffs in our model. As such, a laboratory test is a first and important step to validate the relevance of our theoretical predictions to corporate environments.  

The experimental design replicates the model specification. Two groups of subjects play the roles of first or second bidder in an auction for a target. Their valuations are correlated with a correlation coefficient called “similarity level”. The first bidder chooses his first bid and the

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3 Several other papers also use experiments to test corporate takeovers theories, e.g., Kale and Noe (1997), Weber and Camerer (2003), Croson, Gomes, McGinn and Noth (2004), Gillette and Noe (2006), and Kogan and Morgan (2010).
second bidder can decide to enter or not depending on the first bid and the similarity level. In this way, we collect data about preemptive bidding behavior and conditional entry decisions.

The experimental results support the main insights of the model. High first bids deter second bidders from entering. The proportion of single bidder contests demonstrates a non-monotonic pattern in similarity levels, as predicted. However, preemptive first bids exhibit a monotonic increasing relation with similarity levels, rather than the predicted inverted U-shape. Our explanation for this discrepancy between the model and experimental behavior is the utility of winning hypothesis, which states that the pure fact of winning can bring the winning bidder an additional utility (besides actual payoff). The first bidder with utility of winning is willing to pay a high preemptive bid to secure winning and the second bidder with utility of winning is difficult to be deterred, which reinforces high preemptive bids. Utility of winning has a particularly strong effect on preemptive bids in contests between very similar bidders, which are the most competitive. By adding utility of winning to our model, we get a new predicted equilibrium, which includes a non-monotonic preemption proportion and a monotonic acquisition price. The improvement in fit between theory and experiment findings indicates that the utility of winning can play a role in shaping bidding strategies.

This paper is related to the literature on sequential bidding in takeover contests initiated by Fishman (1988). With sequential entry, there is information externality from initial bids. Hence, a high first bid, which signals a high value of initial bidders for the target, can deter competition. Others have extended this model in various directions. Fishman (1989) shows that the medium of exchange can be a supplementary tool for preemption in addition to a high bid. Chowdhry and Nanda (1993) claim that issuing debt commits the bidder to overbidding, which can be preemptive. Burkart (1995), Singh (1998), Bulow, Huang and Klemperer (1999), and Ravid and
Spiegel (1999) study overbidding induced by toeholds. Hirshleifer and Png (1989), Daniel and Hirshleifer (1998) explore takeovers from the perspective of efficiency, and find that, although preemption reduces competition, it may raise expected social welfare if bidding is costly. Che and Lewis (2007) apply the preemption model to a policy analysis of lockups, and discuss how lockups affect competition levels and allocation efficiency. Bulow and Klemperer (2009) compare simultaneous auctions and sequential-entry takeover contests and rationalize the target’s preference for auctions rather than for sequential bidding by showing how preemptive bids transfer surplus from sellers to buyers. The model presented here differs from all these papers in that it investigates the impact of similarity between bidders on equilibrium bids, participation, and returns by assuming private correlated values. Our experiment is the first direct test in a controlled environment of the underlying model of sequential-entry takeover contrasts.

2. A model of takeover contests

2.1. Bidders and target values

Two potential bidders, firms A and B, compete to acquire a target. The private values of the target for the two bidders are allowed to be interdependent. The valuation of firm $i$ is denoted by $v_i$, $i = A, B$. Both valuations are drawn from normal distributions with equal means, $v_0$, standard deviations, $\sigma$, and are correlated with coefficient $\rho \geq 0$. $f_i$ and $F_i$ denote probability density and cumulative distribution functions of $v_i$. Below we use the notation $\tilde{v}_A$ and $\tilde{v}_B$ for the random

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4 Our focus on the single-bidder and two-bidder contests should be not seen as very limiting as few contests have more than two bidders. Bradley, Desai, and Han (1988) report only eight instances of more than two public bidders in their sample of 286 contests. The number of potential bidders may be higher, but Boone and Mulherin (2008), who also identify potential bidders that did not publicly place a bid, provide evidence that our assumption is close to reality in most situations. They show that the average number of potential buyers (those signing confidentiality agreements to access non-public information about the target) is 3.14 (median 1), of private-bid bidders is 1.24 (median 1) and of public-bid bidders is 1.12 (median 1). The low numbers also indicate that it should be relatively easy for firms to identify other potential buyers.
values and \( v_A \) and \( v_B \) for their realizations to clarify the distinction. The bidders know the distributions of both values, but can observe the realizations of their own values only after conducting costly valuation and cannot directly observe the value realizations of the opponent. Target value without a takeover is equal to \( v_0 \). This means that uninformed bidders expect neither to create nor to destroy value in the takeover. The target accepts any offer at or above \( v_0 \).

We model the interdependence of values using non-negative correlation instead of the commonly-used affiliation, mostly because correlation is easier to understand for the subjects in our experiment.\(^5\) It is important to understand how to interpret different levels of the correlation coefficient. The correlation between bidders’ valuations reflects the degree of similarity of the rival bidders’ resources, capabilities, and post-acquisition strategies. More specifically, we have the following examples in mind. Private equity funds often have very similar post-acquisition strategies and are therefore likely to face high correlation between valuations. For example, in leveraged buyouts, the added value is mainly generated by tax shields, high managerial participation, improved monitoring stemming from concentrated ownership and the disciplining effect of leverage. These value drivers are relatively homogenous and can be obtained by a number of capable investors. Strategic buyers are more heterogeneous as they may have built up unique assets and are likely to create unique synergies that depend on the bidders’ assets and resources and their match with the target. Clearly, in some such cases the correlation may be positive and high (e.g., two industry competitors competing for a horizontal merger with a third firm), but in other situations it can be much lower (e.g., an industry leader aiming at horizontal integration and industry consolidation competing against an industry supplier aiming at limiting bargaining power). Zero correlation can be expected if two bidders derive values from a

\(^5\) Note that affiliation is a subset of positive correlation.
completely different match of resources or industry forces, for example, a hostile bidder with an asset-stripping strategy and a strategic bidder valuing the target as a going concern.

2.2. Bidding and payoffs

We consider the following bidding contest. First, bidder A finds a potential target that is suitable for acquisition. Following Fishman (1989), we assume that there are few potential targets so that it is not profitable for acquirers to perform costly due diligence on random firms. Bidder A pays entry cost $c_A$ to get informed about its private valuation $v_A$ of the target. Next, if $v_A$ exceeds the seller’s reservation price, $v_0$, then bidder A places an initial offer $b$. If bidder A does not place a bid, the contest is over, as bidder B does not know the potential target. After observing $b$, bidder B decides whether to enter the contest and to learn its valuation $v_B$ of the target. We denote bidder B’s decision by $e_B \in \{0,1\}$, where $e_B = 0$ indicates that bidder B does not enter the contest and $e_B = 1$ indicates that bidder B pays entry cost $c_B$ and learns $v_B$. Finally, if bidder B enters, the price is determined by an English auction. This means that the bidder with the highest valuation wins the auction and pays the value of the losing bidder.$^6$.$^7$

Entry is assumed to be costly. The entry costs of both bidders include due diligence costs required to learn the value of the target in acquisition. This includes fees to consultants and investment bankers but also other costs such as disclosure costs, financing fees, or opportunity cost of management time. In effect, we assume that a bidder can participate in the takeover contest only if it pays the entry cost. We simplify the analysis and assume that the entry cost of

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$^6$ English auction is also assumed to represent a sequential bidding contest in takeovers in other related studies (Fishman, 1988; Chowdhry and Jegadeesh, 1994; Burkart, 1995; Bulow, Huang, and Klemperer, 1999; and Ravid and Spiegel, 1999; Che and Lewis, 2007). English auction in our model also ensures that the target is sold to the bidder with highest valuation. This is consistent with legal requirements on target management to solicit the highest tender price (see Che and Lewis, 2007).

$^7$ We note that in our setup a clock auction and an action allowing for jump bidding are equivalent; it is always a dominant strategy to bid up to one’s value.
bidder A, $c_A$, is sufficiently low so that bidder A always performs due diligence if it identifies a potential target. Because the game is trivial if bidder A does not place a bid, this is with little loss of generality.

In the game after bidder A’s entry, we derive equilibrium decisions of bidder A to place the initial bid and of bidder B to enter the takeover contest. This signaling game can have multiple equilibria. We focus on the perfect Bayesian equilibrium that is most profitable for bidder A. This is equivalent to selecting the perfect sequential equilibrium or the one satisfying the credibility refinement.\(^8\)

With this game specification, we can determine the bidders’ payoffs contingent on their valuations and actions. Denote by $\pi_i(v_A, v_B, b, e_B)$ the payoff of bidder $i$ as a function of $v_A, v_B, b,$ and $e_B$. The payoff function of bidder A, if it places a bid, can be written as

$$
\pi_A(v_A, v_B, b, 0) = v_A - b - c_A;
$$

$$
\pi_A(v_A, v_B, b, 1) = \begin{cases} v_A - b - c_A & \text{if } v_B \leq b \\ v_A - v_B - c_A & \text{if } b < v_B \leq v_A \\ -c_A & \text{if } v_B > v_A. \end{cases}
$$

Upon winning the contest, bidder A receives the payoff equal to its valuation of the target $v_A$ minus the price paid and minus the entry cost. The winning bidder pays the value of the losing bidder, so the price paid by winning bidder A if $b < v_B \leq v_A$ is $v_B$. Bidder A loses the contest if $v_B > v_A$ and its payoff is then just $-c_A$. Similarly, bidder B’s payoffs are the following:

$$
\pi_B(v_A, v_B, b, 0) = 0;
$$

$$
\pi_B(v_A, v_B, b, 1) = \begin{cases} -c_B & \text{if } v_B \leq v_A \\ v_B - v_A - c_B & \text{if } v_B > v_A. \end{cases}
$$

\(^8\) The equilibrium selection follows Fishman (1988). See also Che and Lewis (2007) and Bulow and Klemperer (2009, footnotes 11 and 21) for more detailed discussions.
2.3. Informational externalities and competition

We take a first look at the influence of bidder A’s offer on bidder B’s beliefs and payoff. An important observation is that the expected payoff may either increase or decrease in the level of similarity between the valuations. Intuition suggests that there are two effects due to correlated valuations. First, if valuations are dependent, then the second bidder can infer some information about its own value of the target from the first offer. Second, if both bidders enter the contest, the level of similarity will affect the competitiveness of the contest and the price paid by the winning bidder. We refer to the former effect as the informational externality effect and to the latter as the competition effect.

Suppose now that bidder A’s strategy is fully revealing. From observing a bid $b$, bidder B can exactly infer the realization of bidder A’s value $v_A$. In other words, we assume here that bidder A’s strategy is separating and each valuation realization stipulates a different bid. Because $v_A$ and $v_B$ are correlated, information about the realization of $v_A$ affects the posterior distribution of $v_B$. Given bidder A’s value $v_A$, the posterior distribution of the value of bidder B is again normal with probability density function denoted by $f_{B|A}$. The expected value is updated to

$$
\mu_{B|A} = E[v_B | v_A] = \rho v_A + (1-\rho)v_0. \tag{3}
$$

It follows from (3) that the informational externality effect of increasing $\rho$ on bidder B’s expected value is positive for all $\rho$ as long as $v_A > v_0$. Because bidder A places a bid only if $v_A$ exceeds $v_0$, the informational externality effect encourages bidder B to participate and bidder B is better off with a correlation with bidder A that is as high as possible.
The posterior standard deviation of $v_B$ is updated to $\sigma_{\theta|A} = \sigma \sqrt{1-\rho^2}$. It is the largest at $\rho = 0$ and decreases as the value of $\rho$ increases. The posterior standard deviation is related to the competition effect and it works through the expected payoff that bidder B obtains from entering the contest. If bidder B knows the realization of $v_A$, this payoff is given by

$$
E[\pi_B(v_A, v_B, b, 1)] = -\int_{v_A}^{v_B} c_B f_{\theta|A}(v)dv + \int_{v_A}^{v_B} (v - v_A - c_B) f_{\theta|A}(v)dv
$$

$$
= \sigma \sqrt{1-\rho^2} \left[ \phi(z_A) - z_A (1 - \Phi(z_A)) \right] - c_B.
$$

where $z_A = (v_A - \mu_{\theta|A}) / \sigma_{\theta|A}$, and $\phi$ and $\Phi$ denote probability density and cumulative distribution functions of the standard normal distribution.

To isolate the competition effect, we set $v_A = v_0$, at which the informational externality effect is absent. Taking the derivative of (4) with respect to $\rho$, we obtain

$$
-\rho \frac{\sigma}{\sqrt{1-\rho^2}} \sqrt{2\pi}.
$$

The sign of this expression—reflecting the competition effect of similarity—is negative if $\rho > 0$. When taking into account only the competition effect, bidder B prefers the correlation to be equal to zero. Intuitively, if both bidders enter the contest and their valuations are not dispersed, then they outbid each other to the point that the expected price paid by the winning bidder is close to its value. In other words, given the mean of its valuation, bidder B prefers to have the highest variance. The effect is caused by the convexity of bidder B’s payoff function in its valuation of the target, so that a higher posterior variance $\sigma_{\theta|A}^2$ leads to higher expected payoffs.

With the assumption of this subsection that $v_A$ is observable, neither the informational externality effect nor the competition effect dominates for all levels of similarity. The derivate of
the expected payoff of bidder B from entering (given in (4)) with respect to \( \rho \) includes both effects and is given by

\[
\frac{\sigma}{\sqrt{1-\rho^2}} \left[ -\rho \phi(z_A) + (1-\rho)z_A (1-\Phi(z_A)) \right].
\] (6)

It is easy to establish that this expression is positive for relatively small positive \( \rho \) (the positive informational externality effect dominates the negative competition effect), and is negative for large positive \( \rho \) (the negative competition effect dominates the positive informational externality effect).

The preceding discussion clearly conveys the intuition for the two effects of similarity, but the separating strategy of bidder A that fully reveals its valuation cannot be sustained by an equilibrium. The next section analyzes strategies of both bidders that can form equilibrium.

3. Bidders’ strategies and equilibrium

3.1. Bidder A: to preempt or to accommodate

We restrict our attention to cut-off pure strategies in which bidder A with valuations within a certain set places a specified bid. These strategies have a clear interpretation in our bidding game: preemption and accommodation. With a preemptive bid, the expected payoff for the second bidder is sufficiently low so that it is deterred from entering. An accommodating bid does not attempt to limit participation of the follower. If bidder A preempts with a bid \( b \), its expected payoff is given by

\[
E[\pi_A(v_A, v_B, b, 0)] = v_A - b - c_A.
\] (7)
If bidder A accommodates, it cannot gain anything from bidding above the reservation value, so its bid is equal to \( v_0 \) and its expected payoff is

\[
E[\pi_A(v_A, \bar{v}_B, v_0, 1)] = \int_{v_{0}}^{v_{A}} \pi_A(v_A, v, v_0, 1) f_{v|B}(v)dv = \int_{v_{0}}^{v_{A}} (v_A - v_0 - c_A)f_{v|B}(v)dv
\]

\[= \int_{v_{0}}^{v_{A}} (v_A - v - c_A)f_{v|B}(v)dv + \int_{v_{0}}^{v_{A}} c_A f_{v|B}(v)dv
\]

\[= \sigma \sqrt{1 - \rho^2} \left[ \phi(z_A) - \phi(z_0) + z_A \Phi(z_A) - z_0 \Phi(z_0) \right] - c_A,
\]

(8)

where \( z_A = (v_A - \mu_{B|A}) / \sigma_{B|A} \) and \( z_0 = (v_0 - \mu_{B|A}) / \sigma_{B|A} \).

Bidder A will be willing to preempt with a bid \( b \) if the expected payoff from preemption exceeds or equals the expected payoff from accommodation, that is if

\[V(v_A, b) \equiv E[\pi_A(v_A, \bar{v}_B, b, 0)] - E[\pi_A(v_A, \bar{v}_B, v_0, 1)] \geq 0.
\]

(9)

Conversely, if \( V(v_A, b) < 0 \), then bidder A is better off with accommodation. Denote by \( \bar{b}(v_A) \) the maximum bid that bidder A with value \( v_A \) is willing to offer to preempt bidder B. This means that with a bid at \( \bar{b}(v_A) \), the condition in (9) holds in equality. Substituting (7) and (8) into (9), we obtain that

\[\bar{b}(v_A) = v_A - \sigma \sqrt{1 - \rho^2} \left[ \phi(z_A) - \phi(z_0) + z_A \Phi(z_A) - z_0 \Phi(z_0) \right].
\]

(10)

For a given preemptive bid \( b \), bidder A’s incentive for accommodation or preemption depends on the realized value of \( v_A \). If \( b \leq \bar{b}(v_A) \), then the expected payoff from preemption is larger than that from accommodation, and the opposite relation holds if \( b > \bar{b}(v_A) \). In the Appendix we prove that the following result holds given that \( \rho \geq 0 \).

**Lemma 1.** \( \bar{b}(v_A) \) increases in \( v_A \geq v_0 \).
The implication of the lemma is that for a given preemptive bid $b$, such that $b = \bar{b}(\nu)$, bidder A with valuation larger than or equal to $\nu$ prefers to preempt rather than to accommodate. This observation justifies our focus on cut-off accommodation and preemption strategies of bidder A.

3.2. Bidder B: to participate or to stay out

We consider here bidder B’s expected payoff when bidder A uses a cut-off strategy. Suppose a bid $b$ is chosen if the realized valuation of bidder A lies in between some $\nu$ and $\bar{\nu}$. Denote by $W(\nu, \bar{\nu})$ bidder B’s expected payoff if it decides to enter the contest (as long as bid $b$ is lower than $\nu$, which is the case in equilibrium, this value depends only on the implied valuations of bidder A, not on the bid itself). Then

$$W(\nu, \bar{\nu}) = \frac{1}{F_A(\bar{\nu}) - F_A(\nu)} \left[ E[\pi_B(v_A, \bar{\nu}, b, 1)] f_A(v_A) dv_A \right].$$

(11)

Bidder B is deterred by the set of bidder A with valuations in $(\nu, \bar{\nu})$ if $W(\nu, \bar{\nu}) \leq 0$. If this is the case, then bidder B’s payoff from entering falls below its payoff from staying out, which is equal to zero.

From Section 3.1 we know that for $\rho \geq 0$, bidder A’s incentives to preempt increase in its own valuation. Therefore bidder A uses a preemptive strategy if its valuations are above some $\nu$. A preemptive strategy works only if it implies that bidder B does not enter, that is, that the expected payoff of bidder B from entering $W$ is non-positive. The following lemma shows that the cheapest such strategies (with $W$ equal to zero) are unique.

**Lemma 2.** There exists at most one $\nu \geq v_0$ that solves $W(\nu, \infty) = 0$. 

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Let us define $v_L$ such that $W(v_L, \infty) = 0$. $v_L$ is the lowest value such that information that $v_A \geq v_L$ deters bidder B from the contest.

The incentives of bidder B to enter are influenced by the informational externality and competition effects. If the negative effects of similarity dominate, bidder B may easily be deterred. In particular, in some cases, bidder B may be deterred by information that $v_A$ exceeds the reservation value, $v_A \geq v_0$, inferred from observing bidder A placing *any* bid. The following lemma specifies when this is the case.

**Lemma 3.** Let $R = \sqrt{2\pi c_p} / \sigma$ and assume that $2R < 1$. If bidder B believes that $v_A \geq v_0$, then bidder B does not enter the contest whenever $\rho < \rho_1 = R - \sqrt{1 - 2R}$ or $\rho > \rho_2 = R + \sqrt{1 - 2R}$.

We assume from now on that $2R < 1$ to focus on interesting cases. If this condition is not satisfied, then bidder B does not participate after a bid from A for any possible value of $\rho$.\(^9\) Lemma 3 states that if bidder B’s only information is that bidder A’s valuation exceeds the reservation price $v_0$, it may still be sufficient as a deterrent if the valuations are interdependent with a low correlation coefficient, $\rho < \rho_1$, or if the valuations are strongly positively correlated, $\rho > \rho_2$. Intuitively, a high value of $v_A$ together with a low correlation promises a low expected value of $v_B$. For example, consider the extreme case with $\rho = -1$. Then $v_A > v_0$ implies $v_B < v_0$ and bidder B makes sure losses with any positive entry cost. On the other hand, a high value of $v_A$ with a high correlation leaves little profit to be earned in the subsequent auction, because

\(^9\)The condition is a result of the requirement that $W(v_0, \infty)$ is positive at least for some values of $\rho$.
values of both bidders are expected to be similar. At the extreme point as \( \rho = 1 \), \( v_B \) is equal to \( v_A \) with probability one, and after entry the price paid is equal to the value, which leaves no profit. At very low and very high correlation, expected payoffs do not compensate the entry cost. We note that for positive \( c_B \) and \( 2R < 1 \), both \( \rho_1 \) and \( \rho_2 \) are inside the domain for a correlation coefficient and are such that \(-1 < \rho_i < 0.5 < \rho_2 < 1\).

3.3. **Equilibrium**

Equilibrium strategies consist of bidder A’s initial bidding strategy \( b \) and bidder B’s entry strategy \( e_B \). In the previous subsections, we outlined the derivation of the strategies in the signaling equilibrium involving the most profitable outcome for bidder A. These strategies can be interpreted as accommodation with a bid at the reservation price that induces entry of the competitor and as preemption with a bid at a premium over the reservation price that deters the other contestant. In some cases, a deterring bid is placed that, while low at the reservation price, effectively deters the competitor.

For example, in the case of the preemptive outcome, the equilibrium is constructed as follows. We have shown that there is a threshold \( v_L \) such that bidder A with \( v_A \geq v_L \) places a preemptive bid and deters bidder B. For this bid not to be imitated by bidder types with \( v_A < v_L \), it must be at least \( \bar{b}(v_L) \). Bidder A with valuations \( v_A < v_L \) cannot match this bid and offers the lowest price \( v_0 \) which invites the second bidder. These results are gathered in the following proposition.\(^{10}\)

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\(^{10}\) For transparency, Proposition 4 is stated for the case \( \rho_1 < 0 \). Using Lemma 3, it holds if \( R < \sqrt{2} - 1 \). The proposition can be adapted to the other case in the obvious way.
Proposition 4. In the game after bidder A enters, there exists equilibrium \((b^*, e^*_A)\) in cut-off strategies with the following properties. If \(v_A \geq v_0\), then bidder A places a bid and there are two cases.

1. If \(0 \leq \rho < \rho_2\), then
   \[
   b^*(v_A) = \begin{cases} 
   \bar{b}(v_L) & \text{if } v_A \geq v_L \\
   v_0 & \text{if } v_0 \leq v_A < v_L,
   \end{cases}
   \]
   \[
   e^*_A(b) = \begin{cases} 
   1 & \text{if } b < \bar{b}(v_L) \\
   0 & \text{if } b = \bar{b}(v_L);
   \end{cases}
   \]

2. If \(\rho \geq \rho_2\), then \(b^*(v_A) = v_0\) and \(e^*_A(b) = 0\).

Figure 1 presents how the equilibrium strategies depend on the level of correlation between the valuations. There are four possible scenarios depending on the correlation \(\rho\) and the first bidder’s valuation \(v_A\). In Region 1 at intermediate levels of correlation, bidder A preempts bidder B with a high bid. This happens for sufficiently high values \(v_A\) such that \(v_A \geq v_L\). In Region 2 at intermediate levels of correlation and at low valuations (but above \(v_0\)), bidder A accommodates. With increasing correlation, the accommodation strategy is first supported by increasing valuations (preemption is difficult due to the informational externality effect). Then with increasing correlation, preemption becomes easier (due to the competition effect) and accommodation is used only by bidder A with relatively low values.\(^{11}\) In Region 3, the bidders are so similar that it does not pay for bidder B to engage in a costly bidding contest. In Region 4,

\(^{11}\) See the Appendix for a proof that \(v_L\) is always non-monotonic in \(\rho\), increasing for low correlation and decreasing for high correlation.
the bidders are so dissimilar that if the target is sufficiently attractive for the initial bidder to place a bid, then bidder B’s expected payoff is too low to participate.

4. Model implications

Similarity between bidders generates the trade-off between the informational externality of the initial bid and competition intensity. The interaction of these two forces leads to a non-monotonic relationship of the correlation coefficient on acquisition strategies and returns. Figure 2 presents numerical comparative statics with respect to the correlation coefficient between bidders’ valuations. Other exogenous parameters are set at $\sigma = 20$, $c_B = 2$, and $v_0 = 50$. These parameters are later used in our experiments. Figures 2.A and 2.B present the probabilities of observing either a single-bidder contest or a multiple-bidder contest conditional on observing a takeover. The probability of single-bidder contests is non-monotonic and has a U-shape. The complementing probability of two-bidder contests is then also non-monotonic and has an inverted U-shape. The two-bidder contests are mostly observed at intermediate positive correlation. The intuition is that it is most difficult to deter the second bidder at these levels of correlation—the information externality is strong enough to attract followers and the post-entry competition is not yet to fierce—and only the highest valuations of the first bidder can serve as an effective deterrent.

Figures 2.C and 2.D plot the expected prices paid for the target in single-bidders contests and multiple-bidder contests. Contingent on observing a single-bidder contest, the offered price has an inverted U-shape in bidder similarity. This non-monotonic effect is driven by the fact that low initial bids may deter competition if the potential competitors are very similar (post-entry bidding competition makes entry unattractive) or very dissimilar (the initial bid does not convey...
much of positive information to potential followers about their valuation of the target). Similarly, contingent on observing a two-bidder contest, the expected price paid by the winning bidder has an inverted U-shape in bidder similarity. The prices are the lowest for very similar and very dissimilar bidders because multiple-bidder contests arise in these cases only when bidders have low valuations for the target (the first bidder cannot afford to place relatively low preemptive bids).

The expected final price in two-bidder contests is lower than the preemptive bid in single-bidder acquisitions for any given correlation. This is because accommodating bids are offered by bidder A only when it has a relatively low valuation or when it expects weak competition. However, two-bidder contests are most likely when the expected prices in two-bidder contests are high, and single-bidder contests are most likely when the prices in single-bidder contests are low. This may explain why empirical evidence of the effects of competition measured by the number of bidders on target returns is inconclusive and frequently demonstrates a puzzling lack of any significant relation. The analysis indicates that the effect of the number of bidders should be controlled for the level of similarity.

5. The experimental setup

As discussed in the introduction, testing the model’s predictions with historical field data is difficult because the identity of preempted bidders, and so their similarity with acquirers, is not observable to researchers. To address this problem and to offer a first test of the model’s trade-offs, we use experimental data in which we can control the combinations of competing bidders and other characteristics of the environment. Specifically, we design a computerized laboratory experiment in which we recreate the exact setting of the model. In different treatments, we
change only the level of interdependence between bidders’ valuations and keep all other variables constant.

5.1. Treatments and hypotheses

The parameters in the experiment are chosen to replicate a takeover opportunity with uncertain value and with sufficient potential profits to make the investment attractive. The mean target value is set at $v_0 = 50$, the standard deviation of the bidders’ valuation, $\sigma$, equals 20, and the entry cost, $c$, equals 2. When there is no rival, this parameter setting leads to an expected payoff of about 30 to a bidder if he or she enters. With competing bidders, the expected payoff of the initial bidder will vary depending on the intensity of competition and the strategies bidders adopt.

We set up three treatments that differ in the level of correlation between bidders’ valuations. The correlations are 0, 0.5, and 0.95. These levels are sufficiently different to represent three typical takeover contests. In the low similarity treatment (with correlation equal to 0), bidders’ valuations are independent. This is as in the standard Fishman (1988) model and we interpret this case as a contest between a strategic bidder and a financial bidder. The intermediate similarity treatment (with correlation equal to 0.5) represents the case of two strategic bidders. The high similarity treatment (with correlation equal to 0.95) represents the case in which bidders’ valuation are highly dependent with each other as in bidding between two financial bidders.

The three treatments generate qualitatively distinctive equilibrium strategies. Table 1 reports the theoretical predictions for equilibrium strategies and outcomes. At low similarity, the minimum bid that can preempt bidder B is 53 and when bidder A’s value is above 58, he chooses to offer this preemptive bid. This implies that single-bidder contests are expected in 66% of observed takeovers and that the average price in two-bidder contests is about 51. At intermediate
similarity, bidder A makes a preemptive bid equal to 60 when his value is above 69 and the proportion of single-bidder contests is significantly lower at 30%, while prices in two-bidder contests are higher at 54. At high similarity, the proportion of single-bidder contests increases to 70%, bidder A will make a preemptive bid of 56 when his value is above 58, and the average price in two-bidder contests decreases slightly to 53. The model predicts a non-monotonic pattern in the proportion of single-bidder contests and acquisition prices. This leads to three testable hypotheses.\(^{12}\)

**Hypothesis 1.** The proportion of single-bidder contests is higher in the low and high treatments than in the intermediate treatment.

**Hypothesis 2.** Acquisition prices in single-bidder contests in the low and high similarity treatments are lower than in the intermediate treatment.

**Hypothesis 3.** Acquisition prices in two-bidder contests in the low and high similarity treatments are lower than in the intermediate treatment.

### 5.2. Experiment implementation

We carried out the experiment in the Erasmus University Behavioural Lab with subjects that are master-level students in economics and finance. 36 subjects took part in the experiment in two identical sessions with different subjects: 20 in a first session and 16 in a second session.

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\(^{12}\) We do not specify a separate hypothesis for preemption values. First, preemption values used by bidder A are not directly observable in the experiment. Second, in the theory, preemption values measure the same behavior as the proportion of single-bidder contests. The proportion of single-bidder contests is the proportion of bidder A’s distribution that falls above preemption value.
In each session, the bidding game was repeated in 30 rounds. Additionally, the subjects first played six unpaid practice rounds to learn about the experimental setup and the game. Our experiment comprised 540 rounds in total. At the beginning of each session, participants were randomly assigned to play a role throughout the entire session: either "first bidder" or "second bidder". Each first bidder was randomly paired with a second bidder in each round to avoid learning bidder characteristics. This was aimed to facilitate the perception of a series of one-shot games.

The sequence of the game was as follows. At the beginning, both bidders were informed about the level of their similarity. The first bidder was assigned his or her valuation of the target and the entry fee was deducted from its account. Next, the first bidder submitted a bid. After observing the first bid and similarity level, the second bidder chose whether to enter or not. If he entered, the entry fee was deducted from his current account and his valuation of the target was revealed. Then the outcome of the auction was automatically determined by an English auction rule – the bidder with the highest valuation bought the target for the second highest bid.\(^{13}\) If instead the second bidder chose not to enter, the game ended and the first bidder bought the target with his first bid.

Each bidder’s valuation of the target was private information. The similarity level and the distribution of bidders’ valuations were known to both bidders. It was also known that the target would not sell below a reservation price of 50. In every round, the first bidder was assigned a new random valuation drawn from normal distribution with a mean of 50 and a standard deviation of 20 truncated at the mean. The first bidder’s valuation is truncated and is above 50.

\(^{13}\) The second highest bid is defined as the second highest value in \{the first bidder’s valuation, the second bidder’s valuation, the first bid\}.
because otherwise no contest is initiated. The value for the second bidder was drawn from a (non-truncated) normal distribution with a mean of 50 and a standard deviation of 20. The second bidder’s valuation was correlated with the first bidder’s valuation with a coefficient equal to the similarity level. To ensure that participants understood the distribution of bidders’ valuations and their interdependent nature, numerical examples were given for different similarity levels.

Each pair of bidders in each round was assigned with a new similarity level drawn from the set {0, 0.5, 0.95} with equal probability. To control for learning across different similarity levels, the sequence of similarity levels was selected randomly. The experimental sessions lasted about two hours and the final payoffs in the experiment were determined by the performance of the participants and by their roles. The accumulated payoffs were recorded by points they earned or lost, with a conversion rate of €1 for every 20 points. Because of the entry fee, the bidders that lost an auction incurred a net loss. To prevent bankruptcy, each bidder was given 60 initial points, which was just sufficient to cover the entire entry fee if he bid in every round. Furthermore, the second bidders were given an additional fixed payment of €5 to compensate for their disadvantaged initial position compared to the first bidders. The range of actual earnings paid to the first bidder was €5.90-17.00, with a mean of €9.00; the range of actual earnings paid to the second bidder was €7.70-10.90, with a mean of €9.00.

6. Experimental results

We start with an overview of aggregate bidder behavior in different treatments. Table 2 presents descriptive statistics of the results. Panel A shows that the first bid in the single-bidder

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14 Alternatively, we could have used a full normal distribution and removed half of the rounds which involved no actions and had no information.

15 The full experiment instructions can be found at the online appendix.
contests is higher than that in the two-bidder contests. The differences are highly significant in all treatments. We take this finding as reassurance that first bids can be preemptive and most subjects were responding sensibly within our experiment.

Panel B of Table 2 provides some support to the theoretical predictions for the proposed effects of similarity between bidders. The proportion of single-bidder contests is moderately lower in the intermediate similarity treatment compared to the low similarity treatment, while the percentage of single-bidder contests in the high similarity treatment is significantly higher than that in the intermediate treatment. The U-shape across the three treatments is in line with Hypothesis 1. The mean price paid in single-bidder contests is lower in the low treatment than in the intermediate treatment (significant at the 5% level), which is consistent with Hypothesis 2. The mean price paid in the high similarity treatment is higher than in the intermediate treatment, at odds with Hypothesis 2; the difference is, however, not significant. The mean prices paid in two-bidder contests exhibit similar pattern. Compared to the intermediate treatment, the low treatment is characterized with lower mean price, which confirms the prediction in Hypothesis 3, while the high treatment has the highest mean price, deviating from Hypothesis 3.

6.1. H1: proportion of single-bidder contests

The second bidder knows only the first bid and the similarity level before he decides whether to participate in the contest. To explain the binary participation decision in a regression analysis, we use these two variables as explanatory variables. Furthermore, considering that the participation decision may also be affected by individual characteristics, we adopt a random-effect probit regression with an individual specific term included in the disturbance. Specifically, we estimate the following model:
\[ y^*_\mu = \gamma_0 + \gamma_1 \text{FirstBid}_\mu + \gamma_2 \text{Low}_\mu + \gamma_3 \text{High}_\mu + \eta_j + \epsilon_\mu \]

\[ y_\mu = \begin{cases} 
1 & \text{if } y^*_\mu \geq 0 \\
0 & \text{if } y^*_\mu < 0
\end{cases} \]

where \( y^*_\mu \) is a latent variable, and \( y_\mu \) is the observed participation decision of \( j^{th} \) second bidder in round \( t \) (with 1 denoting non-participation and 0 participation). Variable \( \text{FirstBid}_\mu \) is the first bid of the first bidder in round \( t \). Variables \( \text{Low}_\mu \) and \( \text{High}_\mu \) are two dummies indicating the low similarity and the high similarity treatments, respectively. We take intermediate similarity as a reference treatment. If the proportion of single-bidder contests indeed exhibits a U-shape, both \( \gamma_2 \) and \( \gamma_3 \) are expected to be positive. Finally, \( \eta_j \) is an individual random effect of subject \( j \) and \( \epsilon_\mu \) is a residual error term; both are assumed to be normally distributed with a mean zero.

Estimation results are presented in Table 3. The positive sign of the coefficient of \( \text{FirstBid} \) confirms that the probability of successful preemption is increasing in the first bid. Furthermore, the positive signs of the coefficients of \( \text{Low} \) and \( \text{High} \) indicate that the probabilities of being preempted in the low and high similarity treatments are higher than in the intermediate similarity treatment. All the estimates of \( \gamma \) are significantly positive. Therefore, the response of the second bidder is consistent with Hypothesis 1. It seems that the second bidders respond to the tradeoff between similarity effects. Low information externality in the low similarity treatment apparently discourages the second bidder from entering. The strong competition effect in the high similarity treatment can also be discouraging. On the contrary, the second bidder is less likely to be preempted in the intermediate treatment because the information externality is relatively large while the competition is not very high.
6.2. H2: prices in single-bidder contests

According to Hypothesis 2, the intermediate treatment should facilitate the highest prices in single-bidder contests. Prices in single-bidder contests are equal to the first bidder’s preemptive bids. To check whether the first bidder’s strategy follows the prediction, we use observations with single-bidder contests and run a simple panel data regression with random effects of the following form:

\[ Price_{ijt} = \beta_0 + \beta_1 Low_i + \beta_2 High_t + \nu_j + \varepsilon_{ijt}. \]

Dependent variable \( Price_{ijt} \) is equal to the acquisition price in single-bidder contests in round \( t \). As before, variables \( Low_i \) and \( High_t \) are indicators for the low similarity and the high similarity treatments. Variable \( \nu_j \) is an individual random effect of the group consisting of \( i^{th} \) first bidder and \( j^{th} \) second bidder assumed normal with a mean of 0.

According to Hypothesis 2, both \( \beta_1 \) and \( \beta_2 \) are expected to be negative. The estimation results are reported in Table 4. \( \beta_1 \) is significantly negative, while \( \beta_2 \) is positive and significant. The first bids in preempted contests are thus monotonically increasing in the similarity level. This implies that the experimental data are consistent with the comparative statics prediction of Hypothesis 2 between the low and intermediate treatments, but not between the intermediate and high treatments.

Recall that Hypothesis 1 found a clear confirmation in the data. This means that with increasing similarity from intermediate to high levels, the second bidder is less likely to participate in the contest. However, in spite of what the model suggests, the first bidder is either willing or is forced by the (expected) behavior of the second bidder to offer a higher preemptive bid to ensure low participation in the high similarity treatment.
6.3. H3: prices in two-bidder contests

The next step is to check prices in two-bidder contests. According to Hypothesis 3, the intermediate treatment boasts the highest average price compared to low and high treatments. To test it, we run a similar regression as above, but the dependent variable changes to prices in two-bidder contests and we use only observations with two-bidder contests. The regression equation is as follows:

\[ Price_{2ijt} = \theta_0 + \theta_1 \text{Low}_i + \theta_2 \text{High}_i + v_g + \epsilon_{ijt} \]

\( Price_{2ijt} \) denotes prices in two-bidder contests, and \( \text{Low}_i \) and \( \text{High}_i \) are two similarity indicators. Again, we control an individual random effect of group \( ij \), \( v_g \), assumed normal with a mean of 0.

As Hypothesis 3 predicts that prices in two-bidder contests in the low and high treatments are lower than in the intermediate treatment, both \( \theta_1 \) and \( \theta_2 \) are expected to be negative. Regression results in Table 5 provide only partial support to this prediction. \( \theta_1 \) is significantly negative, while \( \theta_2 \) is significantly positive. Instead of a non-monotonic pattern, prices in two-bidder contests increase monotonically in similarity, which is similar to the relation we found for prices in single-bidder contests.

6.4. Overbidding and utility of winning

A quantitative comparison of the theoretical predictions and experimental data (see Tables 1 and 2) shows higher rates of contest participation in all experimental treatments and higher acquisition prices in the high similarity treatment. This indicates that we observe some type of overbidding behavior for both bidders. While such behavior is not accounted for by our rational
model with standard preferences, overbidding in auction experiments has been widely documented (Cox, Smith, and Walker, 1988; Goeree, Holt, and Palfrey, 2002).

A common and successful explanation for overbidding in auction experiments is the utility of winning hypothesis. Utility of winning refers to situations in which bidders enjoy extra utility when they win an auction and take this into account when making their decision. It has been repeatedly shown to play an important role, especially in private-value auctions (Cox et al., 1988; Goeree et al., 2002; Cooper and Fang, 2008).

We explore how utility of winning changes our predictions and if these new predictions can achieve a better match with the experimental data. Utility of winning transforms the bidders’ utility conditional on winning. The extent of utility when winning may be related to the magnitude of the payoff; the higher the payoff, the stronger the positive feeling of winning. Accordingly, we revise the utility of bidder $i$ to

$$U_i = \begin{cases} 
  m\pi_i & \text{if } i \text{ wins} \\
  \pi_i & \text{if } i \text{ loses}
\end{cases}$$

(12)

where $m$ is a multiplier denoting a utility that will amplify the utility in winning cases by $m$ times. Optimal strategies of both bidders can be solved for any value of $m$. We estimate $m$ at a level that is most consistent with the observed behavior in the experiment. For each $m$, we calculate the predicted preemptive bid $b_k$ in the three treatments, $k=\text{low, intermediate, high}$.

The second bidder’s predicted response in treatment $k$ is to enter if the first bid is below $b_k$ and

\[16\] Besides utility of winning, we also checked other explanations for overbidding, such as loss aversion, over-optimism and excessive entry of the second bidder. However, these alternative explanations fail to provide a better fit than utility of winning. Furthermore, these behavioral factors cannot explain co-existence of a non-monotonic proportion of single-bidder contests and monotonic preemptive bids.

\[17\] We also tried a specification of a constant utility of winning, as used in Goeree et al. (2002), i.e., $U_i = \pi_i + w$, where constant $w$ denotes additional utility brought by winning. This payoff insensitive model produces a similar result as the specification in (12) but with a bit higher prediction error (156). To make the discussion concise, we report only the model with a proportional utility of winning.

29
not to enter if the first bid is above \( b_1 \). A prediction error is defined as the difference between actual entry decisions and predicted ones (entry equals to 1 and non-entry equals to 0). By minimizing the sum of squared prediction errors across a grid over \( m \), we get the estimate of \( m \) [this simple procedure follows Levine and Palfrey (2007)].

The estimated parameters and new predictions are reported in Table 6. Compared to the previous predictions with the baseline model, the fit in entry decision is improved. In the baseline model, entry decisions in 179 observations are different from our theoretical prediction, while in the model with utility of winning this prediction error is reduced by 26.\(^{18}\) \( m \) is estimated at 1.22. This implies that when a bidder wins, the utility experienced is 22\% higher than the nominal payoff. The value of parameter clearly larger than one is indicative of the existence of utility of winning.\(^{19}\) Notably, the new predictions have the same comparative statics as those found in the data. The proportion of single-bidder contests exhibits a U-shape (as in the baseline model), while the acquisition prices are now increasing in the similarity level. Utility of winning improved the fit by altering predictions in those areas where the baseline model had problems explaining the data, i.e., in the high similarity treatment and more for preemptive bid and prices in two-bidder contests than for participation rates.

To understand the role of utility of winning, we need to address two questions. Why does utility of winning alter the predicted strategies mostly in the high similarity treatment? Figure 3 plots the probability of winning for each bidder conditional on the second bidder’s entry. The chance that the first bidder (the second bidder) wins decreases (increases) in similarity. Hence,

\(^{18}\) By estimating a preemptive bid \( b_1 \) that best explains the second bidder’s entry decisions in the data regardless of the theoretical predictions, we achieve a prediction error of 134. Taking this into consideration, a reduction of 26 can be viewed as a sizable improvement.

\(^{19}\) We also estimated \( m \) separately for each subject. The estimation ranges from 0.28 to 3.89, with a mean of 2.09. The median is 1.99 and the standard deviation is 0.91. All but three estimations are larger than 1, again supporting the utility of winning hypothesis.
utility of winning brings two effects to the bidders’ incentives. First, to secure winning, the first bidder is willing to offer a high preemptive bid especially in the high treatment. Second, to have a chance of winning, the second bidder is especially willing to enter in the high treatment. Both effects imply that utility of winning will affect bidding and entry strategies mostly at high similarity. The second question to address is: Why is the acquisition price more affected by utility of winning than the entry decision? For the entry decision, a high participation rate of the second bidder is mitigated by the first bidder’s willingness to offer a higher preemptive price. On the contrary, these two effects reinforce each other while affecting acquisition prices in the presence of utility of winning. Both the first bidder’s willingness to invest more in deterrence and the second bidder’s stronger reluctance to be preempted will drive up prices in single-bidder contests (preemptive bid). Furthermore, a high participation rate reinforces a competition effect, which leads to the highest prices in two-bidder contests in the high similarity treatment.

To summarize, we find evidence indicating that utility of winning may play a role in bidding strategies. However, it remains a question whether this finding can be generalized to explain the high takeover premium observed outside the laboratory environment. The stakes in the experiment are much smaller than in corporate takeovers and subjects visiting a laboratory may be particularly prone to pursue winning. CEOs of acquisitive companies, however, are likely to have other and also strong impulses to chase acquisitions for extra non-pecuniary utility. The main reason is that managers operate under agency conflicts. If, apart from value creation, there is additional utility of winning in acquisitions, then managers internalize the majority of the utility but their share in value creation or destruction is at most partial. This means that the decision makers’ incentives are skewed from value creation towards utility of winning. This observation is consistent with a large body of empirical evidence that documents that corporate
acquisitions are, to a large degree, driven by managers’ empire building incentives and managerial hubris.

7. Conclusions

This paper has shown that interdependence (or similarity) in bidders’ private valuations has significant effects on the strategies and outcomes in sequential-entry takeover contests. With interdependent valuations, the initial bid not only conveys information about the first bidder’s valuation but also about other potential bidders’ valuations. Besides this information externality, similarity levels indicate the intensity of bidding competition if both bidders enter the contest. The information externality and the intensity of competition determine the chances of preemption and equilibrium acquisition prices. Our theory for takeover contests predicts that the information externality effect dominates at low levels of similarity and the competition effect dominates at high levels of similarity. The interplay of these two forces generates a non-monotonic effect of similarity: the proportion of multiple-bidder versus single-bidder contests and the level of acquisition prices are the highest at intermediate levels of similarity.

To verify whether these predictions hold, we carried out a controlled laboratory experiment. Subjects participated in three treatments that differed in the level of interdependence between valuations. The comparative statics prediction with respect to the proportion of single-bidder contests is strongly supported by the data. The effect of similarity on acquisition prices finds only partial support. We further find that the bidders in the experiment tend to overbid and excessively participate. By extending the takeover model with utility of winning, a standard explanation of overbidding, we can support all the comparative statics found in the data. Overall, these results indicate that subjects reacted strategically to the effects of information externality.
and competition intensity in the way predicted by our model. We suggest that overbidding and utility of winning found in the laboratory have parallels in the corporate world in forms of empire building tendencies and managerial hubris.

Our findings on the differences between takeover contests with different similarity levels between bidders can be summarized as follows. Contests between dissimilar potential acquirers (e.g., a strategic bidder against a financial bidder) have low prices and are relatively often single-bidder contests. Contests between intermediately similar bidders (e.g., two strategic bidders) generate high prices and are frequently competitive with two bidders placing bids. Contests in which potential acquirers are very similar (e.g., two financial bidders) have high prices and are seldom with more than one bidder.

In conclusion, this paper reveals a strong influence of bidders’ similarity on takeover strategies. The theory and the experiment imply that, in addition to the number of bidders, the similarity in bidders’ characteristics is an important measure of competition intensity which should be accounted for in empirical studies of returns in takeovers.

Appendix. Proofs

Proof of Lemma 1: Taking the derivative of (10) with respect to $v_A$ we obtain

$$
\bar{B}(v_A) = 1 - \Phi(z_0) - (1 - \rho)(\Phi(z_A) - \Phi(z_0))
\geq 1 - \Phi(z_0) - (\Phi(z_A) - \Phi(z_0)) = 1 - \Phi(z_A) \geq 0. \tag{13}
$$

In the first inequality we use that $z_A \geq z_0$ and $\rho \geq 0$. □

Proof of Lemma 2: Let $v \in \{v: W(v, \infty) = 0\}$. We will show that $v$ is unique if it exists. By (11) $W(v, \infty) = 0$ is equivalent to
\[ \int_{\mathcal{Z}} E[\pi_B(v_A, \bar{v}_B, b, 1)] f(v_A) dv_A = 0. \tag{14} \]

Note that \( E[\pi_B(v_A, \bar{v}_B, b, 1)] \) (given in (4)) is negative for large \( v_A \), \( E[\pi_B(\infty, \bar{v}_B, b, 1)] = -c_B < 0 \).

Since \( f(v_A) \) is always positive, \( E[\pi_B(v_A, \bar{v}_B, b, 1)] \) must be positive for some \( v_A \geq \gamma \), for the root \( v \) in (14) to exist. Because \( E[\pi_B(v_A, \bar{v}_B, b, 1)] \) is decreasing in \( v_A \):

\[
\frac{\partial E[\pi_B(v_A, \bar{v}_B, b, 1)]}{\partial v_A} = \sigma \sqrt{1 - \rho^2} \left[ -z_A f(z_A) - 1 + \Phi(z_A) + z_A f(z_A) \right] \frac{dz_A}{dv_A} \\
= \sigma \sqrt{1 - \rho^2} \left[ \Phi(z_A) - 1 \right] \frac{(1 - \rho)}{\sigma_{\beta_A}} \leq 0,
\]

it must be then that

\[ E[\pi_B(v_A, \bar{v}_B, b, 1)] > 0. \tag{15} \]

Suppose now that \( v \) exists so that (15) holds. Then the derivative of \( W(v, \infty) \) with respect to \( v \) evaluated at \( v \) is negative:

\[
\frac{d}{dv} W(v, \infty) \bigg|_{v = \gamma} = \frac{f(v)}{1 - F(v)} \int_{\mathcal{Z}} E[\pi_B(v_A, \bar{v}_B, b, 1)] f(v_A) dv_A - \frac{f(v)}{1 - F(v)} E[\pi_B(v, \bar{v}_B, b, 1)] \\
= \frac{f(v)}{1 - F(v)} (W(v, \infty) - E[\pi_B(v, \bar{v}_B, b, 1)]) \\
= -\frac{f(v)}{1 - F(v)} E[\pi_B(v, \bar{v}_B, b, 1)] \\
< 0.
\]

Since \( W(v, \infty) \) is a continuous function, it follows that it must have at most one root. Therefore the solution to \( W(v, \infty) = 0 \) is unique if it exists. \( \square \)

**Proof of Lemma 3:** We will use the following integrals for some constants \( m \), \( n \), and \( h \):

\[ ... \]

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\[
\int_{m}^{n} \phi(hx)\phi(x)dx = \frac{\Phi(Hn) - \Phi(Hm)}{H \sqrt{2\pi}},
\]
\[
\int_{m}^{n} x\Phi(hx)\phi(x)dx = \frac{h}{H \sqrt{2\pi}} \left(\Phi(Hn) - \Phi(Hm)\right) + \phi(m)\Phi(hm) - \phi(n)\Phi(hm),
\]
where \( H = \sqrt{1 + h^2} \). Then
\[
W(v, \bar{v}) = \frac{1}{F_A(\bar{v}) - F_A(v)} \left[ E[\pi_B(v_A, \bar{v}_b, b, 1)]f_A(v_A)dv_A \right]
\]
\[
= \frac{1}{F_A(\bar{v}) - F_A(v)} \left[ \int \sigma \sqrt{1 - \rho^2} \left( \phi(z_A) - z_A(1 - \Phi(z_A)) \right) - c_B \right] f_A(v_A)dv_A
\]
\[
= \frac{\sigma - \rho \sigma}{\Phi(\bar{y}) - \Phi(y)} \left[ \frac{H}{h \sqrt{2\pi}} \left( \Phi(H\bar{y}) - \Phi(Hy) \right) - \phi(y)(1 - \Phi(h\bar{y})) - \phi(\bar{y})(1 - \Phi(hy)) \right] - c_B,
\]
where \( y = (v - v_0) / \sigma \), \( \bar{y} = (\bar{v} - v_0) / \sigma \), \( h = (1 - \rho) / \sqrt{1 - \rho^2} \) and \( H = \sqrt{1 + h^2} \). In the second line of (17) we use (4) and the third line follows from (16).

If bidder A’s valuation is above \( v_0 \), then bidder B’s expected payoff from entering is equal to
\[
W(v_0, \infty) = \frac{1}{\sqrt{2\pi}} \left[ \sigma \sqrt{2(1-\rho)} - \sigma(1-\rho) \right] - c_B.
\]
The expression follows from (17). Bidder B does not enter if \( W(v_0, \infty) \leq 0 \). Solving this quadratic inequality for \( \rho \), yields \( \rho_1 \) and \( \rho_2 \) given in the proposition. They exist and are distinct under the assumption that \( 2R < 1 \).

**Proof of the non-monotonic shape of \( v_L \) in \( \rho \)**: We show that \( v_L \) increases in \( \rho \) at low \( \rho \) and decreases in \( \rho \) at high \( \rho \). Since \( v_L \) is defined by \( W(v_L, \infty) = 0 \), we have that \( dv_L / d\rho = -\partial W / \partial \rho / \partial W / \partial v_L \). As shown in the proof of Lemma 2, \( \partial W / \partial v_L \) is negative, so \( dv_L / d\rho \) has the same sign as \( \partial W / \partial \rho \). Differentiating (17), we obtain
\frac{\partial W(v_L, \infty)}{\partial \rho} = \frac{-\sigma}{1 - \Phi(y_L)} \left[ \frac{H}{2h\sqrt{2\pi}} \left(1 - \Phi(Hy_L)\right) - \Phi(y_L)\left(1 - \Phi(hy_L)\right)\right], \quad (18)

where \( y_L = (v_L - v_o) / \sigma \).

Suppose first that \( \rho_i \geq 0 \). Then the lowest \( \rho \) that supports preemption is \( \rho_i \). At \( \rho = \rho_i \), \( v_L = v_o \) and so \( y_L = 0 \). We have

\left. \frac{\partial W(v_o, \infty)}{\partial \rho} \right|_{\rho = \rho_i} = \frac{\sigma}{\sqrt{2\pi}} \frac{\sqrt{2(1 - \rho_i)} - 1}{\sqrt{2(1 - \rho_i)}} > 0.

The inequality holds because \( \rho_i < 0.5 \) and thus \( 2(1 - \rho_i) > 1 \).

Suppose next that \( \rho_i < 0 \). Then preemption is possible at \( \rho = 0 \). At \( \rho = 0 \), \( v_L > v_o \) and so \( y_L > 0 \). When \( \rho = 0 \), \( h = 1 \) and \( H = \sqrt{2} \), and (18) becomes

\left. \frac{\partial W(v_L, \infty)}{\partial \rho} \right|_{\rho = 0} = \frac{\sigma}{1 - \Phi(y_L)} \left[ \Phi(y_L)\left(1 - \Phi(y_L)\right) - \frac{1}{2\sqrt{\pi}}\left(1 - \Phi(\sqrt{2}y_L)\right)\right],

which has the same sign as \( G(y_L) \), where

\[ G(y_L) = \Phi(y_L)\left(1 - \Phi(y_L)\right) - \frac{1}{2\sqrt{\pi}}\left(1 - \Phi(\sqrt{2}y_L)\right). \]

Because \( y_L > 0 \),

\[ G'(y_L) = -y_L\Phi(y_L)\left(1 - \Phi(y_L)\right) - \phi'(y_L) + \frac{\phi(\sqrt{2}y)}{\sqrt{2\pi}} = -y_L\Phi(y_L)\left(1 - \Phi(y_L)\right) < 0. \]

In addition, \( G(0) = 1/(2\sqrt{2\pi}) - 1/(4\sqrt{\pi}) > 0 \) and \( G(\infty) \to 0^+ \). It follows that the sign of function \( G(y_L) \) is always positive, which means that \( \frac{\partial W}{\partial \rho} \bigg|_{\rho = 0} \) is positive. The signs of the derivatives at \( \rho = \rho_i \) (if \( \rho_i \geq 0 \)) and \( \rho = 0 \) (if \( \rho_i < 0 \)) show that the preemptive value first increases in similarity level.
The highest $\rho$ that supports preemption is $\rho_2$. At $\rho = \rho_2$,

$$\frac{\partial W(v_0, \infty)}{\partial \rho}_{\rho = \rho_2} = -\frac{\sigma}{\sqrt{2\pi}} \frac{\sqrt{2(1-\rho_2)} - 1}{\sqrt{2(1-\rho_2)}} < 0.$$

The sign is negative because $2(1-\rho_2) > 1$. This shows that the preemptive value $v_L$ decreases in $\rho$ at high $\rho$. □

References


Figure 1. Equilibrium strategies in the bidding game (with bidder A participating) for various correlations $\rho$ and bidder A’s valuations $v_A$. The figure on the left presents the case of $\rho_1 \leq 0$ and the one on the right presents the case of $\rho_1 > 0$. Regions 1-4 specify qualitatively different strategy pairs.
Figure 2. Non-monotonic effects of correlation $\rho$. The figures present the preemptive bid (A), the expected price paid in a two-bidder contest (B), the probability of preemption (C) and of two-bidder contests (D) for different levels of the correlation coefficient between the bidders’ valuations. All the values are calculated for $\sigma = 20$, $c_B = 2$, and $v_0 = 50$. 
Figure 3. Winning probabilities of each bidder conditional on the second bidder’s entry. The probability is calculated from the generated data used in the experiment assuming that the second bidder always enters.
Table 1. Theoretical predictions in the three treatments.

*Single-bidder contests* denotes the proportion of contests in which bidder B does not participate; *Price in single-bidder contests* denotes the level of the first bid that deters bidder B from entering (preemptive bid); *Price in two-bidder contests* denotes the average price in cases where bidder B enters; and *Preemption value* denotes the level of the first bidder valuation above which he decides to place a preemptive bid. The numbers are rounded to integer values.

<table>
<thead>
<tr>
<th>Similarity treatment</th>
<th>Single-bidder contests</th>
<th>Price in single-bidder contests</th>
<th>Price in two-bidder contests</th>
<th>Preemption value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>66%</td>
<td>53</td>
<td>51</td>
<td>58</td>
</tr>
<tr>
<td>Intermediate</td>
<td>30%</td>
<td>60</td>
<td>54</td>
<td>69</td>
</tr>
<tr>
<td>High</td>
<td>70%</td>
<td>56</td>
<td>53</td>
<td>58</td>
</tr>
</tbody>
</table>

* Based on the generated data used in this experiment. The predictions based on the exact theoretical distribution are 67%, 34%, and 67% for Low, Intermediate and High treatments, respectively.
Table 2. Descriptive statistics of the experimental results.

Statistics are calculated from 540 experimental observations. In Panel A, the data are split into two subgroups depending on the number of bidders active in the contest. Columns report the percentage of the two types of contests (Proportion) and the mean of the first bids (First bid) and prices across the three treatments. The last two columns present the difference in first bids across the two types of contests and t-statistics for differences between means. Panel B reports t-statistics for differences between means of the proportion of and prices paid in two types of contests across the three treatments. Parentheses report number of observations or standard errors.

### Panel A: Statistics for each contest outcome

<table>
<thead>
<tr>
<th>Similarity treatment</th>
<th>Single-bidder contests</th>
<th>Two-bidder contests</th>
<th>First bid difference</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Proportion</td>
<td>First bid [=Price]</td>
<td>Proportion</td>
</tr>
<tr>
<td>Low</td>
<td>27%</td>
<td>56</td>
<td>73%</td>
</tr>
<tr>
<td></td>
<td>(N=132)</td>
<td>(0.93)</td>
<td>(N=48)</td>
</tr>
<tr>
<td>Intermediate</td>
<td>22%</td>
<td>58.79</td>
<td>78%</td>
</tr>
<tr>
<td></td>
<td>(N=141)</td>
<td>(1.28)</td>
<td>(N=39)</td>
</tr>
<tr>
<td>High</td>
<td>39%</td>
<td>60.8</td>
<td>61%</td>
</tr>
<tr>
<td></td>
<td>(N=110)</td>
<td>(1.42)</td>
<td>(N=70)</td>
</tr>
</tbody>
</table>

### Panel B: Differences between treatments

<table>
<thead>
<tr>
<th>Comparison pair</th>
<th>Proportion of single-bidder contests</th>
<th>Price in single-bidder contests</th>
<th>Price in two-bidder contests</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>t-stat</td>
<td>Mean</td>
</tr>
<tr>
<td>Low – Intermediate</td>
<td>5%</td>
<td>1.11</td>
<td>-2.79</td>
</tr>
<tr>
<td>High – Intermediate</td>
<td>17%</td>
<td>3.56</td>
<td>2.01</td>
</tr>
</tbody>
</table>

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**Table 3.** Random-effects probit regression on proportion of single-bidder contests.

Regression is done on all experimental data, with a sample size equal to 540. The dependent variable takes a value 1 if the second bidder does not participate in the contest and 0 otherwise. $FirstBid$ is the first bid of the first bidder. $Low$ and $High$ are dummies for the similarity treatments. The second column reports estimated coefficients and standard errors. The third column reports predicted signs and t-statistics.

<table>
<thead>
<tr>
<th>Variable</th>
<th>$\gamma$ estimate</th>
<th>Predicted sign</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(s. e.)</td>
<td>(t-stat)</td>
</tr>
<tr>
<td>FirstBid</td>
<td>0.06 (0.01)</td>
<td>$H_0: \gamma_1 &gt; 0$ (6.53)</td>
</tr>
<tr>
<td>Low</td>
<td>0.31 (0.17)</td>
<td>$H_0: \gamma_2 &gt; 0$ (1.86)</td>
</tr>
<tr>
<td>High</td>
<td>0.52 (0.16)</td>
<td>$H_0: \gamma_3 &gt; 0$ (3.19)</td>
</tr>
<tr>
<td>Constant</td>
<td>-4.55 (0.61)</td>
<td>--</td>
</tr>
</tbody>
</table>
Table 4. Linear regression on prices in single-bidder contests.

Only data in single-bidder contests are included, with a sample size equal to 157 observations. The dependent variable is the price paid for the target in single-bidder contests. Low and High are dummies for the similarity treatments. The second column reports estimated coefficients and standard errors. The third column reports predicted signs and t-statistics.

<table>
<thead>
<tr>
<th>Variable</th>
<th>$\beta$ estimate (s.e.)</th>
<th>Predicted sign (t-stat)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>-1.36 (0.73)</td>
<td>$H_0: \beta_1 &lt; 0$ (-1.87)</td>
</tr>
<tr>
<td>High</td>
<td>2.9 (0.73)</td>
<td>$H_0: \beta_2 &lt; 0$ (3.99)</td>
</tr>
<tr>
<td>Constant</td>
<td>54.89 (0.72)</td>
<td>--</td>
</tr>
</tbody>
</table>
Table 5. Linear regression on prices in two-bidder contests.

Only data in two-bidder contests are analyzed, which include 383 observations. The dependent variable is the price paid for the target in two-bidder contests. Low and High are dummies for the similarity treatments. The second column reports estimated coefficients and standard errors. The third column reports predicted signs and t-statistics.

<table>
<thead>
<tr>
<th>Variable</th>
<th>$\theta$ estimate (s.e.)</th>
<th>Predicted sign (t-stat)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>-1.81 (1.01)</td>
<td>$H_0: \theta_1 &lt; 0$ (-1.79)</td>
</tr>
<tr>
<td>High</td>
<td>4.03 (1.06)</td>
<td>$H_0: \theta_1 &lt; 0$ (3.84)</td>
</tr>
<tr>
<td>Constant</td>
<td>57.80 (0.72)</td>
<td>--</td>
</tr>
</tbody>
</table>
Table 6. Theoretical predictions of the model extended with utility of winning.

*Single-bidder contests* denotes the proportion of contests in which bidder B does not participate; *Price in single-bidder contests* denotes the level of the first bid that deters bidder B from entering (preemptive bid); and *Price in two-bidder contests* denotes the average price in contests where bidder B participates. The numbers are rounded to integer values. To make it comparable with the experimental results, the theoretical proportion of single-bidder contests is calculated with the randomly generated data used in this experiment. The utility of winning parameter, $m$, is estimated by minimizing the sum of squared errors between the predicted participation decision and the actual participation decisions in the data.

<table>
<thead>
<tr>
<th>Similarity treatment</th>
<th>Single-bidder contests</th>
<th>Price in single-bidder contests</th>
<th>Price in two-bidder contests</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>58%</td>
<td>54</td>
<td>51</td>
</tr>
<tr>
<td>Intermediate</td>
<td>20%</td>
<td>61</td>
<td>55</td>
</tr>
<tr>
<td>High</td>
<td>29%</td>
<td>68</td>
<td>58</td>
</tr>
</tbody>
</table>

- Estimated parameters $m = 1.22$
- Sum of squared errors 153
- Sum of squared errors in the baseline model 179

* Based on the generated data used in this experiment.