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ABSTRACT

Surprisingly few papers have attempted to develop a direct empirical test for overbidding in M&A contests. We develop such a test grounded on a necessary condition for profit maximizing bidding behavior. The test is not subject to endogeneity concerns. Our results strongly support the existence of overbidding. We provide evidence that overbidding is related to conflicts of interest, but also some indirect evidence that it arises from failing to fully account for the winner's curse.

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Keywords: mergers and acquisitions; hubris hypothesis; overbidding

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Introduction

The hubris hypothesis of Corporate Takeovers[1] provides a potential explanation of the observed negative acquirer cumulative abnormal returns (CARs) around mergers and acquisition (M&A) announcements commonly reported during the eighties[2]. The explanation combines bidding competition and valuation error. During the takeover contest, bidders compete to acquire the target. The winner posts the highest bid. Because bids increase with assessments of value, the winning bidder generally has one of the highest valuations. This is bad news for the winner because part of the target value originates from valuation common to all bidders. Participants in takeover contests should rationally anticipate the winners' curse and shade their bids accordingly. If they do not, the ex-post observed value-effect of acquiring the target could be negative[3,4].

Numerous empirical papers continue to report negative acquirer CARs, at least for large transactions involving listed targets (see Betton et al., 2008, for an extensive review of M&A research). But negative acquirer CARs are not unambiguous proof of overbidding. Acquisition announcements deliver information not only about the transaction itself but also about the acquirer's current condition and strategy (the revelation effect). Akdogu (2011), for example, emphasizes that acquisitions can be undertaken in response to competitive pressures of which the market is unaware prior to the bid. In such a circumstance, negative acquirer CARs are compatible with value creating transactions because, in the absence of the transaction, acquirers would have been even worse off. Wang (2015) develops a structural model based on this intuition. The author estimates that M&As on average create value for acquirers in excess of 13% once the revelation effect and the acquirer run-up are taken into account. Even assuming that acquisition announcements deliver only transaction level information, negative acquirer

[1] Roll (1986)

[2] At that time, existing empirical studies had rather small samples of a few hundred large transactions. Since then, newer investigations have focused on far larger numbers of transactions (e.g., Fuller et al., 2002). These studies show that negative acquirer CARs are observed mainly when targets are publicly traded firms. This accords with the hubris idea that the observed market price of a target is an accurate estimate of value.

[3] When the target is a publicly traded company, the established market price already represents a de facto bid, so an acquirer must have a valuation exceeding the market price. Even if there is only one acquirer (in addition to the market), the winner's curse could still have an impact.

[4] Burkart (1995) develops an alternative auction theory based argument to explain overbidding. The author shows that, in private-value auctions, a bidder with partial ownership may rationally overbid and this overbidding may lead the winning bidder to suffer from a net loss.

CARs are not unambiguous evidence of overbidding. We show, in Appendix A, in a highly stylized perfect information setup, that equilibrium bidding strategies are potentially compatible with value destruction in industries with significant exit costs.

Bhagat et al. (2005), using a combination of probability scaling and intervention methods, report that perceived value improvements are much larger than previously thought. Comparing the deal value improvement to the toehold-adjusted bid premium, the authors conclude that bidders on average pay fair prices for targets. But positive acquirer CARs are not irrefutable evidence of rational (shareholders value maximizing) bidding either. Even if CEOs undertake transactions that create value for their shareholders, a necessary condition to value maximizing behavior, they might bid so that value creation is less than optimal. For example, there could be substantial synergies in a particular proposed merger but the acquirer gives too much of them to the target. Testing overbidding is therefore inherently challenging; this explains probably the limited number of empirical studies addressing the issue. Moeller et al. (2004) and Boone and Mulherin (2008) report evidence failing to support the winners' curse predictions. But other contributions report results compatible with, or even supporting, the hubris hypothesis (Berkovitch and Narayanan, 1993; Hietala et al., 2003, in the Paramount takeover case; Mueller and Sirower, 2003; Eckbo and Thorburn, 2009)[5]. The debate is clearly still open.

Our paper develops a new direct test of overbidding. Our test relies on the first order condition (FOC) of a bidder's expected profit maximization, a significant step forward with respect to tests of overbidding currently reported into the literature. The bidder's expected profit equals the sum of (a) the probability of a successful acquisition multiplied by the profit conditional on acquisition and (b) the probability of failure multiplied by the costs of failure. The probability of success is increasing in the bid premium, profits conditional on completion are decreasing in it, as is the probability of failure[6]. Value maximizing acquirers select the optimal

[5] Malmendier and Lee (2011) report also clear evidences of irrational bidding in the context of online auctions, due to limited attention.

[6] Note that costs of failure, as defined here, are exogenous to the bid premium because they are essentially competitive and loss of investment opportunities costs (see e.g. Akdogu, 2011). We use estimates provided in Savor and Lu (2009) and Wang (2015). These estimates are based on samples of exogenously failed transactions and are thus immune to potential endogeneity between costs of failure and bid premium.

bid premium by trading off these effects. Therefore, if the bid premium is guided by value maximization, the derivative of acquirer expected profits with respect to the bid premium should be equal to zero on average. We introduce a direct test of this necessary condition for profit maximizing bidding behavior.

Implementing an empirical test of this proposition is challenging for two reasons. First, the probability of success is not directly observable. Using the ex-post observed outcome is not an option. Bids are chosen endogenously based on a prior assessment of completion. Thus, a high bid premium could conceivably be positively associated with a high failure rate ex-post. We follow on Bhagat et al. (2005) to build a proxy for the ex-ante probability of success using a probit specification and a large set of publicly observable determinants, selected by Betton et al. (2014). While we are aware that any proxy suffers from shortcomings, we believe that it is positively correlated with the unobservable true probability of success. Our test is constructed so that the weaker the precision of this proxy (the higher its standard error), the less likely our test will reject rational bidding. Hence, the test is therefore conservative.

Our second challenge arises from the obvious correlation between the probability of success and bidder returns, both being outcomes of the acquirer's expected profit maximization program. The bid premium (the decision variable) chosen by bidder drives both the target shareholders' reaction (probability of success) and the investors' reaction (bidder returns). We take into account of this source of correlation with a seemingly unrelated equations (SUR) estimator. The test of the acquirer's FOC is implemented as a cross-equation restriction evaluated at estimated coefficients. To the best of our knowledge, this paper is the first to introduce such a test procedure.

Our empirical results rely on a sample of 1935 completed[7] acquisition between U.S. listed bidders and targets during the period 1994 to 2014. The average deal size is USD 2,342 million. The average three day bidder CAR is -1.38% (strongly affected by the internet bubble period) and the average 8-week bid premiums is 42.27%, similar to results reported in previous studies for public target takeover contests (see Betton et al., 2008). For each observation, we

[7] We limit our sample to completed transactions because SEC filings are most frequently unavailable for uncompleted transaction. This sample restriction doesn't affect our test because it is the investor perception of the probability of deal completion at the deal announcement that matters.

compute the three-day bidder CAR (using the standard market model as return generating process) and scale them by the probability of success (Bhagat et al., 2005) to obtain a proxy of bidder expected profits. The estimated probability of success is itself obtained using the Betton et al. (2014) probit model estimated on a very large sample of completed and uncompleted acquisition attempts. We collect a large set of previously-studied determinants of bidder CAR and probability of success from the CRSP, Compustat and SDC databases. We also collect information in Security Exchange Commission (SEC) filings (in particular, deal initiation and a description of the selling process) in order to include known determinants of the probability of success and bidder returns, controlling as much as possible for endogenous omitted variables.

On average, our results reject the hypothesis that bids satisfy the FOC of expected profits maximization. Statistical significance exceeds the 1% threshold in most tests. Moreover, the coefficients of the bid premium in the bidder returns and probability of success equations display the expected signs (negative in the former case and positive in the latter) and are statistically significant, buttressing the view that our empirical proxies (the acquirer CAR and the estimated probability of success respectively) are relevant. Thus, we conclude that there is significant overbidding on average. Overbidding is not a theoretical construct.

We check the robustness of this result in many ways. We start by investigating whether a mis-specification of the functional form of our linear SUR drives the FOC test result. Using a non-linear SUR specification based on bid premium terms up to the order three, we confirm the FOC rejection at a high level of statistical significance over almost the whole range of bid premiums observed in our sample. We next replicate the analysis without using the Bhagat et al. (2005) probability scaling procedure and obtain similar results. We also replicate the analysis dropping from the SUR specification all variables that are not statistically significant in our baseline model. This asymmetric SUR specification leads to the same conclusions. Explicitly taking into account heteroskedasticity also confirms our results.

Next, we study the potential consequences of risk aversion on our conclusion, using a CARA utility function to model the CEO risk aversion. Introducing risk aversion leads to rejecting even more strongly the bidder's expected profit maximization FOC. We introduce an alternative estimation strategy based on a parametric model of the joint density of bidder profit and

probability of success. We choose the truncated bivariate normal density to explicitly account for probabilities being bounded between 0 and 1, a potential source of bias using the SUR estimator. We estimate coefficients using the maximum likelihood (ML) estimator. The bidder's FOC is once again strongly rejected.

Finally, we also explore the robustness of the results to measurement errors affecting our empirical proxies for bidder profits (the bidder CAR) and for the probability of success (the probit based estimates). Transaction announcements potentially deliver bidder private information unrelated to the transaction itself. We control for private information revelation in our baseline specification using two different control variables (the relative variation between the pre and post announcement period of the Amihud (2002) illiquidity ratio and of the price non-synchronicity indicator (Roll, 1988). To explore more in depth the potential consequences of private information revelation, we identify a sub-sample of transactions with low private information revelation. Our results show that overbidding is still present. We follow the same strategy for the estimated probabilities of success by selecting a sub-sample of transactions perceived by investors as being almost certain to be completed (the stock price reaction is very close to the announced bid premium). The estimated probability of success for these transactions should be less prone to estimation errors. Overbidding is again confirmed.

Having established the presence of overbidding in the M&A market, we investigate its sources. Overbidding may find its roots either in bidder irrationality (the bidder fails to anticipate the winners' curse, the hubris hypothesis argument) or in decision delegation from shareholders to CEOs, the classic agency conflict (Berle and Means, 1932).

Agency conflicts potentially play a significant role in the case of M&A decisions because CEOs are known to be key decision makers in acquisitions (Harding and Rovit, 2004). CEOs may willingly pursue other goals then shareholder value maximization, e.g. private benefits (Mork et al., 1990), or simply be more risk averse than shareholders and seek diversification (Becker, 2006; Gormley and Matsa, 2016). We first focus on the agency conflict source of overbidding and explore the role of determinants suggested in the literature. In a sub-sample of 805 deals for which we are able to collect these necessary information, we find that overbidding increases with bidder past performance and bidder CEO entrenchment while it decreases with leverage

and the presence of a toehold. We also observe that overbidding is stronger in horizontal mergers and when the target size is high relative the bidder size but weaker in hostile transactions (this surprising result rests on few observations) and in negotiation (as expected)

We explore differences in overbidding among industries. Among high-technology, manufacturing, and financial industries, overbidding appears to be stronger in high-technology. But statistical significance disappears once we control for bidder governance variables, indicating that systematic differences in governance mechanisms between industries drive this result.

We next attempt to test whether overbidding is related to irrationality or some form of cognitive bias. The existence of CEO overconfidence and narcissism has been well documented in the literature (Chatterjee and Hambrick, 2007 and 2011; Malmendier and Tate, 2008; Aktas et al., 2016). We follow Aktas et al. (2016) and use the narcissism first pronoun indicator (the proportion of first person singular pronoun to first person plural pronoun) to characterize the degree of CEO narcissism. Using the de Bodt et al. (2015) extended data set, we are in position to collect the CEO narcissism first pronoun indicator for 174 out of the 805 transactions for which overbidding determinants are available. CEO narcissism appears to reinforce overbidding but the results are not statistically significant at usual levels of confidence. Whether this is due to the limited sample for which the narcissism first pronoun indicator is available or simply to absence of irrational overbidding related to this personality trait deserves more investigations in the future.

Finally, we adopt an alternative indirect empirical strategy to test for the presence of irrational bidding due to not (fully) considering the winner's curse. If overbidding is related to this source of irrational behavior, bidders losing the competition to acquire targets should display less (if not no) overbidding. Losing bidders may indeed be bidding less aggressively because they more fully take into account the winner's curse. Under the winner's curse explanation of irrational bidding, we should therefore observe weaker (or absence of) rejection of the FOC of rational bidding for losing bidders. We test this prediction on a sample of 545 failed transactions. The FOC is not rejected for these bidders , essentially because the bid premium is not negatively related to the bidder (scaled) CAR. This result is not sufficient in itself

to conclude that failing to account for the winner's curse explains irrational bidding but it is consistent with such a possibility.

Our paper contributes to different streams of literature. The first is behavioral corporate finance. Roll (1986) introduced the possibility that irrational behavior could lead to poor corporate performances. A large body of literature developed in the wake of this intuition. In the M&A field, Hayward and Hambrick (1997), Chatterjee and Hambrick (2007, 2011), Malmendier and Tate (2008), Aktas et al. (2016) study the role of hubris, narcissism and overconfidence. Overbidding behavior must be observed empirically for these psychological biases to affect acquisition shareholder value creation. The second research field to which our results contribute is auction theory and its applications. The winners' curse has been subject to extensive analyses (Krishna, 2010). In the absence of overbidding behavior, its relevance could be questioned. By showing that overbidding affects the M&A market, a fundamental resources allocation mechanism in the economy, we confirm that the winner's curse is a potential candidate to explain irrational bidding behavior here also. The third stream to which our paper contributes is the M&A literature itself. Value creation and its repartition between bidders and targets have been central issues for more than 30 years (Betton et al., 2008). Overbidding directly affects the sharing of values between parties, whether it originates from irrationality or agency conflicts. Because ex-post we observe only winners of takeover contests, those who are the most likely bidding beyond reason, and because overbidding behavior is conceivably correlated with other bidder characteristics, ignoring the existence of overbidding may lead to erroneous interpretation of empirical findings.

The paper has three main sections. The first is dedicated to our test of overbidding. The second investigates the robustness of overbidding evidence to various issues. The third section explores potential determinants of overbidding.

Section 1 – The bidder's expected profit maximization

We first motivate our testing procedure. We then describe its implementation. We finally report our results.

1.1. Shareholders' value maximizing bidding behavior

In the absence of irrational behavior and/or agency conflicts, the CEO will choose an equilibrium bidding strategy to acquire the target in order to maximize shareholders' value creation. The risk neutral[8] CEO maximization program takes the following form:

$$\max_{Bid} E(Bidder's\ Profit) =$$
$$\Pr(Success) \times E(Synergies - Bid | Success) + (1 - \Pr(Success)) \times E(Costs | Failure) \quad (1)$$

where $E(\,)$ stands for expectation, $\Pr(\,)$ for probability and $E(\,|\,)$ for conditional expectation . The *Bidder's Profit* is the transaction specific value creation. *Success* indicates that the deal will be completed and *Failure*, the opposite outcome. *Synergies* designate value created specifically thanks to the acquisition and any economic benefits that accrue to the acquirer, such as pressure put on competitors (Akdogu,2011); *Bid* is the target shareholders payment in case of success, whatever the form; and *Costs*, the loss of value in case of failure (due to competitive effects and the loss of investment opportunities)[9]. The corresponding first order condition is:

$$\frac{\partial E(Bidder's\ Profit)}{\partial Bid} =$$
$$\frac{\partial \Pr(Success)}{\partial Bid} \times E(Synergies - Bid | Success) +$$
$$\frac{\partial E(Synergies - Bid | Success)}{\partial Bid} \times \Pr(Success)$$
$$+ \frac{\partial (1 - \Pr(Success))}{\partial Bid} \times E(Costs | Failure) = 0 \quad (2)$$

We propose to test Equation (2) as a necessary condition for shareholders' value maximizing bidding behavior. Violation of Equation (2), depending on the sign of

[8] We explore the consequences of CEO risk aversion in our robustness checks.

[9] Note also that taking failure costs explicitly into account is a way to control at least partially for revelation effects.

$\frac{\partial\, E(Bidder's\ Profit)}{\partial\, Bid}$, indicates either overbidding or underbidding. The test rests on $\frac{\partial \Pr(Success)}{\partial\, Bid}$, the corresponding $\frac{\partial\,(1-\Pr(Success))}{\partial\, Bid}$ and $\frac{\partial E(Synergies-Bid|Success)}{\partial\, Bid}$, the partial derivative of the probability of success with respect to the bid, the corresponding partial derivative of the probability of failure, and the partial derivative of the bidder's profit conditionally on successful acquisition, also with respect to the bid. These three partial derivatives need to be estimated, but, as $\frac{\partial\,(1-\Pr(Success))}{\partial\, Bid}$ is simply $-\frac{\partial \Pr(Success)}{\partial\, Bid}$, only two are required. Irrational bidding originating from not taking into account the winner's curse affects the bid and therefore the probability of success, if other bidders don't display the same degree of irrationality. Deviations from the Equation (2) can also be caused by agency related motives, irrationality and agency based explanations not being mutually exclusive.

We now describe our econometric specification, noting that bidder's profit and probability of success are correlated because both are driven by the bid premium, the bidder's decision variable.

1.2. Econometric specification

The test of Equation (2) is based on the following two equations system estimation:

$$Bidder's\ Profit = a_0 + a_1 \times Bid + Control\ Variables + \varepsilon_1 \quad (3)$$

$$\Pr(Success) = \beta_0 + \beta_1 \times Bid + Control\ Variables + \varepsilon_2 \quad (4)$$

where ε_1 and ε_2 are regression errors and ε_1 and ε_2 are potentially correlated due to the presence of omitted factors affecting both the bidder profit and the probability of success . We estimate the Equations (3) and (4) using seemingly unrelated regressions (SUR). In our baseline specification, we include the same set of control variables in Equation (3) and (4), which leads to a symmetric SUR specification[10]. Point estimates in symmetric SUR specification are identical to ordinary least square ones, but standard-errors account for the correlation between errors

[10] We also report as a robustness check results of an asymmetric SUR specification into which only statistically significant variables of the symmetric SUR specification are kept.

(Greene, 2011). $\hat{\alpha}_1$ is our estimate of $\frac{\partial E(Synergies-Bid|Success)}{\partial\, Bid}$ and $\hat{\beta}_1$, of $\frac{\partial \Pr(Success)}{\partial\, Bid}$ ($-\hat{\beta}_1$, of $\frac{\partial\, 1-\Pr(Success)}{\partial\, Bid}$). We test then Equation (2) as the following cross-equations constraint:

$$\hat{\beta}_1 \times \overline{Bidder's\ Profit} - \hat{\beta}_1 \times \overline{Costs} + \hat{\alpha}_1 \times \overline{\Pr(Success)} = 0 \qquad (5)$$

where $\overline{Bidder's\ Profit}$ and $\overline{\Pr(Success)}$ are the sample mean estimates and average costs of failure are from Savor and Lu (2009) and Wang (2015) The test follows a Chi^2 distribution when using the SUR estimator. The Equation (5) cross-equations constraint tests the bidder profit maximization FOC. This represents a significant improvement with respect to existing tests of overbidding because (i) the correlation between the *Bidder's Profit* and the *Pr(Success)* is taken into account and (ii) the trade-off between these two components of the bidder's expected profit maximization program is explicitly modelled.

1.3. Variables[11]

Bidder's profit

Our proxy for the bidder's profit is based on the classic bidder CAR, the investors' reaction to the acquisition announcement. But bidder CAR are the product of the bidder's profit (as perceived by investors) by the probability of completion. We therefore follow the Bhagat et al. (2005) probability scaling method and divide *Bidder CAR* by the probability of success to obtain the *Bidder Scaled CAR*, our proxy of bidder's profit[12]. We are aware that bidder CARs are possibly contaminated by other information (in particular bidder private information revelation due to the transaction announcement). We note first that our test relies on the estimation of α_1 in Equation (3), the sensitivity of bidder's profit with respect to the bid, and not the level of bidder's profit itself. Contamination raises therefore only an issue if it is itself correlated to the bid (becoming an endogenous measurement error). While such correlation cannot be generally excluded, we introduce a large set of control variables to mitigate this issue (we examine also the robustness of our results to private information revelation in complementary analyses.) CAR

[11] Appendix B provides the precise definitions and data sources of all the variables used in the empirical analysis.
[12] We replicate our results using the bidder CAR as proxy of bidder's profit to check the robustness of our results.

are obtained using the market model (MM) return generating process, using as estimation window from day minus 250 to day minus 10 with respect to the announcement date and as proxy for the market index, the CRSP value weighted index. CAR is the MM residuals sum over a three days event window centered on the announcement date.

Costs of failure

We use estimates of the average costs of failure reported in Savor and Lu (2009) and in Wang (2015). These estimates rely on samples of exogenously failed transactions, mainly due to regulatory interventions. Savor and Lu (2009) collect data over the period 1978 to 2003 and identify 148 exogenous failed transactions, defined as transactions not connected to the mispricing of the acquirer (a restricted sub-sample of 109 transactions is also proposed by the authors). We obtain estimated costs of failure of -16.73% by taking the weighted average of costs of failure for stock financed transactions (-44.2%) and cash financed transactions (+9.3%) obtained over a window going from announcement day minus one to announcement day plus seven hundred fifty, as reported in Table VI of Savor and Lu (2009). The Wang (2015) estimate is based on a sample of 143 exogenous failed transactions, collected over the period 1980 to 2012. In Table 3, the author reports a combined (bidder plus target) value destruction of 9%, 65% of which is attributable to the bidder, obtained using a window going from day minus one to day plus one with respect to the announcement date. This leads to estimated costs of failure of 6.38% .

Probability of success

The probability of success, which is driven by target shareholders' reaction to the acquisition proposal, is not directly observable and the ex-post observed outcome makes no sense as a proxy. Even if the outcome is conceivably correlated with the probability of success, it is fundamentally endogenous to the bid premium. The bidder may optimally decide to choose a large premium when there is a high probability of failure. Consequently, the bid premium may correlate ex-post negatively with the probability of success!

We use as proxy of the ex-ante probability of success the estimated probabilities from a probabilistic model, as in Bhagat et al. (2005). The Betton et al. (2014) specification is selected because it is more recent. This leads to estimate the following model:

$$Probability\ of\ Success = Probit\left(\begin{array}{c}\alpha_0 + \alpha_1\ Target\ Size + \alpha_2\ Nyse\ Amex + \alpha_3\ Turnover \\ + \alpha_4\ Poison\ Pill + \alpha_5\ 52Weeks\ High + \alpha_6\ Toehold + \alpha_7\ Listed\ Bidder \\ + \alpha_8\ Horizontal + \alpha_9\ 8 - Weeks\ Bid\ Premium + \alpha_{10}\ Tender\ Offer + \alpha_{11}\ All\ Cash \\ + \alpha_{12}\ All\ Stock + \alpha_{13}\ Hostile + \alpha_{14}\ Year\ 1990\end{array}\right) \quad (6)$$

where *Target Size* is the logarithm of the target market value estimated 42 days before the announcement date, *Nyse Amex* is a dummy variable taking value 1 if the target is listed on the Nyse or the Amex, *Turnover* is the average daily ratio of the target trading volume to total shares outstanding over the 52 weeks before the announcement date, *Poison Pill* is a dummy variable taking value 1 if the target has a poison pill, *52Weeks High* is the ratio of the share price 42 days before the announcement date to the maximum share price during the 52 weeks before the day of the selected share price , *Toehold* is a dummy variable taking value 1 if the bidder owns shares of the target before the deal to announcement, *Listed Bidder* is a dummy variable taking value 1 if the bidder is a public company, *Horizontal* is a dummy variable taking value 1 if the bidder and the target share the same 4-digits primary SIC code, 8-week *Bid Premium* is the 8-week bid premium winsorized at the one and ninety-nine percentiles in some specifications, *Tender Offer* is a dummy variable taking value 1 if the transaction is a tender offer, *All Cash (All Stock)* is a dummy variable taking value 1 if the payment is 100% cash (stock), *Hostile* is a dummy variable taking value 1 if the target management responds negatively to the acquisition proposal according to the SDC database and *Year 1990's* is a dummy variable taking value 1 if the deal is announcement during the period 1994 to 1999 to capture the internet bubble episode.

To estimate coefficients of Equation (6), we collect a sample of 5,780 transactions announced during the period 1994 to 2014. The sample includes all transactions between US

bidders and US listed targets, with a deal size above USD 1 million, for which the bidder held less than 50% before the acquisition attempt and more than 50% after, reported in the SDC database. Table 1 reports summary statistics by year. The end of the nineties M&A wave is clearly apparent as well as the mid of the 2000s. The average deal completion rate is 80.07% and the average *8-week Bid Premium* is 39.58% (with a corresponding median of 33.43%). Interestingly, the bid premium displays a significant time-variation that appears to be related to the internet bubble and the financial crisis episodes. These figures are in line with previously reported statistics about the US M&A market activity (see Betton et al., 2008).

Table 2 reports descriptive statistics for all the variables included in Equation (6) as well as a test of difference of means between completed and uncompleted transactions. The sample is composed of 80.07% completed transaction (see Table 1 also), 6.18% targets listed on the Nyse or Amex, 1.21% targets with poison pills, 7.99% cases with toeholds, 67.58% listed bidders, 32.80% horizontal transactions, 16.73% tender offers, 43.56% pure cash deals, 27.06% pure stock deals and 2.92% transactions classified as hostile in the SDC database. The sample mimics other large samples of U.S. transactions with public targets in the existing literature (Betton et al., 2008). The average *8-week Bid Premium* is 39.58%, also consistent with figures reported in such samples. The ratio of the price 42 days before announcement to the 52 weeks maximum is 65.94%, an indication consistent with bidder market timing behavior (Baker et al., 2012). Tests of differences of means provides some interesting, but familiar, insights: in the sub-sample of completed transactions, the proportions of targets protected by a poison pill and in which the bidder has a toehold are smaller. All cash payments are also less frequent, as hostile transactions. The sub-sample of completed deals includes higher proportions of transactions by listed bidders and of horizontal transactions. Completed transactions display also higher eight-week bid premium. We note finally that tender offers and all stock deals are more frequent in the completed transactions sub-sample. These results are globally consistent with previous results reported in the literature (eg., Betton et al., 2008; Betton et al., 2014).

Table 3 displays Equation (6) estimation results. Two specifications are reported: Column (1) results obtained with the raw *8-week Bid Premium* and in Column (2) with the *8-week Bid Premium* winsorized to one and ninety-nine percentiles. We observe first the very high stability

of our estimation results across the two specifications: all estimated coefficients keep their signs and statistical significance. As intuitively expected, the *8-week Bid Premium* has a positive and significant coefficient, consistently with Betton et al. (2014). To continue the comparison , we obtain the same coefficient signs and statistical significance for *Target Size*, target *Nyse Amex*, target *Poison Pill*, *52Weeks High*, bidder *Toehold*, *Listed Bidders*, *Horizontal* deal, *Tender Offer*, *All Cash* deal , *All Stock* deal and *Hostility*. Switching from the univariate (Table 2) to the multivariate (Table 3) context brings only some limited differences (*Horizontal* transactions appear not anymore more probable to be successful and *52Weeks High* becomes statistically significant in the this multivariate setup). We use estimated coefficients from Table 3 to build our probit based proxy for the probability of success.

To validate our implementation of the probability scaling method, we replicate the Bhagat et al. (2005) test of overbidding (as reported in their Table 9). The authors check whether the difference between the transaction value improvement and the toehold-adjusted bid premium is significantly negative. Their results show that it is not the case after rescaling the acquirer CAR. We obtain similar results (unreported). But, even if this is a necessary condition for value maximizing bidding behavior, it is not a sufficient one; although they may share in the value created, acquirers may (willingly or unwillingly) concede too much to target shareholders.

We note that the noisiness of the estimated probability of success plays against the cross-equations constraint test rejection. Indeed, a noisy estimate of the probability of success translates into large ε_2 values in Equation (4), leading to a large β_1 coefficient standard-error. And this large β_1 coefficient standard-error enters directly into the cross-equations constraint test standard-error. This effect reduces the probability of rejecting the null hypothesis of rational bidding (the FOC statistic is equal to zero). So, our approach is conservative in that respect. We report also results for sub-samples of transactions perceived as almost certain by investors, to investigate the robustness of the results to the estimated probability of success.

Bid premium

We follow Betton et al. (2014) to compute the *8-week Bid Premium*, which is obtained as:

$$8Weeks\ Bid\ Premium = \frac{Offer\ Price}{Price_{t-42}} - 1 \quad (7)$$

The offer price is itself collected in the SDC database and the share price, in the CRSP database.

Control variables

In addition to variables included in Equation (6), we collect a large set of variables, from both standard electronic databases and SEC filings:

- From the CRSP, Compustat and SDC database, we compute the bidder market value (*Bidder Size*), the target market value (*Target Size*) and *CAR* (*Target CAR*) and the deal CAR (*Deal CAR*), our proxy for *Synergies*[13], using the same return generating process, estimation window and event window as for bidder CAR. We add the target run-up (*Target Runup*) - the ratio of the target share price two days before the announcement date to the target share price forty-two days before it minus one, the target to bidder relative size (*Relative Size*), the *Horizontal* dummy variable (equal to one it the acquirer and the target share the same SIC 4-digits code), the *Target Industry Liquidity* ratio (Schlingemann et al., 2002) in the SIC 2-digits target industry the year of the announcement date, *BidderPrivateR2* and *BidderPrivateAmihud* –, proxies of the revelation of bidder private information around M&A announcement, based respectively on the residuals of the market model and the Amihud (2002) private information ratio. *All Cash, All Stock, Toehold* and *Hostile* variables are collected in the SDC database. We finally identify the number of bidders in the SDC database and code *Multiple Bidder* as a dummy variable taking value one in case of multiple bidder's contests.

[13] Antoniou et al. (2008) show that deal CAR and the bid premium are correlated (correlation condition). Omitting the deal CAR from our specification would therefore raise an issue of endogenous omitted variables because deal CAR is also a determinant of the bidder CAR (relevance condition).

- We collect in the SEC filings two variables: *Initiation* and *Negotiation*. These variables influence directly the probability of success [14]. To obtain them, we use SEC filings DEFM 14A and S-4 for mergers and 14D for tenders offers. *Initiation* is a dummy variable taking value one if the target initiated the transaction. We follow Boone and Mulherin (2007) to identify the sales process and code *Negotiation* with value one in case of one to one negotiation and zero in case of (formal or informal) auction. Omitting *Initiation* and/or *Negotiation* from our specifications would possibly induce an endogenous omitted variable bias, but including them comes at the cost of significantly reducing the sample size, because these variable are collected by hand.

1.4. M&A Sample

We test Equation (5) by collecting a sample of 1,935 completed transactions. We limit ourselves to completed transactions because SEC filings are most often unavailable for uncompleted ones. This sample selection restriction doesn't affect however our empirical test because it is the ex-ante probability of success that matters. Our proxy for the ex-ante probability of success is introduced in the previous section. We start form the sample used in Aktas et al. (2010) and add the period 2008 to 2014 . The sample covers therefore the period 1994 to 2014. The starting 1994 year was chosen because SEC filings became available in the electronic EDGAR database that year and we complement the Aktas et al. (2010) with the more recent period to take into account years after the 2008 financial crisis. The sample is extracted from the SDC database using the following criteria: the bidder and the target must be US listed firms, the deal size must be at least USD 100 million, the bidder must old less than 50% of the target shares before the transaction and more than 50% afterwards (in most cases, the percentage held after completion is in fact 100%). The combination of these criteria generates a sample of 4,142transactions. SEC filings and the collection of variables required for Equations (3) and (4) estimation has been possible 1,935 completed transactions. The sample size shrinking is mainly due to the difficulty to collect *Initiation* and *Negotiation* in many SEC filings.

[14] Note that Boone and Mulherin (2008) infer from the absence of relation between *Bidder's Profit* and the sales process that hubris is unlikely to affect bidder bidding behavior. The intuition is that the winner's curse should be more at play in auctions than in negotiation. But Aktas et al. (2010) shows that even in the case of negotiation, latent competition pressures the bargaining parties. Negotiations are therefore also subject to the winner's curse.

But, this sample size still compares favorably to samples used in many previous academic contributions using SEC filings information.

Table 4 displays descriptive statistics about the sample. The M&A waves of the late nineties and mid of the 2000s are again clearly apparent. The phenomenon is exacerbated in deal value, mega M&As being observed in particular before the internet bubble burst(Moeller et al., 2005)[15]. *Bidder CAR* are negative (-1.38%), as expected for large transactions between listed firms (Betton et al., 2008). *Target CAR* are largely positive (22.47%) and our sample of transactions are, on average, synergistic with an average *Deal CAR* of 1.77% (with a corresponding average *Deal Scaled CAR* of 2.16%). The average *8-week Bid Premium* is 42.27%, close to number classically reported for these kind of samples (Betton et al., 2008). The average estimated *Probability of Success* is 87.20%, which is somewhat higher to ex-post observed success rate (see Table 1). This is to be expected because we focus here on successful transactions. The *Bidder Scaled CAR*, our proxy for the bidder's profit, is -1.63%, strongly affected by the internet bubble episode.

1.5. Descriptive statistics

Table 5 summarizes descriptive statistics about the set of variables used to estimate the system of two equations defined by Equations (3) and (4), and the statistical test of the bidder's expected profit FOC introduced in Equation (5). *P*-values are only reported when the null hypothesis of zero mean makes sense. As Table 5 list twentyvariables, we don't comment them all and limit ourselves to a few highlights.

Table 5 starts by reporting statistics on CAR, already reported in Table 4, and adds the *Target Runup*, positive (9.58%) and highly significant. The *Probability of Success* is 87.20%. The target to bidder *Relative Size* is 27.45%%, an unusual figure (in most studies, the ratio of target to bidder lies between 10% to 5%), but this is a consequence of our sample selection criteria (minimum deal size of USD 100 million). 40.57% of transaction attempts are *Horizontal*, 37.36% are *All Stock*, 2.07% of the bidders hold a *Toehold* and 0.88% of these transactions are classified

[15] We note also the presence of a few mega M&As in 2009 (Pfizer versus Wyeth for USD 68 billion, Merck versus Schering-Plough for USD 41 billion, Exxon Mobile versus XTO Energy for USD 40 billion, etc), and in 2014 (Actavis versus Allergan for USD 68 billion, Facebook versus Whatsapp for USD 19.5 billion, etc).

as *Hostile*. Because *BidderPrivateR2* and *BidderPrivateAmihud* are variations between the pre and the post announcement periods, numbers are themselves uninformative but we observe that, according to these two proxies of private information, the bidder level of private information decreases in the wake of the acquisition attempt announcement, as expected. We finally note that 42.02% of the transactions in our sample are initiated by the target (*Initiation* dummy variable) and that 39.90% are classified as negotiations (*Negotiation* dummy variable).

1.6. Results

Table 6 is dedicated to the system of two equations, defined by Equation (3) and (4), SUR estimation results and the ensuing test of overbidding introduced in Equation (5). Columns (1) and (2) show results using the raw *8-week Bid Premium*, while in Columns (3) and (4), the winsorized *8-week Bid Premium* is used. Columns (1) and (3) display results for the *Bidder Scaled CAR* dependent variable (Equation (3)) and Columns (2) and (4), for the *Probability of Success* (Equation (4)).

The FOC tests of bidder's expected profit maximization strongly reject rational bidding, with a Chi^2 statistic of 132.44 (*p*-value of 0.00) and 124.72 (*p*-value of 0.00) using the raw *8-week Bid Premium* (Columns (1) and (2)),the winsorized *8-week Bid Premium* (Columns (3) and (4)) and the Wang (2015) estimate of costs of failure. Using Savor and Lu (2009), the corresponding figures are 107.21 and 93.77, still with *p*-values of 0.00. The statistic point estimates are all negative and comparable (between -0.04 and -0.05), an indication of overbidding (the slope of the profit function is negative and therefore, by bidding less, the average profit would increase). The estimated coefficient of the *8-week Bid Premium* is negative and highly significant in the *Bidder Scaled CAR* regression (-0.0541 with *p*-value 0.00 and -0.0596 with *p*-value 0.00 respectively in Columns (1) and (3)) and positive in the *probability of success* regression (0.0351 with *p*-value 0.10 and 0.0543 with *p*-value 0.00 in Columns (2) and (4)). The bidder trade-off is clearly captured: bidding more increase the probability of doing the deal at the cost of decreasing profits in case of deal completion. These results take into account the correlation between *Bidder Scaled CAR* and the *probability of success*, a key feature of the chosen econometric approach.

Some control variables also deserve comments: the *Deal Scaled CAR* coefficient is positive and significant in the *Bidder Scaled CAR* regression. *Deal Scaled CAR* being our measure of synergies, this shows that bidders are able to capture part of the created economic value. Still in the *Bidder Scaled CAR* regression the *Relative Size* coefficient is negative and highly significant while Boone and Mulherin (2008) report a negative and significant coefficient for *Bidder Size* but an insignificant coefficient for *Relative Size*. Maybe some mechanic co-linearity between *Bidder Size* and *Relative Size* explains this variation in results (in our case, *Bidder Size* is positive and highly significant). Continuing with the *Bidder Scaled CAR* regression, *Horizontal* has a negative sign, like in Boone and Mulherin (2008), but not statistically significant in our case, and *Negotiation* is positive and significant at the usual level of confidence, an intuitive result (even if negotiations may be under pressure of implicit competition, as pointed it out in Aktas et al. (2010)). We note finally that the *Hostile* coefficient is negative: hostile transactions are less value creating for bidder, as intuitively expected (fighting against the incumbent management is costly).

In the *probability of success* regression, the *Bidder Size* coefficient is positive and significant (large bidders are more likely to complete transactions),the *Relative Size* variable, the *Horizontal* dummy variable and the *All* Stock dummy variable coefficients are all positive and significant, results that must be interpreted with care because potentially affected by endogeneity (e.g., paying in stock may be due to anticipating that the target will agree to complete the transaction), while the *Toehold* dummy variable is negative and highly significant, a result consistent with Betton et al. (2009). Taking a toehold is apparently interpreted as a sign of aggression. Hostility decreases the probability of success, a result consistent with the univariate evidence. *Initiation* appears to play a negative role but is only marginally significant. *Negotiation* is negative and highly significant, an indication that target commitment to sale in negotiation is weaker than in auction.

We obtain mostly the same results using the winsorized *8-week Bid Premium*, as displayed in Table 6 two right columns. Our results are clearly robust to the potential presence of outliers in the *8-week Bid Premium*.

Figure 1 provides the FOC test histogram for the 1,935 transactions included in our sample, corresponding to the *8-week Bid Premium* and Savor and Lu (2009) costs of failure estimates. The histogram is clearly centered in the negative range, with only a few observations above zero.

Section 2 – Robustness

Section 2 is dedicated to a set of robustness checks. They address several potential miss-specification and measurement error issues.

2.1. Linearity

A first potential misspecification that can lead to an incorrect finding of overbidding bears on the SUR linearity specification in Equations (3) and (4). No theoretical development grounds this choice and moreover, the choice of a linear probabilistic model for the probability of success could raise concerns. We test the robustness of our result to this potential issue by adopting the following order three polynomial development in the bid premium[16]:

$$Bidder's\ Profit = a_0 + (a_1 \times Bid) + (a_2 \times Bid)^2 + (a_3 \times Bid)^3 + Control\ Variables + \varepsilon_1 \quad (8)$$

$$\Pr(Success) = \beta_0 + (\beta_1 \times Bid) + (\beta_2 \times Bid)^2 + (\beta_3 \times Bid)^3 + Control\ Variables + \varepsilon_2 \quad (9)$$

where ε_1 and ε_2 are regression errors. We estimate Equations (8) and (9) using seemingly unrelated regressions (SUR) to account for ε_1 and ε_2 correlation. Adopting this non-linear specification raises however a complication: the marginal effects are no longer constant but depend on the bid premium. Indeed, the bidder profit partial derivative with respect to the bid

[16] We get similar results with an order two development.

premium is $\alpha_1 + (2 \times \alpha_2 \times Bid) + (3 \times \alpha_3 \times Bid^2)$ and a similar expression is obtained for the probability of success. Consequently, the Equation (5) constraint test depends on the bid premium:

$$\left(\hat{\beta}_1 + \left(2 \times \hat{\beta}_2 \times Bid\right) + \left(3 \times \hat{\beta}_3 \times Bid^2\right)\right) \times \overline{Bidder's\ Profit} - \left(\hat{\beta}_1 + \left(2 \times \hat{\beta}_2 \times Bid\right) + \left(3 \times \hat{\beta}_3 \times Bid^2\right)\right) \times \overline{Costs} + (\hat{\alpha}_1 + (2 \times \hat{\alpha}_2 \times Bid) + (3 \times \hat{\alpha}_3 \times Bid^2)) \times \overline{\Pr(Success)} = 0 \quad (10)$$

In this non-linear setup, a value for the bid premium must be chosen. To provide a complete picture of the FOC test behavior, we report not only the non-linear SUR estimation results obtained at the sample average bid premium in Table 7 but also, in Figure 2, a graphical representation of the *Chi2* statistic and the bidder profit and probability of success partial derivatives over the whole range of bid premium present in our sample. And, to be consistent, we use fitted values of $Bidder's\ Profit$ and $\Pr(Success)$ at corresponding bid premium values and the mean of control variables.

We observe in Table 7 that estimated coefficients of the bid premium itself are highly statistically significant in both the bidder profit equation (Column (1)) and the probability of success equation (Column (2)). Coefficients of the second order exponent of the bid premium are also statistically significant, but less so in the bidder profit equation (*p*-value of 0.05) and coefficients of the third order exponent are only significant in the probability of success equation. But due to the non-linear specification, these coefficients do not provide marginal effects. We turn therefore to the analysis of Figure 2.

In Figure 2 – Panel A, we graph the *Chi2* statistic of the FOC constraint test (Equation (10)) obtained using the Savor and Lu (2009) estimate of the costs of failure and in Panel B, the bidder profit (left vertical axis) and probability of success (right vertical axis) partial derivatives. The horizontal axis reports the bid premium percentiles in our sample in both panels. Panel A shows us that the null hypothesis of value-maximizing bidding (FOC equal to zero) is rejected over almost the whole range of the bid premium. It is only from percentile 100 that the $Chi2$ falls below 3.84, its critical value at 5% level of confidence, failing to reject the FOC test. Panel B displays the corresponding evolution of the bidder profit and probability of success partial

derivatives. This provides a better understanding of the inverted U shape displayed in Panel A. We observe that the bidder profit partial derivative is negative over the whole range of bid premium (increasing the bid premium reduces the bidder profit conditionally on bid completion), that it is increasing up to percentile 98 (the negative impact is itself decreasing), before decreasing drastically in the last 2 percentiles of the distribution of the bid premium. An inverse behavior is observed for the probability of success, which is positive over the whole range of the bid premium, decreasing up to percentile 97, and rising strongly in the right-most percentiles. Putting into correspondence Panel A and Panel B tells us that the negative marginal effect of the bid premium on the bidder profit dominates the positive one on the probability of success for the most part of the bid premium range. The right-most behavior of the $Chi2$ test statistic is apparently driven by the presence of a limited number of transactions that strongly influence the estimated bid premium partial derivatives and their relative importance.

We conclude from this analysis that the linear specification results are valid over almost the whole range of bid premiums present in our sample.

2.2. Scaling

Another potential issue that could affect the robustness of our results is the scaling procedure borrowed from Bhagat et al. (2005). The denominator of *Bidder Scaled CAR* and the *Deal Scaled CAR* is indeed the estimated probability of success, from Equation (6). In the limit, these probability estimates may go towards zero, generating extreme values for *Bidder Scaled CAR*. We replicate therefore Table 6 estimations in Table 8 using unscaled bidder CAR and unscaled deal CAR. Our results are almost unaffected by this change and the FOC of optimal bidding is again strongly rejected in all specifications.

2.3. Asymmetric SUR specification and Heteroskedasticity

One more potential source of concern is the symmetric SUR specification that we have selected. We present in Table 9 results of an asymmetric SUR specification obtained by dropping all statistically insignificant variables (at the 10% confidence level) from the Table 6 estimated regression equations.

Because the previous estimation results assume homoskedasticity, we present in Table 10 results taking into account heteroskedasticity (but at the price of a less efficient estimator[17]).

Results are once again highly stable and the FOC tests continue to strongly reject the null hypothesis of optimal bidding, with negative point estimates.

2.4. Risk aversion, probability of success truncation and costs of failure

Equation (1), which depicts the bidding CEO's maximization program, relies on risk neutrality. But CEOs are under-diversified (Becker, 2006; Gormley and Matsa, 2016) and therefore more risk averse then shareholders. This diversification wedge may be the source of divergent CEO bidding relative to optimal bidding from the shareholders' perspective. To what extent would this risk aversion wedge potentially affect our results? We explore this issue by modeling CEO utility with a Constant Absolution Risk Aversion (CARA) function. Equation (1) becomes:

$$\max E_{Bid}(Bidder's\ Profit) = \left(\Pr\left(Success\right) \times E\left(-e^{-\gamma\,(Synergies - Bid)} \;\middle|\, Success\right)\right) \qquad (11)$$

with γ being the risk aversion coefficient. We follow the same approach as in Section 1.1, deriving the corresponding FOC and using the Section 1.2 econometric specification to test for rational bidding for levels of γ ranging from 1 to 10. Results are presented in Figure 3. The FOC estimates decrease monotonically with γ. This result is intuitive. A more risk averse CEO would exhibit more conservative bidding. Therefore, the higher the risk aversion, the lower should be the level of rational bidding. The difference between the ex-post observed bidding and the ex-ante expected rational bidding becomes even more significant. Risk neutrality, as in Section 1.1 to Section 1.2, is therefore a conservative assumption.

2.5. Truncation

[17] We use the Eicker-Huber-White-sandwich covariance estimator, which less efficient than SUR estimator if errors are homoscedastic.

Another potential source of misspecification of our SUR econometric approach is the truncated nature of the probability of success dependent variable, which is by definition bounded between zero and one. We develop in this Section an alternative estimator of $\frac{\partial \Pr(Success)}{\partial\ Bid}$ and $\frac{\partial E(Synergies-Bid|Success)}{\partial\ Bid}$, the partial derivative of the probability of success with respect to the bid and the partial derivative of the bidder's profit, also with respect to the bid, taking into account the probability of success truncation.

As pointed out in Reiss and Wolak (2007), when modeling the interactions among variables, the main object of interest is their joint density. From the joint density, one can obtain marginal densities and conditional moments of interest by integration. We are interested here in the effect of the bid premium on bidder profit and probability of success, taking into consideration their correlation. Hence, we propose a direct parametric estimation of their joint density using the truncated bivariate normal density. Denoting by x the bidder profit and y the probability of success, we use the following specification:

$$f_T(x,y) = \frac{\frac{1}{2\pi\sigma_x\sigma_y\sqrt{1-\rho^2}} e^{-\frac{1}{2}\left(\frac{\varepsilon_x^2+\varepsilon_y^2-2\ \rho\ \varepsilon_x\ \varepsilon_y}{(1-\rho^2)}\right)}}{\int_{-\infty}^{+\infty}\int_0^1 f(x,y)\ dy\ dx} \quad (12)$$

Where:

- $f(x,y) = \frac{1}{2\pi\sigma_x\sigma_y\sqrt{1-\rho^2}} e^{-\frac{1}{2}\left(\frac{\varepsilon_x^2+\varepsilon_y^2-2\ \rho\ \varepsilon_x\ \varepsilon_y}{(1-\rho^2)}\right)}$ is the bivariate normal density;
- $\varepsilon_x = \frac{x-\mu_x}{\sigma_x}$ and $\varepsilon_y = \frac{x-\mu_y}{\sigma_y}$ are the standardized bidder profit and the standardized probability of success respectively;
- μ_x is $E(Bidder\ Profit)$. We condition this expectation on the bid premium and on the whole set of control variables included in Equations (3) and (4):

$$E(Bidder'\ Profit) = a_0 + a_1 \times Bid + \ Control\ Variables \quad (13)$$

- μ_y is $E(\Pr(Success))$. Again, we condition this expectation on the bid premium and the same whole set of control variables as in Equations (3) and (4):

$$\mathrm{E}(\Pr(Success)) = \beta_0 + \beta_1 \times Bid + Control\ Variables \quad (14)$$

- σ_x, σ_y and ρ are respectively the standard deviation of the bidder profit, the standard deviation of the probability of success and their correlation.

The truncation of y accounts for the fact that the probability of success is bounded between 0 and 1. Modeling the joint density of the bidder profit and the probability of success allows us to take into account their potential correlation because the truncated bivariate normal density incorporates the correlation ρ between variables. We estimate Equation (12) by maximum likelihood and use the estimates of α_1 and β_1 and their standard-errors to test the cross-equations constraint defined by Equation (5).

Table 11 reports our results. Column (1) displays coefficients and corresponding *p*-values for the bidder profit equation (using *Bidder Scaled CAR* proxy) and Column (2), the probability of success (using *Probability of success* proxy from Equation (6)). In Column (1), the coefficient of the *8-week Bid Premium* ($\hat{\alpha}_1$) is negative and highly significant and in Column (2), the corresponding coefficient ($\hat{\beta}_1$) is positive and highly significant. As with the SUR estimator, we capture again the trade-off driving the choice of the bid-premium: an increase in the probability of success at the cost of a decrease in the bidder profit. The FOC test is strongly rejected (Chi^2 statistic of 132.44 with *p*-value of 0.00 using the Wang (2015) estimate of costs of failure and Chi^2 statistic of 107.21 with *p*-value of 0.00 using the Savor and Lu (2009) one). The negative estimates for the FOC supports again the overbidding interpretation of this rejection. Concerning control variables, most keep their signs and statistical significance with respect to Table 6. We note that the estimated value of the covariance between the bidder profit and the probability of success is positive and significant. Apparently, despite scaling the *Bidder CAR* by the probability of success (as in Bhagat et al., 2005) and conditioning expectations on our whole

set of control variables, the interaction between bidder profit and the probability of success is a relevant issue[18].

2.6. Measurement errors

Our baseline specification introduces two control variables for bidder private information release around the announcement date: the relative variation between the pre and the post announcement periods of the Amihud (2002) illiquidity ratio and of the price non-synchronicity indicatorPrivate information release caused by the transaction announcement is a kind of measurement errors when using the bidder CAR as a proxy for bidder transaction specific value effect. We introduce in this Section an alternative approach to control for this source of error by selecting a sub-sample of transactions for which the bidder level of private information is almost constant between the pre and post announcement periods. The selection criterion is based on the price non-synchronicity indicator ratio and is as follows:

$$0.95 \leq \frac{(1-R^2)_{[42,61]}}{(1-R^2)_{[-61,-42]}} \leq 1.05 \qquad (16)$$

where $(1-R^2)_{[-61,-42]}$ is the non-synchronicity indicator estimated from day minus 61 to day minus 42 relative to the announcement date and $(1-R^2)_{[42,61]}$ is the corresponding indicator estimated from day plus 42 plus day 61. This leads us to select a sub-sample of 339 transactions.

Estimation results are reported in Table 12, in the same layout as in Table 6. Our baseline results are confirmed: the FOC of rational bidding is strongly rejected, with a negative point estimate (a sign of overbidding), significant bid premium coefficients for the bidder profit and probability of success equations, displaying the expected signs.

A second potential source of measurement errors is the estimated probability of deal completion. Even if we follow the Bhagat et al. (2005), our proxy of the probability of

[18] One might expect a negative covariance between bidder profit and the probability of success: the bidder increases the probability of success by bidding more aggressively but, in doing so, concedes a higher fraction of synergies to the target. However, a high bidder profit may signal an attractive opportunity and strongly motivate the bidder to complete the transaction, a source of positive covariance between the bidder profit and the probability of success.

completion is by construction noisy. To test the robustness of our results to this potential issue, we follow a strategy comparable to above. We select a sub-sample of transactions for which, by construction, the source of estimation errors is reduced. In the present case, we select the sub-sample of transactions perceived by investors as almost certain. The selection criterion is the following:

$$0.975 \leq \frac{p_{t+2}}{offer} \leq 1.025 \quad (17)$$

where p_{t+2} is the stock price two days after the announcement date and $offer$ is the offer price. The sub-sample is this time composed by 643 transactions. As shown in Table 13, Table 6 results are again strongly confirmed,.

We conclude from these two additional analyses that measurement errors are unlikely to drive our results.

Section 3 – Overbidding determinants

The test of overbidding in Section 1 delivers a natural avenue to explore overbidding determinants. Equation (5) can be estimated on a transaction by transaction basis, using coefficients $\hat{\alpha}_1$ and $\hat{\beta}_1$ from Equations (3) and (4) respectively. Collecting *Bidder Scaled CAR* and *Probability of Success*, our proxies for bidder profit and the probability of success (see Section 1.3), we can thereby measure the degree of overbidding for each transaction. CEOs may willingly overbid because their utility function differs from shareholders' value maximization, a topic that we already explore under the risk aversion point of view in the previous section. In such case, overbidding finds its roots into agency conflicts. But CEOs may also unwillingly overbid because they don't take (fully) into account the winner's curse (the argument developed in Roll, 1986) and, therefore, act irrationally. Moreover, these two sources of overbidding are not mutually exclusive. We explore the role of agency conflicts and irrationality as driving factors of overbidding in this section.

3.1. Overbidding and Agency Conflicts

The existing literature suggests several potential overbidding determinants related to agency conflicts and governance mechanisms: past performance (Rau and Vermaelen, 1998), CEO variable compensation (Grinstein and Hribar, 2004), the Gompers et al.(2003) index (GIM) that captures CEO entrenchment, free cash-flow (Jensen, 1986), leverage (Jensen and Meckling, 1976), CEO age (Yim, 2012) and the CEO pay-slice (Bebchuk and al., 2011)[19]. Overbidding behavior may also depend on industry factors. We distinguish between manufacturing firms, financial institutions, high-technology firms and other firms. To identify high-technology firms, we follow Kile and Phillips (2009) and use the following list of 3-digits SIC codes: 283, 357, 366, 367, 382, 384, 481, 482, 489, 737 and 873. Manufacturing firms are firms that belong to SIC 4-digits 3000 to 3999 (at the exclusion of codes associated with high-technology firms) and financial institutions are institutions belonging to SIC 4-digits 6000 to 6999. Firms not classified using these SIC codes fall into other industries.

Starting from the M&A sample introduced in Table 4, we are able to collect the necessary information for a sub-sample of 805 deals. Table 14 displays summary statistics. In comparison with descriptive statistics displayed in Table 5, only the mean value of *Bidder Size* and of *Relative* Size undergo a significant change (an increase by around 50%), that indicates that our determinants of interest are only available for larger bidders and transactions. The mean value of our measure of overbidding, *Deal FOC*, is negative (-0.042) and is significantly different from zero (with a *p*-value of 0.00, unreported).

Table 15 shows the results of our multivariate analyses. Column (1) reports results when limiting ourselves to industry dummies. In Column (2), we add bidder, transaction and governance variables, and in Column (3), we replace industry dummies by industry fixed-effects and add year fixed-effects. Column (1) results highlights that overbidding is be more significant in high technology industries (*p*-value of 0.08). In Column (2), four variables are significantly associated with an increase in overbidding: *Bidder Past Performance* (*p*-value of 0.02), the *GIM index* (*p*-value of 0.03), the *Relative Size* (*p*-value of 0.01) and the *Horizontal* dummy variable (*p*-value of 0.07). These results are consistent with the existing literature: Rau and Vermaelen (1998) show that good past performers (glamour firms) underperform in the long run and

[19] Tests of bidder CAR difference of means by quartile of overbidding determinants – unreported – confirm that good past performers, less leveraged bidders and younger CEOs display statistically significant lower CAR.

Gompers et al. (2003) report that more entrenched CEOs underperform also. More overbidding in horizontal is consistent with more intense competition by strategic buyers (see Akdogu, 2011) and Moeller et al. (2005) show that larger transactions (that is, higher relative size) lead to more value destruction *Bidder Leverage* decreases overbidding (*p*-value of 0.01), a result consistent with leverage being an external control mechanism to resolve agency conflicts (Jensen and Meckling, 1976), as does *Toehold* (*p*-value of 0.00). This is consistent with results reported in Table 6 concerning the probability of success, which appears to be decreasing in case of toeholds (less aggressive bidding leads to a lower probability of success). Overbidding appears to be decreasing in the case of hostile transactions but this result rests on a very limited number of observation (1.24% of our sample, see Table 14). Overbidding is also decreasing in case of negotiation, as expected. These results are all confirmed in Column (3).

3.2. Overbidding and Irrationality

We next attempt to test whether overbidding is related to irrationality or some form of cognitive bias. The existence of CEO overconfidence and narcissism has been well documented in the literature (Chatterjee and Hambrick, 2007 and 2011; Malmendier and Tate, 2008; Aktas et al., 2016). Raskin and Shaw (1988) show that the proportion of first person singular pronouns to first person plural pronouns (the I/we ratio) used in speech is correlated with narcissistic personality inventory scores, a questionnaire that provides a narcissism score for individuals. This result motivates Aktas et al. (2016) to use the I/we ratio as measure of CEO narcissism. The I/we ratio is estimated using the proportion of first person singular (*I, me, my, mine, myself*) to total first person pronouns (*I, me, my, mine, myself, we, us, our ours, ourselves*) in CEO speech, following Chatterjee and Hambrick (2007). CEO speeches are mainly transcripts of interviews with financial analysts or journalists, recorded in the Lexis Nexis Academic and The Wall Street Transcript databases, and are filtered manually to avoid contamination (e.g.: transcripts of annual general meetings, that are subject to scripting). We use the Aktas et al. (2016) data set, extended in de Bodt et al. (2015), to collect CEOs I/we ratio for the 805 transactions for which overbidding determinants are available. Despite manual matching, we are only able to obtain the CEO I/we ratio for a sub-sample of 174 transactions.

Table 16 replicates Table 15 results with the addition of CEO narcissism as independent variable for this sub-sample of 174 transactions. The coefficient of the CEO narcissism variable is negative in all specifications, which is consistent with narcissistic CEO bidding more aggressively, but coefficients are not statistically significant at customary levels. Whether this is due to a lack of power due to the small sample size or revealing the absence of effect of this CEO personality trait remains, at this stage, an open issue. The loss of significance of most control variables provides some indication that lack of power may play a role.

As a second attempt to explore the role of irrationality in observed overbidding behavior, we adopt an alternative indirect empirical strategy. If overbidding is related to failing to fully account for the winner's curse, bidders losing the competition to acquire targets should display less (or no) overbidding. Losing bidders may indeed be bidding less aggressively because they are more fully aware of the winner's curse. Under the winner's curse explanation of irrational bidding suggested in Roll (1986), we should therefore observe weaker (or absence of) rejection of the FOC of rational bidding for losing bidders.

Out of the 5,780 transactions included in Table 1 sample, 1,152 are failed. We are able to collect the information needed to test the FOC of rational bidding for 545 transactions out of the them (excluding SEC filings based variables because SEC filings are most often unavailable for failed transactions). Table 17 displays descriptive statistics comparable to Table 5 for this sub-sample of failed transactions. Notably, failed transactions are undertaken by far smaller bidders (USD 6.4 billion against USD 18.5 billion in Table 5), and consequently display a far higher relative size (64.15% versus 27.45% in Table 5). They also display lower target run-up (3.63% versus 9.58% in Table 5), lower 8-week bid premium (35.05% versus 42.27% in Table 5), far higher toehold (10.46% versus 2.07% in Table 5), far more frequent hostility (10.46% versus 0.88% in Table 5) and multiple bidder competition (26.24% versus 2,27% in Table 5). Table 18 replicates Table 6 FOC tests of rational bidding. The FOC of rational bidding is not rejected. This is true whether using the 8-week bid premium or its winsorized version and using the Wang (2015) or the Savor and Lu (2009) costs of failure estimates. These results are striking because of the very high level of rejection displayed in Table 6. A closer analysis of the results reveals that

the FOC is not rejected essentially because the bid premium is not inversely associated with the bidder (scaled) CAR.

We conclude that conflicts between shareholders and CEOs play a role in explaining overbidding behavior and that some indirect evidence exists that failing to fully account for the winner's curse may be also at work.

Conclusion

Behavioral corporate finance has evolved markedly during the last decades. The hubris hypothesis suggests how irrational behavior may lead to overbidding: if bidders don't sufficiently bias bids downward to account for the winner's curse, they overvalue targets. Agency conflicts are a second potential source of overbidding.

Only a limited number of studies report results pertaining to overbidding in M&A. Results are moreover in conflict, some authors failing to find evidence of overbidding (Moeller et al., 2004; Boone and Mulherin, 2008), others failing to reject the absence of overbidding (Berkovitch and Narayanan, 1993) or even reporting results supporting overbidding (Hietala et al., 2003; Mueller and Sirower, 2003; Eckbo and Thorburn, 2009).

In this paper, we introduce a new direct test of overbidding in M&A transactions. The test rests on the first order condition of an acquirer's expected profit maximization. It models the trade-off between the probability of success and the acquirer profit, conditionally on a successful acquisition, when choosing the bid premium. Our results strongly support the presence of overbidding. We highlight the role of bidder past performance, bidder CEO entrenchment, target to bidder relative size and horizontal transactions as overbidding exacerbating factors, while bidder leverage, toeholds and negotiation between the parties attenuate such behavior. Using a sample of failed transactions, we also report indirect evidence that failing to fully account for the winner's curse may be at work.

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Figure 1 – First Order Condition Test of Overbidding Histogram

Figure 1 displays the histogram of the bidder's expected profit maximization first order condition test (Equation (5)) obtained using estimation of Equations (3) and (4) by seemingly unrelated regression and corresponding to the 8-week Bid Premium and Savor and Lu (2008) costs of failure estimate case .. The M&A sample is described in Section 1.4 and Table 4 and is composed of 1,935 transactions.

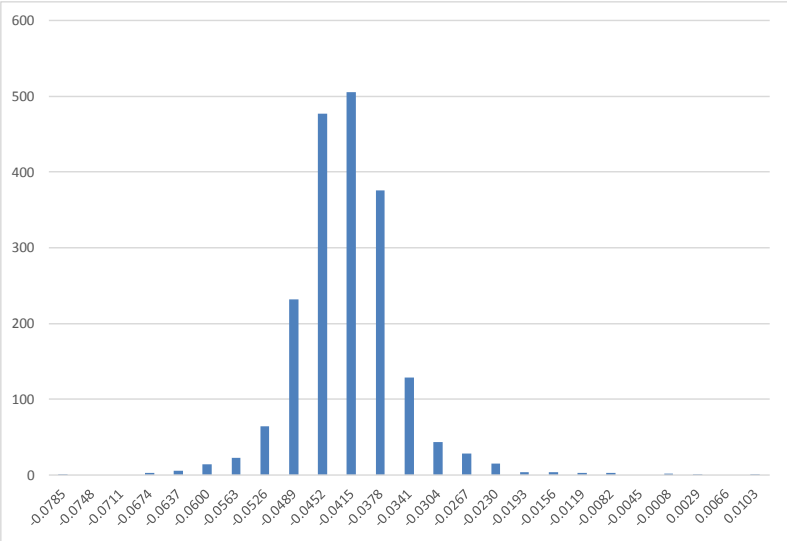
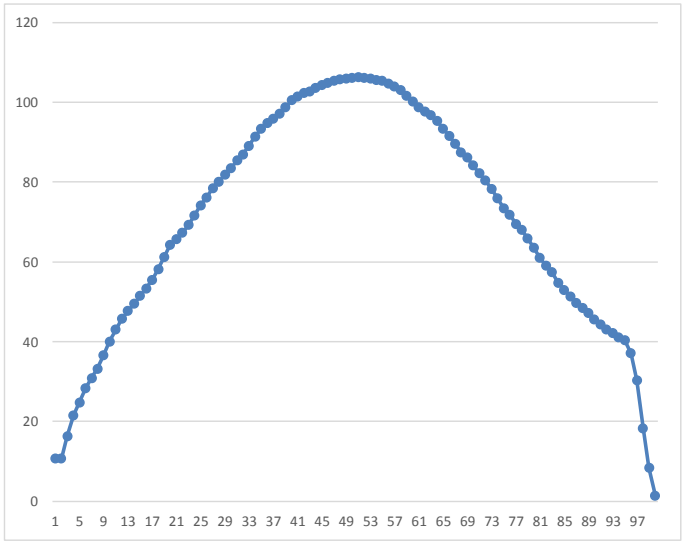


Figure 2 – First Order Condition Test of Overbidding using Non-Linear SUR Specification

Figure 2 displays results obtained using an order three polynomial SUR specification (Equations (8) and (9)). Panel A graphs the bidder's expected profit maximization FOC (Equation (10)) *Chi2* statistic as a function of the winsorized 8-week bid premium, using Savor and Lu (2009) estimate of the costs of failure. Panel B highlights the behavior of the expected profit and the probability of success partial derivatives, again as a function of the winsorized 8-week bid premium. The 8-week bid premium is winsorized at the one and ninety-nine percentiles. The horizontal axis is the winsorized 8-week bid premium percentiles in both panels. In Panel A, the vertical axis reports the *Chi2* statistic. In Panel B, the left vertical axis provides values of the expected profit partial derivatives and the right one, the probability of success partial derivative.

Panel A – Chi2 Statistic as a Function of the Winsorized 8-week Bid Premium



Panel B – Expected Profit and Probability of Success Partial Derivatives as a Function of the Winsorized 8-week Bid Premium

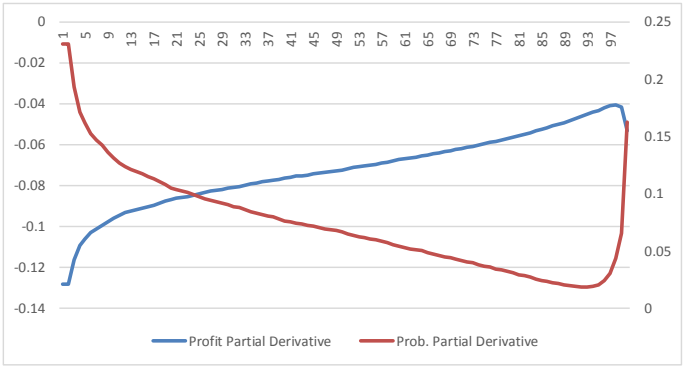


Figure 3 – Overbidding and Risk Aversion

Figure 3 represents the estimates of the CEO maximization program first order condition (obtained solving Equation (11)) as a function of the CEO risk aversion coefficient. As explained in Section 2.4, we use the CARA utility function to model risk aversion. The horizontal axis reports the risk aversion coefficient value (from 1 to 10, by increment of 1). The vertical axis provides the corresponding estimates of Equation (11) first order condition.

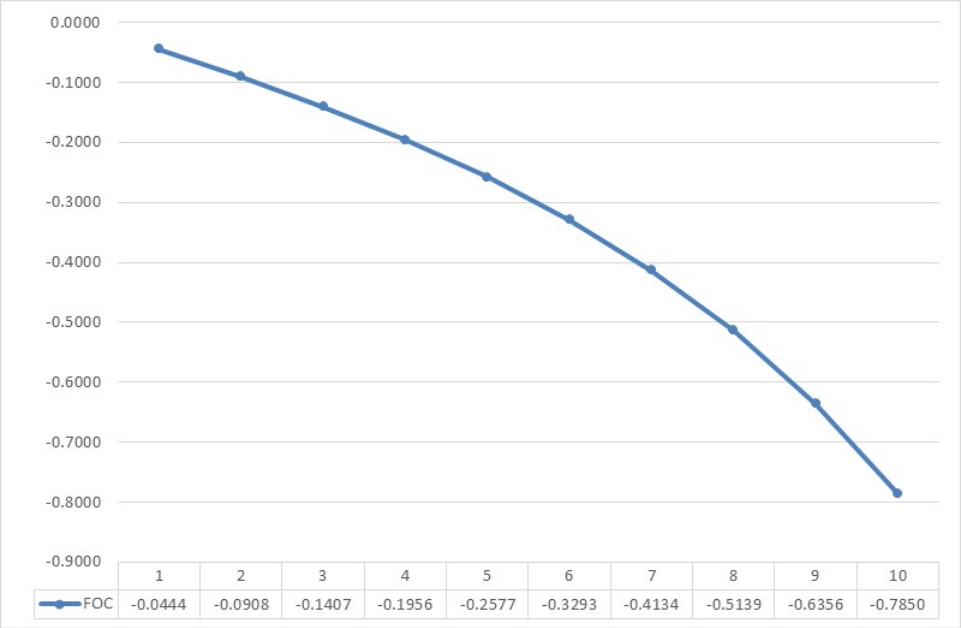


Table 1 – Probit Sample Descriptive Statistics

Table 1 presents the M&A sample used to estimate Equation (6). The sample includes all transactions between US bidders and US listed targets, with a deal size above USD 1 million, for which the bidder held less than 50% before the acquisition attempt and more than 50% after, reported in the SDC database between 1994 and 2014. *#Deals* is the number of deals, *Success* is the percentage of completed transaction by year, *8-week Bid Premium* is the offer price divided by the share price of the target 42 days before the announcement date.

			8-week Bid Premium	
Year	*#Deals*	*Success*	*Mean*	*Median*
1994	202	78.00%	34.03%	33.48%
1995	345	77.00%	42.90%	37.65%
1996	362	80.00%	38.48%	32.31%
1997	496	82.00%	37.22%	34.69%
1998	493	82.00%	40.30%	33.33%
1999	532	78.00%	50.21%	43.40%
2000	433	76.00%	46.81%	40.80%
2001	310	85.00%	44.86%	40.67%
2002	184	77.00%	43.98%	37.18%
2003	234	82.00%	42.95%	31.89%
2004	212	86.00%	31.90%	26.87%
2005	244	81.00%	28.47%	25.37%
2006	292	80.00%	28.65%	24.65%
2007	301	78.00%	28.81%	26.28%
2008	187	66.00%	26.94%	23.57%
2009	119	80.00%	54.38%	46.23%
2010	196	85.00%	45.41%	39.44%
2011	172	80.00%	40.37%	34.43%
2012	160	84.00%	42.30%	34.21%
2013	156	83.00%	38.45%	34.63%
2014	150	85.00%	32.93%	27.55%
Total	5780	80.07%	39.58%	33.43%

Table 2 – Probit Variables Descriptive Statistics and Test of Difference of Means

Table 2 reports descriptive statistics for variables included in Equation (6), the probit model used to estimate the probability of acquisition attempt success (see Section 1.3), as well as a standard test of difference of means between completed and uncompleted transactions. The M&A sample is described in Section 1.3 and Table 1. Variables are defined in Appendix B. *Mean* is for arithmetic average, *Median* for sample median, *Stdev* for standard deviation, *#Deals* for the number of deals, *t-stat* for the Student statistic of the difference of means test and *p-val*, the corresponding probability under the null hypothesis of no difference.

	All deals				*Uncompleted*	*Completed*		
Variable	*Mean*	*Median*	*Stdev*	*#Deals*	*Mean*	*Mean*	*t-stat*	*p-val*
Deal success	80.07%	100.00%	39.95%	5,780	n.a	n.a	n.a	n.a
Target Size	1,137,571	161,655	4,169,262	5,780	1,270,613	1,104,454	1.21	0.23
Nyse Amex	6.18%	0.00%	24.07%	5,780	6.77%	6.03%	0.94	0.35
Turnover	6.0781	3.8701	6.5333	5,780	6.0957	6.0738	0.10	0.92
Poison Pill	1.21%	0.00%	10.94%	5,780	4.08%	0.50%	10.03	0.00
52Weeks High	65.94%	68.51%	18.17%	5,780	65.51%	66.04%	-0.90	0.37
Toehold	7.99%	0.00%	27.12%	5,780	19.27%	5.19%	16.12	0.00
Listed Bidder	67.58%	100.00%	46.81%	5,780	52.43%	71.35%	-12.44	0.00
Horizontal	32.80%	0.00%	46.95%	5,780	27.78%	34.05%	-4.06	0.00
8-week Bid Premium	39.58%	33.43%	39.22%	5,780	33.87%	41.00%	-5.53	0.00
Tender Offer	16.73%	0.00%	37.33%	5,780	9.11%	18.63%	-7.78	0.00
All Cash	43.56%	0.00%	49.59%	5,780	53.82%	41.01%	7.89	0.00
All Stock	27.06%	0.00%	44.43%	5,780	17.80%	29.36%	-7.95	0.00
Hostile	2.92%	0.00%	16.85%	5,780	11.11%	0.89%	19.00	0.00
Year 1990's	42.04%	0.00%	49.37%	5,780	42.53%	41.92%	0.38	0.70

Table 3 – Probability of Deal Completion Estimation Results

Table 3 displays Equation (6) estimation results, the probit model used to estimate the probability of acquisition attempt success (see Section 1.3). The M&A sample is describe in Section 1.3 and Table 1. Variables are defined in Appendix B. Two specifications are reported: in column (1), the raw 8-week Bid Premium is used; in column (2), the 8-week Bid Premium is winsorized at the one and ninety-nine percentiles. *Coeff* stands for coefficient and *p-val* for *p*-value.

	(1)		(2)	
	Coeff	*p-val*	*Coeff*	*p-val*
Target Size	0.0458	(0.00)	0.0460	(0.00)
Nyse Amex	0.0382	(0.64)	0.0344	(0.67)
Turnover	-0.0058	(0.09)	-0.0049	(0.15)
Poison Pill	-0.9149	(0.00)	-0.9215	(0.00)
52Weeks High	0.4115	(0.00)	0.5080	(0.00)
Toehold	-0.6116	(0.00)	-0.6064	(0.00)
Listed Bidder	0.3052	(0.00)	0.3008	(0.00)
Horizontal	0.0145	(0.75)	0.0164	(0.71)
8-week Bid Premium	0.2378	(0.00)	0.3693	(0.00)
Tender Offer	0.8726	(0.00)	0.8629	(0.00)
All Cash	-0.1488	(0.01)	-0.1501	(0.01)
All Stock	0.2289	(0.00)	0.2334	(0.00)
Hostile	-1.6962	(0.00)	-1.7102	(0.00)
Year 1990's	-0.1019	(0.02)	-0.1022	(0.02)
_cons	-0.1558	(0.42)	-0.2709	(0.15)
N	5780		5780	

Table 4 – Bidder's Expected Profit Maximization Test – M&A Sample

Table 4 describes the M&A sample used to estimate Equations (3) and (4) with a seemingly unrelated regression (SUR) estimator and to test Equation (5), the first-order condition of the bidder's expected profit maximization. The sample composition procedure is described in Section 1.4. We obtain a list of 1,935 completed transactions, between US listed bidders and US listed targets, with a deal size of at least USD 100 million. These are control transactions (for completed transactions, the bidder must hold less than 50% of the target shares before the transaction and more than 50% afterwards), necessary information to compute the 8-week Bid Premium must be available and SEC filings must contain necessary information to identify the deal initiator and the sales process. *#Deals* is the number of deals, *Deal Value* is reported in USD million, *Bidder CAR*, *Target CAR* and *Deal CAR* are obtained using the market model as return generating process, day minus 250 to day minus 10 with respect to the announcement date estimation window, the CRSP value weighted index as proxy for the market index and a three days event window centered around the announcement. *Bidder Scaled CAR* and *Deal Scaled CAR* are the bidder and deal CAR divided by the estimated ex-ante probability of deal completion (*Probability of Success*). *8-week Bid Premium* is the offer price divided by the share price of the target 42 days before the announcement date. *Probability of Success* is the average estimated ex-ante probability of deal completion (we follow Bhagat et al. (2005) probability scaling method).

Year	*#Deals*	*Deal Value Mean*	*Deal Value Median*	*Bidder CAR Mean*	*Bidder Scaled CAR Mean*	*Target CAR Mean*	*Deal CAR Mean*	*Deal Scaled CAR Mean*	*8-week BidPremium Mean*	*Probability of Success*
1994	32	1,050	330	-0.07%	-0.10%	26.65%	2.96%	4.02%	45.66%	85.15%
1995	92	1273	315	-1.42%	-1.64%	21.04%	1.78%	2.76%	43.93%	84.92%
1996	110	1,573	419	0.09%	0.07%	19.63%	3.18%	4.04%	41.57%	85.75%
1997	189	1,091	412	-0.82%	-0.99%	15.95%	1.66%	1.79%	42.69%	88.16%
1998	188	3,112	516	-2.30%	-2.62%	17.86%	0.95%	1.12%	42.58%	87.05%
1999	203	1,906	493	-1.40%	-1.61%	23.32%	1.28%	1.51%	53.54%	86.87%
2000	140	3,234	729	-5.40%	-6.54%	23.85%	-1.33%	-0.50%	50.68%	89.17%
2001	88	1,966	413	-3.30%	-3.99%	24.63%	-0.38%	-0.64%	49.68%	87.70%
2002	55	1,884	384	-2.87%	-3.48%	18.93%	-0.49%	-0.75%	33.55%	87.21%
2003	80	1,778	435	-1.63%	-2.10%	22.42%	0.42%	0.32%	43.42%	86.72%
2004	98	2,423	522	-1.77%	-1.92%	18.35%	1.70%	2.07%	32.50%	86.88%
2005	86	3,581	892	-1.26%	-1.49%	20.14%	1.32%	1.54%	33.28%	85.53%
2006	99	3,441	884	-1.12%	-1.18%	18.94%	1.74%	2.13%	29.27%	85.66%
2007	97	1,573	810	-0.57%	-0.64%	24.92%	2.53%	2.92%	32.26%	87.35%
2008	52	3,107	698	-2.92%	-3.37%	29.59%	1.68%	1.85%	27.81%	88.67%
2009	48	4,602	1,049	-0.46%	-0.67%	30.51%	2.87%	3.16%	58.74%	88.67%
2010	59	1,701	673	0.34%	0.43%	31.72%	3.37%	3.89%	44.06%	87.57%
2011	38	3,860	900	-1.02%	-1.13%	27.18%	4.14%	4.69%	44.14%	88.26%
2012	52	1,636	878	0.93%	1.14%	31.69%	4.95%	5.77%	42.29%	87.82%
2013	58	1,695	697	3.16%	3.70%	28.10%	6.53%	7.53%	41.10%	87.48%
2014	71	4,333	1,106	0.93%	1.03%	29.33%	5.06%	5.78%	39.17%	88.98%
total	1935	2,342	571	-1.38%	-1.63%	22.47%	1.77%	2.16%	42.27%	87.20%

Table 5 – Bidder's Expected Profit Maximization Test – Descriptive Statistics

Table 5 reports descriptive statistics for variables used to estimate Equations (3) and (4) with a seemingly unrelated regression (SUR) estimator and to test Equation (5), the first-order condition of the bidder's expected profit maximization. The M&A sample is described in Section 1.4 and Table 4. Variables are defined in Appendix B. *Mean* is the arithmetic average, *Median* the corresponding median, *Stdev*, the standard deviation of the mean. *p*-val reports the *p*-value of the standard test of sample mean statistical significance.

	All deals - 1935 deals			
Variable	*Mean*	*p-val*	*Median*	*Stdev*
Bidder CAR	-1.38%	(0.00)	-1.11%	8.22%
Bidder Scaled CAR	-1.63%	(0.00)	-1.28%	9.62%
Target CAR	22.47%	(0.00)	18.50%	23.42%
Deal CAR	1.77%	(0.00)	1.34%	7.86%
Deal Scaled CAR	2.16%	(0.00)	1.54%	10.01%
Target Runup	9.58%	(0.00)	6.98%	21.84%
Probability of Success	87.20%		87.58%	7.57%
8-week BidPremium	42.27%		35.87%	35.47%
Bidder Size	18,500,000		3,703,431	43,300,000
Target Industry Liquidity	0.0642		0.0382	0.0894
Relative Size	27.45%		13.67%	40.32%
Horizontal	40.57%		0.00%	49.12%
All Stock	37.36%		0.00%	48.39%
Toehold	2.07%		0.00%	14.23%
Hostile	0.88%		0.00%	9.33%
BidderPrivateR2	0.0895	(0.00)	-0.0028	0.5275
BidderPrivateAmihud	-0.0914	(0.00)	-0.1933	0.4919
Initiation	42.02%		0.00%	49.37%
Negotiation	39.90%		0.00%	48.98%
Multiple Bidder	2.27%		0.00%	14.91%

Table 6 – Bidder's Expected Profit Maximization Test – SUR Results

Table 6 summarizes estimation results of Equations (3) and (4) and the ensuing test of the bidder's expected profit maximization FOC (Equation (5)). Estimations are obtained using the seemingly unrelated regression (SUR) estimator. *p*-values are reported between parentheses. The M&A sample is described in Section 1.4 and Table 4. Variables are defined in Appendix B. *Coeff* stands for coefficient and *p-val* for *p*-value. *Chi2* is the chi-squared statistic of the cross-equation restriction defined at Equation (5) and *FOC Test*, the corresponding point estimate (*FOC Test (Wang)* uses Wang (2015) costs of failure estimate and *FOC Test (Savor and Lu),* Savor and Lu (2009) one). Columns (1) and (2) present results for the raw 8-week bid premium, while Columns (3) and (4) report corresponding results using the winsorized 8-week bid premium (winsorization is at one and ninety-nine percentiles). In Columns (1) and (3), the dependent variable is the Bidder Scaled CAR (we follow Bhagat et al. (2005) probability scaling method) and in Columns (2) and (4), it is the probability of deal completion.

	8-week Bid Premium				8-week Bid Premium Winsorized			
	(1)		(2)		(3)		(4)	
	Bidder Scaled CAR		*Probability of Success*		*Bidder Scaled CAR*		*Probability of Success*	
	Coeff	*p-val*	*Coeff*	*p-val*	*Coeff*	*p-val*	*Coeff*	*p-val*
Deal Scaled CAR	0.7968	(0.00)	0.0045	(0.72)	0.7898	(0.00)	0.0055	(0.67)
Target Runup	0.1021	(0.00)	-0.0053	(0.44)	0.1027	(0.00)	-0.0024	(0.73)
8-week BidPremium	-0.0541	(0.00)	0.0351	(0.00)	-0.0596	(0.00)	0.0543	(0.00)
Bidder Size	0.0052	(0.00)	0.0038	(0.00)	0.0050	(0.00)	0.0040	(0.00)
Target Industry Liquidity	-0.0144	(0.34)	-0.0020	(0.88)	-0.0141	(0.35)	-0.0061	(0.65)
Relative Size	-0.0319	(0.00)	0.0119	(0.00)	-0.0327	(0.00)	0.0131	(0.00)
Horizontal	-0.0029	(0.29)	0.0049	(0.04)	-0.0030	(0.28)	0.0053	(0.03)
All Stock	-0.0009	(0.75)	0.0223	(0.00)	-0.0011	(0.70)	0.0228	(0.00)
Toehold	0.0166	(0.08)	-0.1207	(0.00)	0.0172	(0.08)	-0.1183	(0.00)
Hostile	-0.2102	(0.00)	-0.5035	(0.00)	-0.2096	(0.00)	-0.5059	(0.00)
BidderPrivateR2	0.0012	(0.66)	0.0023	(0.31)	0.0012	(0.65)	0.0021	(0.37)
BidderPrivateAmihud	0.0039	(0.17)	0.0068	(0.01)	0.0039	(0.18)	0.0061	(0.02)
Initiation	-0.0035	(0.24)	-0.0040	(0.13)	-0.0031	(0.30)	-0.0043	(0.10)
Negotiation	0.0054	(0.07)	-0.0066	(0.01)	0.0053	(0.08)	-0.0068	(0.01)
Multiple Bidder	-0.0039	(0.67)	0.0113	(0.15)	-0.0027	(0.76)	0.0105	(0.19)
_cons	-0.0864	(0.00)	0.7983	(0.00)	-0.0818	(0.00)	0.7873	(0.00)
N	1935		1935		1935		1935	
FOC Test (Wang)	-0.0455				-0.0495			
Chi2	132.44	(0.00)			124.72	(0.00)		
FOC Test (Savor and Lu)	-0.0419				-0.0438			
Chi2	107.21	(0.00)			93.77	(0.00)		

Table 7 – Bidder's Expected Profit Maximization Test – Non-linear Seemingly Unrelated Regression Test

Table 7 reproduces results displayed in Table 6 using an order three polynomial seemingly unrelated specification (see Equations (8) and (9)). *8-week Bid Premium, 8-week Bid Premium*^{2} and *8-week Bid Premium*^{3} are respectively the winsorized 8-week bid premium, its square and its cube.

	8-week Bid Premium Winsorized			
	(1)		(2)	
	Bidder Scaled CAR		*Probability of Success*	
	Coeff	*p-val*	*Coeff*	*p-val*
Deal CAR	0.7936	(0.00)	-0.0026	(0.84)
Target Runup	0.1073	(0.00)	-0.0106	(0.13)
8-week Bid Premium	-0.1007	(0.00)	0.1456	(0.00)
8-week Bid Premium^2	0.0469	(0.05)	-0.1402	(0.00)
8-week Bid Premium^3	-0.0122	(0.23)	0.0516	(0.00)
Bidder Size	0.0049	(0.00)	0.0041	(0.00)
Target Industry Liquidity	-0.0181	(0.24)	0.0029	(0.82)
Relative Size	-0.0339	(0.00)	0.0143	(0.00)
Horizontal	-0.0036	(0.20)	0.0062	(0.01)
All Stock	-0.0020	(0.49)	0.0253	(0.00)
Toehold	0.0152	(0.12)	-0.1141	(0.00)
Hostile	-0.2076	(0.00)	-0.5077	(0.00)
BidderPrivateR2	0.0013	(0.63)	0.0022	(0.33)
BidderPrivateAmihud	0.0037	(0.20)	0.0066	(0.01)
Initiation	0.0044	(0.14)	-0.0058	(0.03)
Negotiation	-0.0031	(0.30)	-0.0043	(0.10)
Multiple Bidder	-0.0025	(0.78)	0.0105	(0.18)
_cons	-0.0726	(0.00)	0.7726	(0.00)
N	1935		1935	
FOC Test (Wang)	-0.0580			
Chi2	100.62	(0.00)		
FOC Test (Savor and Lu)	-0.0559			
Chi2	91.90	(0.00)		

Table 8 – Bidder's Expected Profit Maximization Test – Unscaled Bidder CAR

Table 8 reproduces results displayed in Table 6 using the Bidder CAR and Deal CAR in place of the Bidder Scaled CAR and Deal Scaled CAR.

	8-week Bid Premium				8-week Bid Premium Winsorized			
	(1)		(2)		(3)		(4)	
	Bidder CAR		*Probability of Success*		*Bidder CAR*		*Probability of Success*	
	Coeff	*p-val*	*Coeff*	*p-val*	*Coeff*	*p-val*	*Coeff*	*p-val*
Deal CAR	0.9802	(0.00)	0.0502	(0.00)	0.9842	(0.00)	0.0515	(0.00)
Target Runup	0.0914	(0.00)	-0.0037	(0.60)	0.0931	(0.00)	-0.0006	(0.93)
8-week Bid Premium	-0.0526	(0.00)	0.0337	(0.00)	-0.0599	(0.00)	0.0525	(0.00)
Bidder Size	0.0057	(0.00)	0.0040	(0.00)	0.0056	(0.00)	0.0043	(0.00)
Target Industry Liquidity	-0.0021	(0.81)	-0.0005	(0.97)	-0.0010	(0.91)	-0.0046	(0.73)
Relative Size	-0.0304	(0.00)	0.0105	(0.00)	-0.0316	(0.00)	0.0116	(0.00)
Horizontal	-0.0037	(0.02)	0.0048	(0.04)	-0.0040	(0.01)	0.0052	(0.03)
All Stock	0.0023	(0.18)	0.0235	(0.00)	0.0024	(0.16)	0.0241	(0.00)
Toehold	0.0087	(0.13)	-0.1209	(0.00)	0.0085	(0.13)	-0.1185	(0.00)
Hostile	-0.0196	(0.03)	-0.5040	(0.00)	-0.0184	(0.03)	-0.5062	(0.00)
BidderPrivateR2	-0.0012	(0.45)	0.0019	(0.40)	-0.0013	(0.42)	0.0017	(0.46)
BidderPrivateAmihud	0.0014	(0.41)	0.0068	(0.01)	0.0013	(0.43)	0.0061	(0.02)
Initiation	-0.0043	(0.02)	-0.0040	(0.12)	-0.0040	(0.02)	-0.0043	(0.10)
Negotiation	0.0059	(0.00)	-0.0063	(0.02)	0.0058	(0.00)	-0.0065	(0.01)
Multiple Bidder	-0.0063	(0.24)	0.0116	(0.14)	-0.0051	(0.34)	0.0109	(0.17)
_cons	-0.0947	(0.00)	0.7935	(0.00)	-0.0913	(0.00)	0.7827	(0.00)
N	1935		1935		1935		1935	
FOC Test (Wang)	-0.0442				-0.0497			
Chi2	356.15	(0.00)			373.02	(0.00)		
FOC Test (Savor and Lu)	-0.0407				-0.0442			
Chi2	288.37	(0.00)			282.53	(0.00)		

Table 9 – Bidder's Expected Profit Maximization Test – Asymmetric SUR Specification

Table 9 reproduces results displayed in Table 6 keeping only statistically significant variables in the seemingly unrelated regression (SUR) specification.

	8-week Bid Premium				8-week Bid Premium Winsorized			
	(1)		(2)		(3)		(4)	
	Bidder Scaled CAR		*Probability of Success*		*Bidder Scaled CAR*		*Probability of Success*	
	Coeff	*p-val*	*Coeff*	*p-val*	*Coeff*	*p-val*	*Coeff*	*p-val*
Deal Scaled CAR	0.7983	(0.00)			0.7913	(0.00)		
Target Runup	0.1022	(0.00)			0.1025	(0.00)		
8-week BidPremium	-0.0546	(0.00)	0.0331	(0.00)	-0.0600	(0.00)	0.0533	(0.00)
Bidder Size	0.0051	(0.00)	0.0038	(0.00)	0.0050	(0.00)	0.0040	(0.00)
Target Industry Liquidity								
Relative Size	-0.0335	(0.00)	0.0118	(0.00)	-0.0342	(0.00)	0.0133	(0.00)
Horizontal			0.0051	(0.03)			0.0055	(0.02)
All Stock			0.0211	(0.00)			0.0225	(0.00)
Toehold	0.0162	(0.09)	-0.1199	(0.00)	0.0168	(0.08)	-0.1170	(0.00)
Hostile	-0.2080	(0.00)	-0.5055	(0.00)	-0.2067	(0.00)	-0.5081	(0.00)
BidderPrivateR2								
BidderPrivateAmihud			0.0058	(0.02)			0.0051	(0.04)
Initiation							-0.0045	(0.09)
Negotiation	0.0069	(0.01)	-0.0055	(0.02)	0.0067	(0.02)	-0.0071	(0.01)
Multiple Bidder								
_cons	-0.0902	(0.00)	0.7973	(0.00)	-0.0859	(0.00)	0.7870	(0.00)
N	1935		1935		1935		1935	
FOC Test (Wang)	-0.0460				-0.0499			
Chi2	137.56	(0.00)			128.81	(0.00)		
FOC Test (Savor and Lu)	-0.0426				-0.0444			
Chi2	114.57	(0.00)			99.12	(0.00)		

Table 10 – Bidder's Expected Profit Maximization Test – Heteroskedasticity Robust Estimation

Table 10 reproduces results displayed in Table 6 using the Eicker-Huber-White-sandwich covariance estimator robust to heteroskedasticity.

	8-week Bid Premium				8-week Bid Premium Winsorized			
	(1)		(2)		(3)		(4)	
	Bidder Scaled CAR		*Probability of Success*		*Bidder Scaled CAR*		*Probability of Success*	
	Coeff	*p-val*	*Coeff*	*p-val*	*Coeff*	*p-val*	*Coeff*	*p-val*
Deal Scaled CAR	0.7968	(0.00)	0.0045	(0.88)	0.7898	(0.00)	0.0055	(0.86)
Target Runup	0.1021	(0.00)	-0.0053	(0.46)	0.1027	(0.00)	-0.0024	(0.74)
8-week Bid Premium	-0.0541	(0.00)	0.0351	(0.00)	-0.0596	(0.00)	0.0543	(0.00)
Bidder Size	0.0052	(0.00)	0.0038	(0.00)	0.0050	(0.00)	0.0040	(0.00)
Target Industry Liquidity	-0.0144	(0.35)	-0.0020	(0.88)	-0.0141	(0.37)	-0.0061	(0.66)
Relative Size	-0.0319	(0.00)	0.0119	(0.00)	-0.0327	(0.00)	0.0131	(0.00)
Horizontal	-0.0029	(0.23)	0.0049	(0.03)	-0.0030	(0.22)	0.0053	(0.02)
All Stock	-0.0009	(0.82)	0.0223	(0.00)	-0.0011	(0.80)	0.0228	(0.00)
Toehold	0.0166	(0.39)	-0.1207	(0.00)	0.0172	(0.38)	-0.1183	(0.00)
Hostile	-0.2102	(0.01)	-0.5035	(0.00)	-0.2096	(0.01)	-0.5059	(0.00)
BidderPrivateR2	0.0012	(0.67)	0.0023	(0.33)	0.0012	(0.66)	0.0021	(0.39)
BidderPrivateAmihud	0.0039	(0.24)	0.0068	(0.01)	0.0039	(0.25)	0.0061	(0.02)
Initiation	-0.0035	(0.25)	-0.0040	(0.13)	-0.0031	(0.30)	-0.0043	(0.10)
Negotiation	0.0054	(0.02)	-0.0066	(0.01)	0.0053	(0.03)	-0.0068	(0.01)
Multiple Bidder	-0.0039	(0.69)	0.0113	(0.15)	-0.0027	(0.78)	0.0105	(0.18)
_cons	-0.0864	(0.00)	0.7983	(0.00)	-0.0818	(0.00)	0.7873	(0.00)
N	1935		1935		1935		1935	
FOC Test (Wang)	-0.0455				-0.0495			
Chi2	56.16	(0.00)			56.86	(0.00)		
FOC Test (Savor and Lu)	-0.0419				-0.0470			
Chi2	46.56	(0.00)			43.48	(0.00)		

Table 11 – Bidder's Expected Profit Maximization Test – Truncated Bivariate ML

Table 11 reproduces results displayed in Table 6 modelling the Bidder Scaled CAR and the probability of deal completion joint density as a truncated bivariate normal density and using the Maximimum Likelihood estimator (see Section 2.5 and Equations (12) to (14)). Column (1) display results for the Bidder Scaled CAR dependent variable and Column (2), for the probability of deal completion.

	8-week Bid Premium			
	(1)		(2)	
	Bidder Scaled CAR		*Probability of Success*	
	Coeff	*p-val*	*Coeff*	*p-val*
Deal CAR	0.7968	(0.00)	0.0045	(0.72)
Target Runup	0.1021	(0.00)	-0.0053	(0.44)
8-week Bid Premium	-0.0541	(0.00)	0.0351	(0.00)
Bidder Size	0.0052	(0.00)	0.0038	(0.00)
Target Industry Liquidity	-0.0144	(0.34)	-0.0020	(0.88)
Relative Size	-0.0319	(0.00)	0.0119	(0.00)
Horizontal	-0.0029	(0.29)	0.0049	(0.04)
All Stock	-0.0009	(0.75)	0.0223	(0.00)
Toehold	0.0166	(0.08)	-0.1207	(0.00)
Hostile	-0.2102	(0.00)	-0.5035	(0.00)
BidderPrivateR2	0.0012	(0.66)	0.0023	(0.31)
BidderPrivateAmihud	0.0039	(0.17)	0.0068	(0.01)
Initiation	-0.0035	(0.24)	-0.0040	(0.13)
Negotiation	0.0054	(0.07)	-0.0066	(0.01)
Multiple Bidder	-0.0039	(0.67)	0.0113	(0.15)
_cons	-0.0864	(0.00)	0.7983	(0.00)
Var	0.0034	(0.00)	0.0026	(0.00)
Covar	0.0004	(0.00)		
N	1935		1935	
FOC Test (Wang)	-0.0455			
Chi2	132.44	(0.00)		
FOC Test (Savor and Lu)	-0.0419			
Chi2	107.21	(0.00)		

Table 12 – Bidder's Expected Profit Maximization Test – Constant Private Information Content

Table 12 reproduces results displayed in Table 6 for a sub-sample of transactions for which the bidder level of private information, measured by the price non-synchronicity indicator, is almost constant between the pre and post announcement period. More specifically, we limit the sample to transactions for which the ratio of the bidder price non-synchronicity during the post the announcement period (day plus 42 to day plus 61) to price non-synchronicity during the pre announcement period (from day minus 61 to day minus 42) is between 0.95 and 1.05.

	8-week Bid Premium				8-week Bid Premium Winsorized			
	(1)		(2)		(3)		(4)	
	Bidder Scaled CAR		*Probability of Success*		*Bidder Scaled CAR*		*Probability of Success*	
	Coeff	*p-val*	*Coeff*	*p-val*	*Coeff*	*p-val*	*Coeff*	*p-val*
Deal Scaled CAR	0.9183	(0.00)	0.0245	(0.38)	0.9246	(0.00)	0.0221	(0.43)
Target Runup	0.1304	(0.00)	-0.0302	(0.05)	0.1407	(0.00)	-0.0324	(0.04)
8-week BidPremium	-0.0737	(0.00)	0.0400	(0.00)	-0.0873	(0.00)	0.0621	(0.00)
Bidder Size	0.0093	(0.00)	0.0062	(0.00)	0.0088	(0.00)	0.0065	(0.00)
Target Industry Liquidity	0.0023	(0.93)	0.0331	(0.25)	0.0063	(0.81)	0.0318	(0.26)
Relative Size	-0.0272	(0.00)	0.0066	(0.32)	-0.0303	(0.00)	0.0073	(0.27)
Horizontal	-0.0023	(0.64)	0.0036	(0.50)	-0.0030	(0.54)	0.0043	(0.41)
All Stock	0.0040	(0.45)	0.0270	(0.00)	0.0048	(0.35)	0.0281	(0.00)
Toehold	0.0009	(0.95)	-0.0455	(0.01)	0.0018	(0.91)	-0.0415	(0.01)
Hostile	-0.1629	(0.00)	-0.6632	(0.00)	-0.1530	(0.00)	-0.6670	(0.00)
Initiation	-0.0079	(0.15)	0.0032	(0.59)	-0.0072	(0.18)	0.0026	(0.66)
Negotiation	0.0051	(0.35)	0.0006	(0.93)	0.0048	(0.37)	0.0012	(0.84)
Multiple Bidder	-0.0217	(0.20)	0.0336	(0.07)	-0.0184	(0.27)	0.0336	(0.07)
_cons	-0.1476	(0.00)	0.7551	(0.00)	-0.1356	(0.00)	0.7422	(0.00)
N	339		339		339		339	
FOC Test (Wang)	-0.0627				-0.0738			
Chi2	103.61	(0.00)			110.26	(0.00)		
FOC Test (Savor and Lu)	-0.0586				-0.0673			
Chi2	89.84	(0.00)			91.46	(0.00)		

Table 13 – Bidder's Expected Profit Maximization Test – High probability of Completion Transactions

Table 13 reproduces results displayed in Table 6 for a sub-sample of transactions for which the probability of successful completion, as perceived by investors, is very high. We use the ratio of target stock price two days after the transaction announcement to the offer price as measure of investors' perception of the probability of completion. The sample is limited to transactions for which this ratio lies between 0.975 and 1.025.

	8-week Bid Premium				8-week Bid Premium Winsorized			
	(1)		(2)		(3)		(4)	
	Bidder Scaled CAR		*Probability of Success*		*Bidder Scaled CAR*		*Probability of Success*	
	Coeff	*p-val*	*Coeff*	*p-val*	*Coeff*	*p-val*	*Coeff*	*p-val*
Deal Scaled CAR	0.9578	(0.00)	-0.0151	(0.67)	0.9628	(0.00)	-0.0119	(0.73)
Target Runup	0.0842	(0.00)	-0.0279	(0.08)	0.0881	(0.00)	-0.0266	(0.09)
8-week BidPremium	-0.0485	(0.00)	0.0507	(0.00)	-0.0533	(0.00)	0.0668	(0.00)
Bidder Size	0.0061	(0.00)	0.0025	(0.13)	0.0062	(0.00)	0.0027	(0.09)
Target Industry Liquidity	-0.0177	(0.35)	0.0870	(0.01)	-0.0162	(0.39)	0.0847	(0.02)
Relative Size	-0.0233	(0.00)	0.0144	(0.09)	-0.0242	(0.00)	0.0153	(0.07)
Horizontal	-0.0032	(0.24)	0.0022	(0.67)	-0.0033	(0.22)	0.0026	(0.60)
All Stock	0.0056	(0.14)	0.0165	(0.02)	0.0055	(0.14)	0.0168	(0.02)
Toehold	-0.0036	(0.73)	-0.1218	(0.00)	-0.0036	(0.72)	-0.1195	(0.00)
Hostile	-0.0699	(0.00)	-0.4098	(0.00)	-0.0710	(0.00)	-0.4136	(0.00)
BidderPrivateR2	-0.0020	(0.36)	0.0044	(0.27)	-0.0021	(0.32)	0.0045	(0.26)
BidderPrivateAmihud	0.0002	(0.94)	0.0234	(0.00)	0.0004	(0.87)	0.0228	(0.00)
Initiation	-0.0041	(0.16)	0.0044	(0.42)	-0.0039	(0.17)	0.0033	(0.53)
Negotiation	0.0019	(0.50)	0.0003	(0.95)	0.0018	(0.51)	-0.0004	(0.94)
Multiple Bidder	-0.0072	(0.42)	0.0064	(0.71)	-0.0077	(0.40)	0.0045	(0.79)
_cons	-0.1001	(0.00)	0.8174	(0.00)	-0.0991	(0.00)	0.8081	(0.00)
N	643		643		643		643	
FOC Test (Wang)	-0.0388				-0.0418			
Chi2	67.27	(0.00)			71.71	(0.00)		
FOC Test (Savor and Lu)	-0.0335				-0.0349			
Chi2	44.20	(0.00)			44.01	(0.00)		

Table 14 – Overbidding Determinants – Descriptive Statistics

Table 14 reports descriptive statistics for variables used to study determinants of overbidding. The M&A sample is a sub-sample of sample describe in Section 1.4 and Table 4, composed of 805 transactions for which we have been able to collect the necessary information. Variables are defined in Appendix B. *Mean* is the arithmetic average, *Median* the corresponding median, *Stdev*, the standard deviation of the mean and *#Deals*, the number of deals. For dummy variables, the mean corresponds to the percentage of observations with value one in the sample.

Variables	*Mean*	*Median*	*Stdev*	*#Deals*
Deal FOC	-0.0420	-0.0424	0.0051	805
Bidder Size	29,100,000.00	6,967,362.00	56,300,000.00	805
Target Industry Liquidity	0.06	0.04	0.08	805
Relative Size	0.18	0.08	0.27	805
Horizontal	39.63%		48.94%	805
Toehold	1.37%		11.62%	805
Hostile	1.24%		11.08%	805
Initiation	41.86%		49.36%	805
Negotiation	37.64%		48.48%	805
Multiple Bidder	2.61%		15.95%	805
Bidder Past Performance	0.00	0.00	0.00	805
Bidder Variable Compensation	0.81	0.86	0.16	805
Bidder GIM index	9.29	9.00	2.61	805
Bidder Free Cash Flow	0.09	0.09	0.06	805
Bidder Leverage	0.17	0.14	0.14	805
Bidder CEO age	55.66	56.00	6.14	805
Bidder CEO Pay slice	39.94%	40.07%	12.68%	805
HT	36.65%		48.21%	805
MANUF	19.50%		39.65%	805
FIN	23.23%		42.26%	805

Table 15 – Overbidding Determinants – Multivariate analyses

Table 15 summarizes multivariate analyses of overbidding determinants. The dependent variable, *Deal FOC*, is the degree of overbidding, obtained by estimating Equation (5). Column (1) reports results when limiting ourselves to industry dummies. In Column (2), we add bidder and transaction characteristics. In Column (3), we replace industry dummies by industry fixed effects (SIC 3-digits code) and add year fixed effects. And, finally, in Column (5), the full specification results are displayed. Standard-errors are robust to heteroskedasticity and *p*-value are reported between parentheses. Descriptive statistics about variables for the M&A sub-sample are reported in Table 14. Variables are defined in Appendix B. *Year FE* and *Sector FE* stand for year and industy fixed-effects respectively. *Coeff* stands for coefficient and *p-val* for *p*-value. *Adj-R-sq* is the adjusted R-square coefficient.

	(1)		(2)		(3)	
	Deal FOC		*Deal FOC*		*Deal FOC*	
	Coeff	*p-val*	*Coeff*	*p-val*	*Coeff*	*p-val*
HT	-0.0011	(0.08)	-0.0010	(0.08)		
MANUF	-0.0006	(0.38)	-0.0009	(0.17)		
FIN	-0.0008	(0.20)	-0.0002	(0.74)		
Bidder Past Performance			-0.4394	(0.02)	-0.3975	(0.08)
Bidder Variable Compensation			-0.0013	(0.39)	-0.0018	(0.35)
Bidder GIM index			-0.0002	(0.03)	-0.0002	(0.02)
Bidder Free Cash Flow			0.0042	(0.36)	0.0068	(0.23)
Bidder Leverage			0.0051	(0.01)	0.0045	(0.06)
Bidder CEO age			-0.0003	(0.89)	-0.0021	(0.32)
Bidder CEO Pay slice			0.0026	(0.17)	0.0031	(0.17)
Bidder Size			0.0000	(0.87)	0.0000	(0.87)
Target Industry Liquidity			-0.0030	(0.26)	-0.0028	(0.44)
Relative Size			-0.0021	(0.01)	-0.0023	(0.02)
Horizontal			-0.0007	(0.07)	-0.0007	(0.14)
Toehold			0.0083	(0.00)	0.0072	(0.01)
Hostile			0.0255	(0.00)	0.0247	(0.00)
Initiation			-0.0004	(0.35)	-0.0004	(0.38)
Negotiation			0.0010	(0.03)	0.0010	(0.04)
Multiple Bidder			-0.0015	(0.34)	-0.0022	(0.22)
_cons	-0.0433	(0.00)	-0.0411	(0.00)		
Year FE	no		no		yes	
Sector FE	no		no		yes	
N	805		805		805	
adj. R-sq	0.004		0.296		0.311	

Table 16 – Overbidding Determinants – CEO Narcissism

Table 16 reports multivariate analyses of overbidding determinants including CEO Narcissism. We use CEO narcissism first pronoun indicator (the proportion of first person singular pronoun to first person plural pronoun used by CEO in CEO speech transcripts) as measure of CEO Narcissism, as in Aktas et al. (2016). Out of the 805 transactions for which we have the necessary information (see Table 15), using de Bodt et al. (2015) extended data set, we obtain the CEO indicator for 174 transactions. The dependent variable, *Deal FOC*, is the degree of overbidding, obtained by estimating Equation (5). Column (1) reports results when limiting ourselves to CEO narcissism. In Column (2), we add industry dummies. In Column (3), we complement Column (2) specification with bidder and transaction characteristics. And, finally, in Column (4), we keep bidder and transaction characteristics but exclude industry dummies. Standard-errors are robust to heteroskedasticity and *p*-value are reported between parentheses. Variables are defined in Appendix B. *Year FE* and *Sector FE* stand for year and industy fixed-effects respectively. *Coeff* stands for coefficient and *p-val* for *p*-value. *Adj-R-sq* is the adjusted R-square coefficient.

	Deal FOC		*Deal FOC*		*Deal FOC*		*Deal FOC*	
	Coeff	*p-val*	*Coeff*	*p-val*	*Coeff*	*p-val*	*Coeff*	*p-val*
Narcissism	-0.0068	(0.20)	-0.0076	(0.16)	-0.0073	(0.17)	-0.0085	(0.27)
HT			0.0008	(0.49)	0.0001	(0.92)		
MANUF			0.0010	(0.46)	0.0005	(0.74)		
FIN			0.0011	(0.44)	0.0005	(0.79)		
Bidder Past Performance					-0.2641	(0.68)	-0.1986	(0.84)
Bidder Variable Compensation					0.0022	(0.59)	0.0025	(0.63)
Bidder GIM index					-0.0002	(0.36)	-0.0001	(0.61)
Bidder Free Cash Flow					0.0017	(0.89)	-0.0022	(0.93)
Bidder Leverage					-0.0013	(0.77)	-0.0026	(0.74)
Bidder CEO age					-0.0021	(0.65)	-0.0007	(0.92)
Bidder CEO Pay slice					-0.0014	(0.77)	-0.0018	(0.74)
Bidder Size					-0.0006	(0.22)	-0.0001	(0.88)
Target Industry Liquidity					0.0016	(0.58)	0.0008	(0.86)
Relative Size					-0.0049	(0.01)	-0.0035	(0.11)
Horizontal					-0.0008	(0.38)	-0.0014	(0.19)
Toehold					0.0085	(0.21)	0.0020	(0.80)
Hostile					0.0249	(0.00)	0.0216	(0.00)
Initiation					0.0004	(0.63)	-0.0006	(0.61)
Negotiation					0.0012	(0.20)	0.0014	(0.21)
Multiple Bidder					-0.0008	(0.70)	-0.0007	(0.81)
_cons	-0.0424	(0.00)	-0.0430	(0.00)	-0.0233	(0.25)		
Year FE	no		no		no		yes	
Sector FE	no		no		no		yes	
N	174		174		174		174	
R-sq	0.009		0.013		0.235		0.168	

Table 17 – Bidder's Expected Profit Maximization Test – Failed Transactions Descriptive Statistics

Table 17 reports the same descriptive statistics as in Table 5. Selected variables are the ones used to estimate Equations (3) and (4) with a seemingly unrelated regression (SUR) estimator and to test Equation (5), the first-order condition of the bidder's expected profit maximization. With respect to Table 5, SEC filings variables, most often not available for failed transaction, are excluded. The sub-sample of failed transactions comes from the M&A sample presented in Table 1. Among the 5,780 transactions, 1,152 are failed and for 545 of them, information necessary to compute variables needed to the estimate Equations (3) and (4) are available. Variables are defined in Appendix B. *Mean* is the arithmetic average, *Median* the corresponding median, *Stdev*, the standard deviation of the mean. *p*-val reports the *p*-value of the standard test of sample mean statistical significance.

	Failed deals - 545 deals			
Variable	*Mean*	*p-val*	*Median*	*Stdev*
Bidder CAR	-0.99%	(0.04)	-0.82%	11.24%
Bidder Scaled CAR	-6.55%	(0.08)	-1.07%	86.29%
Target CAR	16.95%	(0.00)	13.02%	21.53%
Deal CAR	2.89%	(0.00)	2.53%	9.20%
Deal Scaled CAR	7.49%	(0.01)	3.56%	66.88%
Target Runup	3.63%	(0.00)	3.03%	22.41%
Probability of Success	74.73%		83.33%	22.28%
8-week BidPremium	35.05%		31.25%	40.53%
Bidder Size	6,389,036		740,001	30,600,000
Target Industry Liquidity	0.0627		0.0369	0.0970
Relative Size	64.15%		40.28%	100.82%
Horizontal	42.20%		0.00%	49.43%
All Stock	32.84%		0.00%	47.01%
Toehold	10.46%		0.00%	30.63%
Hostile	14.68%		0.00%	35.42%
BidderPrivateR2	0.0572	(0.00)	-0.0001	0.3658
BidderPrivateAmihud	0.1087	(0.01)	-0.1415	0.9600
Multiple Bidder	26.24%		0.00%	44.03%

Table 18 – Bidder's Expected Profit Maximization Test – SUR Results for Failed Transactions

Table 18 replicates Table 6 SUR results for the sub-sample of failed transactions introduced in Table 17. Estimations of Equations (3) and (4) are obtained using the seemingly unrelated regression (SUR) estimator. *p*-values are reported between parentheses. Variables are defined in Appendix B. *Coeff* stands for coefficient and *p-val* for *p*-value. *Chi2* is the chi-squared statistic of the cross-equation restriction defined at Equation (5) and *FOC Test* (*FOC Test (Wang)* uses Wang (2015) costs of failure estimate and *FOC Test (Savor and Lu),* Savor and Lu (2009) one), the corresponding point estimate. Columns (1) and (2) present results for the raw 8-week bid premium, while Columns (3) and (4) report corresponding results using the winsorized 8-week bid premium (winsorization is at one and ninety-nine percentiles). In Columns (1) and (3), the dependent variable is the Bidder Scaled CAR (we follow Bhagat et al. (2005) probability scaling method) and in Columns (2) and (4), it is the probability of deal completion.

	8-week Bid Premium				8-week Bid Premium Winsorized			
	(1)		(2)		(3)		(4)	
	Bidder Scaled CAR		*Probability of Success*		*Bidder Scaled CAR*		*Probability of Success*	
	Coeff	*p-val*	*Coeff*	*p-val*	*Coeff*	*p-val*	*Coeff*	*p-val*
Deal Scaled CAR	0.5761	(0.00)	-0.0110	(0.06)	0.6620	(0.00)	-0.0104	(0.06)
Target Runup	0.1113	(0.48)	-0.0304	(0.10)	0.1585	(0.39)	-0.0353	(0.08)
8-week BidPremium	-0.0163	(0.80)	0.0391	(0.00)	-0.0402	(0.69)	0.0714	(0.00)
Bidder Size	-0.0309	(0.07)	0.0098	(0.00)	-0.0327	(0.08)	0.0102	(0.00)
Target Industry Liquidity	0.3556	(0.29)	-0.0404	(0.31)	0.3752	(0.30)	-0.0429	(0.28)
Relative Size	-0.1111	(0.02)	0.0144	(0.01)	-0.1214	(0.02)	0.0161	(0.00)
Horizontal	0.0657	(0.32)	-0.0006	(0.94)	0.0684	(0.34)	0.0007	(0.93)
All Stock	-0.0211	(0.77)	0.0563	(0.00)	-0.0193	(0.80)	0.0573	(0.00)
Toehold	-0.4656	(0.00)	-0.1948	(0.00)	-0.5168	(0.00)	-0.1929	(0.00)
Hostile	-0.4426	(0.00)	-0.5018	(0.00)	-0.4755	(0.00)	-0.5058	(0.00)
BidderPrivateR2	0.0403	(0.65)	-0.0093	(0.37)	0.0421	(0.67)	-0.0105	(0.32)
BidderPrivateAmihud	-0.0050	(0.89)	-0.0001	(0.99)	-0.0066	(0.86)	-0.0004	(0.91)
Multiple Bidder	0.0518	(0.50)	0.0295	(0.00)	0.0516	(0.54)	0.0297	(0.00)
_cons	0.4334	(0.08)	0.6640	(0.00)	0.4686	(0.08)	0.6450	(0.00)
N	545		545		545		545	
FOC Test (Wang)	-0.0123				-0.0305			
Chi2	0.07	(0.80)			0.16	(0.69)		
FOC Test (Savor and Lu)	-0.0083				-0.0231			
Chi2	0.03	(0.86)			0.09	(0.76)		

Appendix A – Bidder CAR and Overbidding

Assuming that bidder CAR is entirely transaction related (no bidder specific information release or other sources of contamination), a negative bidder CAR around an M&A announcements may appear to be a conclusive empirical evidence of bidder overbidding. We show in this Appendix that this is not necessarily the case. Bidders may adopt equilibrium bidding strategies generating negative CAR in the presence of exit costs. We develop our analysis in the simple perfect information setup in order to abstract away from any modelling complexity but the same argument can be embedded in more sophisticated environments, without changing the nature of the argument.

We study a strategic game of perfect information with two bidders, A and B, who fight to acquirer a target T. The target is unique. Buying T will deliver a competitive advantage to the winning bidder (denoted $S_{i\in\{A,B\}}$) and a corresponding loss to the defeated one (denoted $-S_{i\in\{A,B\}}$). We assume that $S_A = S_B + \varepsilon$, with $\varepsilon > 0$ (A is a stronger bidder than B). T is fully committed to sale. In case of ties, A wins (efficient allocation rule). The financial market is informationally efficient and the M&A is unanticipated.

A perfect information Nash equilibrium of the game is the following:

- A bids $2 \times S_B$
- B bids $2 \times S_B$

The outcome is that A wins and pays $(2 \times S_B)$. His profit is $S_A - (2 \times S_B)$. A has no incentive to bid more. If A bids less, he loses and his profit is $-S_A$. As long as $S_A - (2 \times S_B) > -S_A$ or $(S_A - S_B) > 0$, which is the case here by construction, he has no incentive to bid less. B loses and pays nothing. B also has no incentives to deviate. By bidding less, B still loses. By bidding more, B wins, pays $(2 \times S_B) + \delta$, with $\delta > 0$. His profit is $S_B - \big((2 \times S_B) + \delta\big)$, or $-S_B - \delta$, which is more negative than $-S_B$.

Can this outcome generate negative CAR for bidder A? It is indeed the case if $S_B < S_A < 2\,S_B$. Note that if $S_A < 2\,S_B$, $S_A - (2 \times S_B) < 0$. Completing the acquisition generates a value destruction and therefore, generates a negative CAR.

Note finally that bidder A participates in the game only when there are some large fixed costs associated with exit.

The intuition is simply that, in equilibrium, if exit is costly and acquisition opportunities are limited, as it is frequently the case in reality, acquiring the target is less value-destroying than allowing the competitor to do so.

Appendix B – Variable definitions

Variable	Definition	source
52Weeks High	Target stock price on day minus 42 before the announcement over the maximum target stock price observed during the 52 weeks before day minus 42	crsp
8Weeks Bid Premium	Offer price divided by market price of the target 42 days before the announcement (computed by authors)	crsp,sdc
All Cash	Dummy variable =1 if the consideration is cash only and 0 otherwise	sdc
All Stock	Dummy variable =1 if the consideration is stock only and 0 otherwise	sdc
Bidder CAR	Bidder CAR over the three days event windows centered on the announcement date, estimated with a market model and with an estimation window from day minus 250 to day minus 10. CRSP value weighted index is used as proxy for the market index	crsp,sdc
Bidder CEO age	Bidder CEO's age in year (logarithm is used in the regression)	execucomp
Bidder CEO payslice	Percentage of the bidder CEO's total pay (item TDC1) among the top five executives as in Bebchuck et al. (2011)	execucomp
Bidder Free Cash Flow	operating income before depreciation (compustat item oibdp) minus interest expense (compustat item tie) minus income tax (compustat item txt) plus changes in deferred taxes and investment tax credits (compustat item txditc) minus dividends on both preferred (compustat item pdvc) and common share (compustat item cdvc) divided by total assets (compustat item AT)	compustat
Bidder GIM index	Bidder Gompers et al. (2003) governance index	riskmetric
Bidder Leverage	Long term debt (compustat item DLTT) divided by total assets (compustat item AT)	compustat
Bidder Past Performance	Abnormal return (alpha) obtained from the estimation of the market model estimated during the period day minus 250 to day minus 20	crsp,sdc
Bidder Scaled CAR	*Bidder CAR* divided by *probability of success*	
Bidder Size	Market value of bidder 42 days before announcement (logarithm is used in the regression)	crsp,sdc
Bidder Variable Compensation	Variable component of the bidder CEO's compensation : (item TDC1-item SALARY)/item TDC1	execucomp
BidderPrivateAmihud	Relative variation of the bidder Amihud(2002) illiquidity ratio between the pre (day minus 61 to day minus 42) and the post announcement period (day plus 42 to day plus 61)	crsp,sdc
BidderPrivateR2	Relative variation of the value of 1-R^2, obtained from the estimation of the market model, between the pre (day minus 61 to day minus 42) and the post announcement period (day plus 42 to day plus 61)	crsp,sdc
CEO Narcissism	CEO narcissism is measured using the I/we ratio as in Aktas et al. (2016). This is the proportion of first person singular (I, me, my, mine, myself) to total first person pronouns (I, me, my, mine, myself, we, us, our ours, ourselves) in CEO speech.	
Deal CAR	Weighted average of *BidderCAR* and *TargetCAR* by market value computed in day minus 42	crsp,sdc
Deal Scaled CAR	*Deal CAR* divided by *probability of success*	
Deal FOC	First order condition estimated value for one deal (Equation (5)). Computation is based on the system of Equations (3) and (4). Table 6, Columns (3) and (4), results are used. This corresponds to results obtained using the winsorized 8-week bid premium (one and ninety-nine percentiles), with Savor and Lu (2009) costs of failure estimate..	crsp, compustat, sdc
Deal success	Dummy variable =1 if deal is successed and 0 otherwise	sdc

FIN	Dummy variable = 1 if the bidder is in financial sector (sic code between 6000 and 6999)	
Horizontal	Dummy variable = 1 if bidder and target have the same sic code 4-digit, 0 otherwise	sdc
Hostile	Dummy variable = 1 if the deal is classified hostile by sdc, 0 otherwise	sdc
HT	Dummy variable = 1 if the bidder is in HT sector (Kile and Philipps (2009) definition)	sdc
Initiation	Dummy variable= 1 if the target initiated the deal, 0 otherwise.	SEC fillings
Listed Bidder	Dummy variable =1 if the bidder is a public firm, 0 otherwise	sdc
MANUF	Dummy variable = 1 if the bidder is in manufacturial sector (sic code between 2000 and 3999, HT sectors excluded)	sdc
Multiple Bidder	Dummy variable=1 if the number of bidders reported in SDC is greater than one, 0 otherwise	sdc
Negotiation	Dummy variable = 1 if the selling procedure is a negotiation (SEC filings indicates one buyer), 0 otherwise	SEC fillings
Nyse Amex	Dummy variable =1 if the target is quoted in Nyse or Amex stockexchange, 0 otherwise	sdc
Poison Pill	Dummy variable = 1 if target has a poison pill , 0 otherwise	sdc
Probability of success	Fitted probability of success estimated from a probit model (equation (6))	crsp,compustat,sdc
Relative Size	Ratio of target market value computed on day minus 42 on bidder market value computed in day minus 42	sdc
Target CAR	Target CAR over the three days event windows centered on the announcement date, estimated with a market model and with an estimation windows from day minus 250 to day minus 10. CRSP value weighted index is used as proxy for the market index	crsp,sdc
Target Industry Liquidity	Schlingeman (2002) liquidity index. Ratio of the value of M&A transactions in a year to the total asset (item compustat AT) of firms in the two-digit SIC code for that year.	sdc,compustat
Target Runup	Target stock performance during the period between day minus 42 and day minus 2	crsp,sdc
Target Size	Target market value 42 days before announcement (logarithm is used in regression)	crsp,sdc
Tender Offer	Dummy variable = 1 if the deal is classified as a tender offer by sdc, 0 otherwise	sdc
Toehold	Dummy variable = 1 if the bidder holds a non-zero percentage target's share before the announcement, 0 otherwise	sdc
Turnover	Target average daily ratio of trading volume to total shares outstanding over the 52 weeks before the announcement	crsp
Year 1990's	dummy variable =1 if the deal is announced in the period 1990 to 1999, 0 otherwise	sdc