Takeover Duration and Negotiation Process

Riccardo Calcagno*

Eric de Bodt†

Irina Demidova‡

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Abstract

We study the determinants of the takeover processes duration. Risk averse bidders submit bids to targets. Targets either accept, and the transaction is completed, or negotiate one more period. As time goes on, bidders and targets learn about true synergies thanks to the due diligence process. But rival bidders can show up and compete to acquire targets, a desirable event from targets point of view, but costly for bidders. Using a discrete time finite horizon dynamic programming approach, our simulations characterize the relation between negotiation duration, pressure of potential competition and the learning process. Our empirical exercise is based on a large sample of merger negotiations identified through the manual examination of SEC filings. We use the simulated method of moments to match the frequency distribution of private negotiation duration in a calibration exercise. Our results show that a 10% ex-ante probability of new bidders entering in the M&A process each month is consistent with the data.

*em **lyon business school**, Department of Economics, Finance and Control, Avenue Guy de Collongue 23, 69134 Ecully Cedex (France), email: calcagno@em-lyon.com

†Université de Lille – EA 4112 LSMRC, Rue de Mulhouse 2, 59020 Lille Cedex (France), email: eric.debodt@univ-lille2.fr

‡Université du Québec à Montréal, ESG, Department of Finance, 315 Rue Sainte-Catherine Est, Montréal, QC H2X 3X2 (Canada), email: demidova.irina@uqam.ca

I Introduction

Is the market for corporate control really competitive? Before Boone and Mulherin (2007), the empirical evidence on the number of bidders participating in M&As suggested that competition in the market for corporate control was low (Betton et al., 2008). This stylized fact raised real concerns for such an important resources allocation and external corporate governance mechanism. However, Boone and Mulherin (2007), examining the content of Security Exchange Commission (SEC) filings, find that, before the official announcement of M&As, private *auctions* (formal or informal) are organized to invigorate competition in roughly fifty percent of transactions. Concerning the remaining fifty percent that are one-to-one negotiations, latent competition may also play an important role. The purpose of this paper is to quantify the intensity of latent competition.

Competition is by definition not observable in case of negotiations. And finding empirical proxies for latent competition is a tough challenge (see Aktas et al., 2010). We take here another route. Our initial intuition is that latent competition should influence negotiations' duration. Starting from this proposition, we develop a model of merger negotiation that captures the tradeoffs faced by negotiating parties and opens the door to empirical investigations. The negotiation process may require lengthy information acquisition, especially in its early stages. From the bidder's perspective, deals that are reached too fast may be risky because of synergies valuation uncertainty. But too long negotiation periods may allow entry of rival bidders, a costly outcome for bidders but enjoyable for targets. Time and competitive information disclosure (Hansen, 2001) are however costly for targets. Both sides, bidders and targets, face therefore a tradeoff between hurrying and delaying. Using a discrete time finite horizon model, we show that negotiation duration depends on the degree of potential competition and on the deal complexity. The bidder's optimal offer and the negotiation duration are jointly determined and positively correlated. Stronger competition induces the target to wait longer, hoping to receive additional offers; in complex deals, i.e. deals for which potential synergies are highly uncertain, a risk-averse bidder offers lower prices that in turn motivate less the target to wait (the marginal benefits of waiting is smaller), so that the negotiation duration is shorter.

The time spent into direct interactions between bidders and targets has attracted only limited

attention in the academic literature, especially on the theoretical side. Some contributions provide predictions about the time it takes to setup a deal (eg.: Calcagno and Falconieri, 2014). Other papers rely on the real option modelling framework (Grenadier, 2002; Hackbarth and Miao, 2012) to explain the time at which an acquisition is launched, but they offer limited possibilities to study the negotiation process itself and its length. Several empirical contributions report stylized facts. On a sample of 25,166 successful takeover contests for US targets between 1980 and 2005, Betton et al. (2008) report that the mean time to completion (measured from the date of the public announcement of the initial control bid to the effective merger date[1]) is approximately 65 trading days. A limited number of other empirical studies display similar figures on comparable but smaller samples[2]. The pre-completion stage of the acquisition process is however not limited to the public phase alone. Negotiations start well before official announcement, as emphasized in Hansen (2001) and Boone and Mulherin (2007), a period designated as the the private part of the negotiation process. This private phase starts when a "selling firm hires an investment banker and considers the number of potential bidders to contact" (Boone and Mulherin, 2007, p. 849), but it can also be that the first contact is at bidder's initiative (Eckbo, 2014).[3] During this time period, a number of important decisions are made on both sides of the bargaining table and a set of sensitive non-publicly available information is disclosed. The length of private negotiations provides indications about the intensity of information exchanges, the difficulties met by the parties and the pressure of latent competition.

We start by a theoretical study of forces driving negotiations' duration. Improving our understanding of the mechanisms at play is an important achievement in itself. Resources committed by participants in terms of managerial time, energy[4] and financial expenses (e.g., accounting,

[1]The effective date is the date target shareholders approve the merger agreement, as reported by the SDC.

[2]Cheng and Chan (1995) report a mean of 65.4 trading days on a sample of 70 international takeovers involving a publicly traded US target company and covering the period 1985 to 1990. Dikova et al. (2010) report 96 days for a sample of 2,389 cross-border deals between 1981 and 2001.

[3]In particular, an unpublished working paper by Eckbo, Norli and Thorburn (2013) finds that on a sample of 3,800 takeover bids between 1996 and 2009 "only" 45% of all bids were target-initiated, therefore leaving us with a 55% for bidder-initiated takeovers.

[4]Another aspect of time pressure is the level of CEO's "busyness". For example, Ferris et al. (2003) consider the number of directorships that CEOs occupy in other firms, which considerably diminishes the time they can spend on other activities, including intensive negotiations.

financial and legal advisor fees[5], regulatory compliance costs, breakup, termination[6] and other commitment fees) are indeed significant. Our model provides the foundations to get realistic estimates of the pressure of latent competition in the M&A market, our primary focus, by confronting its predictions to the data in a calibration exercise. Our analysis offers also insights on takeover premium, another important outcome of the takeover process.

Need for speed or need for information? To address this question, central to the negotiation process, we develop a discrete time finite horizon model and adopt a dynamic programming approach to solve it. Finite horizon makes sense in the context of M&A negotiations: Boone and Mulherin (2009) report that, on average, the private phase lasts about 6 months. Technically, the finite horizon assumption, in the case of a discrete state space, also guarantees the existence of optimal solutions (Miranda and Fackler, 2004), not necessarily unique. In each period, bidders submit bids and targets either accept or reject them. If the target accepts the pending offer, the transaction is completed. Rejection opens one new period of negotiation. In such a case, bidders receive additional information about the private component of synergies with targets and, therefore, are less exposed to valuation errors. But, at each new period, a rival bidder can show up, revealing information about the common component of synergies, and put the current bidder under pressure of competition. Our model incorporates five main ingredients, which are all potential determinants of the negotiation duration according to the existing literature: (1) synergies are at the heart of the neo-classical view of M&As (Bradley et al., 1988) and they condition bidders' choice of optimal bid in our model; (2) but synergies are uncertain (Bhagwat et al., 2016). It is therefore in the interests of both parties to acquire information about them during negotiations as it is the case in auctions, see (Hansen, 2001).[7] We explicitly model information acquisition as a Bayesian learning process, based on signals observed by both parties during the due diligence process; (3) CEOs play a central role in M&A decision processes (Harding and Rovit, 2004; Graham et al., 2015) but CEOs are under-diversified (Hall and Murphy, 2002; Becker, 2006) and therefore risk-averse. This is the reason why our bidder CEOs display a quadratic utility function; (4) we allow new rival

[5]Financial advisor fees represent about 1% of deal value for completed deals (Source: Thomson Financial SDC database (SDC), M&A and Advisors' Summary Report, Fourth Quarter 2015).

[6]For example, Officer (2003) reports that target termination fees represent as much as 3.80% of deal value (a similar number is reported for bidder termination fees).

[7]We refer to symmetric information over synergies in our model since when the negotiation starts, also targets are likely not to know how much value bidders are able to generate in case the deal goes through.

bidders to challenge the current bidder at each period to capture the role of latent competition; (5) finally, negotiation is costly, not only because investment bankers are expensive (Golubov et al., 2012), but also because time is limited (Ferris et al., 2003) and bidders may leave due to alternative investment opportunities arising in the meantime. Incorporating explicitly these five ingredients in our model allows us to analyze the dependence of negotiation duration on each of them and, in particular, on the intensity of latent competition.

We adopt a discrete state space, formed by signals received about synergies and rival bidder entries. The benefits of this strategy are exhaustiveness (we are in position to explore the whole state space and to identify all global optima, a process out of reach in a continuous state space, except in the restrictive case of global concave optimization problem) and transparency (we escape from numerical convergence issues and related results replicability concerns). The main drawback of this strategy is the limit it puts in terms confrontation to the data: statistical inference is by nature impossible (because the set of optimal parameter values is not unique and, in this sense, our problem is not identified), voiding any attemp to go to structural estimation (see Strebulaev and Whited (2012)). We develop consequently a calibration exercise, based on a large M&A sample and SEC filings hand-collected data.

Before turning to this empirical exercise, we report extensive simulation results. These provide us with two main insights:

1. optimal bids and negotiation duration are increasing in competition intensity, synergies (common and private) and decreasing in bidder risk aversion, negotiation costs and bidder reservation utility. The relation between negotiation duration and the learning process is not monotone. Bids are increasing in information precision, but only up to a point where the marginal increase of bids due to a more precise estimate of the synergy becomes too weak to compensate for the increase in negotiation costs. Consequently, the optimal negotiation duration follows an inverted U-shape;

2. the positive correlation between bids (or rate of bids increase) and negotiation duration tells us that optimal bids and optimal negotiation duration are fundamentally endogenous: bidders bid more aggressively when they anticipate that targets have stronger incentives to postpone the acceptation decision (a.o., because targets expect that new bidders will

challenge the current one). This calls for caution on any attempt to regress these variables on each other without controlling for endogeneity in empirical works.

To confront our model to the data, we collect a large sample of M&A transactions in the SDC database. Following Boone and Mulherin (2007), we complement this information with hand-collected data from SEC filings where we obtain the date of first contact between the parties (to compute the private process duration), the identity of the initiating party (to select acquirer-initiated transactions) and the sale procedure (to focus on negotiations). This allows us to assemble a large sample of 870 negotiations initiated by acquirers, covering the period from 1994 to 2014.

Our calibration exercise matches the empirical frequency distribution of negotiation duration, adopting a simulated method of moments (SMM) style approach. The main lessons drawn from our calibration exercise are the following:

- A probability of rival bidder entry around 10% by month minimizes the SMM error. Over a period of six months (the part of the negotiation duration frequency distribution that we attempt to match in our calibration), we reach a cumulated probability of entry of 60%. With such a cumulated probability of entry, the average number of bidders would be around 1.6, significantly higher than the 1.01 average reported in the SDC database. We conclude that latent competition in the M&A market appears to be higher than observed ex-post, and this by a wide margin;

- This result is robust to the level of bidder risk aversion, common synergies, private synergies and bidder reservation utility;

- The level of competition intensity interacts with information precision and negotiation costs but, except in case of very low or very high information precision and as long as negotiation costs are close to figures reported in the literature, the 10% probability of rival bidder entry by month is still supported.

The paper is organized as follows. We start by reviewing shortly the relevant literature in Section 2 and then introduce our model (Section 3). We next present our solution concept (Section 4) and the simulation results (Section 5). In Section 6 we present our empirical

strategy and the calibration exercise, together with its results. We finally conclude. In the Appendices, we provide analytical proofs of our results (Appendix A), the sample selection criteria (Appendix B), the SEC filings we use (Appendix C) and the precise definitions of all the variables used in the calibration exercise (Appendix D). All Tables and Figures are collected at the end.

II Literature review

A Negotiation duration and optimal timing of mergers

A limited number of recent studies explore the topic of time invested in negotiations in conjunction to the various outcomes of the takeover process. Offenberg and Pirinsky (2015) model and test the tradeoff between speed and cost of deal execution to explain how bidders choose between mergers and tender offers. Negotiation duration is present in the analysis, but only as a determinant of choice of the merger form.

To understand the optimal timing of mergers, both Lambrecht (2004) and Bhagwat et al. (2016) compare the decision to merge to the exercise of an option[8]: forgoing higher profits by not merging acts as an incentive to start the acquisition process while incurring irreversible costs once merged acts as an incentive to delay it. Other authors (Grenadier, 2002; Hackbarth and Miao, 2012) use the real options modeling framework to analyze the effects of greater industry competition on the timing of mergers: the opportunity cost of waiting to invest may or may not accelerate the option exercise. These real option based models abstract from the length of the negotiation. The discrete time dynamic programming model that we develop implicitly incorporates insights from these models but, in addition, our framework offers more flexibility to describe the negotiation process itself.

B Determinants of negotiation duration

As argued in the introduction, negotiation delays may attract additional competition (Aktas et al., 2010) and prevent the current bidder from completing the acquisition. But potential

[8]"Since both firms have the right, but not the obligation, to merge, each firm's payoff resembles an option and the decision to merge can be assimilated the exercise of an option." (Lambrecht, 2004, p. 43)

competition is fundamentally a latent variable, unobservable to the econometrician. Providing the theoretical foundations to obtain estimates of latent competition is the main endeavour of this paper and our model explicitly incorporates therefore the threat of rival entry from period to period.

Which other factors affect the length of time between deal initiation and its effective completion?

B.1 Synergies

The neo-classical view of M&As argues that synergies, whether private or common, fundamentally motivate acquirers. Bradley et al. (1983) compare successful and failed transactions to uncover that synergies are the main driver of targets' shares price increase. Healy et al. (1992) study post-acquisition operating performance of 50 very large transactions from the eighties and report improvements, unrelated to costs cutting decisions. Maksimovic and Phillips (2001) use plant level data (thanks to access to the U.S. Census database) and find that more productive firms buy less productive firms, especially during economic expansion periods, and that productivity improves at the plant level after acquisition. Harford (2005) studies M&As waves and puts into light the importance of industry shocks and macro-economic factors to explain the appearance and formation of waves. These are only a few references among the long list of contributions emphasizing the importance of synergies as a driver of the decision to acquire (see Eckbo, 2014). The perspective of capturing high synergies is a natural candidate of first order importance to explain negotiation duration.

B.2 Uncertainty and learning

Uncertainty is known to affect the corporate investment decision and its dynamic (Bernanke, 1983; Bloom et al., 2007; Gulen and Ion, 2016) generating possible delays in the conclusion of the deal. Recently, Bhagwat et al. (2016) emphasize the importance of uncertainty as a determinant of M&As activity. This contribution builds on several streams of literature that focuses on sources of uncertainty such as the role of transaction and target complexity (Jemison and Sitkin, 1986; Kale et al., 2003) and learning from prior experience (Vermeulen and Barkema, 2001; Very and Schweiger, 2001; Hayward, 2002; Barkema and Schijven, 2008; Aktas et al., 2009, 2011, 2013). In particular, Aktas et al. (2009, 2011, 2013) underpin the effects of CEO learning

through successive acquisitions, showing that bidders gain valuation expertise, transfer their specific knowledge to subsequent deals by taking less time between deals and pay attention to the market signals by adjusting their bidding behavior accordingly. Learning takes also place during the negotiation period. Huang and Wang (2014) build a model of bilateral negotiation that accounts for the target's learning about the private value of the bidder and features its effects on the outcomes of M&A negotiations, including the probability of deal completion. But Huang and Wang (2014) do not study the evolution of the bilateral negotiation and its relation with the negotiation duration, which is the focus of our paper. Betton et al. (2014) study the informational effects of pre-offer target stock price run-ups as signals of potential deal synergies and conclude that they are caused by rational deal anticipation.

Therefore, there is significant evidence that the duration of the takeover process is affected by the precision of information concerning synergies, which in turn depends on the complexity of the target valuation and on the learning process.

B.3 Risk aversion

CEOs are key decision makers in M&As (Harding and Rovit, 2004; Graham et al., 2015). But CEOs are under-diversified , their wealth and human capital being overinvested in the firm (Hall and Murphy, 2002; Becker, 2006). They are therefore more risk-averse than their shareholders. The academic literature provides many contributions showing that CEO personality traits matter (Custódio and Metzger, 2013; Bertrand and Schoar, 2003; Kaplan et al., 2012). We posit therefore that acquirer CEOs' risk aversion is a determinant of negotiation duration.

Shouldn't we also take into account target CEOs' risk aversion? Target CEOs are submitted to fiduciary duty (Betton et al., 2008), forcing them to let competitive offers to be submitted by rival bidders during a period of one month after the official announcement date. Under such constraint, target CEOs' risk aversion appears to us to be of less importance that acquirer ones. We chose to ignore it, not arguing that it plays no role, but trading off tractability and completeness.

B.4 Negotiation costs

Negotiations are expensive. They consume time and time is limited, especially for key decision makers (Ferris et al., 2003). Moreover negotiations entails also direct costs, in particular investment bankers' fees. McLaughlin (1992) reports, for a sample of large M&As during the early eighties, that targets' (resp. acquirers' and total) advisor fees represent on average 0.77% (resp. 0.56% and 1.29%) of the transaction value. Chahine and Ismail (2009) report average total (resp. acquirer and target) fees of 1.15% (resp. 0.71% and 0.83%) of the deal value, on a sample of 635 transactions completed by US public acquirers between 1985 and 2004.

An additional hidden cost of time is information leakages and dissemination. Providing enough information to acquirers to be fairly valuated is in the best interest of targets but disclosing too much private information (e.g., about patents, contracts, know-how) may be highly value-damaging. Such competitive information may indeed be used afterwards by rivals (Hansen, 2001) and this explains the widespread use of private selling procedures as a means to protect valuable private information (Boone and Mulherin, 2007).

B.5 Others

Several other factors potentially affect the negotiation duration. CEOs' behavioral biases are known to be present and to play a role in M&As. CEO hubris (Roll, 1986), CEO overconfidence (Malmendier and Tate, 2008), CEO narcissism (Aktas et al., 2016), and even CEO envy (Goel and Thakor, 2010) have been pointed out in the literature. As our model rely fundamentally on rational behaviour, we abstract from these factors.

The target willingness to sell (de Bodt et al., 2014) is also important. A large body of literature on target resistance suggests indeed that a bidder trying to acquire an openly uncooperative target will have greater chances to fail (Walkling, 1985; Officer, 2003; Bates and Lemmon, 2003; Betton et al., 2009; Golubov et al., 2012; Dimopoulos and Sacchetto, 2014). Furthermore, such bidder would probably need more time to overcome target resistance, compared to his friendly counterpart, suggesting that friendly negotiations should go faster than hostile acquisition attempts. We abstract from target hostility because the concept of hostility is itself not as

clear as it might appear at first sight (Schwert, 2000) and hostile takeovers are a marginal phenomenon since the beginning of the nineties (Betton et al., 2008).

Yet another factor explored in the literature is board connections: Renneboog and Zhao (2014) study the impact of corporate networks on the takeover process and document that, for better connected companies (i.e., those having one or more directors in common), the probability of a successfully completed transaction is higher and the duration of negotiations is lower. Board connections is one more determinant that we do not incorporate explicitly in our model but it may be considered as being part of negotiation costs (more connections between boards presumably making easier communication between negotiators).

Concerning the bidder reservation utility, to the best of our knowledge, our paper is the first to study explicitly the relation between the market power of the acquirer, which affects its outside option value, and the negotiation duration. The higher the rent that the bidder earns if the deal does not go through, the lower its bids, and the lower the negotiation duration, as we will show in Section 5.

To summarize, the negotiation duration determinants that we incorporate in our analysis in addition to latent competition are private and common synergies, information precision, acquirer CEOs risk aversion, negotiation costs and bidder reservation utility. We believe that controlling for these additional factors offers already a fruitful setup to gain a better understanding of tradeoffs driving the negotiation duration.

C Legal constraints

It is important to note that while there are no legal delays imposed on the private negotiation process[9], the duration of public negotiation process is subject to regulations and close supervision by national and international authorities (Herzel and Shepro, 1990)[10]. These regulations

[9]Firms have no obligation to disclose preliminary discussions, but if they choose to confirm or deny rumours about a pending transaction (for example, following a request by the Stock Exchange where one of the companies is listed or inquiries from an activist investor), this has to be done accurately to avoid any misleading information.

[10]In the United States, the Securities Exchange Commission (SEC) and the Federal Trade Commission (FTC) are the two main federal agencies is charge of enforcing a wide variety of federal securities and antitrust laws. As a general matter, companies have to pre-notify the antitrust authorities of the planned merger transaction. Under the 1976 Hart-Scott-Rodino Antitrust Improvements Act (HSR), the required waiting period before a transaction can be consummated is 30 calendar days (except for cash tender offers where this period is reduced to 15 calendar days). This waiting period can be extended for additional 30 days (10 days for cash tender offers)

put constraints on the duration of the public part of the merger process. Our model is primarily designed to capture the dynamics of negotiations during the private interactions between the parties. These regulatory constraints appear therefore mostly irrelevant in our case.

III The Model

This section introduces our model of private negotiation between merging parties for transactions initiated by a bidder.

A Timing, Agents, Synergies and Information structure

There are T periods, indexed by $t = \{1, ..., T\}$, where $T > 1$ is finite. In the first period, $t = 1$, a bidder starts a merger negotiation with a target.[11] Both bidder and target firms have no debt and there are no financial constraints on the bidder side. The two negotiating parties act in the best interest of their shareholders. All agents involved in the model are fully rational.

Before the process starts, both the target and the bidder values correspond to their market values, and therefore are known. Without loss of generality, we normalize these values to one. We assume that financial markets are efficient and there is no time discount. We assume also that any deal signed after period T has no value for the parties[12]. If the bidder acquires the target before period T, then a synergy $S \geq 0$ is produced. Given that our model has no time discount, we assume that payoffs of bidder and target are obtained at period T. The synergy value S (i.e., its value at T) represents the present value of synergies that will be realized thanks to the acquisition. S is to be considered as a return, so that the target value at T if merged

whenever a "second request" for additional information is issued by the authority during the initial period. The additional time for case revision starts only from the date when all the required information has been submitted. The timing of the public negotiation process largely depends on the expiration of the waiting period under HSR act: a transaction cannot be completed until its clearance by the authorities (the end of the original period or its extension, whichever is longer) and compliance with a "second request" may sometimes take several months.

[11] We focus on bidder initiated deals, but we do not make explicit assumptions on the nature of the offer, i.e. whether it is a friendly one or a hostile one, because the concept of hostility is not as clear as it may appear to be at first sight (see Schwert, 2000).

[12] Period T represents a terminal condition, i.e. the latest period at which negotiation can take place. One can think that at $T + 1$, the initial bidder (or the target) walks away and refuses any further negotiation, because it considers having spent already too much time on the deal negotiation. This assumption captures the idea that if negotiations last too long, the bidder may infer that the target is putting in place some form of latent resistance to the deal, that in turn could destroy synergies after the acquisition has taken place. Or, alternatively, that market conditions have changed after a certain time, and the deal-specific synergy expected at the beginning is likely to dissipate. We obtain similar results relaxing this assumption by stating that after T, at each period, the bidder walks away from the negotiation with some positive probability.

with the bidder equals $(1 + S)$. The synergy S results from two elements. The first, S_p, is a private-value component, representing the value increase that can be obtained by merging with the specific bidder under consideration. The second, S_c, is a common value component that can be appropriated by any firm acquiring the target. The synergy S is unknown at the beginning of the first period.

Assumption 1 (synergy): *The synergy S has a binomial distribution with realizations equal to $S = S_p + S_c > 0$ and $S = 0$. The initial probability of the synergy being positive is denoted by p_0. When S is positive, then $S_p = \overline{S} > 0$ while S_c increases with the number of offers formulated by competing bidders that have been observed up to time t, $N_t \geq 0$, according to:*

$$S_c = \omega\sqrt{N_t} \tag{1}$$

with $\omega > 0$.

If the merger produces positive synergies, both parties know that the private value component equals $\overline{S}$. The common value component S_c is inferred from the intensity of competition for the target. More competitors bidding for the target signal that this component is greater, as in (1).

In every period $t = 1, 2, ..., T$, the bidder proposes an acquisition price. In accordance with practices observed in the reality, we assume that the bidder cannot reduce an offer after having formulated it.[13] Before the bidder makes his offer, in each period t, two events occur. They capture the two main dimensions of merger negotiations incorporated in our model: the learning process about the value of the synergy and the potential competition coming from other firms.

First, both the bidder and the target obtain information about the private-value component of the synergy. We model this by assuming that during every negotiation period t, the parties observe a noisy signal I_t that is correct with probability $q \in]\frac{1}{2}, 1[$.[14]

[13]We do not incorporate provisions such as MAC (Material Adverse Change) or MAE (Material Adverse Effect) clauses because these will appear when a formal agreement is signed, this is to say at the end of the private negotiation phase.

[14]For clarity of the exposition, in the following, we denote random variables using a tilde.

Assumption 2 (learning process): *The noisy signals* $\widetilde{I}_t$ *observed in every period* $t = 1, 2, ..., T$ *are i.i.d. and have a binomial distribution with* $P(\widetilde{I}_t = S_p) = q > \frac{1}{2}$, *and* $P(\widetilde{I}_t \neq S_p) = 1 - q$, *where* S_p *denotes the realized private-value component of the synergy.*

The parameter q captures the informativeness of the signal: a higher q indicates that the parties are able to valuate the synergy faster (in this sense, the transaction is less complex, or the learning process more effective). Conditional on the observation of the realized signals, both bidder and target update their beliefs about the true synergy originating from the deal.[15] The initial belief p_0 is updated to p_t upon the observation of I_t. In words, p_t represents the probability that in period t both the initial bidder and the target attribute to the event that the merger will produce positive synergies.

Second, concerning the potential competition for acquiring the target, we assume that at every period $t = 1, 2, ..., T$, a new rival bidder offers a competing bid to the target with probability λ:[16]

Assumption 3 (degree of potential competition): *Let the entry of a second bidder be* $\widetilde{E}_t = \{E, NE\}$ *where* E *denotes entry and* NE *no entry.* $\widetilde{E}_t$ *follows an i.i.d. Poisson process with rate of arrival equal to* $\lambda \in [0, 1[$ *per period.*

Due to the common-value component of synergy described in Assumption 1, the entry of a second competitor formulating an alternative offer to the target signals that the value generated by the takeover is greater.

In addition, the fact that a new bidder formulates an offer for the target changes the relative bargaining power of initial parties in their bilateral negotiation. In case of no entry, the initial bidder can simply maintain the bid previously offered. But entry of a competitor puts pressure on the first bidder and forces him to revise upward his bid. To precisely define such a bid revision process, we now turn to the description of the negotiation dynamic and to the payoffs of the two negotiating parties.

[15] We assume that the learning process is symmetric in the sense that during the negotiation period both parties learn about the synergy generated by the acquisition in a symmetric way. This does not preclude other sources of information asymmetries between the bidder and the target.

[16] The assumption that only one potential bidder can enter the process by period has strong empirical support: it is very unusual to observe deals with more than two bidders. Also, it is without loss of generality in modelling terms: as in Calcagno and Falconieri (2014), one can consider the second bidder as the one with the highest private valuation of the target among many potential other ones.

B Development of the game

The takeover process develops as follows. In period $t = 1$, both target and bidder observe signal I_1 and update their beliefs on the synergy given this information. At the same time, they observe whether a second competitor makes an offer to the target or not. Given the realizations of these two events, the bidder proposes its binding offer b_1 to the target. [17] The target then decides whether or not to accept the offer b_1. If the target accepts, the deal is signed, the merger takes place and the bidder pays b_1. If the target rejects the offer, the process continues to period $t = 2$, when the same sequence of events occurs. The process continues until the target accepts the bidder's offer at a period that we will denote by t^*, which corresponds to the official announcement date. If the target rejects all offers until period T, the deal does not take place, since after T either bidder or the target leave the negotiation table. Figure 1 illustrates the first two stages of the merger process. The negotiation then proceeds in the same way until a deal is signed.

[Insert Figure 1 approximately here]

C Payoffs and decision variables

The target pays an opportunity cost of time c for every period spent in the negotiation [18]. If the bidder and the target reach an agreement in period $t \in [1, T]$ at bid b_t, then their payoffs are, respectively:

$$\begin{aligned} \widetilde{\pi}_t^{bid} &= \widetilde{S} - b_t \\ \pi_t^{tar} &= b_t - (t \times c) \end{aligned}$$

where the bidder's profit is uncertain, given that the synergy S is known only at (the end of period) T, when the merger will effectively be implemented.

[17] Recall that, in order to capture more realistically merger negotiations, we assume that once a bid has been proposed, the bidder cannot reduce it afterwards.

[18] The opportunity cost of time paid by the bidder for negotiating is implicit in its reservation utility $\overline{u}$ that we define below (see Assumption 5)

Assumption 4 (bidder expected utility): *The bidder has a quadratic expected utility:*

$$E[u(\widetilde{\pi})] = E[\widetilde{\pi}] - \gamma E[\widetilde{\pi}^2]$$

Assumption 4 relies on the observation that, in most cases, it is the acquirer who supports the synergies' risks. This is certainly true for transactions which are paid in cash, a phenomenon growing in importance since the abolishment of the pooling of interests accounting method (de Bodt et al., 2016) and the increase in private bidders' activity in the M&A market (Eckbo et al., 2014).

In every period $t = 1, 2, ..., T$, the target solves a problem that can be described as follows. Let $\widetilde{b}_1, \widetilde{b}_2, ..., \widetilde{b}_T$ be the sequence of random variables describing the bids offered by the bidder at successive periods. Consider the sequence of target's profit functions:

$$\pi_1^{tar}(b_1) = b_1 - c;\ \pi_2^{tar}(b_1, b_2) = b_2 - 2c; ...;\ \pi_T^{tar}(b_1, b_2, ..., b_T) = b_T - Tc \tag{2}$$

which are all real-valued functions depending on the sequence of the observed bids. If the target refuses to start the merger negotiation process, we assume that its value does not change and hence, it makes a zero profit: $\pi_0^{tar} = 0$. Once the process reaches period t, the target decides whether to accept the bidder's offer or not, depending on the sequence of bids observed up to that period ($\widetilde{b}_1 = b_1$, $\widetilde{b}_2 = b_2$,..., $\widetilde{b}_t = b_t$), on the signals acquired up to t, $(I_1, ..., I_t)$, and on the sequence of entries (or no entries) by other bidders $(E_1, ..., E_t)$. The sequence $H_t = \left\{\{I_k\}_{k=1}^t, \{E_k\}_{k=1}^t\right\}$ collects all the information available at period t and identifies the *state* of the problem in t. [19]

Using the fact that the potential takeover has no value after date T, we can obtain the target's optimal payoff using backward induction. Let $V_T(H_T)$ be the maximum payoff the target can obtain in period T, having reached state H_T. Inductively, for any period $t = T - 1$, backward up to period $t = 1$, we define the sequence of target problems as:

$$V_t(H_t) = \max_{x_t \in \{0,1\}} \{x_t(b_t - t \times c) + (1 - x_t)(-c + E_t[V_{t+1}(H_{t+1})\,|H_t])\} \tag{3}$$

[19] Alternatively, we say that H_t indicates one node of the events tree.

The target's choice is $x_t = \{0, 1\}$, where $x_t = 1$ (respectively 0) indicates that the target accepts the bidder offer and stops the negotiation (respectively continues it) at period t. The decision in problem (3) is discrete, and we rule out mixed-strategy solutions. The space state of our problem is the set of all states H_t and is also discrete. The bids are the result of a bargaining process between the target and the bidder that repeats period by period. We consider a reduced form of these bargaining problems with the following characteristics:

Assumption 5 (bidder strategy): *In every period $t \in [1, T]$:*

(i) if there is no entry by a competing bidder, the initial bidder offers the same price as in the previous period: $b_t = b_{t-1}$ [20]*;*

(ii) if a second bidder enters, then the initial bidder's offer is such that the its expected utility from acquiring the target at that price equalizes its reservation utility $\overline{u} \geq 0$.

The bidder's reservation utility $\overline{u}$ measures its alternative investment opportunities and can be considered as a proxy of its opportunity cost of capital. Assumption 5 captures the idea that the relative bargaining power of the two parties depends on the presence of a competitor in the takeover negotiation.[21] One may interpret Assumption 5 as implicitly assuming that the initial bidder is the one who offers the highest price for the target in the end (e.g.: because the initial bidder has a first-mover advantage, and hence values the target the most)[22], but at the same time the potential competitors can bid high enough to force its profit down to its reservation value.

Hence, by Assumptions 4 and 5, if a competitor enters the process in period t, the bid b_t satisfies

$$E_t[\widetilde{\pi}_t^{bid}] - \gamma E_t[(\widetilde{\pi}_t^{bid})^2] = \overline{u} \tag{4}$$

[20] Let $b_0 \geq 0$ before the process starts.

[21] Our Assumption 5 can be interpreted using a finite horizon version of the Rubinstein (1982) alternating offer bargaining game, in which outside options are considered. Sloof (2004) shows that this game admits a unique subgame perfect equilibrium where, in every period, the respondent is indifferent between accepting the offer and taking the best of two alternatives, either delaying or opting out from the game. In our model, when receiving an offer by the initial bidder, the target can accept it and sign the deal, or reject the offer and delay the process by one period. If the target receives a competing offer in a given period, in principle it can always accept this other offer. Thus, in case of entry by a competitor, the initial bidder needs (at least) to match this second offer if the target has to stay in the game (either by accepting the deal or delaying). Assumption 5 implies that in order to match the offer by the competitor the initial bidder ends up getting its reservation utility $\overline{u}$.

[22] Alternatively, Krishna (2009, Ch. 4) shows that, in an asymmetric auction, a weak bidder can overbid a strong bidder, weakness stimulating bidding aggressiveness (see also Maskin and Riley, 2000).

where $\widetilde{\pi}_t^{bid} = \widetilde{S} - b_t$.

The sequence of bids defined by (4), depending on entry or not of a competitor, together with the sequence of signals observed along the negotiation, allow both parties to construct the tree of all possible events proceeding forward in time. We describe the procedure that allows us to construct such a tree in Section IV.A.

In Figure 2, we illustrate the structure of the model for $t = 0, 1, 2$.

[Insert Figure 2 approximately here]

IV Model Resolution

We proceed in two steps. First, we explicitly construct the sequences of bids $\{b_t\}_{t=1,..,T}$ and of beliefs $\{p_t\}_{t=1,...,T}$ at all states H_t, $t = 1, 2, ..., T$. In order to do so, we proceed forward in time, starting from the normalized $b_0 \geq 0$ [23] and from the prior belief $p_0 = P(S > 0)$, formed given all the public information available before the initial bidder starts the process[24]. Second, to solve for the optimal target decision, we proceed backward in time, the usual procedure for finite horizon model.

A Forward path: the construction of the sequence of bids

Recall that p_t equals the belief at period t that the takeover generates positive synergy given all the information available at that point in time, i.e.:

$$p_t = P(S > 0 \,|I_t, p_{t-1})$$

The sequence $\{p_t\}_{t=1,...,T}$ can be obtained by updating prior beliefs, using Bayes rule, after the observation of the current signal about the synergy.

[23]The focus of our paper is on the merger negotiation process and therefore we consider b_0 as exogenously given. This is without loss of generality because it allows b_0 to be the outcome of a jump bidding process. Given that the initial bidder does not know the value of the synergies generated by the merger at the beginning of the process, pre-emptive bidding does not make sense in our model. Alternatively, our model implicitly assumes costless bidding.

[24]Assuming efficient markets, this information is impounded in stock market prices prior to the start of the merger process.

Lemma 1: *By Assumption 1 and 2, $\{p_t\}_{t=1,\ldots,T}$ follows a Markov process with:*

$$\begin{aligned}
P(S &> 0) = p_0 \\
P(S &> 0\,|I_t > 0, p_{t-1}) = p_t(\overline{S}, p_{t-1}) = \tfrac{qp_{t-1}}{qp_{t-1}+(1-q)(1-p_{t-1})} \\
P(S &> 0\,|I_t = 0, p_{t-1}) = p_t(0, p_{t-1}) = \tfrac{(1-q)p_{t-1}}{(1-q)p_{t-1}+q(1-p_{t-1})}
\end{aligned} \tag{5}$$

We then turn to the construction of the sequence of bids $\{b_t\}_{t=1,\ldots,T}$.

Lemma 2: *The sequence of the initial bidder's bids $\{b_t\}_{t=1,\ldots,T}$ is given by:*

$$b_t = \begin{cases} b_0 \geq 0 & \\ b_t^E = \max\left\{\widehat{b}_t, b_{t-1}\right\} & \textit{if a second competitor enters at } t \\ b_t^{NE} = b_{t-1} & \textit{if there is no entry by a second competitor at } t \end{cases} \tag{6}$$

where $\widehat{b}_t$ is the root of

$$S_t - b_t - \gamma\left(\sigma_t^2 + S_t^2 - 2S_t b_t + b_t^2\right) - \overline{u} = 0 \tag{7}$$

with $S_t = E_t[\widetilde{S}]$ and $\sigma_t^2 = Var_t[\widetilde{S}]$ and:

$$\begin{aligned}
S_t &= p_t\left(\overline{S} + \omega\left(\lambda\sqrt{N_{t-1}+1} + (1-\lambda)\sqrt{N_{t-1}+1}\right)\right) \\
\sigma_t^2 &= \lambda p_t\left(\overline{S} + \omega\sqrt{N_{t-1}+1} - S_t\right)^2 + (1-\lambda)p_t\left(\overline{S} + \omega\sqrt{N_{t-1}} - S_t\right)^2 + (1-p_t)S_t^2
\end{aligned}$$

Equation (7) admits a unique positive real root $\widehat{b}_t$

$$\widehat{b}_t = S_t - \tfrac{1}{2\gamma}\left(1 - \sqrt{1 - 4\gamma^2\sigma_t^2 - 4\gamma\overline{u}}\right) \tag{8}$$

if $\gamma < 1/2\sigma_1$ and $\overline{u}$ sufficiently small.

The analysis of equation (7) allows us to determine the properties of the bids $\widehat{b}_t$.

Lemma 3: *The solution $\widehat{b}_t$ in (8) is increasing in λ (the intensity of potential competition), and in ω (the measure of the common value component of the synergy), while it is decreasing*

in $\overline{u}$ (the bidder's reservation utility) and in γ (the bidder's risk aversion), for $\overline{u}$ sufficiently small.

The bid offered at t in case of entry of a competitor in period t may be higher than b_{t-1}. If this is the case, it equals the expected synergy, S_t, minus a discount term due to the residual uncertainty over the realized synergy. The higher the residual uncertainty, σ_t^2, the lower the bid. The discount is bigger when the bidder's degree of risk-aversion is higher, so that overall, more risk-averse bidders offer lower bids, *ceteris paribus*. The other comparative statics of $\widehat{b}_t$ are intuitive: the higher the outside opportunity for the bidder $\overline{u}$, the lower the bid; the higher the probability of entry by competitors at each period (λ), the higher $\widehat{b}_t$.

The solution $\widehat{b}_t$ of (7) depends both on the probability p_t that the parties assign to the event that the realized synergy is positive having observed all signals $\{I_1, I_2, ..., I_t\}$ and on N_t, the number of offers by competing bidders observed up to period t. Hence, the process $\left\{\widehat{b}_t\right\}_{t=1}^{T}$ is interrelated to the dynamics of beliefs p_t characterized in Lemma 1.

B The optimal target decision by backward induction

Since after period T no agreement can be reached, the target accepts any positive offer once the negotiation reaches that stage. Starting from this terminal decision, we solve the target's problem by backward induction. For the target, the value of the negotiation in T is:

$$V_T(H_T) = b_T - cT \tag{9}$$

which depends on the realized state $H_T = \left\{\{I_t\}_{t=1}^{T}, \{E_t\}_{t=1}^{T}\right\}$.

Proceeding backward to period $T-1$, at every state H_{T-1} we compute

$$V_{T-1}(H_{T-1}) = \max \left\{ \begin{array}{c} b_{T-1} - (T-1)c; \\ \sum_{k=1}^{4} P(H_{T,k} \,|H_{T-1}) V_T(H_{T,k}) \end{array} \right\}$$

where V_T is given by (9) at all nodes k of the subtree with origin at H_{T-1}, that is at the four nodes $H_{T,k} = \{(I_T = \overline{S}, E), (I_T = \overline{S}, NE), (I = 0, E), (I = 0, NE); H_{T-1}\}$ following H_{T-1}. The next Lemma characterizes the functional form of $V_{T-1}(H_{T-1})$.

Lemma 4: *The function* $V_{T-1}(H_{T-1})$ *is defined by*

$$V_{T-1}(H_{T-1}) = \max\left\{b_{T-1} - (T-1)c; \pi_{T-1}^{tar,rej}(H_{T-1})\right\} \tag{10}$$

where

$$\begin{aligned}\pi_{T-1}^{tar,rej}(H_{T-1}) &= \lambda\left[\begin{array}{c} P(I_T = \overline{S}\,|p_{T-1})\left(b_T^E(p_T(\overline{S}),(N_{T-1}+1);H_{T-1}) - Tc\right) + \\ +P(I_T = 0\,|p_{T-1})\left(b_T^E(p_T(0),(N_{T-1}+1);H_{T-1}) - Tc\right)\end{array}\right] \\ &\quad +(1-\lambda)(b_{T-1} - Tc)\end{aligned}$$

denotes the target's expected payoff at state H_{T-1} *from rejecting the bidder's offer* b_{T-1} *and* N_{T-1} *denotes the number of entries up to, and including, period* $T-1$*.*

Given $V_{T-1}(H_{T-1})$, we can proceed backward to find the optimal decision at period $T-2$, at every state H_{T-2}. To do this, we simply repeat the same procedure starting from (8) translated one period back and using (10) as value in $T-1$.

Repeating this argument recursively for any period t and at every state H_t, we obtain:

$$V_t(H_t) = \max\left\{b_t - ct; \sum_{k=1}^{4} P(H_{t+1,k}\,|H_t)V_{t+1}(H_{t+1,k})\right\} \tag{11}$$

where V_t represents the maximum expected payoff the target can obtain given the current state H_t and using the optimal behavior from $t+1$ until T. The index k denotes the four possible states that can be observed in period $t+1$ following the current state H_t, i.e.: $H_{t+1} = \{(I = \overline{S}, E)$, $(I = \overline{S}, NE)$, $(I = 0, E)$, $(I = 0, NE);\ H_t\}$.

The solution of (11) would be unique if the expected benefit of continuing the negotiation one period ahead - and then following the optimal decision rule afterwards - was decreasing with time no matter what events (i.e. signal realizations and entry) realize in the next period. In such a case the target problem would be monotonic, and we would be sure that if it is optimal for the target to accept the deal at t', then it is optimal to accept it also at a later period $t > t'$. However, problem (11) is not monotonic. The reason is that the bid increase in case of entry by a second bidder in a given period depends on the solution of equation (7), which in

turn depends on the sequence of events observed up to (and including) that period. Thus, the expected benefit of continuing the negotiation for one additional period varies in a non trivial way across all realizations of next period events, and it is not monotonically decreasing with time.

Given that problem (11) is not monotonic, we cannot solve it analytically. But we can interpret its solution as follows. The target optimally stops the negotiation when the offer it receives is at least equal to the expected payoff it gets rejecting the offer and delaying the negotiation further. The target expected payoff of delaying varies in a non-trivial way with time and with the events observed. First, as time goes by, this payoff decreases, since there are less and less periods available for entries of competing bidders, which in turn increase the bids. But also the learning process affects the value of delaying for the target. High realizations of the signals suggest that a positive synergy is more likely, and this increases the expected future bids. At the same time, high signals realizations increase the probability to receive other positive signals in the future. All in all, then, the expected payoff of delaying increases if the parties have observed a positive signal realization in the current period. Closing the deal at a given period t is more likely if a competing bidder entered the contest at t (because this forces the initial bidder to increase its offer), and if a negative signal has been observed (because this decreases the target expected profit of delaying).

C Expected optimal merger outcome

Because the optimal value of (11) may be achieved at several nodes of the events tree, we have to fully explore it in order to characterize, along each path of events, the optimal choice of the target. More precisely, we proceed as follows:

1. we start fixing the vector $x = (\lambda, \overline{S}, \omega, q, \gamma, c, \overline{u})$ of model parameters and construct the tree of beliefs and bids using the procedure described in Lemma 1 and 2 above;

2. next, we go along one path of events $(i_t, e_t)_{t=1}^{T}$ on this tree, identifying the node reached in every period t. Let z be the collection of nodes composing that path. Solving the target problem as described in the backward pass procedure above, we can determine numerically the earliest optimal pair of negotiation duration and bid $(t^*(z), b^*(z))$ at which the target

accepts the deal along the path z. We refer to this optimal pair as the merger outcome $(t^*(z), b^*(z))$ associated to path z, and denote it with $O^*(z)$. Note that $O^*(z)$ corresponds to a state $H^*(z)$;

3. we replicate step 2 for all possible path z in the state space tree and collect, in the set H^*, the optimal merger outcomes $O^*(z)$ obtained for each path z. We compute for each $O^*(z)$ the associated ex-ante probability $Pr(H^*(z))$ of observing the corresponding state $H^*(z)$;

4. we finally compute the expected optimal merger outcome $E(O^*)$ as the average of optimal merger outcomes $O^*(z)$ collected in H^*, weighted by their corresponding probability of occurrence $Pr(H^*(z))$:

$$E(O^*) = \sum_{O^*(z) \in H^*} Pr(H^*(z)) \times O^*(z) \tag{12}$$

The possibility to proceed to a full exploration of the state space tree provides two benefits:

1. exhaustiveness: the whole set ot states is taken into account in Equation 12. This contrasts with continuous non-linear state space models for which, even if the existence of a unique global optimum may be proved, the existence of local minima precludes general claims about reaching the global optimum;

2. transparency: issues related to numerical convergence, initialization of the parameters and replicability of results do not exist in our case.

In the next Section, we solve the target problem (11) numerically and study the effect of the exogenous parameters of the model on the negotiation duration and the takeover bid. However, we are able to determine analytically the impact of the intensity of potential competition λ on the deal outcome.

Lemma 5: *Let $t^*(z)$ be the optimal stopping time of the negotiation given the vector of starting values $\mathbf{x}_0 = (\lambda_0, \overline{S}_0, \omega_0, q_0, \gamma_0, c_0, \overline{u}_0)$ and given path z. Denote with $H^*(z)$ the state at*

which the negotiation stops, i.e. the optimal stopping state. If

$$c_0 \geq \lambda_0(E\left[b^E_{t^*+1}|H^*(z)\right] - b_{t^*}(H^*(z))) \tag{13}$$

then there exists a $\lambda_1 < \lambda_0$ *such that the optimal stopping time becomes* $t^*(z) - 1$ *keeping all the other parameters in* $\mathbf{x}_0$ *constant.*

Even if we can not solve analytically for the optimal stopping time in our model, Lemma 5 shows that the optimal negotiation duration reduces if the probability that a second bidder competes for the target is lower. If potential competition for the target is less fierce, the target has less incentives to postpone the deal waiting for a new bidder who triggers an increase in the bid.

V Numerical Simulations

We generate our numerical simulations by implementing the procedure described in Section IV to solve our model. We first discuss the chosen set of parameter values and then, comment the obtained results.

A Parameters

We study the model's behavior by one parameter at a time, the other ones being fixed. Baseline parameter values used for these simulations are reported in Table 1.

The baseline values of parameters λ, γ, ω, c and $\overline{S}$ are chosen, when possible, according to results reported in the literature (see Section II):

- λ (competition intensity): this parameter will be the one subject to the calibration exercise (Section VI). We fix it here to 0.5, meaning equal chances that a new bidder will enter the process each month;
- γ (bidder risk aversion): a number of studies conclude that the value for the investors' average risk aversion coefficient is lower than 10 and is between 2 and 4 (Cohn et al., 1975; Mehra and Prescott, 1985; Rabin, 2000; Aıt-Sahalia and Lo, 2000; Jackwerth, 2000).

Given that we refer to CEOs degree of risk-aversion, we use the lower bound of these estimates;

- ω (common synergy revision): empirical evidence about average bid revision in case of a new bidder entry (Betton and Eckbo, 2000) suggests that the average bid jump througout multibid contests is 5.43% (5.00% when second bid is made by the initial bidder and 6.67% when second bid is made by a rival). There is also evidence that bidders lower their bids by 3.2% per additional competitor in common-value auctions (Bajari and Hortacsu, 2003). We fix ω to 5%;

- c (negotiation costs): a cost equal to 1% of the deal size is in accordance with stylized facts reported by McLaughlin (1992) and Chahine and Ismail (2009);

- $\overline{S}$ (private synergies): Gorbenko and Malenko (2014) report an average private component of valuation in the order of 25% for strategic bidders.

The remaining parameters correspond to an environment of high opacity ($q = 0.6$ means that the probability of a correct signal about the synergy is merely above one out of two, in which case the signal would be uninformative) and high competition ($\overline{u} = 0.1\%$ is set close to zero, a value corresponding to perfect competition).

Using these parameter values, we study the behavior of the bidder's offer, inferred probabilities of high synergy and negotiation duration for a range of values for each parameter. The chosen ranges correspond to the parameter domain of validity and are reported in the fourth column of Table 1.

Note also that, for these simulations, the value of p_0, the probability of positive synergy when the initial bidder starts the negotiation, is 0.5, a starting situation of significant uncertainty (see, for example, Shleifer and Vishny, 2003; Rhodes-Kropf and Viswanathan, 2004) and the number of periods T is 10 (Boone and Mulherin (2009) report that the average private process duration is around 6 months).

B Results

Results are presented graphically, in Figures 3, 4, 5, 6, 7, 8 and 9, respectively for parameters q, λ, γ, ω, c, $\overline{S}$ and $\overline{u}$. Each figure is composed of three panels: the top panel displays the evolution of the expected optimal bid, the middle panel the corresponding evolution of the inferred probability of high synergy and the bottom one, the evolution of the optimal negotiation duration.

We first note that these three merger outcomes display similar trends in each figure: they are either all increasing or all decreasing. These positive correlations between optimal bids, inferred probability of high synergy and negotiation duration are noteworthy: higher inferred synergy provides incentives to the bidder to bid higher (the equilibrium bidding function is increasing in the expected synergy, as intuition suggests) and higher bids lower the costs of delaying (in relative terms) for the target, providing incentives to wait more for the potential entry of new bidders. The positive correlation between the optimal bid and the negotiation duration may appear at first sight surprising. It tells us that bidder's optimal offer and the negotiation duration are jointly determined and that the bid level can not be be taken as exogenous to the negotiation duration (an increase in the offer would then be interpreted as *causing* an increase in negotiation duration, a clearly misleading interpretation). Capturing this endogenous relation calls for caution on any attempt to regress these variables on each other without controlling for this specification issue in empirical works.

Parameter by parameter analysis of the results reveals that the optimal bid, inferred probability of high synergy and negotiation duration are:

- increasing in precision of the information signal (q) up to 0.7, and decreasing afterwards;
- increasing in competition intensity (λ);
- decreasing in bidder risk aversion (γ);
- increasing in common synergy revision (ω);
- decreasing in negotiation costs (c);
- increasing in private synergy ($\overline{S}$);

- decreasing in bidder reservation utility ($\overline{u}$).

These results make again economic sense: higher competition motivates the target to wait longer, hoping for additional bidders to show up; higher bidder risk aversion leads to more cautious bidding, increasing the relative costs of waiting for the target; higher synergy (whether private or public) leads to higher bids, motivating again the target to wait longer; higher negotiation costs push the target to the settle the deal faster and higher bidder reservation utility lowers its incentives to bid aggressively.

We note however one notable exception in these monotonic relations: in Figure 3, the relation between q and the negotiation duration displays an inverted U-shape:

- for low values of information precision, an increase in precision reduces risks considerably, leading to higher bids and therefore, longer negotiations (because the relative negotiation costs decrease);
- for high information precision, the marginal increase in bids (that slows down as q increase) is not large enough to compensate for the increase in negotiation costs.

VI Empirical investigations

A M&A Sample

Our sample is composed of takeover bids announced between January 1994 and December 2014, as recorded by the Securities Data Company (SDC). The initial set of selection criteria applied to the whole M&A universe is the following[25]:

1. Bidders and targets are both US firms;
2. Form of the deal is either a "Merger", "Acquisition of Majority Interest", "Acquisition of Partial Interest", "Acquisition of Remaining Interest" or "Acquisition";
3. Deal value is above 100 million of US dollars;
4. Deal is not a self-dealing transaction (bidder and target have different CUSIPs);
5. Deal is a bid for control (bidder holds less than 50% of target shares before the transaction and seeks to own more than 50% of its shares after the transaction);

[25] The detailed sample selection procedure is provided in Appendix B.

6. Target firms are public companies.

These selection criteria produce a total of 4,870 deals. Further, we follow the Betton et al. (2008)'s procedure for the identification of takeover contests. This procedure allows identifying the initial step of each selling process in order to measure the negotiation time that elapses between the private initiation date and the announcement date (private duration) and further between the announcement date and the effective date (public duration)[26]. In our empirical analysis, we are primarily interested in identifying a setup where the tradeoff between benefits and costs of staying into a merger negotiation is the most relevant. In that perspective, building the takeover contests and focusing on the actions of the initial bidder is of prime importance. Applying these criteria gives a total of 4,634 contests, comprised of 4,421 single-round contests (only one bid by contest) and 213 multiple-round contests (more than one bid by contest, including 3 cases of quadruple-round, 17 cases of triple-round and 193 cases of double-round contests).

To ensure that we keep public acquirers only, we eliminate all contests where the first bid is made by a non-public company. Further, assuming target's rationality, the negotiation process should stop at some optimal time when the costs of waiting outweight the benefits of continuing to negotiate. We keep only contests opened by ultimately successful bidders (i.e., SDC Deal Status variable: "Completed") because complete descriptions of the negotiation process in SEC filings are often not available for the deals that have failed.[27] This leaves us with a total 2,819 deals opening 23 double-round and 2,796 single-round contests.

The final requirement for a transaction to be included in our sample is the availability of information relating to the private selling process (i.e., the one that takes place before the announcement date) for each deal. This information is available in the company-related SEC filings, freely accessible online via the EDGAR website[28]. The SEC information is available for 2,366 deals with 1,407 cases of bidder-initiation versus 974 cases of target-initiation. To

[26] According to this procedure, all bids regardless of their completion status are grouped by target firm and organized into separate contests according to the following principle (Eckbo, 2008): each contest opens with a first bid after a period of at least 182 "silent" calendar days without any offer; all subsequent bids for the same target are included in the contest if the time distance between them is less than 182 calendar days; and the closing offer is defined as being the last bid in that sequence.

[27] It is crucial for our purposes to measure the contest duration precisely. Hence we need to recover a precise date for the initiation of the private phase in a negotiation, which often is missing for failed deals.

[28] https://www.sec.gov/edgar/searchedgar/companysearch.html

empirically test the predictions of our theoretical model, which identifies the acquirer as being the first firm that starts an acquisition process for exogenous reasons (e.g., synergy-creation), we focus on the former subsample. Finally, in order to be consistent with our model we keep only (one-to-one) negotiated transactions which produces a final sample of 870 deals.

Table 2 presents the frequency distribution of M&A transactions included in our final sample. The end of the nineties M&A wave is clearly apparent, with a peak in 1998, as it is regularly reported in the literature (see, for example, Betton et al., 2008), as the dramatic effect of the 2008 financial crisis.

B Variables

For each transaction, we gather eight variables. The first five are hand-collected in the SEC filings. More precisely, the background section[29] of filings 14A and S-4 for mergers and 14D and TO-T for tender offers contains useful information to determine to whom belongs the initiative (i.e., bidder or target), when exactly the process started (private initiation date), and what was its form (i.e., negotiation or auction, either formal or informal)[30]. Filing types the most frequently used in data collection are listed in Appendix C. Using information collected in these SEC Filings, we obtain *DURPRIV*, the duration of the private process in days, *DURPUB*, the duration of the public process in days, *DURTOT*, the addition of *DURPRIV* and *DURPUB*, *NEGOTIATED*, a dummy variable equal to one in case of negotiations, and *AINITIATED*, a dummy variable equal to one for transactions initiated by acquirers[31]. Table 3 reports descriptive statistics. On average, the private process takes 168 days (a little bit less than 6 months) and the public process, 135 days (4.5 months)[32]. Our sample includes only negotiations and

[29]The full name of this section may be the either of (non-comprehensive list): Background of the Offer; Background of the Merger; Background of the Transaction; Background and Reasons for the Merger; Background to the Arrangement; Past Contacts or Negotiations with Parent and Purchaser; The Solicitation or Recommendation – Background and Reasons for the Board's Recommendation – Background of the Offer.

[30]Following Boone and Mulherin (2007), the transaction is classified as a "Formal Auction" when the target hires an investment bank to act as its financial advisor and delegates to that institution the task of organizing a sale of the company. The investment bank then contacts potential bidders, signs necessary confidentiality agreements, and supervises the submission of bids. The transaction is classified as an "Informal Auction" when multiple bidders are at play (not necessarily contacted) but the bidding process evolves in a less structured way. This category also includes all cases where the private negotiation is affected by competing bids. Finally, the transaction is classified as a "Negotiation" when it is a pure bilateral negotiation unaffected by rival offers.

[31]Detailed definitions of all variables are provided in Appendix D.

[32]Boone and Mulherin (2009) report that, on average, the private process lasts between 6 and 7 months. Betton et al. (2008) report that the mean time to completion for the public phase alone is approximately 65 trading days (or 3 months).

acquirer initiated transactions, as clearly apparent.

We collect in the SDC database the 4-weeks bid premium, *BIDPREM*, the deal value, *DEALVAL* and the number of bidders, *NBBIDDERS*. As reported in Table 3, the average 4-weeks bid premium is 41.54%, a typical figure for this kind of sample (Betton et al., 2008), the average deal value is 3,031 million of US dollar, close to the average target size in Boone and Mulherin (2007) and the average of number of bidders is 1.01, a low figure to be expected (collecting a sample of 8,259 bids in the SDC database over the period 1980 to 2005, Betton et al. (2008) report that 7,364 are single bid transactions).

C Calibration

The primary goal of our investigations is to infer the level of competition in the M&A market (the latent variable of interest) from the observed negotiation duration. The model introduced in Section III relates competition (λ) to a set of other parameters (q, the information precision; γ, the bidder risk aversion; ω, the common component of synergies; c, the negotiation costs; $\overline{S}$, the private component of synergies and $\overline{u}$, the bidder reservation utility). Our model provides the needed machinery to extract from the data estimates of λ.

More precisely, we will match the empirical frequency distribution of private negotiation durations (in month) as present in our sample. This distribution is reported in Table 4. We observe that, out of the 870 transactions present in our sample, 624 are completed within the six months (71.09%).

The peak month is the third one, with 144 transactions (16.55%). We focus in our empirical exercise on matching the frequency distribution up to month six, to avoid putting to much weight on sub-samples of limited number of observations that last longer.

As our goal is to match empirical moments observed in our sample of M&A transactions, the natural approach is the simulated method of moments (SMM, see Strebulaev and Whited, 2012). The intuition backing this approach is to use the model to simulate *synthetic* M&A transactions, using these ones to compute *simulated* moments and, finally, to choose parameters' values so as to minimize some measure of distance between the simulated moments and their empirical

counterparts (the SMM error). In our case, simulated moments are obtained thanks to the procedure introduced in Section IV.

We meet however a limitation due the very nature of our model. The state space is the sequence $H_t = \{\{I_k\}_{k=1}^t, \{E_k\}_{k=1}^t\}$, where I_k and E_k are respectively the information signal and the entry event at period k. With such a discrete state space, while we benefit from exhaustiveness and transparency (see Section IV), the SMM error function is discontinuous. Probably the most intuitive way to show this is to graphically represent the change in SMM error as model parameters changes, that we report in Figure 10. The horizontal axis reports λ values, the vertical axis the corresponding SMM error. Estimates are computed at values displayed in Table 1 for the remaining parameters $(q, \gamma, \omega, c, \overline{S}, \overline{u})$. The discontinous nature of the SMM error function is clearly apparent, with ranges of λ values for which the SMM error is flat and others generating significant jumps.

The discontinuous nature of the SMM error function in turn implies that by definition, there is no unique global optimum but, at best, a unique range of values for the parameters of interest for which the SMM error is minimized. In other words, identification can't be achieved. Walking towards statistical inference (and test of hypotheses) does not make sense therefore. As statistical inference is the utimate goal of structural analysis (Strebulaev and Whited, 2012), we have therefore to limit ourselves to a calibration exercise. This calibration is built around fitting the empirical frequency distribution of duration by adjusting the competition intensity parameter λ, controlling for the $(q, \gamma, \omega, c, \overline{S}, \overline{u})$ remaining parameters.

Exhaustiveness and transparency being the two benefits of our discrete state space approach, we opt for a graphical presentation of our results, isolating in a first stage the range of λ values that are minimizing the SMM error function and, in a second stage, exploring the robustness of our results to variation of the $(q, \gamma, \omega, c, \overline{S}, \overline{u})$ other parameters.

D Results

Starting with Figure 10, we observe that the minimum SMM error is located for values of λ close to 0.1. This estimate is obtained at values displayed in Table 1 for $(q, \gamma, \omega, c, \overline{S}, \overline{u})$. In order to best match the frequency distribution of negotiation duration, a probability of rival

bidder entry around 10% by month is optimal. Over a period of six months (the part of the frequency distribution that we seek to match in our empirical exercise), we reach a cumulated probability of entry of 60%. With such a cumulated probability of entry, over a period of six months, the average number of bidders would be around 1.6, significantly higher than the 1.01 average reported in the SDC database. We conclude that latent competition in the M&A market appears to be higher than the one observed ex-post, and this by a wide margin.

Is this result robust? We investigate this issue by checking the location of the SMM error function minima when we vary simultaneously λ and another parameter. Results are presented in Figures 11 to 16. All these three dimensional plots are built the same way: the floor is the plane of combinations formed by λ and the second parameter under consideration, the vertical axis measures the SMM error value. In each of the Figures, λ ranges from 0.01 to 0.99. Results are the following:

1. Figure 11 - Information Precision (parameter q): q ranges from 0.51 to 0.99. a clear valley appears for values of λ around 10% (the left hand side of the graph, in orange), for the whole range of values of q. For low values of q (close to 0.51) and high values of q (close to 0.99), the SMM error minimum is also reached, this time for the whole range of values of λ. Two conclusions emerge:
    (a) The 10% λ estimate is robust to changes in information precision (q);
    (b) Competition and information precision interact in the sense that for either very low or for very high values of information precision (q), the frequency distribution of negotiation durations can be matched at all levels of λ's. For extreme values of the informativeness of the due diligence process, the intensity of potential competition does not affect duration, which is mainly determined by the learning process;
2. Figure 12 - Risk Aversion (parameter γ): the SMM error minimum is reached for low values of λ and it is insensitive to changes in the value of γ. Our estimates of competition is clearly robust to the level of bidder risk aversion;
3. Figure 13 - Common Synergies (parameter ω): even if the valley of SMM error minimum values is larger than for γ, low values of λ are again supported over the whole range of ω

values. The right moderated curvature of the valley shows a low sensitivity of competition level estimates to the common value component of the synergies;

4. Figure 14 - Negotiation Costs (parameter c): the three dimensional plot of λ versus c has a fundamentally different shape than the previous ones. For low values of negotiation costs, the SMM error minimum is reached for low values of λ (again around 10%). But, as negotiation costs increase, the values of λ that minimize the SMM error minimum (to stay in the orange valley) are also increasing. This interaction between competition and negotiation costs makes economic sense: for a given negotiation duration, an increase in negotiation costs must be compensated by an increase in competition to avoid shortening the negotiation. We note also that the ranges of possible λ where the SMM error is minimum (the width of the orange valley) is itself increasing in negotiation costs. As negotiations costs are reported to be close to 1% (Ferris et al., 2003; Chahine and Ismail, 2009), in reality we are most probably on the left hand side of the plot, where the valley is narrow (the indeterminacy of λ is reduced);

5. Figure 15 - Private Synergies (parameter $\overline{S}$): the graphic has a similar shape than for common synergies (ω). This is not surprising as, in our model both ω and $\overline{S}$ enter in the bid revision process in a comparable way[33];

6. Figure 16 - Bidder Reservation Utility (parameter $\overline{u}$): as for bidder risk aversion (γ), the SMM error minimum is reached for the whole range of $\overline{u}$ and clearly insensitive to its specific value (no curvature of the orange valley). Our 10% competition estimate is clearly robust to the choice of the bidder reservation utility.

In conclusion, our 10% estimate of the competition parameter (λ) is supported in most cases. In addition, our analysis highlights interesting interactions between competition (λ) and information precision (q) as well as competition (λ) and negotiation costs (c).

[33] We note also that, if we had to attempt a structural estimation of our model, this result would raise an identification issue.

VII Conclusion

To what extent is the M&A market competitive? In this paper, we address this question by studying the determinants of M&A negotiation duration. The case of M&A negotiations is interesting because competition is, by definition, not directly observable but this doesn't preclude potential competition to play a role. The takeover process may require lengthy information acquisition, especially in its early stages. From the bidder's perspective, two opposing forces determine his willingness to stay in negotiations: (i) the need to learn about the potential synergies with the target through negotiation and due-diligence processes, and (ii) the risk of paying a higher premium due to potential competitors' entry. From the target's perspective, the entry of rival bidders is an enjoyable outcome but time and information revelation are costly however. Therefore, both sides, bidders and targets, face a tradeoff between the need for speed and for correctly assessing synergies.

We start our investigations by developing a discrete time finite horizon model and adopt a dynamic programming approach to solve it. In each period, the bidder submits a bid and the target either accepts or rejects it. If the target accepts the transaction is completed. Rejection opens one new period of negotiation. In such a case, the bidder receives additional information about the private component of real synergies with the target and, therefore, is less exposed to valuation errors. But, at every negotiation period, a rival bidder can show up, putting the current bidder under pressure and, simultaneously, revealing information about the common component of synergies. We introduce a backward induction procedure to solve the model and proceed to extensive simulations. Our results show that equilibrium negotiation duration is responsive to the five determinants incorporated in our model. More specifically, the optimal negotiation duration is (i) increasing in private and common value components of synergies, (ii) increasing in the intensity of potential competition, (iii) increasing in the precision of the information signal, (iv) decreasing in bidder risk aversion and (v) decreasing in negotiation costs. The positive correlation between the negotiation duration and synergies is driven by the equilibrium bidding strategy, which is itself increasing in synergies. These results highlight the fundamentally endogenous relations between these variables, which should be explicitly be addressed in empirical works.

Our model leads naturally to a calibration exercise. We use a sample of 870 acquirer initiated M&A negotations spread over the period 1994 to 2014. Initiation and the selling procedure are collected in SEC filings. The calibration itself is based on a moments matching procedure, in the spirit of the simulated method of moments. The main outcome of this exercise is that the empirical distribution of negotiation duration frequency is compatible with a probability of new bidder entry of 10% per month. The average negotiation time being 6 months, this would lead to an ex-ante average number of bidders of 1.6 by transaction. This estimate indicates that the M&A market is more competitive than previously thought, even for deals negotiated one-to-one between target and acquirer.

Appendices

A Proofs

Proof of Lemma 1: Applying Bayes' rule after observing the signal in period $t = 1$:

$$\begin{aligned} P(S &> 0 \,|I_1 = \overline{S}, p_0) = \tfrac{P(I_1=\overline{S}|S>0,p_0)P(S>0)}{P(I_1=\overline{S})} = \tfrac{qp_0}{qp_0+(1-q)(1-p_0)} \equiv p_1(\overline{S}, p_0) \\ P(S &> 0 \,|I_1 = 0, p_0) = \tfrac{P(I_1=0|S>0,p_0)P(S>0)}{P(I_1=\overline{S})} = \tfrac{(1-q)p_0}{(1-q)p_0+q(1-p_0)} \equiv p_1(0, p_0) \end{aligned}$$

while $P(S = 0 \,|I_1 = \overline{S}, p_0) = 1 - p_1(\overline{S}, p_0)$ and $P(S = 0 \,|I_1 = 0, p_0) = 1 - p_1(0, p_0)$. Analogously, applying Bayes' rule iteratively in periods $t = 2, ...T$, one obtains (5). ■

Proof of Lemma 2: Suppose that the negotiation starts with an initial offer $b_0 \geq 0$. In $t = 1$, both parties observe signal I_1 and update their belief from p_0 to p_1 as in (5). If in $t = 1$ there is no entry by a competitor, the initial bidder is not required to increase its offer and $b_1^{NE} = b_0$, where b_1^{NE} indicates the outstanding bid in case of no entry in period $t = 1$. If instead a new bidder makes a second offer to the target in $t = 1$, by Assumption 5 the initial bidder is forced to increase its bid up to $b_1^E \geq b_0$. To compute b_1^E, we first solve (4):

$$E_1[\widetilde{\pi}_1^{bid}] - \gamma E_1[(\widetilde{\pi}_1^{bid})^2] = \overline{u}$$

$$\begin{aligned} E_1[\widetilde{S} - b_1] - \gamma E_1[(\widetilde{S} - b_1)^2] &= \overline{u} \\ E_1[\widetilde{S}] - b_1 - \gamma \left[Var_1[\widetilde{S} - b_1] + \left(E_1[\widetilde{S} - b_1] \right)^2 \right] &= \overline{u} \\ E_1[\widetilde{S}] - b_1 - \gamma \left[Var_1[\widetilde{S}] + \left(E_1[\widetilde{S}] - b_1 \right)^2 \right] &= \overline{u} \end{aligned}$$

and denoting the expected synergy given the information available at $t = 1$ as $S_1 = E[\widetilde{S}\,|I_1, E_1] = E_1[\widetilde{S}]$ and $\sigma_1^2 = Var[\widetilde{S}\,|I_1, E_1] = Var_1[\widetilde{S}]$:

$$S_1 - b_1 - \gamma \left(\sigma_1^2 + S_1^2 - 2S_1 b_1 + b_1^2 \right) - \overline{u} = 0 \tag{14}$$

This second degree equation in b_1 admits a unique positive solution $\widehat{b}_1$ in a certain region of the exogenous parameters, $(q, \lambda, \gamma, \omega, p_0, c, \overline{u}, \overline{S})$. Let us rewrite equation (14) as:

$$\begin{aligned} Ab_1^2 + Bb_1 + C &= 0 \\ A &= -\gamma \\ B &= 2\gamma S_1 - 1 \\ C &= S_1 - \gamma \left(\sigma_1^2 + S_1^2 \right) - \overline{u} \end{aligned}$$

with

$$\begin{aligned} E_1[\widetilde{S}] &= S_1 = p_1 \left(\overline{S} + \omega \left(\lambda \sqrt{N_0 + 1} + (1 - \lambda) \sqrt{N_0} \right) \right) \\ Var_1[\widetilde{S}] &= \sigma_1^2 = \lambda p_1 \left(\overline{S} + \omega \sqrt{N_0 + 1} - S_1 \right)^2 + (1 - \lambda) p_0 \left(\overline{S} + \omega \sqrt{N_0} - S_1 \right)^2 + (1 - p_1) S_1^2 \end{aligned}$$

The unique positive solution of (14) is:

$$\widehat{b}_1 = S_1 - \frac{1}{2\gamma}\left(1 - \sqrt{B^2 + 4\gamma C}\right)$$

with

$$B^2 + 4\gamma C = (2\gamma S_1 - 1)^2 + 4\gamma\left(S_1 - \gamma\left(\sigma_1^2 + S_1^2\right) - \overline{u}\right) = 1 - 4\gamma^2\sigma_1^2 - 4\gamma\overline{u} < 1$$

There exists a unique real root of (14) if the term $B^2 + 4\gamma C > 0$. This condition holds, for values of $\overline{u}$ sufficiently close to zero, when $\gamma < \frac{1}{2\sigma_1}$. Given that the bidder is not allowed to reduce its offer, the outstanding bid in period one in case of entry is then $b_1^E = \max\left\{\widehat{b}_1, b_0\right\}$. Overall, the outstanding bid in $t = 1$ is then:

$$b_1 = \begin{cases} b_1^E = \max\left\{\widehat{b}_1, b_0\right\} & \text{if a second competitor enters in } t = 1 \\ b_1^{NE} = b_0 & \text{if there is no entry by a second competitor in } t = 1 \end{cases}$$

Iterating this process up to time T one obtains all the outstanding bids at all stages as in (6) in every state H_t. When performing the iteration, one has to consider that the bid in case of entry in period t equals $b_t^E = \max\left\{\widehat{b}_t, b_{t-1}\right\}$ where $\widehat{b}_t$ solves equation (14) translated to period t. That is, $\widehat{b}_t$ is the unique positive, real root of

$$S_t - b_t - \gamma\left(\sigma_t^2 + S_t^2 - 2S_t b_t + b_t^2\right) - \overline{u} = 0 \tag{15}$$

with $S_t = E[\widetilde{S}\,|H_t]$ and $\sigma_t^2 = Var[\widetilde{S}\,|H_t]$. Given that $\sigma_t < \sigma_1$ the condition $\gamma < \frac{1}{2\sigma_1}$ implies that $\gamma < \frac{1}{2\sigma_t}$. Thus, when (14) admits a unique real solution, also (15) has a unique real solution. ■

Proof of Lemma 3: The unique solution $\widehat{b}_t$ of (15) is smaller than S_t since $B^2 + 4\gamma C < 1$. To study the properties of the solution $\widehat{b}_t$, we first compute $\frac{\partial \widehat{b}_t}{\partial \sigma_t^2} < 0$. Then we substitute for

$$S_t = p_t\left(\overline{S} + \omega\left(\lambda\sqrt{N_t + 1} + (1-\lambda)\sqrt{N_t}\right)\right)$$

$$\sigma_t^2 = \lambda p_t\left(\overline{S} + \omega\sqrt{N_t + 1} - S_t\right)^2 + (1-\lambda)p_t\left(\overline{S} + \omega\sqrt{N_t} - S_t\right)^2 + (1-p_t)S_t^2$$

in $\widehat{b}_t$ to obtain: (i) $\frac{\partial \widehat{b}_t}{\partial \gamma} < 0$ for $\overline{u}$ sufficiently small, since both S_t and σ_t are independent of γ; (ii) $\frac{\partial \widehat{b}_t}{\partial \omega} > 0$; (iii) $\frac{\partial \widehat{b}_t}{\partial \lambda} > 0$; and (iv) $\frac{\partial \widehat{b}_t}{\partial \overline{u}} < 0$. ■

Proof of Lemma 4: In order to explicitly compute $V_{T-1}(H_{T-1})$ we need to find the optimal target's decision at every state H_{T-1} in period $T-1$. To do so, we first obtain the transition probabilities $P(p_{T,k}, N_{T,k}\,|H_{T-1})$ in equation (B):

$$\begin{aligned} P(I_T &= \overline{S}\,|p_{T-1}) = P(I_T = \overline{S}\,|S > 0)P_{T-1}(S > 0) + P(I_T = \overline{S}\,|S = 0)P_{T-1}(S = 0) \\ &= qp_{T-1} + (1-q)(1-p_{T-1}) \\ P(I_T &= 0\,|p_{T-1}) = P(I_T = 0\,|S > 0)p_{T-1} + P(I_T = 0\,|S = 0)(1-p_{T-1}) \\ &= (1-q)p_{T-1} + q(1-p_{T-1}) \end{aligned}$$

Since by Assumption 3 entry by a second bidder is i.i.d. across stages, we can write the transition probabilities as

$$
\begin{aligned}
P(p_T(\overline{S}, p_{T-1}), N_{T-1}+1 \,|H_{T-1}) &= \lambda P(I_T = \overline{S}\,|p_{T-1}) && (16)\\
P(b_{T-1}, p_T(\overline{S}, p_{T-1}), N_{T-1} \,|H_{T-1}) &= (1-\lambda) P(I_T = \overline{S}\,|p_{T-1}) && (17)\\
P(p_T(0, p_{T-1}), N_{T-1}+1 \,|H_{T-1}) &= \lambda P(I_T = 0\,|p_{T-1}) && (18)\\
P(b_{T-1}, p_T(0, p_{T-1}), N_{T-1} \,|H_{T-1}) &= (1-\lambda) P(I_T = 0\,|p_{T-1}) && (19)
\end{aligned}
$$

and we plug (16)-(19) into (B).

Next we compute explicitly the expected payoff from rejecting bid b_{T-1} at state H_{T-1}, $\pi_{T-1}^{tar,rej}(H_{T-1})$:

$$
\begin{aligned}
\pi_{T-1}^{tar,rej}(H_{T-1}) \;=\; & \lambda \left[\begin{array}{l} P(I_T = \overline{S}\,|p_{T-1})\left(b_T^E(p_T(\overline{S}), N_{T-1}+1; H_{T-1}) - cT\right) + \\ +P(I_T = 0\,|p_{T-1})\left(b_T^E(p_T(0), N_{T-1}+1; H_{T-1}) - cT\right) \end{array} \right] \\
& +(1-\lambda)(b_{T-1} - cT)
\end{aligned}
$$

In case of no entry in the next period T, the bid does not increase, $b_T = b_{T-1}$. In this case the target obtains for sure $b_{T-1} - cT$ since it anticipates it will close the deal in period T. In case of entry in T, the expected profit from rejecting the deal in $T-1$ is an average of the values obtained in T weighted by the probabilities of the two possible events occuring at T, that is whether the next signal indicates a positive synergy, or not, with

$$
\begin{aligned}
b_T^E(p_T(\overline{S}), N_{T-1}+1; H_{T-1}) &= \max\left\{\widehat{b}_T(\overline{S}), b_{T-1}\right\}\\
b_T^E(p_T(0), N_{T-1}+1; H_{T-1}) &= \max\left\{\widehat{b}_T(0), b_{T-1}\right\}
\end{aligned}
$$

where $\widehat{b}_T(\overline{S})$ (resp. $\widehat{b}_T(0)$) is the solution of (7) with $S_T = E_T[\widetilde{S}]$ and $\sigma_T^2 = Var_T[\widetilde{S}]$ computed using $p_T(\overline{S})$ and $N_{T-1}+1$ (resp. $p_T(0)$, $N_{T-1}+1$). Once we have obtained the expression for $\pi_{T-1}^{tar,rej}(H_{T-1})$, the value function is defined as:

$$
V_{T-1}(H_{T-1}) = \max\left\{b_{T-1} - c(T-1); \pi_{T-1}^{tar,rej}(H_{T-1})\right\} \tag{20}
$$

Finding the maximum of these two expressions gives us the optimal target's decision at state H_{T-1}. ■

Proof of Lemma 5: By optimality of $t^*(z)$ (for brevity, t^* in the following), the target accepts bid $b_{t^*}(H^*(z))$ (for brevity, b^*) and $V_{t^*} = b^* - c_0 t^*$. Hence, at t^* the expected payoff from rejecting the offer is lower than the payoff from accepting it:

$$
E[V_{t^*+1}\,|H^*(z)] < b^* - c_0 t^*
$$

Also, by the same optimality condition, it must be that at the previous period t^*-1, for the target is better to continue the negotiation one step further rather than to accept the deal at t^*-1:

$$
E_{t^*-1}[V_{t^*}] > b_{t^*-1} - c_0(t^*-1)
$$

where E_{t^*-1} denotes the conditional expectation taken at period t^*-1 at the node preceeding state $H^*(z)$, on the path z. Using $V_{t^*} = b^* - c_0 t^*$ we can rewrite the above condition as:[34]

$$
\begin{aligned}
b_{t^*-1} - c_0(t^*-1) &< E_{t^*-1}[b_{t^*} - c_0 t^*]\\
c_0 &< E_{t^*-1}[b_{t^*}] - b_{t^*-1}\\
c_0 &< E_{t^*-1}[b_{t^*}] - b_{t^*-1} && (21)
\end{aligned}
$$

[34] Notice that in period t^*-1, whatever node has been reached following the path z, the next period bid is a random variable, that we denote by b_{t^*} to distinguish it from its realization, b^*.

Condition (21) states that in period $t^* - 1$ the cost of negotiating one period ahead, c_0, is lower than the expected benefit of doing so, which in turn equals the expected increase in bid compatible with the realized path observed up to $t^* - 1$.

Given that the game has reached a certain node $t^* - 1$, the target expects a higher bid in t^* only if there is entry in t^*, that is $b^E_{t^*} \geq b_{t^*-1}$, where by (6), $b^E_{t^*} = \max\left\{\widehat{b}_{t^*}, b_{t^*-1}\right\}$ and $\widehat{b}_{t^*}$ solves (7) in t^*. Hence $E_{t^*-1}[b_{t^*}] = \lambda_0 E_{t^*-1}[b^E_{t^*}] + (1-\lambda_0)b_{t^*-1}$ and (21) becomes

$$c_0 < \lambda_0 \left(E_{t^*-1}[b^E_{t^*}] - b_{t^*-1}\right)$$

Since $\left(E_{t^*-1}[b^E_{t^*}] - b_{t^*-1}\right) \geq 0$ it exists a $\lambda_1 < \lambda_0$ such that the above inequality is reversed and for the target it is optimal to stop at $t^* - 1$ when the degree of potential competition is equal to λ_1. The same argument holds for any path satisfying the assumptions of the Lemma, hence it holds as well for the expected optimal duration. ■

B Sample selection

Criteria	Nb of obs.
Date Announced: between 01/01/1994 and 31/12/2014	824,010
Target Nation: United States of America	227,316
Acquirer Nation: United States of America	197,146
Form of the Deal: United States of America Merger (Stock or Assets) Acquisition of Majority Interest (Stock) Acquisition of Partial Interest (Stock) Acquisition of Remaining Interest (Stock) Acquisition (Stock)	56,782
Deal Value ($ Mil): Greater than 100 million	9,445
Bids for control: % of shares held prior to the transaction $< 50\%$ % of shares seeking to own in the transaction $\geq 50\%$	8,000*
Public status: Target is public	4,870
Takeover contests: by Target CUSIP Initial date: the announcement date of the first bid after a period of 182 calendar days clean of other control bids Final date: the announcement date of the last control bid with no more control bids during the following 182 calendar days	4,634**
Public status: Acquirer is public	3,346***
Keeping **"complete" takeover contests** only	3,277†
Keeping **1st "successful" bids** of each contest only	2,819††
SEC information available:	2,366†††
• Acquirer-initiated deals	*1,407*
• Negotiated deals	*870*

* Comprised of 7,015 deals with *Completed* deal status and 985 failed deals (including *Intended, Intent Withdrawn, Pending, Status Unknown, Withdrawn* deal status).

** Comprised of 4,421 *single-round* contests (only one bid in the contest, including 3,891 completed and 530 failed deals) and 213 multiple-round contests (more than one bid in the contest, including 3 cases of *quadruple-round*, 17 cases of *triple-round* and 193 cases of *double-round* contests). In each case, we also know whether it was the same acquirer or a different acquirer who made an offer (therefore, we can build a variable called "Multiple acquirers" distinct from that given by SDC).

*** Among these 3,346 deals we are left with 3,216 takeover contests which may be "incomplete" due to the fact that some bids were made by non-public bidders (therefore, the first bid maybe missing)...

† Comprised of 2,871 completed and 406 failed deals which form a total of 3,183 takeover contests.

†† Comprised of 23 *double-round* and 2,796 *single-round* contests.

††† Information fields collected include: *Private initiation date, Initiating party, Selling procedure.*

C SEC filings

This Appendix provides a comprehensive list of SEC filings types used in data collection:

- **S-4** – Registration of securities and business combinations statement
- **DEFM 14A** – Definitive proxy statement relating to merger or acquisition
- **DEFM14C** – Definitive information statement relating to merger or acquisition
- **DEFR14A** – Definitive revised proxy soliciting materials
- **DEFS14A** – Definitive proxy statement for special meeting
- **PREM14A** – Preliminary proxy statements relating to merger or acquisition
- **PREM14C** – Preliminary information statements relating to merger or acquisition
- **PRER14A** – Preliminary revised proxy soliciting materials
- **SC 14D9** – Solicitation/Recommendation Statement
- **SC TO-T** – Tender offer statement by Third Party
- **SC 14D1** – Tender offer statement

D Variable definitions

Label	Variable name	Definition
Durpriv	Private Duration	Number of calendar days between the date when the private part of the process starts and the SDC public announcement date.
Durpub	Public Duration	Number of calendar days between the SDC announcement date and the SDC effective date.
Durtot	Total Duration	The sum of Private duration and Public duration, in days.
Negotiated	Selling procedure	Dummy variable: 1 if the selling procedure is a bilateral negotiation, 0 if the selling procedure is an auction (formal or informal).
Ainitiated	Initiating party	Dummy variable: 1 if the deal is acquirer-initiated, 0 otherwise.
Bidprem	Bid Premium	SDC 4-week percentage bid premium as a ratio of the offer price to the target's share price 4 weeks prior to the announcement, minus one.
Dealval	Deal Value	Value of transaction, as reported by SDC, in millions of dollars.
NBbidders	Number of bidders	SDC Number of Bidders (BIDCOUNT) variable: The number of entities (including the acquiror) bidding for a target. Also, the number of challenging deals for one target. For deals with only one bidder (ie. no challenger), Number of Bidders will be 1.

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Parameter	Notation	Value	Range
Information precision	q	0.6	[0.51;0.99]
Competition intensity	λ	0.5	[0.01;0.99]
Bidder risk aversion	γ	2	[1.1;2.5]
Common synergy revision	ω	5%	[0.1%;8%]
Negotiation costs	c	1%	[0.1%;5%]
Private synergy	$\overline{S}$	25%	[1%;35%]
Bidder reservation utility	$\overline{u}$	0.1%	[0%;5%]

Table 1: Parameter Values for Simulations

Table 1 reports the parameter values used for model simulations (see Section V). The two fist columns provide the parameter descriptions and the corresponding notations. The third column displays the baseline value used in simulations and the fourth, the range of values along which model outcomes are simulated for each parameter.

Item	Number	Per cent
1994	16.00	1.84
1995	49.00	5.63
1996	65.00	7.47
1997	92.00	10.57
1998	105.00	12.07
1999	104.00	11.95
2000	81.00	9.31
2001	49.00	5.63
2002	21.00	2.41
2003	37.00	4.25
2004	41.00	4.71
2005	34.00	3.91
2006	40.00	4.60
2007	30.00	3.45
2008	8.00	0.92
2009	15.00	1.72
2010	16.00	1.84
2011	14.00	1.61
2012	14.00	1.61
2013	19.00	2.18
2014	20.00	2.30
Total	870.00	100.00

Table 2: MA Sample by Year

Table 2 displays the frequency distribution of our M&A sample by year. This sample includes initial completed control M&As between US public bidders and targets, with deal value above 100 million US dollars, for which we have able to collect the needed information in SEC filings. Sample selection criteria details are provided in Appendix B.

variable	**mean**	**sd**	**min**	**max**
DURPRIV	168.65	140.75	0.00	1121.00
DURPUB	135.18	91.15	0.00	893.00
DURTOT	303.83	171.86	0.00	1248.00
NEGOTIATED	1.00	0.00	1.00	1.00
AINITIATED	1.00	0.00	1.00	1.00
BIDPREM	41.54	41.42	-64.71	445.18
DEALVAL	3031.53	7712.45	100.04	78945.79
NBBIDDERS	1.01	0.12	1.00	3.00

Table 3: Descriptive Statistics

Table 3 reports the arithmetic average (*mean*), the standard-deviation (*sd*), the minimum (*min*) and the maximum (*max*) of the set of variables that we use in the empirical analysis. *DURPRIV* is the duration of the private process in days, *DURPUB* is the duration of the public process in days, *DURTOT* is the addition of *DURPRIV* and *DURPUB*, *NEGOTIATED* is a dummy variable equals to one in case of negotiation, *AINITIATED* is a dummy variable equals to one in case transaction initiated by the acquirer, *BIDPRIM* is the SDC 4 weeks bid premium, *DEALVAL* is the transaction deal value in million of US dollar and *NUMBIDDERS* is the number of bidders. All variables are defined in Appendix D.

Month	Number	Per cent
0	6.00	0.09
1 month	66.00	7.58
2 months	132.00	15.17
3 months	144.00	16.55
4 months	123.00	14.13
5 months	91.00	10.45
6 months	62.00	7.12
7 months	45.00	5.17
8 months	37.00	4.25
9 months	26.00	2.98
10 months	25.00	2.87
> 10 months	113.00	13.58
Total	870.00	100.00

Table 4: **Negotiation Duration Frequency Distribution**
Table 4 reports the frequency distribution of private negotiation duration ($DURPRIV$) by month for our sample of 870 M&A transactions. *Number* is the length of private negotiation in month and *Percent*, the corresponding percentages. The sample of M&A transactions is presented at Table 2.

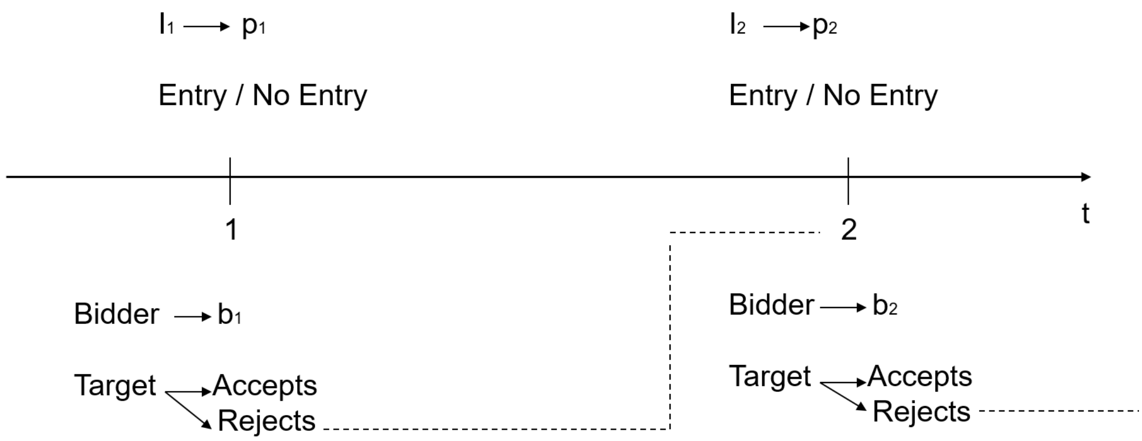

Figure 1: Merger Process

Figure 1 provides a representation of the merger process. I_1 and I_2 are the signals observed in period 1 and 2, respectively. p_1 is the posterior belief that the synergy is positive after signal I_1 is observed. b_1 and b_2 are the bids offered by the initial bidder in period 1 and 2, respectively;

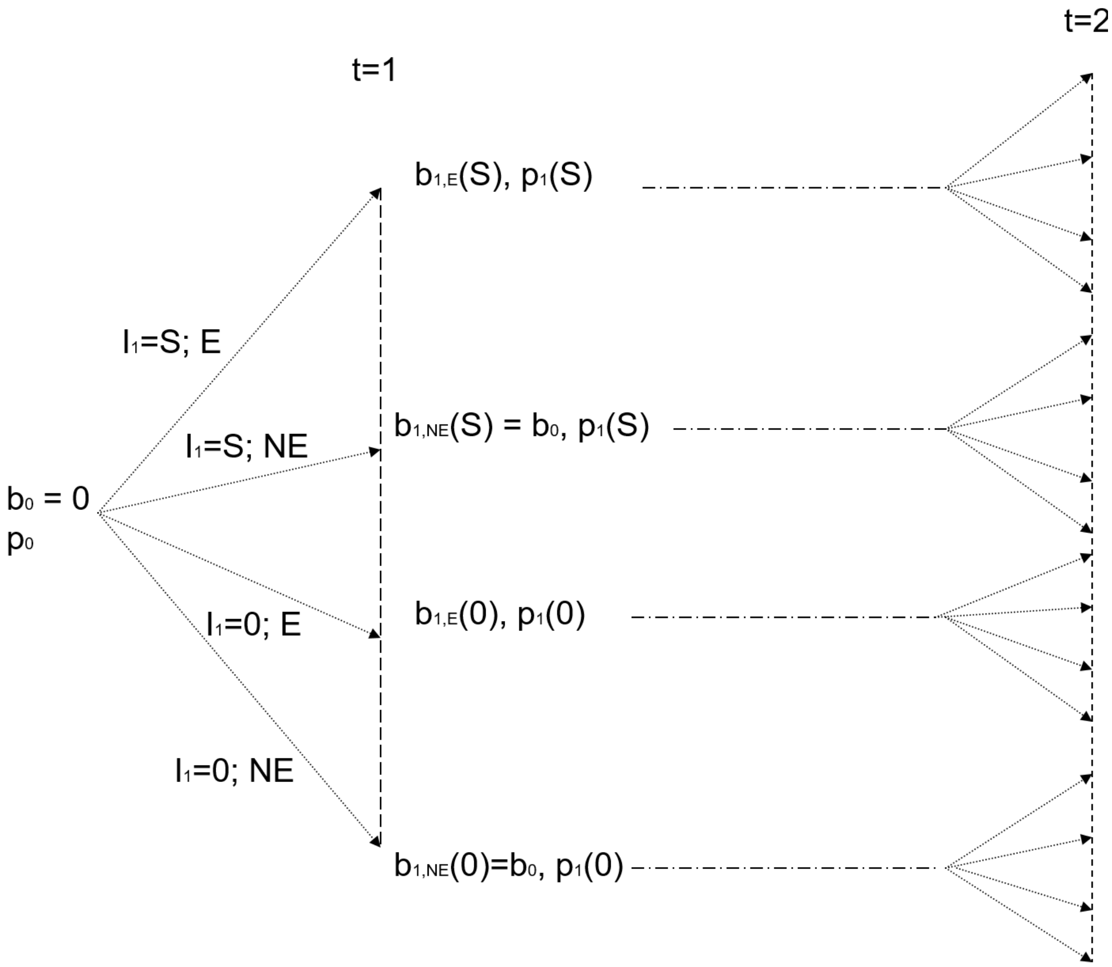

Figure 2: Model Structure

Figure 2 displays the tree underlying of model. S and 0 are the realizations of the signal $\widetilde{I}_1$ in period 1. E and NE indicate respectively Entry, No Entry of a competing bidder, i.e. the realization of signal $\widetilde{E}_t$ in every period t. b_1 is the bid offered by the initial bidder in period t, depending on the realizations of $\widetilde{E}_t$ and of the signal $\widetilde{I}_t$. p_1 is the posterior belief over the synergy being positive in period 1 depending on the realizations of $\widetilde{I}_1$.

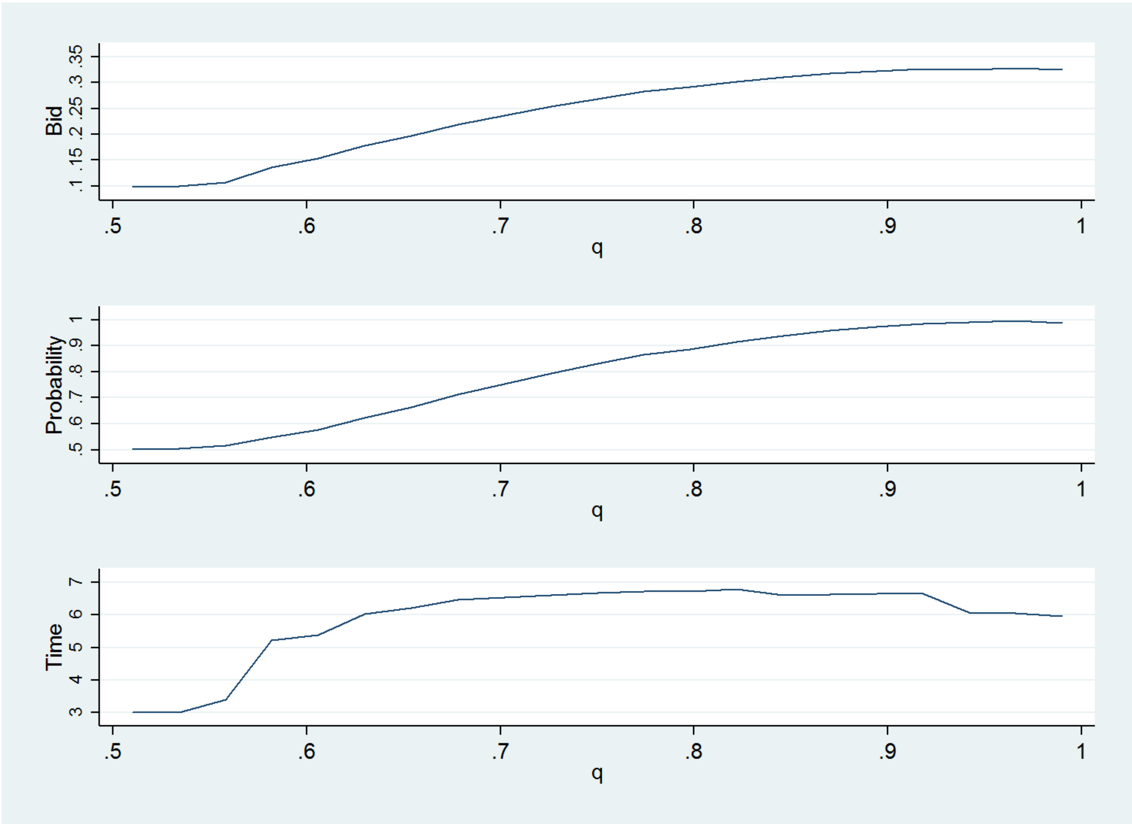

Figure 3: Information Precision (q) and Equilibrium Negotiation Outcomes

Figure 3 presents the evolution of the equilibrium bid, the inferred probability of high synergy and the negotiation duration as a function of information precision (q). q ranges from 0.51 to 0.99. Estimations are obtained at values 0.5, 2, 0.05, 0.01, 0.25 and 0.001 respectively for λ, γ, ω, c, $\bar{S}$ and $\bar{u}$.

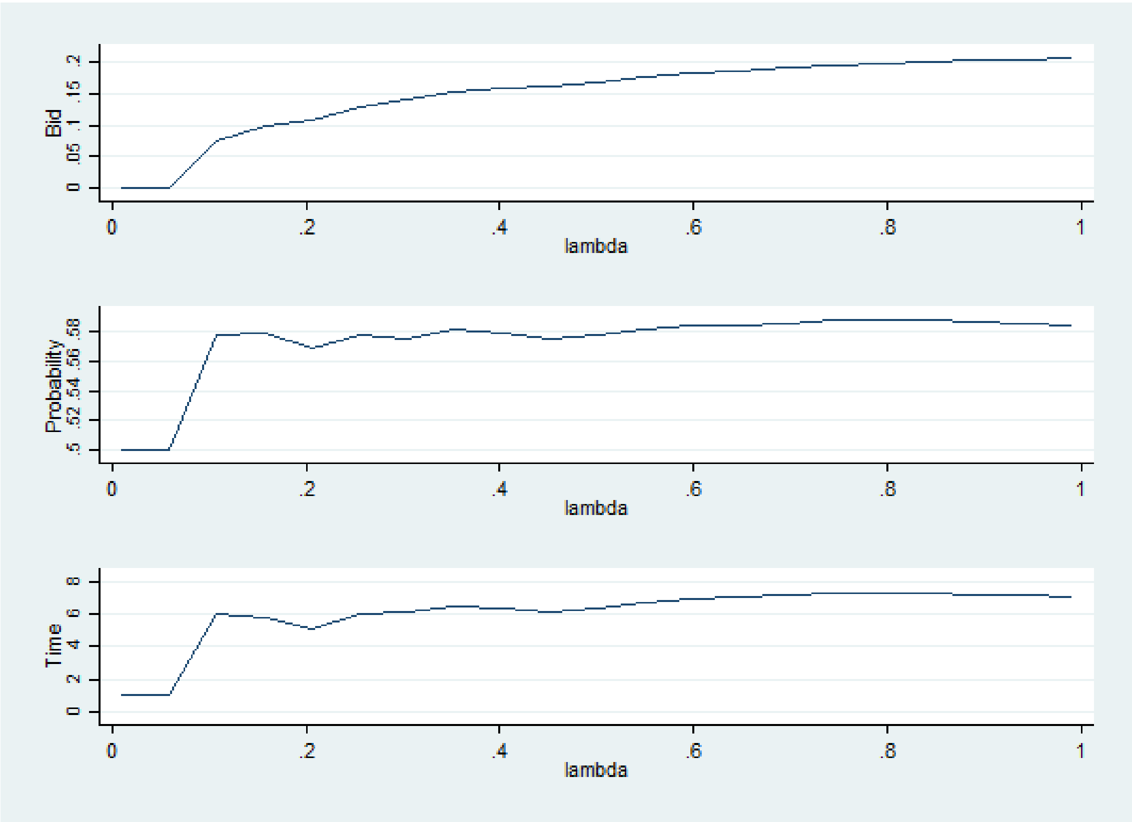

Figure 4: Competition (λ) and Equilibrium Negotiation Outcomes

Figure 4 presents the evolution of the equilibrium bid, the inferred probability of high synergy and the negotiation duration as a function of competition intensity (λ). λ ranges from 0.01 to 0.99. Estimations are obtained at values 0.6, 2, 0.05, 0.01, 0.25 and 0.001 respectively for q, γ, ω, c, $\bar{S}$ and $\bar{u}$.

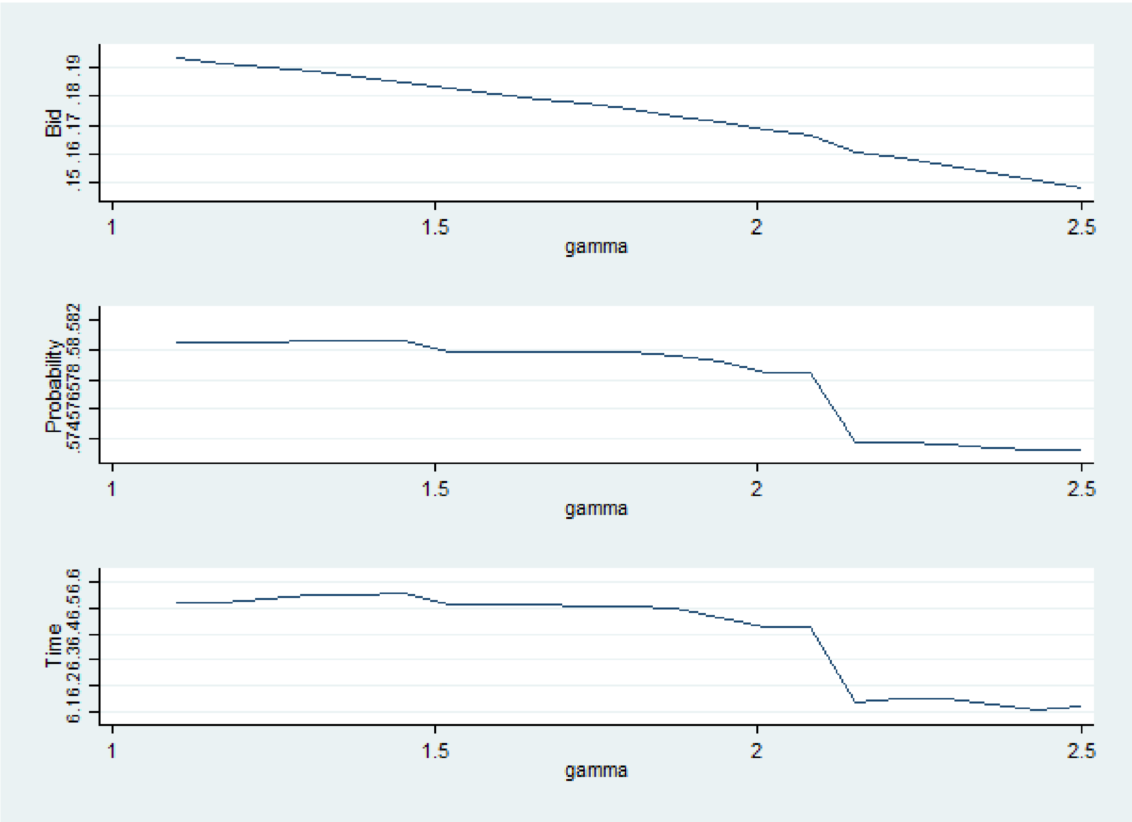

Figure 5: Risk Aversion (γ) and Equilibrium Negotiation Outcomes

Figure 5 presents the evolution of the equilibrium bid, the inferred probability of high synergy and the negotiation duration as a function of risk aversion (γ). γ ranges from 1.1 to 2.5. Estimations are obtained at values 0.6, 0.5, 0.05, 0.01, 0.25 and 0.001 respectively for q, λ, ω, c, $\bar{S}$ and $\bar{u}$.

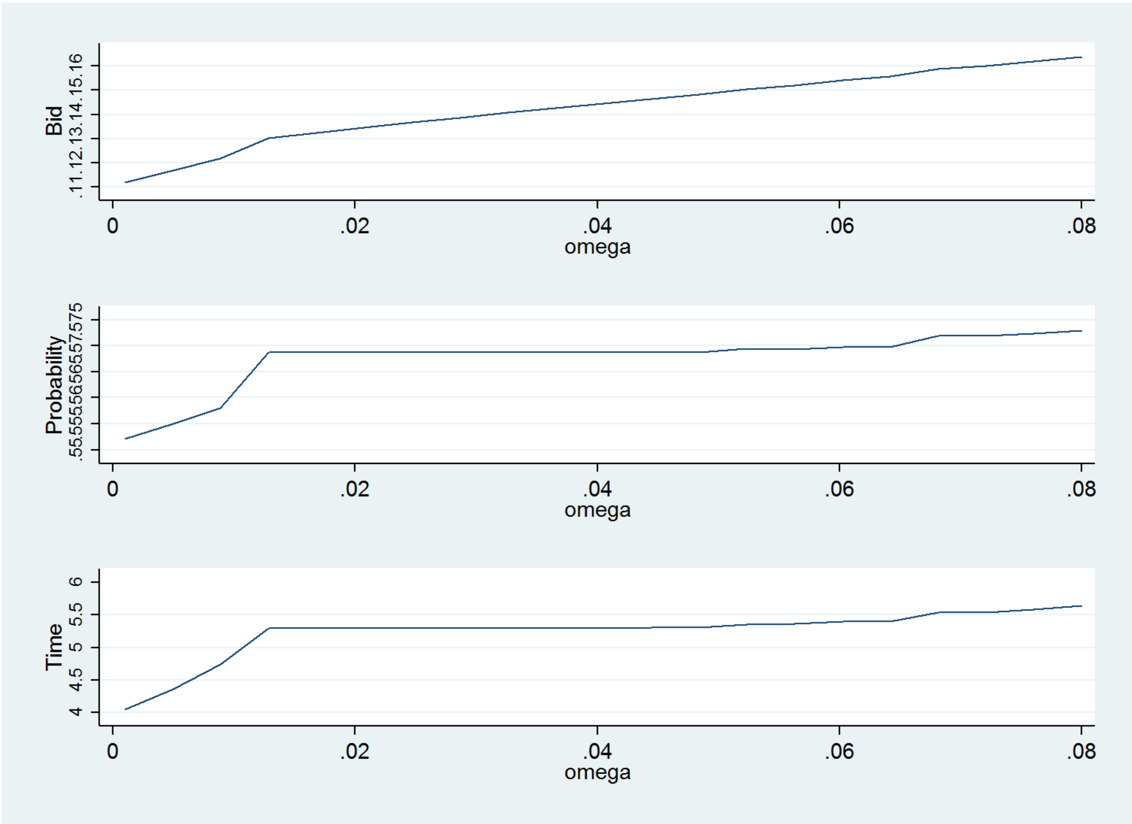

Figure 6: Common Synergies (ω) and Equilibrium Negotiation Outcomes

Figure 6 presents the evolution of the equilibrium bid, the inferred probability of high synergy and the negotiation duration as a function of common synergies (ω). ω ranges from 0.001 to 0.08. Estimations are obtained at values 0.6, 0.5, 2, 0.01, 0.25 and 0.001 respectively for q, λ, γ, c, $\bar{S}$ and $\bar{u}$.

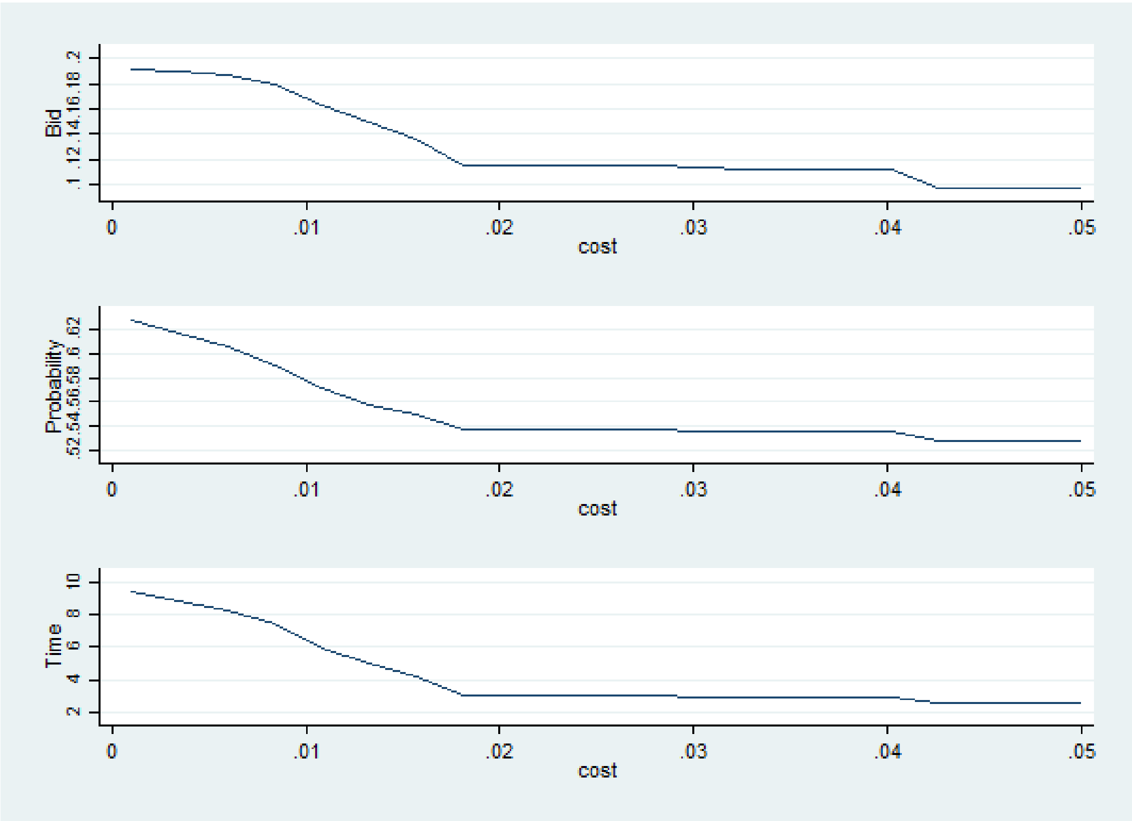

Figure 7: Negotiation Costs (c) and Equilibrium Negotiation Outcomes

Figure 7 presents the evolution of the equilibrium bid, the inferred probability of high synergy and the negotiation duration as a function of negotiation costs (c). c ranges from 0.001 to 0.05. Estimations are obtained at values 0.6, 0.5, 2, 0.05, 0.25 and 0.001 respectively for q, λ, γ, ω, $\bar{S}$ and $\bar{u}$.

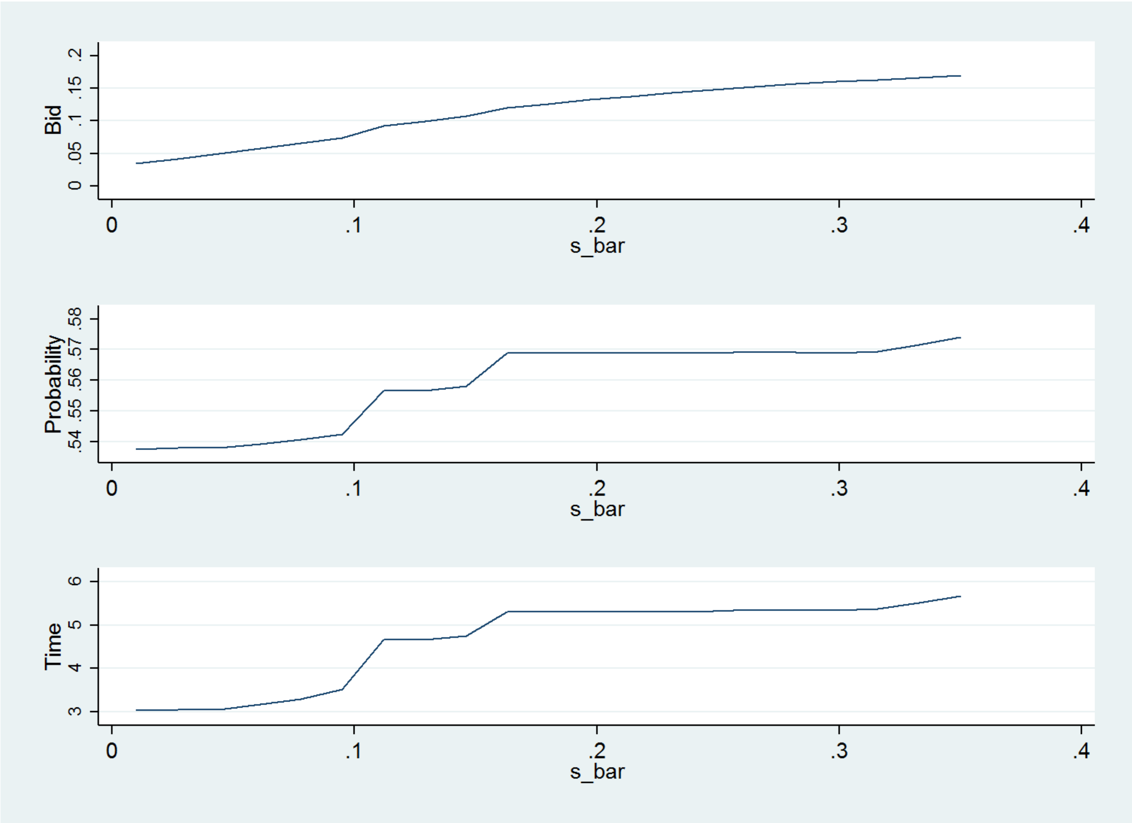

Figure 8: Private Synergies ($\bar{S}$) and Equilibrium Negotiation Outcomes

Figure 8 presents the evolution of the equilibrium bid, the inferred probability of high synergy and the negotiation duration as a function of private synergies ($\bar{S}$). $\bar{S}$ ranges from 0.01 to 0.35. Estimations are obtained at values 0.6, 0.5, 2, 0.05, 0.01 and 0.001 respectively for q, λ, γ, ω, c and $\bar{u}$.

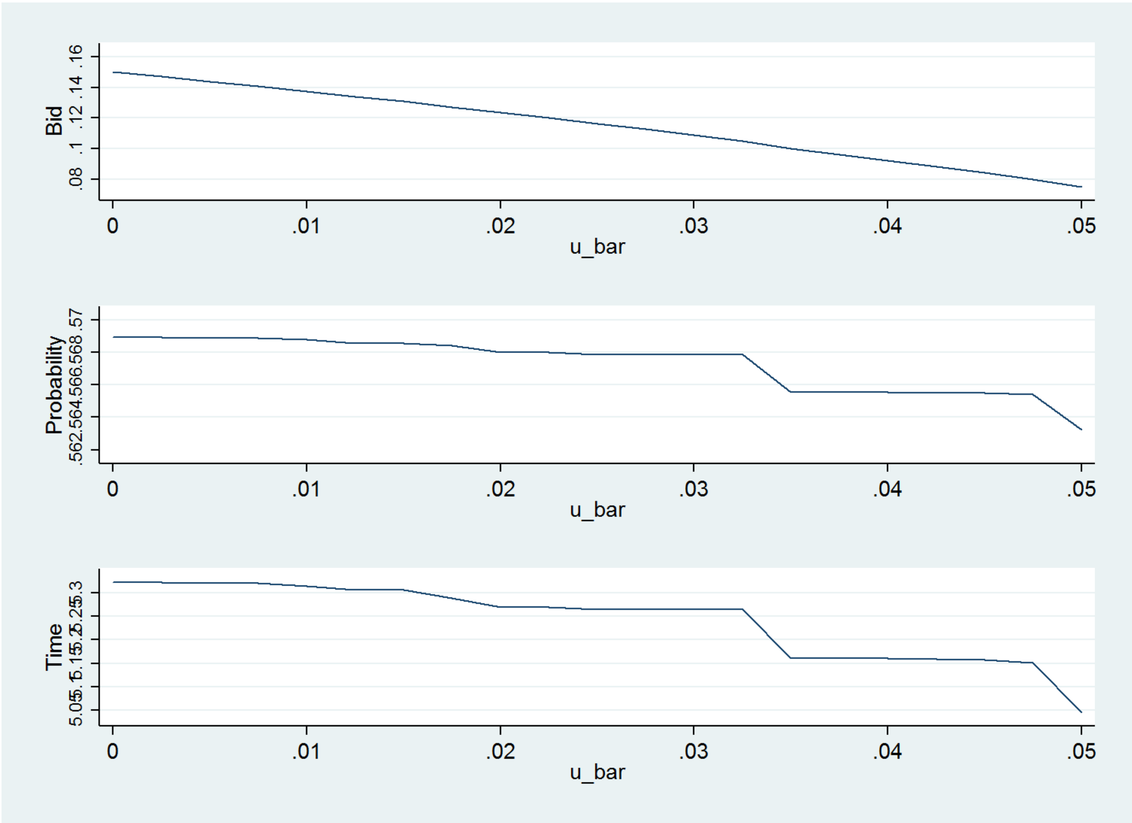

Figure 9: Bidder Equilibrium Rent ($\bar{u}$) and Equilibrium Negotiation Duration

Figure 9 presents the evolution of the equilibrium bid, the inferred probability of high synergy and the negotiation duration as a function of the bidder equilibrium rent ($\bar{u}$). $\bar{u}$ ranges from 0 to 0.05. Estimations are obtained at values 0.6, 0.5, 2, 0.05, 0.01 and 0.25 respectively for q, λ, γ, ω, c and $\bar{S}$.

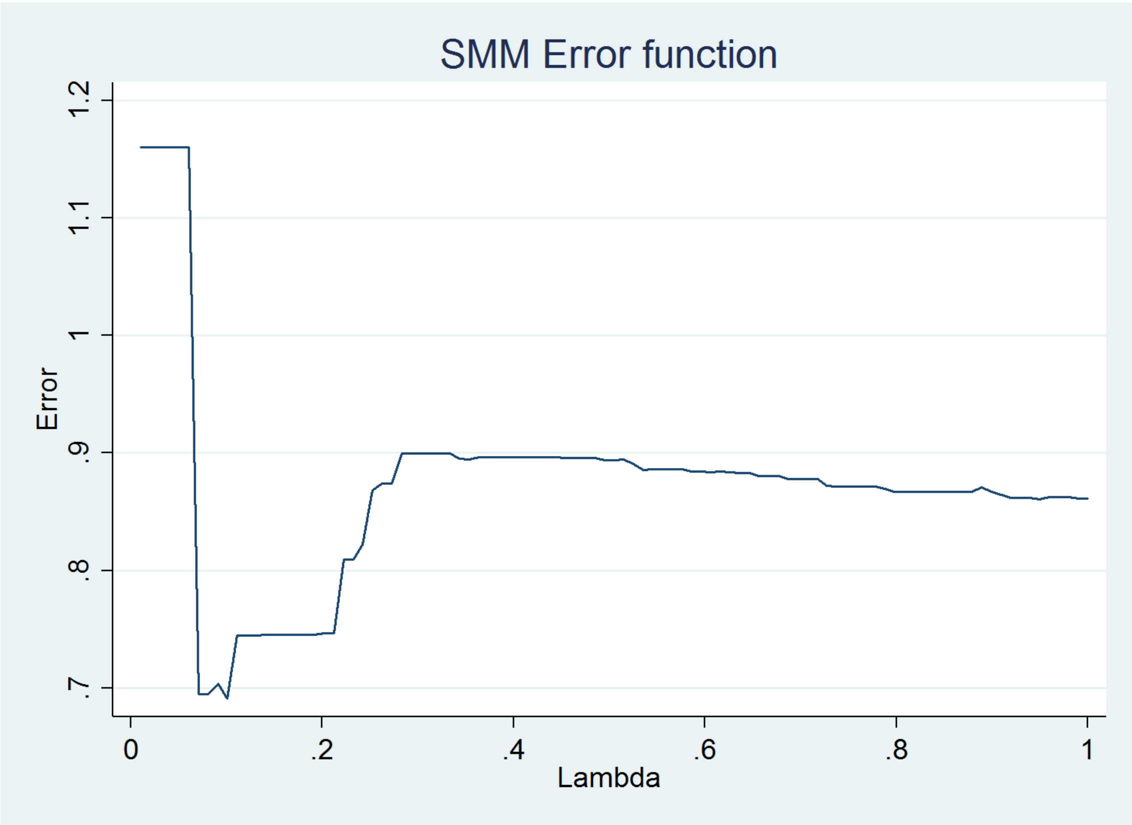

Figure 10: SMM Error Function

s

Figure 10 displays the Simulated Method of Moments error as a function of the competition intensiveness (λ). We use the relative frequency distribution of negotiation duration from month one to month six as moments. λ ranges from 0.01 to 0.99. Estimations are obtained at values 0.6, 2, 0.05, 0.01, 0.25 and 0.001 respectively for q, γ, ω, c, $\bar{S}$ and $\bar{u}$.

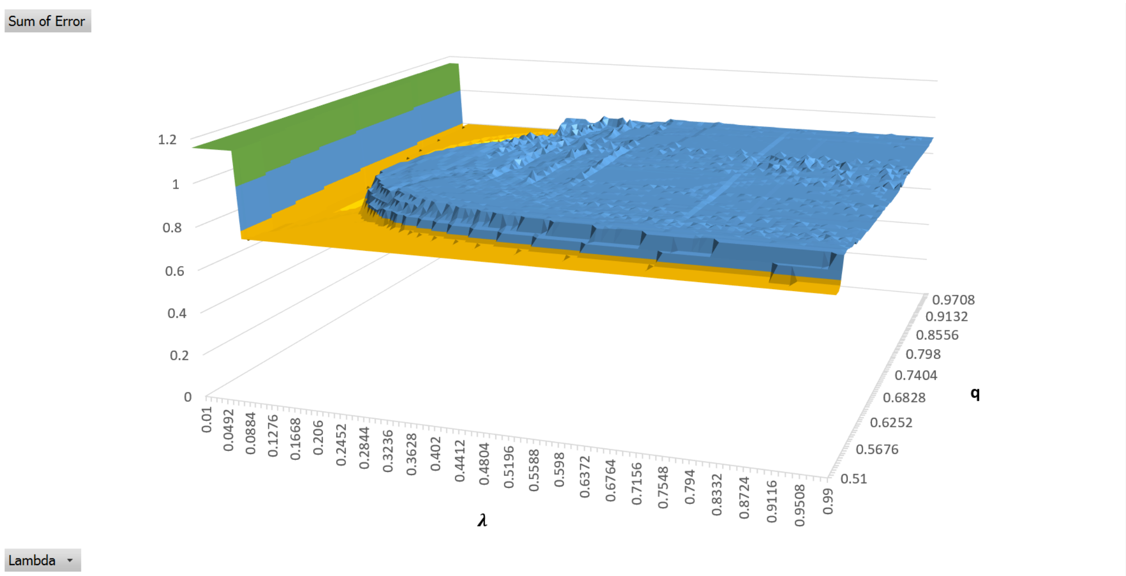

Figure 11: Competition (λ) versus Information Precision (q)

Figure 11 displays the Simulated Method of Moments error as a function of the competition intensiveness (λ) and information precision (q). We use the relative frequency distribution of negotiation duration from month one to month six as moments. λ ranges from 0.01 to 0.99 and q from 0.51 to 0.99. Estimations are obtained at values 2, 0.05, 0.01, 0.25 and 0.001 respectively for γ, ω, c, $\bar{S}$ and $\bar{u}$.

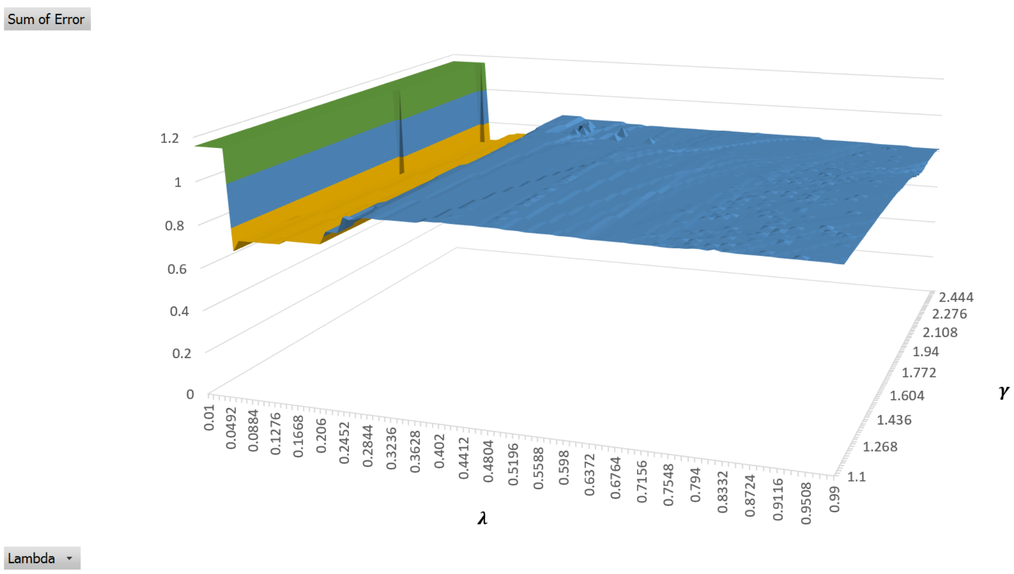

Figure 12: Competition (λ) versus Risk Aversion (γ)

Figure 12 displays the Simulated Method of Moments error as a function of the competition intensiveness (λ) and risk aversion (γ). We use the relative frequency distribution of negotiation duration from month one to month six as moments. λ ranges from 0.01 to 0.99 and γ from 1.1 to 2.5. Estimations are obtained at values 0.6, 0.05, 0.01, 0.25 and 0.001 respectively for q, ω, c, $\bar{S}$ and $\bar{u}$.

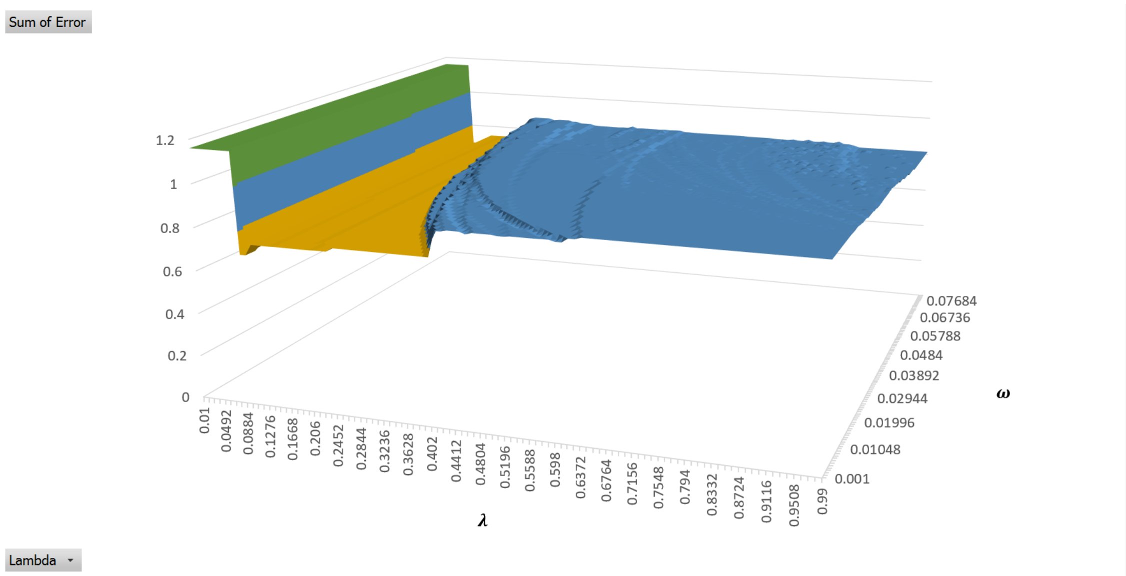

Figure 13: Competition (λ) versus Common Synergies (ω)

Figure 13 displays the Simulated Method of Moments error as a function of the competition intensiveness (λ) and common synergies (ω). We use the relative frequency distribution of negotiation duration from month one to month six as moments. λ ranges from 0.01 to 0.99 and ω from 0.001 to 0.08. Estimations are obtained at values 0.6, 2, 0.01, 0.25 and 0.001 respectively for q, γ, c, $\bar{S}$ and $\bar{u}$.

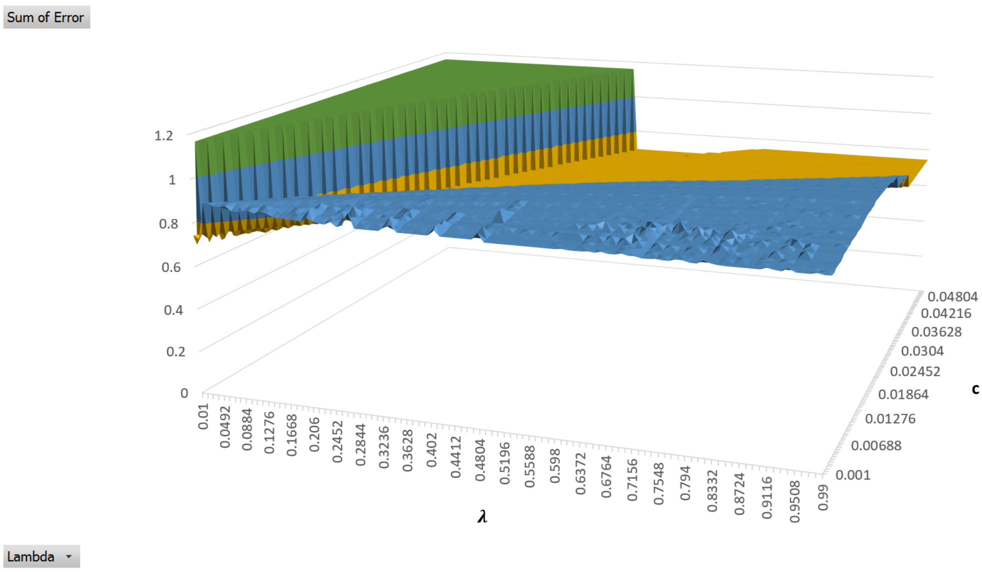

Figure 14: Competition (λ) versus Negotiation Costs (c)

Figure 14 displays the Simulated Method of Moments error as a function of the competition intensiveness (λ) and negotiation costs (c). We use the relative frequency distribution of negotiation duration from month one to month six as moments. λ ranges from 0.01 to 0.99 and c from 0.001 to 0.05. Estimations are obtained at values 0.6, 2, 0.05, 0.25 and 0.001 respectively for q, γ, ω, $\bar{S}$ and $\bar{u}$.

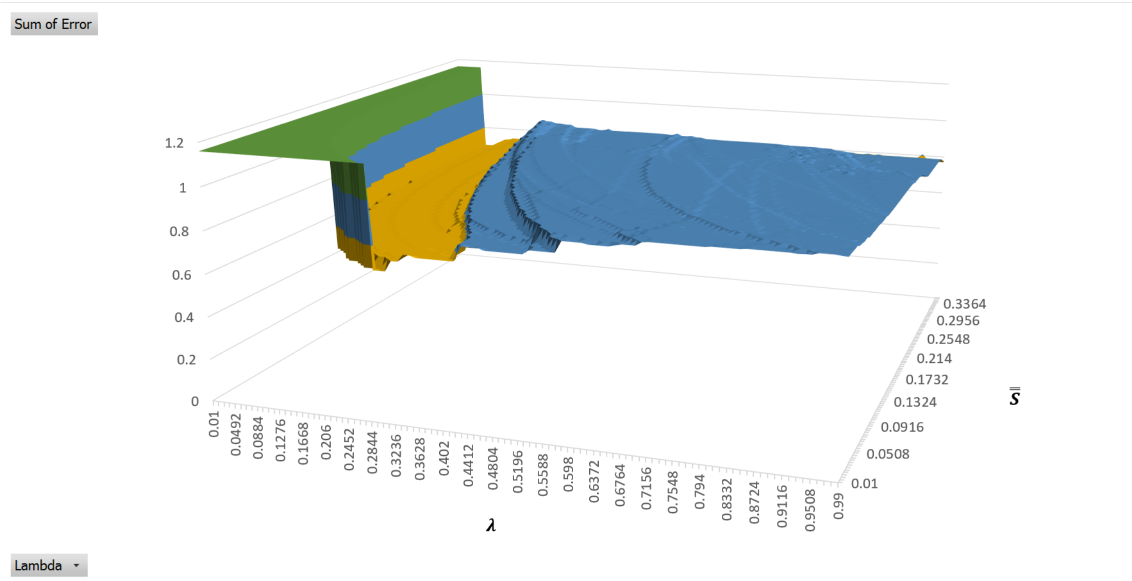

Figure 15: Competition (λ) versus Private Synergies ($\bar{S}$)

Figure 15 displays the Simulated Method of Moments error as a function of the competition intensiveness (λ) and private synergies ($\bar{S}$). We use the relative frequency distribution of negotiation duration from month one to month six as moments. λ ranges from 0.01 to 0.99 and $\bar{S}$ from 0.01 to 0.35. Estimations are obtained at values 0.6, 2, 0.05, 0.01 and 0.001 respectively for q, γ, ω, c and $\bar{u}$.

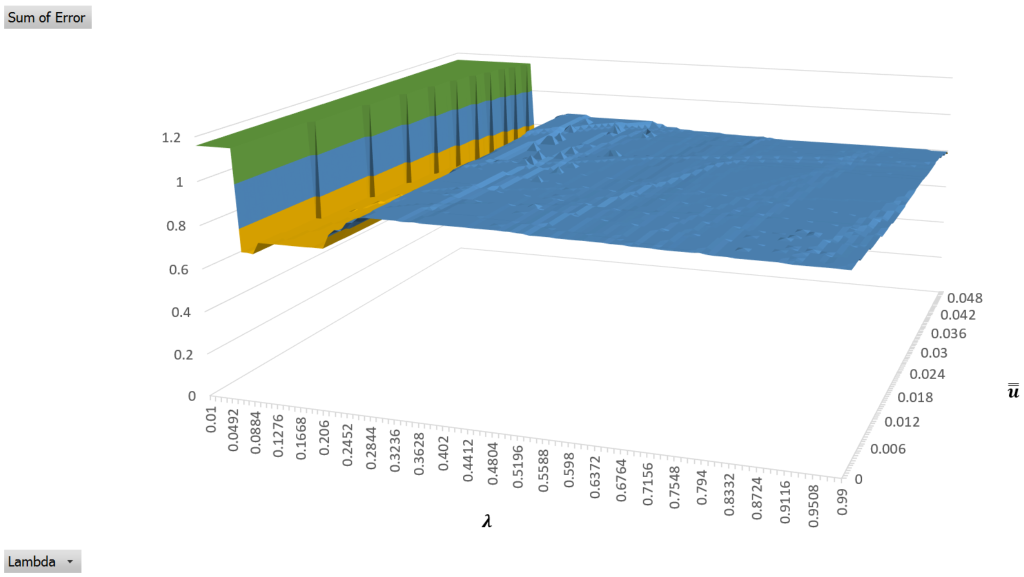

Figure 16: Competition (λ) versus Bidder Reservation Utility ($\bar{u}$)

Figure 16 displays the Simulated Method of Moments error as a function of the competition intensiveness (λ) and the bidder reservation utility ($\bar{u}$). We use the relative frequency distribution of negotiation duration from month one to month six as moments. λ ranges from 0.01 to 0.99 and $\bar{u}$ from 0 to 0.05. Estimations are obtained at values 0.6, 2, 0.05, 0.01 and 0.25 respectively for q, γ, ω, c and $\bar{S}$.