ERASMUS UNIVERSITY ROTTERDAM
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MSc Economics & Business
Master Specialisation Financial Economics

How bidding costs affect auction strategies in mergers and acquisitions.

When bidders face various bidding cost structures: a game-theoretical approach.

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PREFACE AND ACKNOWLEDGEMENTS

I used to presume –before attending the Erasmus School of Economics- that every price reflected the value of the underlying asset. Of course, reality is more complex than I expected. Warren Buffet already acknowledged the discrepancy between value and price in 1930: “Price is what you pay. Value is what you get.” I was very intrigued by this statement, since it is not always clear what the exact value is. If people value goods differently, it is assumed in neoclassic economic theory that the one with the highest valuation buys the good, since that would be the optimal (Pareto) allocation. However, there are several ways to allocate goods; one of these is through auctions. Auctions differ from markets, as an auction can be time-consuming, while markets offer goods immediately. As time is costly, this allocation system has game-theoretical consequences, and therefore different economic theories apply.
My personal goal was to add new findings to existing academic literature by combining economic theories. I am truly convinced that I have added new insights to M&A auction theory.

This goal led to this thesis which concludes my four year study period at the Erasmus School of Economics. In these four years I have had the fortune to have many wonderful experiences on which I look back with nostalgia, gratitude and proud. Therefore, I want to convey my thanks.

First, I would like to sincerely thank PhD D. Leegwater for his guidance and his trust. I am sure not many students were given the opportunity to work as independent as I did. It developed my individuality and self-sufficiency strongly. I also thank Irik Tolboom for his patience and time when he helped me running the statistical analyses.
I would also like to thank my grandparents. They have had a major impact on the person I am today, as they have been -and still are- a true inspiration to me.
Especially, I would like to thank Cassandra Vandeberg. Her contribution to my life is indescribable. I am very grateful having her as a mother. Without her support I wouldn’t have had the privilege of studying at all.

Sylvestro Lorello
May, 2012

ABSTRACT

D. Hirshleifer and I. Png (1990) show that jump bidding is a sufficient auction strategy when bidders face variable bidding costs. This thesis shows that inverse jump bidding, which I call *delay bidding*, has strategically advantages as well. Current literature on auction theory mostly does not include cost structures of bidders. Those cost structures, however, can offer great game-theoretical strategies which enhances the bargaining power of bidders.

Furthermore it shows how bids should be optimized when bidders face various cost structures. I also show how these optima are affected by different risk appetites. Also, my empirical analyses of 1,829 mergers and acquisitions, in the period January 1980 to March 2012, evince the existence of justifications of delay bidding and thereby confirms theory, by showing a significant negative relation between the bidding costs and the settlement time of a takeover (model p-value = 0.000).

Keywords:

Auctions, delay bidding, bidding costs, opportunity costs, game theory, jump bidding, delay process, settlement time.

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LIST OF SYMBOLS AND ABBREVIATIONS

ATP	Anti-takeover provision
CDF	Cumulative distribution function
EBIT	Earnings before interest and taxes
EBITDA	Earnings before interest, taxes, deprecation and amortization
EUT	Expected Utility Theory
M&A	Mergers and acquisitions
OLS	Ordinary Least Squares
R&D	Research and development
RET	Revenue Equivalence Theorem
SDC	Securities Data Corporation
SIC	Standard Industrial Classification

F(.)	The cumulative distribution of the prices other players are willing to bid for the auctioned object
V_i	Value of the auctioned object for player i
π_i	Profit for player i
$C_{f,i}$	Fixed costs for player i
$C_{v,t,i}$	Variable costs for player i at time t

I. Introduction

Auctions are no new concept. Long since, the ancient Greeks auctioned mine concessions- in addition to their slave auctions- and the Romans auctioned almost everything from war booty to property of debtors who were in default. Even still, auctions play a part in our daily financial life.

They are of practical importance because they allocate huge volume of assets. Most are familiar with auctions in which antiquities are sold and online auctions as eBay, Yahoo! Auctions and Amazon.com Auctions. But auctions play a evident bigger role in financial transactions. For example, governmental institutions participate in auctions when they sell treasury bills, mineral rights (e.g. oil fields) and firms to be privatized. Also companies can participate in auctions. This could be one of the auctions mentioned before, but of more academic relevance are the disguised auctions including Mergers & Acquisitions (M&A), Research & Development (R&D) competitions and lobbying activities. In these auctions, theory determines equilibriums and strategic actions of players.

So, auctions are also of theoretical importance because auction theory provides us with insights from other fields. Auction theory plays a role in a lot of areas of economies[1]. Also in other fields, auction theory proves its use. An example: in 1991, the US Vice President Dan Quayle suggested to reform the US legal system, expecting litigation costs to decline. With 90% of all the world's lawyers in the US the total expenses were $300 billion per year. One of his proposal was to let the loser of the lawsuit pay the winner an amount equal to the cost of his expenses. Meaning, every dollar spent on your lawsuit could either mean that it contributed to winning the lawsuit, or being end up paying double (to the winner and to your lawsuit). If we assume that both parties have a privately known value of winning the law suite relative to losing it and that the party who spends the most wins the law suit[2], then this situation can be considered an auction.

[1] E.g. perfect competition, monopoly pricing, game theory, extended models in finance and law & economics.
[2] Hence, spending the most money will not let you win a lawsuit in a legal way. However, the other party will
[2] Hence, spending the most money will not let you win a lawsuit in a legal way. However, the other party will
default in an auction if his expected costs will be larger than his expected gains.

Therefore, auctions have been actively studied in the recent years. There are several surveys of the auction theory literature available. The key result in auction theory is the Revenue Equivalence Theorem (RET) of Vickrey (1961). This theorem tells us that, under certain conditions, the seller expects equal profits on average from all the standard (and some non-standard) types of auctions, and that buyers are indifferent among them[3].

This theorem forms the basis for other auction theory. Those include Myerson (1981) who showed us how to derive optimal (maximizing sellers profits) auctions when the assumption of symmetry fails. Maskin and Riley (1984) showed that in cases where bidders are risk-averse the first-price sealed-bid auction is optimal. Milgrom and Weber (1982) showed that if the assumption of independent information is replaced with affiliated information, the most profitable standard auction is the English auction (ascending open auction).

Besides these surveys, research is done on a more strategic level. Klemperer (2000) shows that discouraging collusion can be enlarged by a sealed-bid auction. Fishman (1988) argues that jump bidding has a signaling effects towards other players. It shows that the bidder has a high private value, so potential players are discouraged joining the bidding game. Daniel and Hirshleifer (1995) argue that placing bids is costly, and show that in the presence of such variable costs, a signaling jump bidding in English auctions will arise. Hirshleifer and P'ng (1995) construct an equilibrium for jump bidding when bidders face entry (fixed) and bidding (variable) costs. A more general theory of jump bidding as a signaling device is offered by Avery (1998).

Although, I would like -for academic purposes- to capture all types of auctions in this thesis, I must restrict the scope. The English auction, with one object will be analyzed in the theoretical part[4]. This is a well-known auction and easily interpretable. Hence, most conclusions regarding this auction can also be applied on other auction mechanisms.

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[3] Hence, in the legal-example mentioned in the previous paragraph the suggested reforming will not decrease the litigation costs. The argument of facing more costs –and therefore has an incentive not to start a lawsuit- is offset by the fact that the winner will win the costs of the other player.

[4] Note that theory sometimes can be applied to several auction types. Therefore, this thesis is not useless if other types of auctions are analyzed. It can still form a profound basis to analyze auctions considering the cost structures of players.

This thesis provides new elements in auction theory. (i) It introduces various cost structures of players and shows how these affect equilibriums. Hirshleifer and P’ng (1995) used cost structures in their models, but did not take into account different cost structures of players, which induce game theoretical aspects in the auction. Game-theoretically, the cost structure cannot be seen as an independent factor in games, optimal actions are defined by characteristics of all players in a cohesive way. (ii) Also, this thesis provides a new bidding strategy: *delay bidding*. The effectiveness of this bidding strategy depends on cost structures of bidders (and the auctioneer). (iii) The empirical analyses prove that this new bidding strategy is statistically justified.

Delay bidding works as following. In an auction it is expected that players who face variable cost will try to settle the auction faster than players who face fixed costs or no costs at all (Fishman (1988), Hirshleifer and P’ng (1985) and Avery (1998)). However, these researches do not acknowledge that bidders can strategically delay an auction, in order to enlarge the costs of bidding for other bidders. Also, in the case of M&A, the seller can delay the selling process of the company in order to induce costs to the bidders. This gives the seller a stronger negotiation position, and possibly enhances the premium being paid.

After analyzing 1,829 mergers and acquisitions in Canada, USA and Europe, the empirical results show a significant positive relationship between settlement time and (variable) opportunity costs (model p-value = 0.000).

The structure of this thesis is as follows. The theoretical parts consist of: Chapter 2, which discusses auctions in general, it considers the players, the process and the object being auctioned. Chapter 3 describes in more detail how takeover auctions work. Chapter 4 assesses auctions in a game-theoretical perspective. Chapter 5 will add the cost structures of bidders to the auction games and look at the strategies for the bidders. The empirical part of this thesis is set out in chapter 6, which will describe the dataset, methodology and test the hypotheses. The last chapter concludes the paper.

II.Auctions

There are four basic types of auction widely used. The ascending-bid auction (English auction), the descending-bid auction (Dutch auction), the first-price sealed-bid auction and the second-price sealed-bid auction (Vickrey auction).

For simplicity I will describe the rules of these auctions concerning the auctioning of one single object. In the ascending-bid auction, the price is raised until one bidder remains. This can be approached in two ways: either there is one bidder remaining, or there is a bidder who is willing to pay the highest price. The most-commonly used is the first approach, where bidders gradually quit the auction and are not allowed to re-enter the auction game (Japanese auction).

The descending-bid auction works exactly the other way around: the auction starts at a very high price and is lowered continuously. The first bidder wins the auction, hence, he pays the most for the object.

In the first-price sealed-bid auction, bidders independently (without seeing each others bids) submit their bid. The bidder with the highest bid pays his bid. The second-price sealed-bid is slightly different. In those auctions the bidder with the highest bid wins the auction, but has to pay the second-highest-bid.

Often the Dutch auction is considered a first-price open-bid auction and the English auction is considered a second-price open-bid auction. Acknowledging this is of great importance in order to analyze the auctions.

First, consider the descending auction. Note that in a Dutch auction the bidder with the highest bid wins the auction, and has to pay his bid. This is the same in a first-price sealed-bid auction. Thus strategically seen these auctions are similar.

Now in the ascending auction (still assuming players have private values) it is a evident dominant strategy to stay in the auction game if the price is lower than what you are willing to pay for it. The next-to-last person will eventually drop out, which implies you are the last person left. Thus you will win the auction, but only have to pay the price at which the next-to-last person dropped out, which is the second-price. However, these auctions are not strategically similar. In a second-price sealed-bid auction the optimal action for a player is to bid his true value (this is proven in appendix A), in an English auction the optimal action for a player is to bid the price the next-to-last person would have bid.

Besides of these basic type auctions there are also various auctions which are derived from these types. Since the scope of this thesis is restricted to the English auction I will explain two auctions derived from the English auction. One of these was the already mentioned: Japanese auction. It is exactly the same as an English auction, except when bidders quit the auction game they are not allowed back in. This auction learns us –more than the English auction- how other players value the object, since a player quits the auction if his threshold is reached. In an English auction you cannot know for sure if the threshold is reached or a player is \`strategically waiting´.

Another game-theoretically interesting auction is the all-pay auction in which a bidder always has to pay his bid, regardless if he is the winner of the auction. This is –for example- the case in R&D, assuming who spends the most on R&D will become market leader on the researched field. However, spending an amount of money on R&D cannot be reversed. So you always pay your bid in an R&D competition auction.

III.Takeover auctions

As the empirical research in this thesis will investigate takeover auction[5], this chapter emphasizes on this special kind of auctions. First, it must be said that not all takeovers have the form of an auction. There are two ways of taking over a firm; by negotiation or by auction. In the former case, there is just one bidder and no other potential bidders. This does not necessarily means that no other parties are interested in the target firm; the target firm could exclude other potential bidders. Boone and Mulherin (2006) show that approximately 50% of the takeovers are auctions. These competing bids are rarely public, rather these bids are non-public.

Second, if a firm is to be auctioned, takeovers take a 'free form' of auctioning. That is, there is no specific auction model that captures the nature of takeover auctions. For example, if one would assume that take over auctions take the form of a button auction, this is likely to be inconsistent with the observed jump bidding and re-entering a takeover auction[6].

Takeover process

Boone and Mulherin (2006, 2007) describe the process of a typical takeover auction as following. The firm has come to the conclusion that it is in her best interest to sell the firm, and then an investment bank examines potential strategic and financial buyers, and presents this list to the firm. The firm and its investment bank contact the parties, which the firm is interested in. If the contacted party is interested, he needs to sign a confidentially agreement in order to receive non-public information about its target. After studying this information, and doing a valuation, the potential bidders can submit preliminary bids in several rounds[7].

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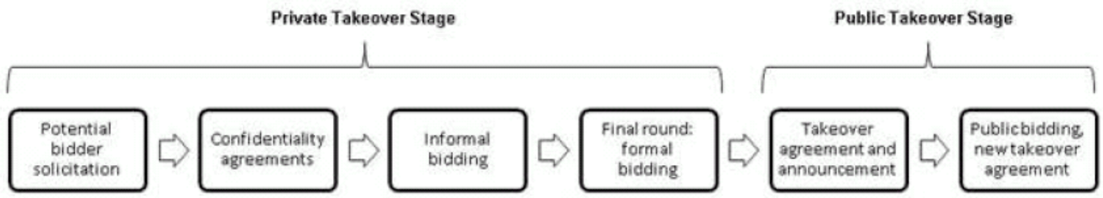
[5] This thesis uses M&A and takeovers as synonyms, more specifically, mergers are the consequence of mutual agreement to merge two companies, while acquisitions/takeovers does not necessarily have to be the consequence of a mutual agreement, and it mostly between unequal parties, i.e. a large firm takes over a small firm.

[6] A 'button auction' is an auction in which the price continuously increases, as in the work of Milgrom and Weber (1982).

[7] These bids are non-binding, meaning that they can be renegotiated at a later time.

After several rounds of bidding, the investment bank and the firm, request a smaller group of bidders to submit final round bids. These last round is usually signed soon (2 to 3 days). The following figure shows this process graphically.

Figure 1: Auction process in takeovers.



Financial bidders versus strategic bidders

Both academic and business literature recognizes two major groups of bidders: financial and strategic bidders. The financial bidders are mostly institutional investors, like private equity funds, investment banks and pension funds. These bidders seek financial diversification, undervalued companies, and are willing to sell the company if there are sufficiently profitable exit opportunities. In contrary, strategic bidders are mostly related firms, like a competitor, supplier or customer. They are seeking long-term synergies.

My empirical research is based on takeover auctions between strategic bidders. Those bidders are influenced by actual opportunity costs of the firm and less by speculation, like financial bidders.

IV.Auctions as games

Game-theoretic concepts apply when the actions of several agents are interdependent. The concepts of game theory provide a language to formulate, structure, analyze, and understand strategic scenarios (Turocy and Stengel, 2001). As the result of an auction is dependant of the dynamics of the bidders, game theory can be applied to auctions. This gives us some tools to analyze auctions, but also sets some rules related to game theory. The assumptions made in game theory and therefore in this thesis (unless stated different) are the following:

a. Each player has available to him two or more well specified choices.
b. Every possible combination of plays available to the players leads to a well-defined end-state (win, loss or draw) that terminates the game.
c. A specified payoff for each player is associated with each end-state.
d. Each player has perfect knowledge of the game and of his opposition; that is, he knows in full detail the rules of the game as well as the payoffs of all other players.
e. All players are rational; that is, given several alternatives, the player will select the one that yields him the greater payoff.

The last two assumptions, in particular, restrict the application of game theory in real-world conflict situations. Nonetheless, game theory has provided a means for analyzing many problems. However, this thesis will also analyze auctions if assumptions (4) and assumptions (5) do not hold. In reality, we do not always have full knowledge of our opponents, or it is too costly to gather this information. Moreover, when more players get involved in the auction.

Regarding the rationality-assumption, it is widely acknowledged that this assumption rarely holds when people are involved. Therefore, this paper also examines behavioral aspects of people on auction strategies.

This chapter consists of the following sections. First, the process of an auction will be dealt with. Second, the characteristics of the players will be described. Last, the object value will be discussed.

Process

Simultaneous and sequential games

In game theory we can distinguish two games: either players act simultaneous or players act sequential. The sealed-bid auctions are auctions in which bidders submit there bid simultaneously. The Dutch and English auctions are sequential games because you bid on another bidder's bid. This can create value for players, since the sequence of the auction game can be of influence of the actions, and therefore the payoff, of a player (Bagwell, 1995). Players always need to keep in mind how other players react.

This thesis focuses on English auctions, so we must take into account any advantages induced by this sequential game. To illustrate a first-mover advantage, consider the following example:

Two players (A, B) are involved in a R&D competition, they can both choose either to make high R&D costs (H) or to make low R&D costs (L). The payoff matrix (payoff A, payoff B) is given:

Table 1: Payoff matrix, the first-mover advantage.

		B	
		L	**H**
A	**L**	(200, 100)	(10, 200)
	H	(100, 10)	(-100, -100)

If both players act simultaneously we can solve this game by eliminating the dominated strategies. Player A's action to make high R&D costs is dominated because 200 > 100 and 10 > -100. Player B knows this (assumption 4) and therefore will choose to make high R&D investments. So, the equilibrium if players act simultaneously is (10, 200). Now consider the case where player A may act first and player B second. In such a case player A will choose to make high R&D costs, since player B has than an option to either make low R&D costs (and receive 10) or also to make high R&D costs (and lose 100). So the equilibrium if player act sequential is (100, 10). This first mover advantage lies in the fact that player A has committed itself to make high R&D investments.

This is one of the advantages for a first mover. Of course there are some drawbacks. In the example of R&D competition, players not making the high R&D costs can free ride. Also the player who makes high R&D costs bears the full risk of the new market. But, these drawbacks are not included as they violate the assumptions, since it is assumed that players have a specified payoff at each end-state, so we do not take into account free-riding effects and uncertainty in the value of the object (this is described further on in this chapter).

However, this does not imply that auctions are stand-alone games. They can lead to new strategic positions which enables players to enlarge their options, like buy-and-build-strategies.

Number of players

The Revenue Equivalence Theory (Avery (1998)) tells us that -under the assumptions- revenues at each auction are equal, regardless of the number of the players. It also does not matter if the number of players is known on forehand.

However, approaching auctions from a game theoretical perspective the number of players do matter, since the bidding strategy of players depend on variables of his opponents. With every extra competitor we must take into account more information, making the strategic game more complex.

Also, Robinson (1985) has shown that the possibilities of collusion decline when the number of bidders increases. This makes sense, since there are more parties who can default on the agreement, hence this is a typical Prisoners' Dilemma, where player A makes an agreement with all other players. D stands for default on the agreement, and C stands for comply with the agreement. If all players default the payoffs are uncertain, because the auction mechanism decides what the payoffs are, and hence, this depends on the player's characteristics. At least we know that if all parties default, their payoffs will not be negative, but lower than if all parties would comply. The payoffs (A, All other players) are as following.

Table 2: Prisoner's dilemma when parties collude in auctions.

		All other players	
		D	**C**
A	**D**	(x, y)	(100, 0)
	C	(0, 100)	(50, 50)

In this case the strategy to comply is dominated for player A since 100 > 50 and x ≥ 0. In this symmetric game, the same logic can be applied to all the other players.

The more players enter the agreement, the more likely it is that at least one will default. However, if we take into account multiple auctions, one may argue that in multiple games parties have an incentive to comply with the agreement since you learn if your competitor is trustworthy.

Time

Time is a very important element in strategic games, and hence, in auctions as well. There are three main reasons why players have an incentive to settle auctions quickly: players face variable costs, players face opportunity costs and players operate in a competitive market.

As mentioned earlier, variable costs increases as the auction game takes more time. Players can also face opportunity costs, that is, if the object would generate –or contribute to generating- cash flows right after acquiring the object, e.g. a firm, oil field and exploitation rights. Last, players can operate in a competitive market. Especially for R&D competitions this is an important aspect. Players can lose a bigger share of the market if they wait with their research. In a competitive market this erosion effect is enlarged.

Correlation

Furthermore, we assume that there is no correlation between each bidder's private information. The only information a player has about other players is what they bid during the auction game, unless stated different in this thesis.

Information asymmetry

An important form of asymmetry among players is that one player has superior information. In an auction with private values, it is hard to say if one player has additional information about the value of the object, since different valuations can also be directed to the players characteristics. However, in an auction with common values we can learn during the auction how other players value the object. This gives us information about how other players value the object and, hence, what the value would be if we resell the object.

Characteristics of players

This section describes what characteristics of bidders and sellers must be taken into account for anticipating bidding strategies and equilibriums. Most theories, also RET, make assumptions on bidder and seller behaviour: rationality. However, this seems inevitable, it surely is correct to mention the most important behavioural aspect in bidding games that can violates this assumption.

Risk appetite of players

The Expected Utility Theory (EUT) assumes that players have one risk profile. It is obvious how risk aversion affects an auction in a revenue equivalence situation. In a second-price auction a bidder will still bid his true value (appendix A), however in a first-price auction a small increase in a player's bid increases the probability of winning the auction. Note that this player will gain less since he bids more aggressively (higher) in order to win the auction, meaning he will gain less on the margin (value of the object minus the costs). Empirically this can have consequences for the settlement time. In order to capture the effect of risk appetite, the regression includes a control for crises years and excess volatility. Those variables explain at least a part of the risk appetite of bidders.

However, generally accepted in behavioural finance is the prospect theory, which states that players are risk-seeking over losses and risk-averse over gains. That is, they tend to value a loss less costly than they tend to value a gain more worthy. For example: a player participates in the following gamble:

Gamble I: (A) gain 1,000 with a probability[8] of 50%, or (B) gain 500 with certainty

Gamble II: (C) lose 1,000 with a probability of 50%, or (D) lose 500 with certainty.

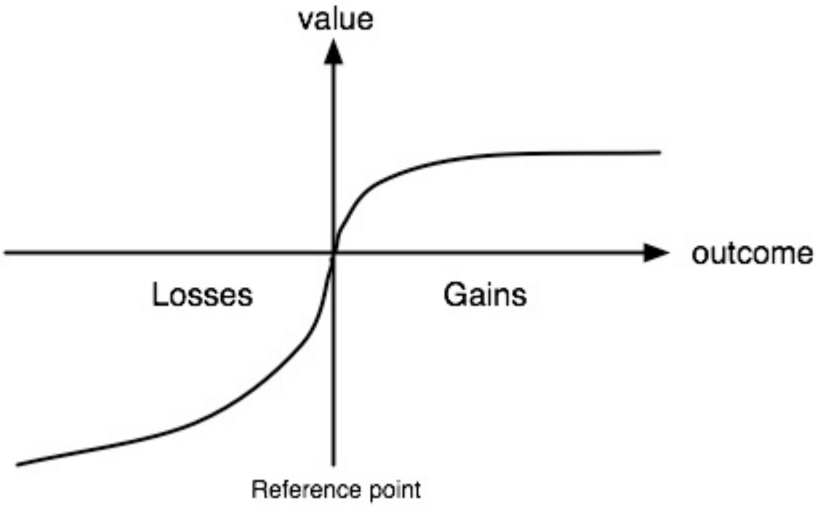
Regarding EUT an agent should be indifferent between the choices in the gambles, as they both have the same expected value. In gamble I it is expected to gain 500, and in gamble II it is expected to lose 500.

However, prospect theory shows risk-aversion over gains, which means that agents prefer choice B over A, as you are sure you will receive 500. In gamble II, agents prefer

[8] By probability is meant: interpreted probability. Agents tend to transform probabilities: low probabilities are seen as higher, while high probabilities are being seen as lower.

choice C over D, as they are risk-seeking and hope to avoid their loss by taking risks (figure 2).

Figure 2: Utility (value) as a function of the outcome in prospect theory. People prefer taking more risk over losses, and prefer averse risk over gains. This is caused by the probability that if one takes more risk in the loss-side he might end up in the gain-side. The reference point is a non-fixed point which determines whether an agent interprets an outcome as a gain or as a loss.



Acknowledging this is of great importance. Some auction bids are being made in the losses side of the reference point, while other bids are made in the gains side of the reference point. To be clear, the reference point is the point on which the agents do not consider the outcome as a loss of as a gain. In the case of auctions this is when his expected profit of the auction is zero (this is the point at which he started in the first place).

Depending on the cost structure and auction type, people will change their risk-attitude. Consider the following auction. Player A has made fixed costs of F, while the common value of the object is V. Player A is then willing to bid a maximum amount of (F+V) for the object. Hence, he already has paid F. Therefore paying (V+1) and winning the object will cost him 1, while not winning the object cost him F. However, paying more than V is a loss, which changes the risk-attitude of the bidder towards risk seeking.

Hyperbolic discounting and deferred gratification

If a player faces fixed costs, this will be often seen as an investment to acquire the object. This is obvious when paying R&D costs in order to acquire a bigger market share or to develop new products. But also when players would pay a fee to enter an auction game, this will be seen as an investment on which investors want to generate a return.

Fixed costs will put more pressure on the bidders who have invested more money than other bidders, since their invested money comes with opportunity costs. Therefore their discount factor on the object value (discussed in the next section) will be higher.

For illustrative purposes, assume that there are two companies (company S and P) who try to develop a new series of televisions. Because company S has more knowledge it only has to invest $100 million, whereas company P has to invest $300 million in order to acquire the opportunity to produce the new series of televisions. This will occur more opportunity costs for company P since both companies also could have invested their money in risk-free assets generating $\$300 * (1+ R_f)^T$ for company P, which is higher than $\$100 * (1+ R_f)^T$ for every T.

It does not need much explanation that in this particular case company P has an incentive to do the R&D process more quick than company S. Although, the money invested in this bidding game is sunk and therefore should not influence future decisions, in practice, agents would rather show returns on investments to the stakeholders than showing no returns in their investments. This can cause irrational management actions and even bidding more for the object than its actual value.

Object value

Value uncertainty

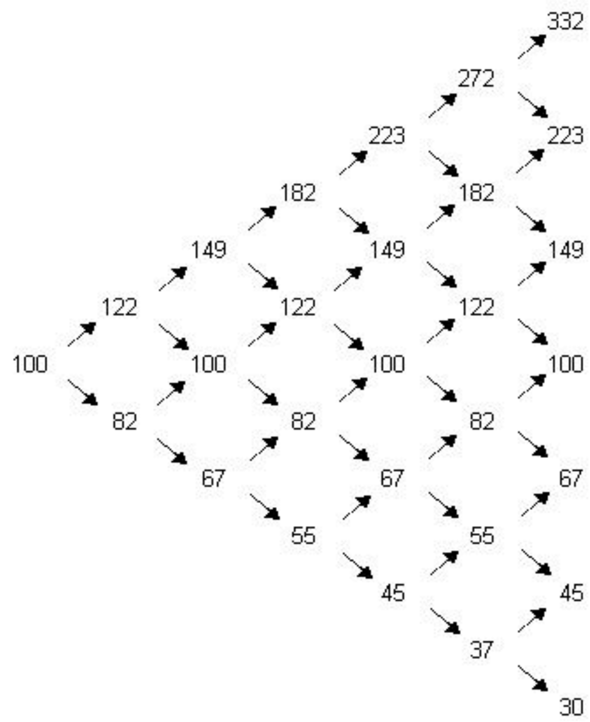
The value of an object can be uncertain. Especially over time, when more information is available the private value becomes more certain. This can be caused by gaining more market information, change in oil prices etcetera. Because most uncertainty of this object is related to options: hence, bidding on an oil field is actually bidding on the option to exploit an oilfield. And bidding in a R&D competition is bidding on the option to invest in a new industry or product line.

To take into account this uncertainty one can use several models, among which the Black and Scholes option pricing model, Monte Carlo simulation models or the binomial pricing model. Black and Scholes are less accurate than binomial pricing models when it comes to longer-dated options with cash flow generating possibilities after acquiring the object. Monte Carlo simulations are very useful when different sources of risk influence the value of the object.

If we assume that the value of an oilfield depends on the price of oil. If oil prices increase, the value of the object increases and vice versa. In that case we can use the binominal pricing model of Cox et al. (1979). In this model the new value after a value jump is either $S_{t+1} = S_t * u$ (upward scenario) or $S_{t+1} = S_t * d$ (downward scenario). Here, $u = e^{\sigma\sqrt{t}}$ and $d = e^{-\sigma\sqrt{t}} = \frac{1}{u}$.

If we have one value jump per time period ($t = 1$) and $\sigma = 20\%$ we derive the following valuation tree for the next six jumps.

Figure 3: Example of a valuation tree, conducted by a binominal-pricing model.



In this case also the phenomenon "winner's curse" is discussed. This occurs when bidders have the same, or almost the same, value attached to the auctioned object (common value), but are uncertain about what the value is. The winner's curse reflects the risk that the highest bidder has overestimated the value of the object. Since the bidder with the highest bid will win the auction, the winner's curse assumes that he probably has overestimated the value of the object, since the average valuation was lower. This paper shows in chapter VI that bidding more than the object value can be rational.

Value asymmetry

The object has a value for each player. In some cases this value is common for all players. But when more players participate in the auction game the chances of having private values increase rapidly. Mergers and acquisitions offer companies several advantages, like diversification effects, growth opportunities and economies of scale. These effects can differ among the bidders, and hence, not the bidder with the lowest cost will win the auction per se. Also bidders with high variable costs, but who attach a high value to the company, can profitable take over a firm.

Also, private values are not always known by all players. This can induce game strategic advantages, assuming there is a certain distribution in the value of the object among bidders.

V.Cost structures

Types of costs

Bidders can face two types of costs: fixed costs C_f and variable costs $C_{v,t}$. In economics: fixed costs are not influenced by the produced volume and variable costs are. In auctions we could say that fixed costs are not influenced by the length of the auction, and variable costs are. The length of an auction can be defined in two ways: number of bids to settlement and time. For simplicity we will refer to both lengths as t and not distinguish the variable costs into these two ways. Of course, it is possible that a player can face as well variable costs per bid as variable costs per time unit.

The definition of fixed and variable costs are clear, however, assigning this type to an expense can be rather difficult. For example, addressing loans. On the one hand it makes sense addressing loans as variable costs, since we pay employees per month. On the other hand, the employer has a contract in which he is obliged to pay the employee a loan. Hence, the loan the employee receives does not relate to the length of the auction (not considering any bonuses). My solution would be to address loans as variable costs, since the employee can produce a certain amount of goods and services per month. So when he is not involved in the auction process he is able to produce other goods and services, and therefore loan is a variable cost.

Fixed costs

Fixed costs are mostly faced in an early auction process. For example, when entering an auction one may pay an auction fee. Or when acquiring a firm one should perform a due diligence to estimate the value of the auctioned object. These fixed costs are of importance when determining what the optimal bid should be in order to maximize the expected profit. They do not determine what an optimal settlement time of an auction would be, since fixed costs occur once, and after, they are sunk.

Variable costs

In contrary, variable costs are faced during the whole auction process. Variable costs can be related to the object (opportunity costs of not having the object) or variable costs can be unrelated to the object (e.g. loans of investment bankers). The opportunity costs related to the object are the major part of the variable costs.

Sunk costs

An important matter in the case of fixed costs is the concept of sunk costs. These are costs that have already been incurred, and cannot be recovered. When an auction started and players paid their fee or performed their due diligence, these expenditures are irreversible, therefore they may not influence our choices in the auction when these costs are incurred. However, on forehand, before incurrence of fixed costs, they are not sunk. Therefore, if players enter an auction they should take into account what fixed costs they will face.

The following example will show the importance of recognition of sunk costs:
Player A and B enter an auction. Player A pays a fee of 10, while both private values of the object are 100. No other costs are considered.
Player A will obviously not bid more than 90, since bids higher than 90 will generate losses. However, if player A already entered the auction he will maximum bid 100. Hence, if the bidding reached 90 he has to chose, either to leave the auction and loose 10 or to bid 91. In the first case his loss is just 10, in the latter case his loss is only 1 (100 – 10 – 91). So player A is willing to pay 100, since he is indifferent between the two alternatives then, in both cases a loss of 10. The same result would have been found if we did not consider this fixed cost.

Summarizing, fixed costs are of relatively more importance in determining the optimal bid in order to maximize the expected profit than variable costs. Variable costs are of great importance in determining the optimal bid raise, since a bidder who faces variable costs gains more if the auction settlement time is reduced. Since the empirical part of this thesis assesses the relationship between settlement time and bidding costs, I do not need to include fixed costs, as they are sunk after the payment and therefore do not influence future decisions (like optimal settlement time).

Cost structure

When taking into account fixed and variable cost, in which the costs –respectively- are independent and dependant on time, we can derive the following formula.

$$\pi_i = V_i - B_i - \sum_{t=0}^{T} C_{v,t,i} - C_f \qquad \textbf{(1)}$$

In which, π_i = profit for player I, V_i = private value of the object,

B_i = bid of player I, $\sum_{t=0}^{T} C_{v,t,i}$ = sum of the variable costs and C_f = total fixed costs.

This equation shows that not only the surplus of the bid and the private value of the objects plays a role in the expected profit, but also the costs that incur during the bidding process. Strategies can merely be achieved through the optimization of time. As the equation suggests, it would be beneficial to reduce the settlement time T as much as possible. However, the next chapter will show that there is a trade-off concerning time, and also will provides techniques to maximize the expected profits.

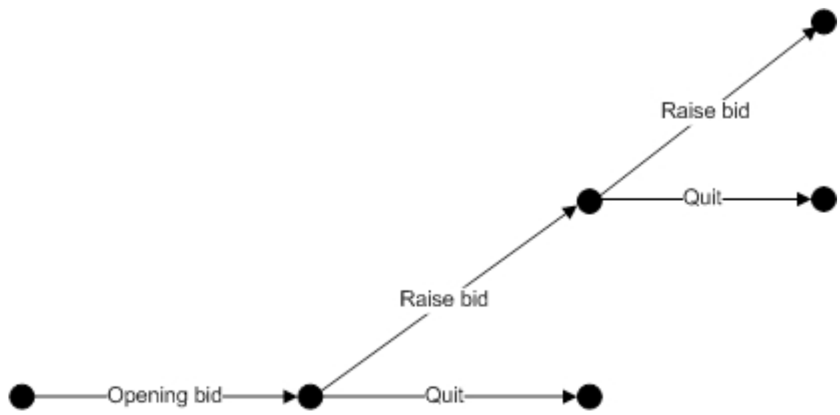
VI.Strategies

This chapter will show how strategies are formed in a bidding game if we take into account cost structures of the bidders. In order to do so, this chapter is divided in several sections. First, this thesis will assume an auction design on which I base the strategy, second the interrelationships between bidders will be discussed, third, the trade-off in auctions is treated, and last, I describe how expected profits can be maximized in this trade-off.

Auction design

In defining strategies I assume a discrete sequential bidding game with dichotomous choices at every time for $t > 0$. At $t = 0$ the first player starts with his optimal bid, and the following times, the other bidders have the choice to either raise the bid or to quit the auction. This process continues until all other bidder decide to quit the auction, meaning that there will be one bidder left, who is by definition the winner. This approach implies that when a bidder exits the auction, he will not re-enter the auction, hence, this is different from an open auction, like a M&A and R&D, in which bidders are not bound by such rules. Such an auction design, with $T = 3$, will take the following form.

Figure 4: Auction design.



At every time t each individual bidder forms his optimal bid in which he considers the following aspects: (i) participants' value of the object, (ii) the cost-structure of participants, (iii) the chances of winning at each time.

The value of the object (i) and the cost-structure of the bidding game (ii) lead to a profit, since the value minus the bid and the costs are the net profit.

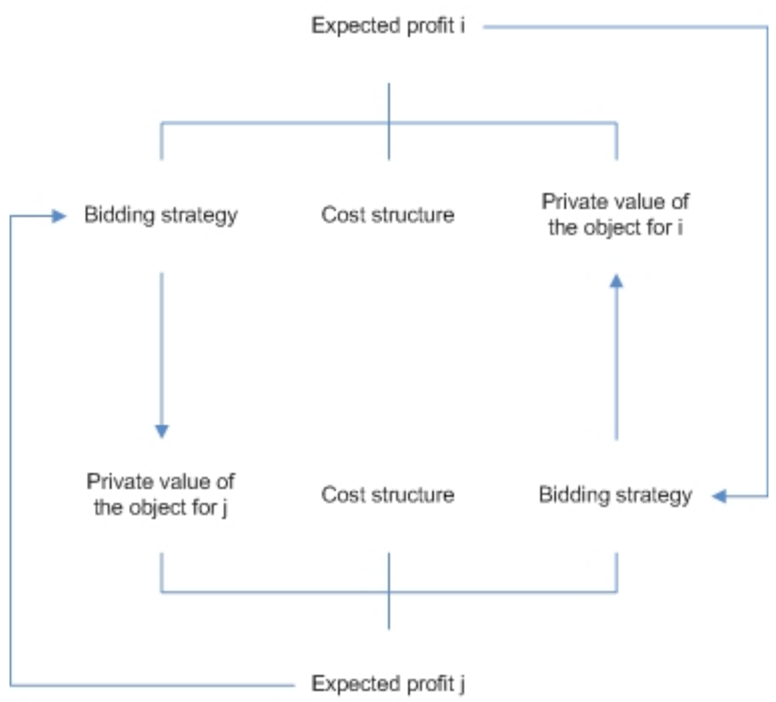
Taking into account a value distribution of the object we can derive an expected profit for every player. An optimization of this value will be discussed in the section 'Maximizing expected profits'. Before doing so, this thesis provides more insight in the interrelationships between bidders, and what the exact trade-off in auctions is.

Interrelationships

The breakdown of the expected profit of a player is as following. Each player has a private value assigned to the object, also, players have a cost structure. These two factors lead to a bidding strategy. Of course, there is an interaction within the expected profit for a player, since the cost structure and the value of the object determines how a player forms his strategy. For example, if bidders face high variable costs, their strategy will be more aggressive.

Also of great importance are the interrelationships of players expected profits. All three elements (the expected profit) influence the bidding strategy of the opponent. This makes sense, since another bidder can make advantage of this information by forming an adequate bidding strategy. Also, the bidding strategy can influence the value of the object for the opponent. That is, a bidder learns about the value the other players assign to the object, so he knows more about the resale value (Lebrun, 2005).

Figure 5: Interrelationships of players' expected profits.



The auction trade-off

What makes cost structures interesting is that there exists a trade-off regarding the bid amount. On the one hand, one may benefit from starting with a high bid in order to save some of the variable costs, hence, this will have a positive impact on the expected profits. Recall equation 1, where I show how the profit is affected by the private value, bid and cost structure.

Now, the expected costs are positively causal related to time, while the expected costs are negative related to the expected

$$\frac{d\sum_{t=0}^{T} C_{v,t,i}}{dt} > 0 \wedge \left(\frac{d\sum_{t=0}^{T} C_{v,t,i}}{d\pi_i} \right)^{-1} < 0 \tag{2}$$

Therefore, profits are negatively influenced by time. More formally, the following relation holds.

$$\frac{d\pi_i}{dt} < 0 \tag{3}$$

On the other hand one may benefit by raising his bid with a small amount in order to maximize the difference between the object value and the maximum amount other bidders are willing to pay, hence, this will also positively impact his expected profits. So, there are two factors influencing the expected profit positively, but they cannot occur at the same time, since there is a negative causal link between them (time). Maximizing the expected profits is actually maximizing the net effect of these two factors.

The next section will generate a formula in order to maximize the expected profits for risk-neutral bidders, and also show, how this optimization will differ for risk-seeking and risk-averse bidders.

Maximizing expected profits

In the case of information asymmetry, an auction game becomes more interesting. We do not know for sure if our bid will be high enough to win the auction, that is, if it is high enough to be the only player left. This is when our bid is at least as high as the second-highest bid would have been.

Equation 1 shows the profit function of a bid. Since the maximum bids have a certain distribution, we can derive an expected profit function. This functions provides us with an expectation of the profits, as we know that bidding at least as high as the second highest bidder would do, lead to winning the auction.

$$E(\pi_i) = [F(B_{t,i})]^{n-1}(V_i - B_{t,i}) - \sum_{t=0}^{T}(C_{v,t,i}(1-[F(B_{t,i})]^{n-1})) - C_f \qquad \textbf{(4)}$$

Where $F(.)$ denotes the cumulative distribution function (CDF) of the prices other players are willing to bid for the object. Specifically, $[F(\chi)]^{n-1}$ represents the probability that n-1 players are willing to pay a maximum amount of χ. Hence, this is the probability that one player is left in the auction game, and therefore is won by the player that bids at least the amount of χ.

Further in this thesis, I assume a normal distribution of the maximum bids, which parties are willing to submit[9]. The strategy formulated here is based on a dichotomous choice at each time t: either you bid higher than the last bid, or you stop bidding. This process is continued until $n-1$ players stop bidding. Meaning, that every time t, bidders must make a choice (see figure 4), and this choice can be optimized such that the expected profits are maximized $\max\{E(\pi_i)\}$.

[9] I did not test whether this distribution is observed. However, for the sake of giving numerical examples I must assume a distribution, the normal distribution is familiar and therefore easy interpretable.

When we assume a normal distribution, the expected profit equation becomes as following.

$$E(\pi_i) = \int_{-\infty}^{B_{t,i}} \frac{e^{-\frac{1}{2}(B-\mu)2/o2}}{\sigma\sqrt{2\pi}} dB(V_i - B_{t,i}) - \sum_{t=0}^{T}(C_{v,t,i} \int_{B_{t,i}}^{\infty} \frac{e^{-\frac{1}{2}(B-\mu)2/o2}}{\sigma\sqrt{2\pi}} dB) - C_f \qquad \textbf{(5)}$$

The first component shows the expected profit, the chance of bidding high enough times the difference in the value of the object minus the bid. The second and third components show the costs. The former are the expected variable costs, which is the sum of the variable costs from the start of the auction until the end of the auction multiplied by the chance of getting to that stage. That is, when a bidder won, or when a bidder exits the auction. The latter are the fixed costs are implemented in the formula.

An example makes this formula more clear. Assume that $B_{t,i}$~N(70, 10), while our private value is estimated at 100, with a discount rate of 1% per t. Fixed costs are 3, and the variable costs are 1 per t. The following table shows the expected profit per t, if we raise our bid with 10% every time.

Table 3: Example of calculating expected profits, when $B_{t,i}$ is normally distributed.

t	Your value	Bid	Var. Costs	Fix. Costs	P(win)	P(lose)	Expected profit
1	100	77	1	3	76%	24%	14
2	99	85	1	3	93%	7%	10
3	98	93	1	3	99%	1%	1
4	97	102	1	3	100%	0%	-9
5	96	113	1	3	100%	0%	-20

In order to calculate our expected profit for the next round, we must complete the formula as following:

$$E(\pi_i) = 76\% * (100 - 77) - 1 * 24\% - 3 \approx 14 \qquad \textbf{(6)}$$

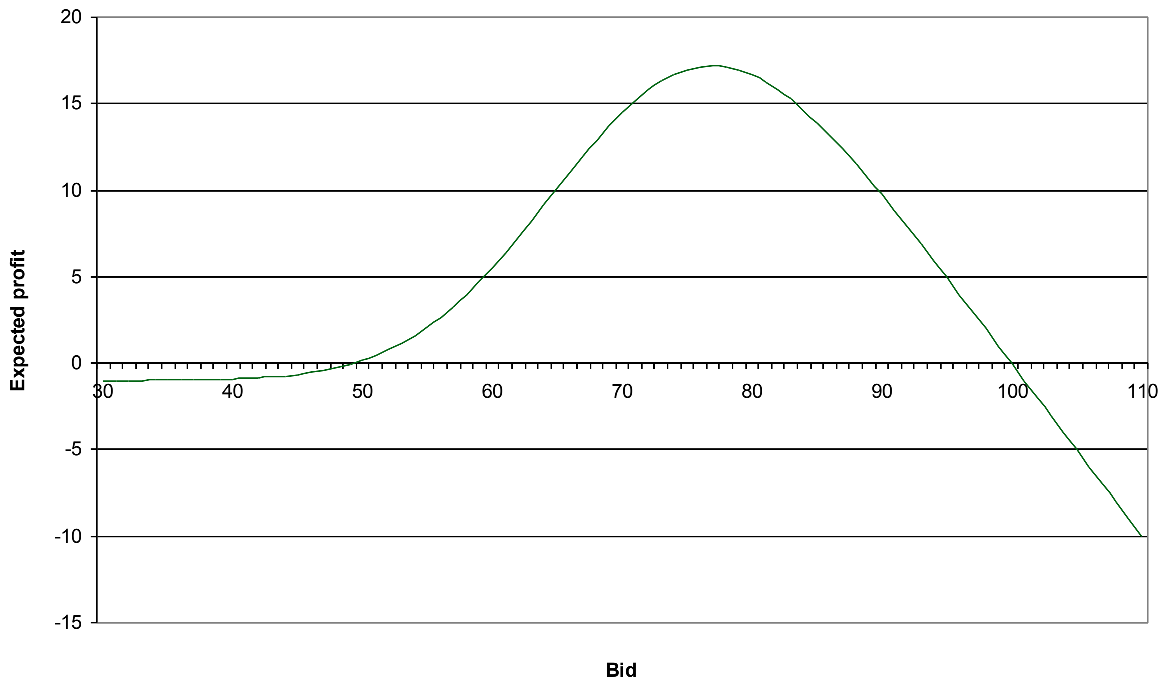
If we follow this strategy, then our expected profit in the second round would be as following.

$$E(\pi_i) = 93\% * (100 - 85) - (1 * 24\% + 1 * 7\%) - 3 \approx 10 \qquad \textbf{(7)}$$

Optimizing restrictions

Jensen (2010) shows that optimization can be just in one dimension. That is, we can optimize our bid for the next round, or we can optimize our bid for the third round. It is not possible to maximize your expected profits for several rounds, since you would need to bid different amounts in the same round. The example in table 3 shows that if the bidder would like to maximize his expected profits in the next round, his optimal bid would be 77 (see figure 6).

Figure 6: Expected profits as a function of the bid amount.



However, this is not optimal if he would end up in the round after the one he optimized his bid one. In the example, the expected profits in t = 2 are 10, but could be 13, if the bidder would follow the same strategy, but would make a bid of 68 at t = 1[10]. Note that the optimization depends on the expectation of the bidder on winning in a certain round.

Risk appetite

As can be seen in table 3, the optimal bid (maximize the expected profit in round 1) is 77. This bid is not adjusted for the risk attitude of the bidder, but is optimal for a risk-neutral bidder[11].

The more risk-averse a bidder is, the higher his bid will be. This is due to the fact that higher bids reduce the chance of losing. If a bidder submits an insufficient bid, his variable costs will increase, and hence, he takes less risks of bearing those costs if his bid would be higher. Vice versa, a risk-seeking bidder might bid too low, and end up with high costs, as the settlement time of that auction is likely to be longer. However, a risk-seeking bidder is willing to take that risk, in order to minimize the difference between his bid and the highest bid of other bidders (see equation 8).

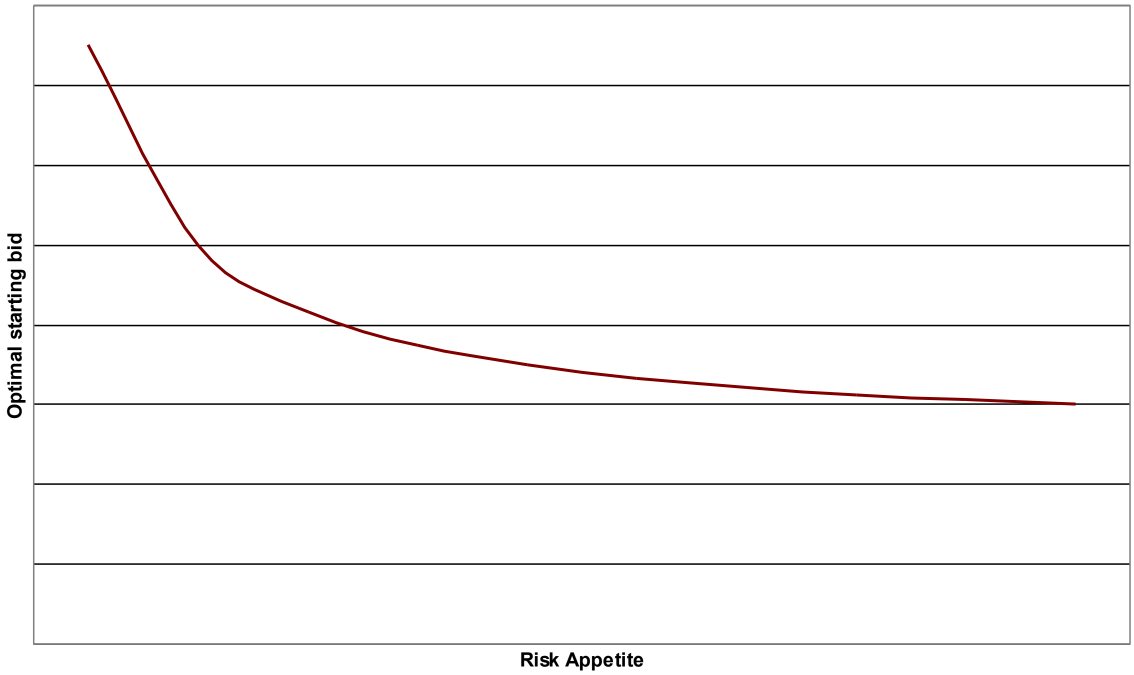
$$\min\{\max\{B_1,..,B_n\} - B_i\} \qquad \textbf{(8)}$$

Expressed graphically, there is a convex relationship between the starting bid and the risk appetite of a bidder, as can be seen in figure 7.

[10] This strategy assumes that the opponents' bid at time t is lower than the bid of the initial bidder at time t + 1.

[11] That is, a risk neutral bidder does not take into account risk preferences, but rather looks at expectations. A risk neutral person who faces the following choice is indifferent between the choices A and B. (A) receive 500 monetary units for sure or (B) a 50% chance of receiving nothing, and a 50% chance of receiving 1,000. In both choices the expected outcome is 500, hence a risk-neutral bidder does not prefer a choice. However, a risk-averse person attaches more value to choice A, while a risk-seeking person attaches more value to choice B.

Figure 7: Relationship between optimal starting bid and risk appetite.



Winner's curse

One of the most common assumptions in auction theory -a bidder will not bid more than his value for the object- does not hold when we take into account costs. The more risk seeking (having a higher chance of not winning at all, relatively to more risk averse bidders) bidders are, the more they would overpay. A bidder is willing to bid an amount as long as the following criterion holds.

$$\sum_{t=0}^{t}(C_{v,t,i}) + C_f + V_i > B_{t+1,i} \qquad \textbf{(9)}$$

Example: if a bidder's maximum bid would be 100, but his incurred costs (already made variable and fixed costs) are 10. Then he would lose less if he would bid 101, and win. In the latter case you lose 1, but if you would quit, he would have a loss of 10. In this example, a risk-seeking bidder is willing to submit a bid of 101 quicker than a risk-averse bidder. This could explain why the winner's curse is the consequence of rational behaviour. So, bidding more than the object value will always lead to a negative expected profit. However, stop bidding will lead to losing the auction, which can be even more costly.

Strategies

Since taking into account cost structures -this explicitly- is quite new in auction literature, some attention must be given to new strategies it implies. Research has shown that jump bidding is a well-known strategy in auctions where the bidder faces relatively high variable costs. In contrary, the auction can also be delayed in order to create strategic advantages.

This section is split up in two ‘time strategies’. First, it reviews the literature on jump bidding. Second, I show how a reversion of jump bidding can create strategic advantages for bidders and auctioneers. Especially, I will focus on auctions in M&A, since this will be the subject of research in the empirical part of this thesis.

Jump bidding

Jump bidding is an auction strategy, which can be helpful to bidders in several ways (Grether et al., 2011), (i) first it lowers variable costs and enhances the utility of impatience bidders, second, (ii) hand it reduces competition in an earlier state, which reduces the expected price paid for the object and provides a Pareto improvement for the seller (Avery, 1998). These advantages are being respectively discussed below.

(i) Daniel, K. and Hirschleifer, D. (1995) argue that bidding can be costly. D. Hirshleifer and I. Png (1990) suggests that these costs can consist of fees for advising, opportunity cost of executive time and the cost of obtaining financing for the bid. Although, I am convinced this list is not complete and does not include the major bidding costs that incur[12], their theory still explains the strategy of jump bidding.

I will not set out the mathematical framework of their theory, as the model presented in this thesis elaborates on the model of Daniel and Hirschleifer. They show that even with low bidding costs, the auction is completed with small numbers op bids, as the

[12] H.N. Seyhun (1997) notes that cumulative abnormal returns (CAR) of bidders’ stock prices, who failed in a takeover, are -0.7%. He argues that this reflects the costs the bidder is stuck with. This is true, however, this does not fully reflect the opportunity costs of the bidder. Hence, when an auction is going on, there is a probability, p, that the bidder takes over the firm and gains synergistic benefits, B. Therefore, for risk neutral agents, the stock will be corrected with the expected benefits: p*B – C. When the auction fails, the costs, C, are incurred, and the stock price will be lowered with p*B, as these benefits will not be realized. Therefore, the net effect (CAR) are just the costs, C, which are -0.7%.

bidders communicate rapidly by their jump bids.

Furthermore, they show that when bidding is costly, the model implies that bidders may delay before starting to bid. This happens when a bidder believes he is unlikely to win the auction because of this high bidding costs. However, when every bidder delays, by waiting, they can gain confidence, since this information enlarges their chances on winning.

(ii) Avery shows how jump bidding reduces the expected price for bidders and therefore reduces the expected revenues to sellers. He states that bidding is a way of communicating to the other bidders. By jump bidding one sends out an aggressive effect. This message discourages bidders to compete for the object for two reasons: aggressive bidding suggests that the bidder who does so, values the object more than anyway else, so, others are unlikely to win the auction, and, if the aggressive bidder drops out, this action shows that you probably have overbid.

His paper provides a citation from the book 'Wednesday the Rabbi Got Wet' (Harry Kernelrnan), which shows how competition in auctions can be reduced through jump bidding: "*...he bid seventy-fivegrand for the land whenthe other operators were offering bids in the low fifties . . . . Naturally he got it . . . and made himself a sweet little bundle. After he bought it, I told him he could havegot it for twenty thousand less and you know what he said? "I never try to buy a property as cheap as possible. That way you're in competition withthe other operators. They keep kicking eachother up and before you knowit, you're paying morethan you intendedand more than it's worth to me, and that's what I offer. That way you discouragethe competition. It takes the heart right out of him".* "

Isaac et al. (2002) show more formally how this mathematically works and also provide numerical examples. Consider an English auction with 2 bidders: i and j, where every bid must be raised with a certain amount m, so $B_t \geq B_{t-1} + m$. And the starting bid is denoted as $B_t \geq m$.

Note that the factor m introduces strategic choices in the auction. Consider the value of the auctioned object (V), a player will not bid more than his value for the object as it causes a negative surplus[13]. Therefore, a player will not place a new bid if his minimum bid must be higher than his private value for the object, that is, $B_{t-1} + m > V$. Thus, the optimal bid is $B^* \begin{Bmatrix} B_t = V_j - m & \text{for player i} \\ B_t = V_i - m & \text{for player j} \end{Bmatrix}$. However, the value of the bidders, υ, is distributed according to a CDF on integers in the range $[\alpha,\beta]$. Thus, their can be some optimization in expectations of one others value. Note that Isaac et al. do not take into account path dependency. From a behavioural aspect this can have a huge impact. There is a difference in signalling if the current bid is the result of multiple bidding rounds or if that same bid was made instantly. The only information a bidder can observe in their model is that the value of the other player is at least as high as his latest bid.

To derive the optimal bid, consider also the following. Bidders can have a discount rate of $\delta \in [0,1]$, where $\delta = 1$ implies perfect patience, and a lower value implies impatience. Isaac et al. then use the general Bellman equation to define the optimal bid as defined by equation 10.

$$\max W(b_t \mid b_{t-1}) = \begin{bmatrix} (\upsilon_i - b_t)\Pr(b_t + m > v_j \mid v_j \geq b_{t-1} + \\ \delta(1 - \Pr(b_t + m > v_j \mid v_j \geq b_{t-1}))E[W(b_{t+2} \mid b_{t+1})] \end{bmatrix} \qquad \textbf{(10)}$$

This equation defines the bidder's expected surplus as the surplus if he would win $(\upsilon_i - b_t)$, times the probability of winning with the specific bid, corrected for a factor of patience. A key detail in their approach is the updating of the probability of winning.

The value functions for this problem are inherently discontinuous due to the minimum increment. The problem is that a small increase in a bidder's bid might cause him to win, but because of the minimum increment he ends up in a negative surplus. Isaac et al. solved this problem by using backward induction algorithms. Which is, finding the best response for every possible value of the opponent. Without going into further detail, this results in a 100x101 best response matrix. To make clear how the factor m influences jump bidding strategies, table 4 provides a part of their results.

[13] This is true for the example. As I have shown earlier, considering bidding costs it can be optimal to bid more than the private value of an object.

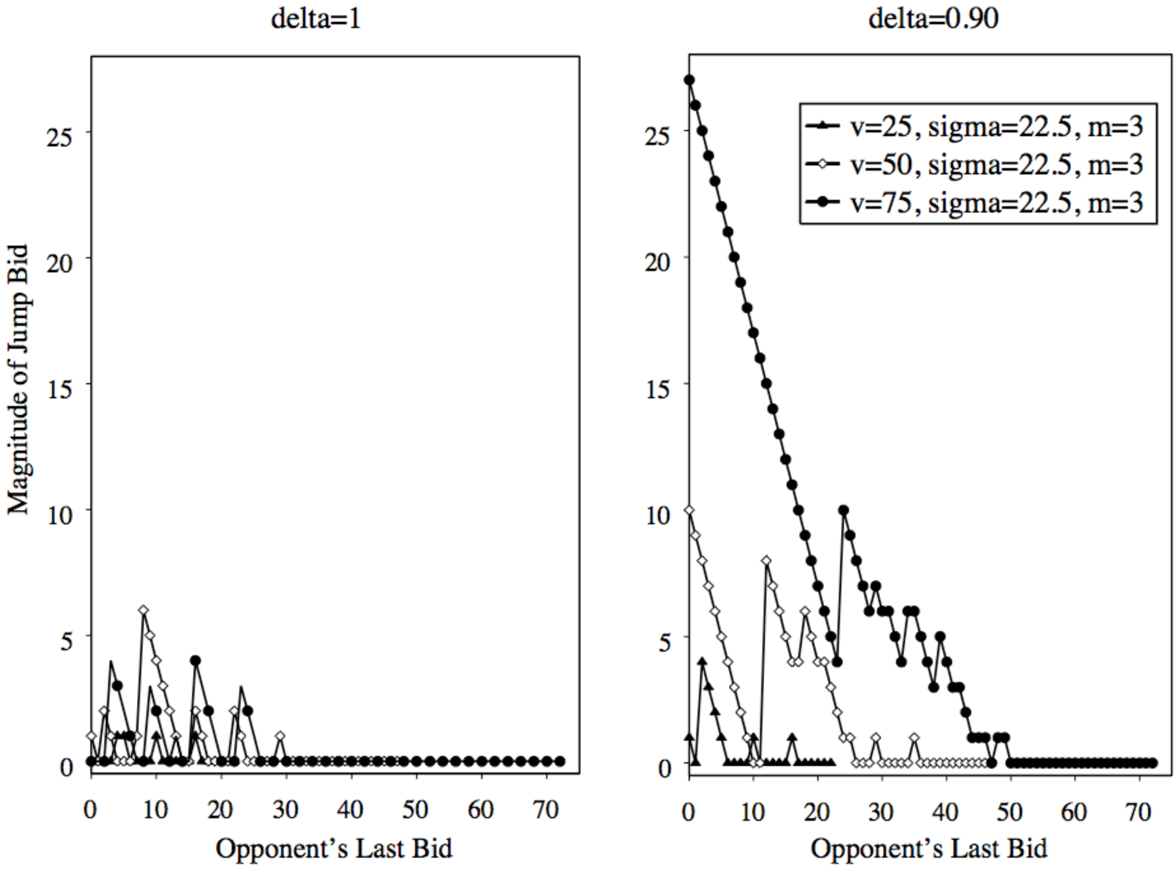
Table 4: How jump bidding changes the revenues equilibrium (Eq) compared to straightforward bidding (St). These numbers are generated under the assumption of a normal distribution with δ=1.

	$\sigma = 15$		$\sigma = 22.5$		$\sigma = 30$	
	St	**Eq**	**St**	**Eq**	**St**	**Eq**
$m = 1$	42.57	42.35	39.51	39.33	38.85	38.59
$m = 3$	42.49	41.93	39.47	38.89	38.72	38.23
$m = 7$	42.13	41.90	39.29	39.01	38.67	38.27
$m = 10$	41.68	41.95	39.97	38.89	38.65	38.28

Figure 8 shows the equilibriums of a set of strategies assuming normally distributed values, where $m = 3$ and $\sigma = 22.5$. The two panels show how the delta (δ) influences the magnitude of the jump bids. As expected, impatience causes a higher jump bidding. This makes sense, since bidders who are inpatient wants to acquire the auctioned object quicker.

The authors fail to recognize that impatience is merely affected by bidding costs, and not by behavioural effects. Their model would reflect reality better if bidding costs were split up in time-related (variable) and non-time related (fixed) costs.

Figure 8: Comparison of the equilibriums of bidding strategies. The left panel assumes δ=1 and the right panel δ=0.90. The right panel shows that impatience causes higher jump bids. Impatience is inherently related to costs of waiting. Hence, this are time-related costs: variable costs.



Delay bidding

Instead of jump bidding in order to reduce bidders' own bidding costs, players can follow another strategy. By doing exactly the counterpart (delaying the auction), players who face (almost) no variable costs can induce bidding costs to the other bidders. They can delay the M&A auction process in several ways: (i) not make the first move, (i) make low bids, (iii) set long formal bidding rounds, (iv) introduce time-consuming procedures.

A major difference with other bidding games is that the auctioneer (the firm who would like to sell itself) can also be the party that is benefited by the process delaying. First (i), I will explain how bidders can profit by delaying the auction process, and second (ii), I will show how the selling firm can profit by delaying the auction process. Third (iii), I will consider these strategy from a game-theatrical approach.

(i) Bidders with (almost) no variable costs can enhance their chances of winning, by delaying the auction process, if –and only if- there are other players who face variable bidding costs. This can be easily shown as follows. Consider an auctioned object with a value V, which is F-distributed. The maximum bid, $\overline{B}$, is equal to V, if we do not take into account bidding costs. We can implement bidding costs by denoting it as $\sum_{t=0}^{T} C_{v,t}$. Where $C_{v,t}$ are the variable costs per bidding round. The new maximum bid, considering the costs is:

$$\overline{B} = V - \sum_{t=0}^{T} C_{v,t} \qquad \textbf{(11)}$$

Now, the chance that the maximum bid of player i (who has no variable costs) is larger than the maximum bid of player j (who does face variable costs) enhances over time. Hence, the chance that player i has a higher maximum bid than player j is 50%, and vice versa, while the maximum bid of player j decreases over time.

$$\Pr(\overline{B}_i > \overline{B}_j \mid t > 0 \wedge C_{v,t,i} = 0 \wedge C_{v,t,j} > 0) \qquad \textbf{(12)}$$

(ii) Also, the selling firm can benefit from delaying the auction process. As the firm induce variable costs to some bidders, the chances of winning of these bidders become lower than the changes of winning of bidders who do not face variable costs (under the assumption that there is a common object value with a certain distribution). This is shown by equitation 1.

The firm could profit from this by letting bidders now on forehand that they will incur these costs. In order to save these costs, bidders who face variable costs must jump bid, and eventually pay more than what they would have bid if they did not jump bid. The firm could maximize this premium, $\max\{P\}$. A bidder is willing to pay no more than the difference in his expected profits is the auction would not be delayed and if the auction would be delayed. This gives the following equation.

$$\max\{P\} = E[\pi_i | D = 0] - E[\pi_i | D = 1] \qquad \textbf{(13)}$$

Where $\max\{P\}$ is the maximum premium the firm could negotiate, $E[\pi_i | D = 0]$ are the expected profits when the auction process is not delayed by the firm, and $E[\pi_i | D = 1]$ are the expected profits when the auction process is delayed by the firm.

Note that this premium must be an estimation, since it is not possible to observe the same object at the same time in a delaying and in a non-delaying auction process. Also, measures which are likely to incur costs do not encourage those bidders to start bidding at all.

(iii) Table 5 shows what the excess expected profits are of players, with high and low (or no) variable costs, in the cases where they can choose to delay the auction process or to not delay the process. The excess expected profits are notated as following.

$$(\mathrm{E}\{\Delta\pi_i\}, \mathrm{E}\{\Delta\pi_j\}) = (\mathrm{E}\{\pi_i\} - \mathrm{E}\{\pi_j\}, \mathrm{E}\{\pi_j\} \;\; \mathrm{E}\{\pi_i\}) \qquad \textbf{(14)}$$

Where $E\{\pi_i\}$ and $E\{\pi_j\}$ are respectively the expected profits of player i and j, and $E\{\Delta\pi_i\}$ and $E\{\Delta\pi_j\}$ are respectively the excess expected profits of player i and j. Further, this table assumes that players either have no variable costs, or high variable costs. In reality, there will be gradual differences in variable costs. For the sake of showing the strategies, we take the two extremes: having no variable costs and having high variable costs.

Table 5: Expected excess profits. When two players delay the process, the effect will be higher as if one player would delay and the other one does not. When both players do not delay, there will be even a smaller effect on the excess expected profits. Also note, that the effect of players is the same for every choice, where $x < y < z \land x = 0$.

Player i / *Player j*		No variable costs		High variable costs	
		Delay	**Not delay**	**Delay**	**Not delay**
No variable costs	**Delay**	(x,x)	(x,x)	(-z,z)	(-y,y)
	Not delay	(x,x)	(x,x)	(-y,y)	(x,x)
High variable costs	**Delay**	(z,-z)	(y,-y)	(-z,-z)	(-y,-y)
	Not delay	(y,-y)	(x,x)	(-y,-y)	(x,x)

From table 5 we can derive Nash equilibriums, which are dominant strategies, since no choices of other players would chance the initial strategy.

1. Players who both face no variable costs are indifferent in delaying or not delaying the auction process;
2. Players who both face high variable costs will not delay the process, since $-y > -z$ and $x > -y$;
3. If one player faces no variable costs and the other faces high variable costs, then the former player will delay the auction, since $z > y$ and $y > x$. While the latter player will try to settle the auction as quick as possible, since $-y > -z$ and $x > -y$.

The last implication is the one that induces strategic thinking in M&A auctions, since one player's dominant strategy is to fasten the auction process, while the other player benefits from disbenefits of the first player.

$$\frac{dE\{\pi_i\}}{dE\{\pi_j\}} < 0 \qquad \textbf{(15)}$$

Assuming that player i does not face variable costs, and player j does, this is true, since player i can make advantage of the fact that he knows that player j will make more costs if he would delay the process.

Choosing the optimal strategy

Concluding, the optimal strategy depends on bidders' variable bidding costs. Fixed bidding costs determine whether it is profitable to participate in an auction and to determine the optimal bid. However, fixed bidding costs do not determine time strategies, as they are independent of time.

Table 6 provides information on the optimal strategy. First, a bidder should make an analysis of competitors. When there are no other competitors for an object the bidder should negotiate with the seller. The final price will depend on the bargaining power of parties.

However, when there are competitors, they can start bidding against each other. If so, bidders should determine whether they (player A) face high or no variable costs and if their competitors (player B) face high or no variable costs. High variable costs of player i is stated as $i(C_{v,t}) >> 0$.

Eventually, bidders can end up in three strategies:

1. **Jump bidding.** When a bidder faces high variable costs, Isaac et al. (2002) show that it is always profitable, at least not unprofitable, to jump bid.
2. **Minimally increase bid.** If all bidders have no variable bidding costs, then each bidder will minimally increase its bid until he is the only bidder left.
3. **Delay process.** When a bidder faces low variable costs and his opponents high variable costs, I have shown that it is always profitable, at least not unprofitable, to delay the bidding process.

Of course, if a bidder knows that his opponent will jump bid or delay the process, he may choose not to participate in the auction at all. And rationally will not, if the threat is credible, that is, if he knows that the opponent can perform the strategy without harming himself.

Table 6: The optimal strategy depending on bidders' variable bidding costs. These strategy choice model assumes that bidders know each others costs, but do not know each others private values.

<table>
<tr><td colspan="5">Analyze number of competitors (N)</td></tr>
<tr><td>If N = 0, then negotiate</td><td colspan="4">If N > 0, then start auction</td></tr>
<tr><td rowspan="3">Final price depends on bargaining power of parties.</td><td colspan="2">$A(C_{v,t}) >> 0$</td><td colspan="2">$A(C_{v,t}) = 0$</td></tr>
<tr><td>$B(C_{v,t}) = 0$</td><td>$B(C_{v,t}) >> 0$</td><td>$B(C_{v,t}) = 0$</td><td>$B(C_{v,t}) >> 0$</td></tr>
<tr><td>Jump bidding</td><td>Jump bidding</td><td>Minimally increase bid</td><td>Delay process</td></tr>
</table>

VII. Empirical analyses

The empirical analyses of this thesis justifies the effectiveness of a delay bidding strategy. It examines to what extent the auction settlement time is related to incurred variable costs at the acquirers side. As shown earlier, bidders are likely to reduce their auction settlement time in order to reduce their incurred costs. Therefore, I expect that settlement time is negatively influenced by the total incurred variable costs. Note that proxies for fixed costs are not included in the regression, but were extensively treated in the theoretical part of this thesis. Reason for this is that fixed costs do not influence the settlement time of an auction (except for possible psychological effects mentioned in chapter VI), but rather affect the optimal bidding amount. For the purpose of justifying delay bidding as a successful strategy, I do not need to assess fixed costs bidders face during the auction.

A negative relationship between settlement time and incurred costs indicates the effectiveness to adapt a delay bidding strategy. As empirically observed, higher costs are related to shorter settlement times. This is in line with theory, as bidders would like to reduce their settlement time in order to save costs. Hence, delay bidding can therefore be an effective strategy as bidders are willing to pay a premium to reduce settlement time.

First, this chapter shows what data is used for the research, second, the methodology to capture the incurred costs is set out, third, the results are presented, and last, the results are interpreted.

Data

I analyze a sample of corporate takeovers announced and completed in the period January the 1st, 1980 until the March 15th, 2012. Stock prices are gathered from Datastream and other M&A data is gathered from the Securities Data Corporation (SDC). Only those takeovers are investigated that satisfy the following requirements:

- The target and bidder are publicly traded on a U.S., Canadian or European stock exchange;
- The bidder and target are non-financial (Standard Industrial Classification (SIC) codes 6000-6999 are excluded);
- The EBIT and EBITDA of the target and bidder is at least $1 million.
- Bidders acquire 100% of the targets' share;
- The takeover is an auction;
- All necessary data for the regressions are available.

The first two criteria are important constraints, and need an explanation. We need targets and bidders to be publicly traded, in order to get the value of their market capitalization. Also, firms cannot be financials, since financials do not acquire firms in order to add them to their operational portfolio. In that way, financial firms do not have an incentive to acquire the target firm quicker for their potential economies of scale.

Furthermore, a takeover is considered an auction if there are more than two parties who signed a confidentiality agreement, or, if there are at least two parties who submitted a bid. Although, this is not absolutely accurate, it is a common way of investigating whether a takeover is an auction (e.g. Gorbenko and Malenko (2010))[14].

I did not winsorized or trim any of the data. Extreme high or low variables can explain an extreme high or low settlement time.

[14] It is not absolute accurate since an auction has n bidders. If a bidder with the highest willingness to bid makes his bid first, there will be no one else submitting a bid. This case will be considered a negotiation and not an auction. Although, this is untrue, data does not allow me to get an insight in the number of potential bidders.

As M&A activities start to grow rapidly since the 90s, I want to give an overview of the number of M&A included in my research per target region (table 7). Furthermore, table 8 shows a data descriptive of the settlement time per target region.

Table 7: Number of included takeovers per target region and per time period. North America (Canada and the United States) provides most of the data, while only 220 observations are European. The results are therefore biased towards North America, however, I try to capture possible differences by dividing the data into panels.

	1980 - 1989	1990 - 1999	2000 - 2009	2010 - 2012	
North America	12	546	921	130	*1,609*
United Kingdom	0	15	107	11	*133*
Western Europe	0	1	43	6	*50*
Scandinavia	0	4	29	2	*35*
Eastern Europe	0	0	2	0	*2*
	12	*566*	*1,102*	*149*	*1,829*

Table 8: Data descriptive of the settlement time per target region. Note that the average T and the volatility of T in Western Europe is relatively high. This is likely to be caused by the difference in foreign takeovers. 48.0% of the takeovers in Western Europe is foreign, while in the other region only 13.2% of the takeovers are foreign. This explains why there is on average more time needed to settle the takeover (disadvantages like culture difference and long distance communication occur). The volatility is explained by the fact that neighbour countries face less of these disadvantages, and the overall T's differ among the region. E.g. takeovers between Swedish and Finnish firms are likely to be more flexible than a takeover of a Swedish firm by a Greece firm.

	Average	**Median**	**Minimum**	**Maximum**	**Volatility**
North America	117	91	0	881	88.7
United Kingdom	95	66	0	480	86.1
Western Europe	158	123	0	755	124.7
Scandinavia	120	90	32	350	83.8
Eastern Europe	55	55	25	84	41.7
All data	*87*	*90*	*0*	*881*	*88.4*

In order to get a feeling with the data, table 9 provides a descriptive of the explanatory and control variables.

Table 9: Data descriptive of explanatory and control variables.

		Minimum	Maximum	Median	Average
Explanatory variables	E_{t-1}	-\$11 billion	\$18 billion	\$9 million	\$95 million
	$\frac{EBIT_B - EBITDA_B}{Sales_{T,t-1}}$	-40.2%	4,195.8%	0.3%	10.8%
	$\frac{Empl_T}{Empl_B}$	0.0%	1,402.0%	0.2%	1.3%
	$\frac{MV_T}{MV_B}$	0.0%	91.3%	0.1%	0.3%
	$D_{industry}$	0	1	0	0.3
Control variables	ATP	0	4	0	0.3
	$D_{\text{home\_country}}$	0	1	0	0.1
	$D_{crisisyear}$	0	1	0	0.3
	$\frac{\sigma_{Benchmark,T}}{\overline{\overline{X}}_{Benchmark,T}}$	1.8%	22.7%	5.7%	6.2%

Berksonian bias

I would like to point out that –as in all researches- a selection bias (Berksonian bias) can occur. First of all, for analytical purposes, only firms, which are listed, can be used for this research. To see if, and to what extent, private firms' settlement time in takeovers is affected by incurred costs, case studies might be more appropriate.

Also, one of the control variables is the number of anti-takeover provisions (ATPs). This is an indicator of the level of corporate governance. A low number of ATPs indicates strong corporate governance, as managers have fewer possibilities to extract benefits from the takeover. However, ATPs enhance the chance of not completing a takeover, while it should have if the ATPs would not have been in place. Therefore, firms with strong corporate governance are more likely to be in the dataset. Moreover, since firms with strong corporate governance more often provide data for external use, hence, this is one of the criteria in order to analyze an auction.

Methodology

In this chapter I define the independent, explanatory and control variables. Furthermore, this chapter explains these variables and shows the expected sign of the coefficient in the regression.

The multiple regression is separated in three panels in order to see the effect of control variables. Panel A regresses the data using the explanatory variables. Panel B regresses the data using the explanatory and corporate governance control variables. Panel C regresses the data using the explanatory and crisis control variables. And last, panel D regresses the data using the explanatory and all control variables.

Table 10: Overview of included variables in panels.

	Panel A	**Panel B**	**Panel C**	**Panel D**
Explanatory variables	*Included*	*Included*	*Included*	*Included*
Control variables: corporate governance		*Included*		*Included*
Control variables: crisis years			*Included*	*Included*

Independent variable

I define the settlement time as the time difference in days of the rank date and the date of the actual settlement. The rank date is the date of the first public disclosure of the intent to merge or to acquire. The date of the actual settlement is the date when the takeover is unconditionally completed. Using unconditional takeovers provides values, which do not have to be corrected for the chance of not completing the takeover.

Recall the takeover process as shown in chapter [x]. This data does not capture the bidding process before the rank date, as this is not available in databases. Hence, the actual settlement time is likely to be longer.

Explanatory variables

Theory suggests that the settlement time is influenced by variable costs. Therefore, proxies are needed to estimate these costs[15]. In order to include the variable costs, they need to be specified for each bidder, since the costs differ depending on bidders' characteristics. The major part of variable costs consists of fees and opportunity costs. Fees are not taken, specifically, into account in the regression as I assume that fees are more or less the same per time period. On average this is $20.81 million per year in my dataset, with a correlation of fees and time of 0.461 (after exclusion of outliers), the non-explained part is due to bidder characteristics like size, which are already included in the regression. I divide opportunity costs into three categories: (i) missed profits, (ii) missed costs savings which would occur by economies of scale and (iii) higher risk capital, caused by less diversification effects if the firm would diversify its activities.

Ad i. In order to capture the costs of missed profits, the regression contains the net profit of the last fiscal year. Assuming that the net profits of last year are being paid out during the settlement period, these can be considered as variable costs[16].

Ad ii. To take into account missed costs savings, five categories of economies of scale are distinguished: technical economies, managerial and administrative economies, financial economies, marketing economies and social economies. To address the technical economies a measure of the fixed costs of the bidder's firm related to the new sales is needed, as I try to capture how much of the fixed costs of the acquirer can be spread out over the sales of the target. Therefore the regression includes the ratio of the sum of the deprecations and amortizations (EBITDA – EBIT) to the sales of the target firm of the last fiscal year. To estimate the managerial and administrative economies, the regression contains the ratio of the number of employees of the target company to the number of employees of the bidder's firm. Last, the other economies are proxied by including the percentage change in firm size (market capitalisation), if the target would be acquired. This

[15] Note that I do not need to assess whether it is profitable to actually take over the firm, and therefore no assumptions are required on that.

[16] In practice, stocks denote a ex dividend date, on which the stockholder at that moment receives the right to cash the dividends. Hence, this is not gradually distributed.

is equal to the ratio of the market capitalisation of the target divided by the market capitalisation of the acquirer[17].

Ad iii. To address the missed diversification effects I add a dummy which is zero if the target is not in the same industry[18] as the bidder, hence, diversification effects will arise. And is one if the target is in the same industry as the bidder. I do acknowledge that this approach does not perfectly capture the diversification effects between industries. To solve this one should set up a correlation matrix across industries. Because of practical issues, we assume that only significant diversification effects (which are the same across industries) arise if companies are not classified in the same industry.

However, it might be that firms in the same industry can negotiate easier as they have done business together. The coefficient of this dummy therefore represents the net effect of missed diversification effects and more flexible negotiations.

Panel A consists of the previously mentioned main explanatory variables. The following formula is derived.

$$T = \alpha + \beta_1 E_{t-1} + \beta_2 \frac{EBIT_B - EBITDA_B}{Sales_T} + \beta_3 \frac{Empl_T}{Empl_B} + \beta_4 \frac{MV_T}{MV_B} + \varepsilon \qquad \textbf{(16)}$$

Where, T is the settlement time of the M&A, α is the intercept and ε the error term. The explanatory and control variables will be more elaborator explained in table 11.

[17] The percentage change is equal to (new value – old value) / old value. Where the old value is the market capitalisation of the acquirer and the new value is the sum of the market capitalisation of the acquirer and the target. Therefore, the formula becomes: (MVacquirer +MVtarget – MV target) / MV target, which is MVacuirer / MV target.

[18] I use the SIC-codes to determine the industry of the firm. The following classification is made. Codes starting with 07: Agriculture, Forestry and Fishing, 10: Mining, 15: Construction, 20 and 30: Manufacturing, 40: Transportation and Public Utilities, 50: Wholesale Trade, 52: Retail trade, 60: Finance, Insurance and Real Estate, 70: Services, 80: Health services.

Control variables

I add two types of control variables to the initial regression (panel A). First the controls for corporate governance are added to panel B. ATPs may cause the settlement time to enlarge, as they can be used by managers to enhance their bargaining power in order to extract benefits from the firm. To control for this I count the number of following the ATPs in place at the target firm.

1. **Poison pill**: Provide target shareholders the right to purchase additional shares at a discount or to sell shares to the target at a premium if certain ownership changes occur;
2. **Asset lockup**: Lockup involves an option to purchase target company assets, usually at a bargain price;
3. **Back-end defense**: Each common stock holder receives a right for each share owned that entitles them to exchange each share for a note that matures within a short period of time (usually one year), upon the occurrence of a triggering event;
4. **Flip-over defense**: Dividend rights are issued to the company's common shareholders which allow shareholders to purchase additional shares in a surviving corporation after a merger at a significant discount (typically 50% of the market price);
5. **Greenmail**: A company or a group of investors will acquire a significant stake in another company and threaten to initiate a takeover and will then offer to resell those shares back to the target company, usually at a price much higher than they were originally bought at;
6. **Pacman defense**: The target company of an unfriendly bid makes an attempt to acquire its suitor, i.e. if company A makes a hostile bid for company B, and company B responds by making an attempt to take over company A;
7. **Recapitalization defense**: The target company proposes a recapitalization plan as a defense against a hostile takeover bid;
8. **Repurchase defense**: The target company buys back stock on the open market or in privately negotiated transactions as a defensive measure;
9. **Scorched earth defense**: The target company sells off assets in order to make itself

less attractive as a takeover target;

10. **Self-tender defense**: The target company offers to buy back stock through a tender offer as a defensive tactic;
11. **Voting plan defense**: An attempt to reduce the voting power of large shareholdings held by hostile raiders, usually through preferred stock dividends with different voting rights for different holders;
12. **White knight defense**: The target company attempts to thwart an unsolicited or hostile bid by selling a majority of shares (usually convertible preferred with special voting rights) to a friendly third party;
13. **White squire**: The target company attempts to thwart an unsolicited or hostile bid by selling a block (less than a majority) of shares (usually convertible preferred with special voting rights) to a friendly third party.

Also, I add a dummy for foreign takeovers. When an acquirer takes over a firm in another country this can cause more difficulties, like culture differences and long-distance communication.

Including these control variables (panel B) leads to the following regression.

$$T = \alpha + \beta_1 E_{t-1} + \beta_2 \frac{EBIT_B - EBITDA_B}{Sales_T} + \beta_3 \frac{Empl_T}{Empl_B} + \beta_4 \frac{MV_T}{MV_B} + \beta_5 D_{industry} + \beta_6 ATP + \beta_7 D_{\mathrm{foreign}} + \varepsilon \qquad \textbf{(17)}$$

Second, there are two controls for crisis years. First, I add a dummy if the rank date falls in a crisis year. Crisis years are defined as years when there was a strong, significant, non-temporary stock price change of the benchmark[19], which are the following years.

[19] European stocks are benchmarked with the S&P Europe 350 (free float market capitalization weighted index, covers at least 70% of European equity market capitalisation), US stocks are benchmarked with the AMEX Composite Index (composite value of all of the stocks traded on the American Stock Exchange).

1. **1980: Silver Thursday.** On Thursday, 27 March 1980, a steep fall in silver prices led to panic on commodity and future exchanges.
2. **1987: Black Monday.** On Monday, 19 October 1987, stock markets around the world crashed. The crash began in Hong Kong and spread to Europe and the United States.
3. **2000-2002: Lapse of internet bubble.** Lapse of the fast growing internet-sector in 1997 – 2000. Also known as the dot com bubble.
4. **2008-2010: Late-2000s financial crisis.** Bursting of the U.S. housing bubble, which peaked in 2007, caused structured products tied to U.S. real estate to plummet, damaging financial institutions globally.

Also, the volatility as a percentage of the mean price index of the benchmark (from now referred to as 'volatility') is added, which is especially larger in times of crisis. The volatility is the target's benchmark price index volatility in the rank year of the takeover. This variable indicates how hard it is to estimate the value of the company. When there are large fluctuations in the market, bidders are less sure about the true value of the company and may need more time to investigate that value.

Adding these control variables to panel A gives the following regression (panel C).

$$T = \alpha + \beta_1 E_{t-1} + \beta_2 \frac{EBIT_B - EBITDA_B}{Sales_T} + \beta_3 \frac{Empl_T}{Empl_B} + \beta_4 \frac{MV_T}{MV_B} + \beta_5 D_{industry} + \beta_8 D_{crisisyear} + \beta_9 \frac{\sigma_{Benchmark,T}}{\overline{X}_{Benchmark,T}} + \varepsilon \tag{18}$$

Combining all control variables gives the following regression (panel D).

$$T = \alpha + \beta_1 E_{t-1} + \beta_2 \frac{EBIT_B - EBITDA_B}{Sales_T} + \beta_3 \frac{Empl_T}{Empl_B} + \beta_4 \frac{MV_T}{MV_B} + \beta_5 D_{industry} + \beta_6 ATP + \beta_7 D_{\text{foreign}} + \beta_8 D_{crisisyear} + \beta_9 \frac{\sigma_{Benchmark,T}}{\overline{X}_{Benchmark,T}} + \varepsilon \tag{19}$$

An overview of the explanatory and control variables, with an explanation and expected sign of the coefficient is given in table 11.

Table 11: Explanation of explanatory and control variables.

		Variable	**Expected sign of coefficient**	**Explanation**
Explanatory variables	*Missed profits*	E_{t-1}	Negative or positive	The net profit of the last fiscal year indicates how much dividend will be missed by delaying the auction. If the weighted average net profit of the last fiscal year is positive, then the overall tendency to settle quickly is larger.
	Economies of scale	$\frac{EBIT_B - EBITDA_B}{Sales_{T,t-1}}$	Negative	This ratio indicates to what extent the fixed costs of the acquirer can be divided over the extra sales after the acquisition. *(technical economies of scale)*
		$\frac{Empl_T}{Empl_B}$	Negative	This ratio indicates to what extent the number of employees can be reduced. *(managerial and administrative economies of scale)*
		$\frac{MV_T}{MV_B}$	Negative	This ratio of market values indicates to what extent the percentage change in firm size influences the settlement time. *(financial, marketing and social economies of scale)*
	Missed diversification effects	$D_{industry}$	Negative	The dummy is one if the target firm operates in another industry as the bidder. The dummy value is zero otherwise. This dummy proxies for the diversification effects. The coefficient is unknown as it represents the net effect of missed diversification effects and flexible negotiations of intra-industry firms.
Control variables	*Corporate governance*	ATP	Positive	Number of ATPs. The more ATPs present, the harder it is for a bidder to take over the firm.
		$D_{foreign}$	Positive	The dummy value is 0 if the takeover is in the bidder's home country and 1 otherwise. A foreign takeover may cost more time.
	Crisis years	$D_{crisisyear}$	Positive	The dummy value is 1 if the year of the rank date is a crisis year. This dummy corrects for crises, since M&A settlement time can be affected by the crisis.
		$\frac{\sigma_{Benchmark,T}}{\overline{\overline{X}}_{Benchmark,T}}$	Positive	A higher standard deviation of the benchmark can influence the valuation process of a firm. Therefore, a higher standard deviation enhances the settlement time, since parties need more time to estimate the firm value.

Logarithmic transformation

As economies of scale are not infinite I cannot use these ratio's (see table 11 for the economies of scale ratio's) in a liner regression without transforming them. I use the natural logarithm to transform these ratio's, as the positive effects of economies of scale on the costs of acquirers (hence, a negative effect on the settlement time) are concave. Economies of scale have diminishing returns, that is, the first marginal euro of scale has more benefits than the last marginal euro of scale. E.g. financial economies of scale arise when larger firms can borrow cheaper than smaller firms. Hence, there is not a linear relationship between firm size and interest rate, as there will be a minimum interest rate. As a consequence, panel A will be estimated as following:

$$T = \alpha + \beta_1 E_{t-1} + \beta_2 Ln(\frac{EBIT_B - EBITDA_B}{Sales_T}) + \beta_3 Ln(\frac{Empl_T}{Empl_B}) + \beta_4 Ln(\frac{MV_T}{MV_B}) + D_{industry} + \varepsilon \qquad \textbf{(20)}$$

Logarithmic transformation has the statistical advantage that it improves homoskedasticy in Ordinary Least Squares (OLS) if relationships are logarithmic instead of linear, and therefore, stabilizes the variance.

Note that coefficients should be interpreted slightly different. Where the non-logarithmic used to show how the dependant variable would increase with the coefficient if the dependant variable would increase with one, the coefficients of logarithmic transformed variables show how much percent the dependant variable would increase if the transformed variable would increase with one percent.

Endogeneity

Furthermore, the problem of endogeneity should be addressed. In my model the exogeneity of the main explanatory variables is assumed. But this may be false and problematic if a variable is correlated with the error term. The 'problem of endogeneity' arises when variables that are supposed to affect a particular outcome, depend themselves on that outcome.

In my model this could be the case if I controlled for excess volatility using the stock price volatility of the firm and the benchmark volatility. If so, the stock price volatility of the firm is assumed to affect the settlement time, while a long settlement time could also influence the stock price volatility as investors change their buy and selling behavior due to the long settlement time. I solved this problem by using time-varying excess volatility of the benchmark and apply this to the corresponding firms.

Increasing model power

This thesis uses three ways in which the statistical and economical power of the model is improved and guaranteed. (1) First, the model uses a large dataset. This proves that the theory underlying the empirical test applies in a large timeframe. Furthermore, a large number of observations enlarges the F-statistic of the model. (2) Second, the model logarithmic transforms some variables. Regarding economical power, this means that the effect of economies of scale is better captured since those economies are not linear. Also, logarithmic transformation lowers the variance of the error term, creating more homoscedasticity. (3) Third, data is not winsorized or trimmed. Large differences in settlement time can be explained by large differences in costs. Therefore the variance of the observations is enhanced, meaning that statistically the power is enhanced, and economically, a broader range of settlement times is included in the analyses.

Results

The panel regressions are run using OLS and the results are presented in table 12. This table shows that control variables in panel B, C and D are not significant. Also, I tested whether control variables would be significant if they would be individually added to panel A. This is not the case.

Therefore, the ultimate regression is derived from panel A as shown in equation 21.

$$T = 165.6 + 0.019 lE_{t-1} + 5.763 \ln\left(\frac{EBIT_B - EBITDA_B}{Sales_T}\right) + 7.631 \ln\left(\frac{Empl_T}{Empl_B}\right) + 11.185 \ln\left(\frac{MV_T}{MV_B}\right) - 7.707 D_{industry} \quad \textbf{(21)}$$

As can be seen the coefficients of the economies of scale are all positive. This is contrary with the expected coefficients given in table 11. However, these coefficients are positive since the variable is changed by the logarithmic transformation. Hence, all economies of scale are expressed as a ratio. The ratio's (R) are mostly between 0% and 100% as table 11 indicates.

So, the coefficient multiplied with the new variable still has a negative sign. The natural logarithm of $R \in [0,1]$ is smaller than zero. This variable (R) is multiplied with a positive coefficient, which still leads to a negative sign. Hence, this is the same negative expected sign as the non-natural logarithm of R (which is positive) multiplied with a negative coefficient.

Therefore, the expectations of the signs are also observed, as also $D_{industry}$ shows a significant negative relation with the settlement time.

Table 12: regression results. The adjusted R-square is a modification of the regular R-square that adjusts for the number of explantory terms in a model. Unlike the regular R-square, the adjusted R-aquare increases only if the new term improves the model more than would be expected by chance. * indicates that the variable is significant at a 1% level, ** indicates that the variable is significant at a 10% level, *** indicates that the variable is significant at a 40% level.

		Panel A	**Panel B**	**Panel C**	**Panel D**
Explanatory variables	α	165.6*	166.0*	169.1*	168.9*
	E_{t-1}	0.019*	0.019*	0.019*	0.019*
	$Ln(\frac{EBIT_B - EBITDA_B}{Sales_{T,t-1}})$	5.763*	5.774*	5.808*	5.809*
	$Ln(\frac{Empl_T}{Empl_B})$	7.631*	7.422*	7.660*	7.465*
	$Ln(\frac{MV_T}{MV_B})$	11.185*	11.339*	11.158*	11.302*
	$D_{industry}$	-7.707**	-7.875**	-7.751**	-7.894**
Control variables	ATP	-	1.355	-	1.326
	$D_{\text{home\_country}}$	-	-5.932***	-	-5.286***
	$D_{crisisyear}$	-	-	-0.537	-0.373
	$\frac{\sigma_{Benchmark,T}}{\overline{X}_{Benchmark,T}}$	-	-	-52.901***	-45.668
	Adjusted R-square	11.1%	11.2%	11.1%	11.2%
	Included observations	1,829	1,829	1,829	1,829
	Model F-statistic	44.715	32.158	32.054	25.067
	(p-level)	(0.000)	(0.000)	(0.000)	(0.000)

Interpretation

Results show that the expected signs from table 11 are observed in the data sample. Implying that settlement time is reduces by opportunity costs, being missed profits, economies of scale and diversification opportunities.

All main explanatory variables are significant, of which missed profits and economies of scale strongly significant (p-value of lower than 1%). The industry-dummy variable is not as significant as the other main explanatory variables. This is caused by the fact that a dummy either has a value of 0 or has a value of 1. Therefore, this nominal (categorical) variable does not contain as much information as other variables. A more accurate estimation of diversification effects can be achieved by calibrating a correlation matrix of all industries. Low-correlated industries create more diversification benefits than high-correlated industries.

However, the control variables do not significantly contribute to explaining the settlement time. There are several explanations for this:

1. The crisis dummy and excess volatility are significantly correlated ($\rho=0.366$) to each other. This is unlikely to explain their insignificance as these control variables are also insignificant when I regress them separately with the main explanatory variables.
2. The control variables are of great importance in determining the time for the private takeover stage, while T provides the settlement time of the public takeover stage;
3. The control variables do not contain much information, since ATP and excess volatility can only take some values. The maximum number of ATPs is four, excess volatility is benchmarked with three benchmarks, and the dummies are either zero or one;
4. Control variables provide mixed effects. On the one hand a crisis makes it harder to take over a firm, while on the other hand crises can make it necessary to merge in order to survive. The latter explanations seems plausible, as the coefficient of this variable is negative, meaning that if there is a crisis, settlement time is shorter.

5. The control variables do not matter because of Berksonian bias. I already mentioned that the dataset only contains takeovers that have been taken place. Meaning that the control variables, which control for problems are already overcome. Low corporate governance, hard to determine firm values and international communication were apparently not a great enough issue to stop the takeover.

This is not a disappointing result, as we want to know the impact of the main explanatory variables on the settlement time, and made controls in case corrections are necessary. In my model the data does not need to be corrected.

We observe that the main explanatory variables explain 11.1% of the variance of the settlement time (hence, this is without removing or adjusting outliers). Meaning that 88.9% of the variance is explained by other factors, like the experience of the investment banker, private information on the importance of taking over the firm quickly and other strategic growth opportunities.

In social sciences like economics, where human behaviour is studied, this R^2 is considered high. People often misinterpreted this number by stating that R^2 shows how good the model is. This is untrue as R^2 is an indicator of the completeness of the regression model. It shows how much of the data sample's variance can be explained. Of more importance is the p-value in the regression ANOVA table and the p-value of the coefficients, as they indicate a significant relationship. In my model all variables were highly significant, just like the model.

Although, I could have added all these variables, this was not my intention. I do not want to explain by what factors the settlement time is influenced. I showed how opportunity costs influences the settlement time. I showed that opportunity costs significantly influence the settlement time negatively, meaning that the more costs involved, the quicker a bidder wants to settle the auction. This confirms my theory. Hence, proven that firms have a tendency to settle auctions quicker when higher opportunity costs incur, the "delay bidding"-strategy provides bidders and auctioneers with new strategic insights.

As the theoretical part of my thesis showed, there are two time-strategies concerning auctions: jump bidding and delay bidding. The empirical results show that there is a significant relationship between costs and settlement time. This implies that bidders bid faster when they face more costs.

This provides opportunities for delay bidding. If delay bidding would be applied, than one would expect non-significance between auction settlement time and costs, since auctioneers who deal with bidders with high bidding costs enlarge the settlement time. This is not the case.

One explanation for this could be that the threat of delaying the auction is enough to drive up the premium paid for the firm, another valid explanation is that this strategy is not exploited. Both make sense, in the case a bidder with high bidding costs is forced to participate in a long bidding process, he is more likely to quit. However, since this thesis provides the concept of delay bidding, it may not be applied very often.

VIII. Conclusion

This thesis provides a theoretical framework on strategic and optimal bidding and finds empirical support for this new strategy. The thesis relates to three strands of literature, and offers complete new insights in every strand.

First, it is related to strategic bidding. I show that reversing the jump bidding strategy, which I call delay bidding, is always profitable, at least not unprofitable, if bidders face no variable bidding costs. It becomes more profitable when bidders' opponents face more variable bidding costs, as the impact of delaying the auction will increase.

Second, it is related to optimal bidding. I developed a model which calculates the optimal bid (maximizing the expected profits for risk-neutral bidders), taking into account the variable and fixed bidding costs of bidders. I also show how this optimum is affected by different risk appetites.

Third, I empirically show that there is a significant negative relationship between opportunity costs (missed profits, missed economies of scale and missed diversification effects) and the settlement time of a takeover (model p-value = 0.000). This is a justification of the delay bidding strategy. 1,829 mergers and acquisitions from 1980 (January) up to 2012 (March), show that bidders who face high opportunity costs tend to takeover a firm more quickly, than bidders who face less opportunity costs.

Furthermore, this thesis forms a basis for new areas of research. It would be interesting to look at paid premiums for a firm when bidders face opportunity costs. Theory suggests that bidders with high opportunity costs have less bargaining power and therefore are likely to pay a higher premium. Such competitor analyses can offer firms successful negotiations strategies.

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APPENDIX A Dominant strategy in second-price sealed-bid private-value auctions

To prove if the dominant strategy is to bid your private-value we can consider the cases in which you not do: bid less than your true value of bid more than your true value.

First consider the case in which you bid the value of the object (v) minus $x \in [0, v]$, so $v - x$. If you submitted the highest bid you only have to pay the bid of the next-to-last person (w). In that case you will win the auction if $v - x > w$ and have a surplus of $v - w$, since you pay w and receive v. However, you would have also won the auction if your bid was v and still receive $v - w$. Of course, $P(v - x > w) < P(v > w)$, so you should bid v.

Now consider the case in which you bid $v + x$, with $x \in [0, \infty)$. In the case $v + x > w$ you have a surplus of $v - w$. Because w can be bigger than v you could end up with a negative surplus. Since you are not willing to pay more than v you do not want w to exceed v which can only be achieved if you bid v or less. Since we proved that bidding less than v is a dominated strategy, the dominant strategy is to bid v.

APPENDIX B Correlation matrix of dependant and control variables

Correlation (ρ)	E_{t-1}	$\frac{DA_B}{Sales_{T,t-1}}$	$\frac{Empl_T}{Empl_B}$	$\frac{MV_T}{MV_B}$	$D_{industry}$	ATP	$D_{\text{home\_country}}$	$D_{crisisyear}$	$\sigma_{t-1} - \overline{\sigma}$
E_{t-1}	1.000								
$\frac{DA_B}{Sales_{T,t-1}}$	-0.012 (0.614)	1.000							
$\frac{Empl_T}{Empl_B}$	-0.002 (0.927)	-0.003 (0.897)	1.000						
$\frac{MV_T}{MV_B}$	0.009 (0.689)	-0.011 (0.643)	0.003 (0.887)	1.000					
$D_{industry}$	-0.030 (0.200)	-0.008 (0.729)	-0.014 (0.552)	-0.022 (0.339)	1.000				
ATP	-0.010 (0.671)	-0.012 (0.605)	-0.007 (0.756)	0.005 (0.818)	-0.016 (0.495)	1.000			
$D_{\text{home\_country}}$	0.021 (0.373)	0.030 (0.194)	-0.012 (0.611)	0.005 (0.818)	-0.016 (0.495)	-0.106 (0.000)	1.000		
$D_{crisisyear}$	0.000 (0.983)	0.023 (0.983)	-0.017 (0.463)	-0.011 (0.637)	-0.044 (0.060)	-0.107 (0.000)	0.012 (0.620)	1.000	
$\sigma_{t-1} - \overline{\sigma}$	-0.002 (0.915)	-0.002 (0.915)	0.056 (0.017)	0.001 (0.956)	-0.013 (0.572)	0.019 (0.420)	0.132 (0.000)	0.366 (0.000)	1.000

Note: Numbers in brackets are p-values. Some of the control variables show significant correlations, this is caused by the fact these variables do not vary much in value. Not that they economically correlate with each other. The main explanatory variables (panel A) do not correlate at all, therefore we should not worry that they explain the same components in the settlement time of an auction.