Merger & Acquisition Pricing Using Agent Based Modelling

A thesis submitted in fulfilment of the requirements for the degree of **Master of Science**

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Declaration

I certify that the substance of this thesis, has not already been submitted for any degree and is not currently being submitted for any other degree or qualification.

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12th August 2016

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I would especially like to thank my supervisor, Associate Professor Paul Kwan for his outstanding advice and support. I have really appreciated his guidance through my candidature and he has provided me with excellent advice through my time with him. I would also like to devote this thesis to my wife Ashima, son Aarav and my parents, who are very important to me.

Abstract

Merger & acquisition (M&A) transaction pricing is important to the growth of the global economy. If mergers are overvalued, when business cycle peaks, then the acquiring firms often have sub-optimal performance when the business cycle starts to reverse in a downward trend. Mergers & acquisitions are the main form of inorganic growth and allow companies to grow across geographical boundaries and across sectors rapidly. Traditional finance models do not consider the behavioural biases that exist in M&A pricing. This thesis intends to use agent based modelling to analyse behavioural biases that exist in M&A transaction pricing and to understand how changes in the business cycle, differing perception of synergies between the acquirer and the target firm or a situation of a hostile takeover can impact the pricing of such M&A transactions.

This agent based model considers the behavioural characteristics of risk aversion versus risk taking and optimistic versus pessimistic for the acquirer and target firm respectively. Results show that behavioural characteristics of the seller and buyer do impact the price paid in the different circumstances. For example, in an improving business cycle, acquirers are willing to overpay to purchase target firms, while it is the opposite when the business cycle trough occurs. The agent based model introduced in this thesis shows that the best time to undertake an M&A transaction is when the economy is coming out of a business cycle trough because the acquirer will not overvalue the target firm, but will be able to obtain the full value of the acquisition as the business cycle turns up. This is contrary to the existing practice, where acquirers purchase target firms when the business cycle peaks and they are often stuck with overpayment for these M&A transactions. In another circumstance, where an acquirer wants to undertake a hostile takeover, the behaviour of the target firm has some impact on price paid. An optimistic target firm can help improve the price paid by rejecting the offer made by the acquirer.

Finally, this thesis has developed an agent based model to analyse M&A transaction pricing while considering behavioural biases. The main contribution is that this is the first type of model to undertake such an analysis in relation to

M&A transaction pricing. As a result, it provides a platform to extend this discussion further and will allow other researchers to look at other factors that may impact such prices, for example, additional behavioural factors (like greed, herding, fear etc.) or transaction costs that may impact M&A pricing.

Journal Publications

The following chapters have been published in **peer-reviewed** journals:

Chapter 3 has been accepted in the **Strategic Change: Briefings in Entrepreneurial Finance** journal.

Agarwal, N. and Kwan, P. (2017). *Merger & Acquisition Pricing with Differential Synergies.* Strategic Change: Briefings in Entrepreneurial Finance, Special Issue on M&A Pricing (forthcoming), Wiley Finance, New York.

Chapter 4 and **Chapter 5** have been accepted in the **Economics, Management and Financial Markets** journal.

Agarwal, N. and Kwan, P. (2017). *Merger & Acquisition Pricing using Agent Based Modelling.* Economics, Management and Financial Markets, Vol. 12(1), p.15-24, Addleton Publishers, New York.

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CHAPTER ONE

Introduction

1.1 Introduction

Psychological pricing of mergers & acquisitions is an important field of study as companies grow mainly through organic and inorganic growth. Mergers & acquisitions (M&A) are the main forms of inorganic growth and allow organisations to expand quickly across sectors and geographic boundaries. As M&A activity is critical to the growth of the economy, it is important to make sure that such transactions are priced correctly. If we do not price M&A transactions correctly, it is possible that acquiring companies might pay a higher price for the transaction, which in turn will reduce the efficiency of the merged organization. Behavioural finance has also shown that human psychology has an impact on the way pricing of assets occurs. For example, Kahnemann and Tversky (1979) as part of their prospect theory and cumulative prospect theory stated that human beings value gains more than losses. This also occurs in the pricing of M&A transactions. As a result, this thesis intends to analyse M&A transaction pricing in view of behavioral biases by using agent based modelling.

1.2 Research questions and their significance

The main research problem that is answered in this thesis is to understand how behavioral factors impact the pricing of merger and acquisition transactions. Merger & acquisition (M&A) transactions are the main source of inorganic growth in companies and a significant part of the economic cycle, especially when merger waves result in industry consolidation that sets the industry up for cost rationalization, higher competition and growth. As a result, it is important to study M&A transaction pricing and understand how behavioral factors impact this pricing. This thesis analyses behavioral factors under the following contexts:

1. How does the acquirer and target firm's behavior impact M&A pricing at the different phases of a business cycle?

2. How does the acquirer's behavior impact M&A pricing in a hostile takeover?

3. Is there a difference in M&A pricing when the acquirer and target firm have a different analysis of the synergies to be obtained from the M&A transaction?

1.3 An original contribution to knowledge

This thesis develops agent based simulations to analyse the impact of behavior on M&A pricing under the following conditions, which is a new area of research:

1. Analyse the impact of behavior on M&A pricing during the different phases of the business cycle, and

2. Analyse the impact on M&A pricing in a hostile takeover condition and under conditions where the acquirer and target firm have a different understanding of synergies that will eventuate from the M&A deal.

1.4 Outline of the thesis

Merger & acquisition (M&A) pricing is a critical activity that impacts global economic growth. This thesis analyses the impact of behavioral factors on M&A pricing using agent based modelling. In order to undertake this analysis and to answer the research questions, the thesis is set out in the following manner:

Chapter 1 – this chapter provides the motivation and introduction to this thesis,

Chapter 2 – reviews the literature and methodology that relates to M&A pricing,

Chapter 3 – develops the agent based simulation model for analyzing acquirer and target firm behavior when both have a different view of synergies from the M&A deal,

Chapter 4 – develops the agent based simulation model to analyse the impact of behavior on M&A pricing through the different phases on the business cycle,

Chapter 5 – develops the agent based simulation model to analyse the impact of behavior on M&A pricing under a hostile takeover condition,

Chapter 6 – the final chapter of this thesis that provides a summary of the discussion, limitations and extensions of the research undertaken in this thesis.

1.5 Conclusion

In conclusion, this chapter has identified the motivation, potential research questions, the original contribution and the outline of this thesis. The intent of this chapter has been to set out the reasoning on why this thesis is valuable and the structure of the thesis to allow the reader to work through the research in order to analyse and answer the research questions. The next chapter will provide an insight into the literature review and methodology related to M&A pricing and agent based modelling, which are the main research areas of this thesis.

CHAPTER TWO

Literature Review & Methodology

2.1 Introduction

While merger & acquisition (M&A) pricing is important to economic growth, still few researchers have considered using agent based modelling to analyse it and how behavioral factors might impact this pricing outcome. The intent of this thesis is to analyse M&A transaction pricing using agent based modelling. As a result, this chapter will undertake a literature review of the M&A transaction pricing area and review the methodology related to agent based modelling.

2.2 Merger & Acquisition Pricing

Merger & acquisition tend to occur in waves. Rhodes-Kropf, Robinson and Viswanathan (2005) tested theories to identify if valuation errors impact M&A activity. In order to perform this test, they broke the Market-to-Book value ratio into three components: price divergence of firm valuation from the short run industry valuation, divergence of the long term firm's valuation from the sector wide short run valuation and finally, the firm's long term valuation compared to its book value. Their results showed that most of the market-to-book misvaluation in the short term occurs due to the divergence of the firm's valuation from the short term industry valuation. Also, they found that low long run Market-to-Book value companies tend to buy the high long run Market-to-Book value companies.

Shleifer and Vishny (2003) have raised the question that often firms can undertake misvaluation. This could potentially occur if the acquirer believes that it can gain greater synergies than actually occur in reality after the post-merger integration is completed. However, Kiymaz and Baker (2004) stated that mergers occur to maximise synergies, while divestments occur to spin-off misaligned parts of a firm. Becher (2000) analysed a sample of 558 bank mergers from 1980 to 1997 and found that target firms' stock prices usually gained 22%, while acquiring firm stock prices broke even and merged firm stock prices increased by 3% on average.

On the other hand, Robinson and Viswanathan (2005) and Shleifer and Vishny (2003) found that mergers occur in waves, where valuations depend on the market condition and the reason the merger is taking place. Krummer and Steger (2008) found that these merger waves reoccur over a few decades. But, Bouwman (2009) acknowledged that firms often undertake herding behavior that may be associated with merger waves and in these circumstances overvaluation of target firms can occur during market peaks. However, Eccels, Kersten and Wilson (1999) warned acquirers that they should not overvalue firms and should walk away from deals that are overvalued. However, this does not happen due to numerous behavioral reasons and often due to herding behavior shown by acquirers, who may overvalue target firms at business cycle peaks and then be stuck with higher debt when the business cycle turns downwards.

Kahneman and Tversky (1979) stated that human beings value gains more than losses, which means that a drop in the valuation of the target firm is more valuable to an acquirer than an equivalent gain in the valuation and vice versa from the target firm's perspective. Baker, Pan and Wurgler (2009) have empirically shown that the shareholder of target firms usually accept offers that are above the 52 week high stock price. This would mean that the shareholder of the target firm usually believe that the value obtained is equal or less than what they would receive and that the 52 week high stock price provides a better valuation. While, we have discussed M&A pricing related research, we need to review the concepts around agent based modelling to understand how the methodology was used in this research.

2.3 Agent Based Modelling

Agent based models have been developed by Famer and Foley (2009), Chan, LeBaron, Lo, Poggio, Yy, and Zz, (1999), Cont (2007), Gilbert and Terna (2000), Duffy (2006) and Windrum, Fagiolo and Moneta (2007) to review economic, financial and social science problems respectively. Agent based modelling has been successfully used in different areas of research in both academia and industry. Bonabeau (2002, p.7280) has stated that "Agent-based modeling is a powerful simulation modeling technique that has seen a number of applications in the last few years, including applications to real-world business problems". Macy and Willer (2002) have analysed social interactions using agent based modelling

to understand human interaction. Macal and North (2009, p.86) explained the application of agent based modelling as "Applications range from modeling agent behavior in the stock market, supply chains, and consumer markets, to predicting the spread of epidemics, mitigating the threat of bio-warfare, and understanding the factors that may be responsible for the fall of ancient civilizations. Such progress suggests the potential of ABMS (Agent-based modeling and simulation) to have far-reaching effects on the way that businesses use computers to support decision-making and researchers use agent-based models as electronic laboratories."

Gilbert and Bankes (2002) have explained how agent based modelling has progressed over the decades. In the 1990s, programmers used to use C++, Java, Turbo Pascal, SOAR, Dynamo, SQPC, Z and Small Talk to program. But, this progressed to more specific languages that facilitated agent based modelling like ASCAPE, REPAST, Star Logo and Agent Sheets. However, these systems had their shortcomings as well. For example, in Agent Sheets it was hard to program the interaction between agents using this program. More recently, other tools like MATLAB and Mathematica are being used for agent based modelling as they provide a set of functions and classes to program the desired agent based model.

For almost the last ten years, the agent-based modelling approach has allowed us to conceptualize and simulate an organized population of agents that have interactions among themselves and with their environment. In the social sciences, such an approach allows us to formalize complex situations with multiple scales (either spatial, temporal or organizational) and heterogeneous agents engaged in social activities as well. These agents can have more or less developed capabilities, from reactive agents constitutive of the collective intelligence to cognitive agents having more sophisticated patterns of rationality, as anticipated those patterns being formalized for instance by using appropriate logics. (Amblard and Phan 2007)

In agent-based modeling (ABM), a system is modeled as a collection of autonomous decision-making entities called agents. Each agent individually assesses its situation and makes decisions on the basis of a set of rules. Agents may execute various behaviors appropriate for the system they represent—for example, producing, consuming, or selling. Repetitive competitive interactions

between agents are a feature of agent-based modeling, which relies on the power of computers to explore dynamics out of the reach of pure mathematical methods. At the simplest level, an agent-based model consists of a system of agents and the relationships between them. Even a simple agent-based model can exhibit complex behavior patterns and provide valuable information about the dynamics of the real-world system that it emulates. In addition, agents may be capable of evolving, allowing unanticipated behaviors to emerge. Sophisticated ABM sometimes incorporates neural networks, evolutionary algorithms, or other learning techniques to allow realistic learning and adaptation. (Bonabeau 2002)

ABM is a mindset more than a technology. The ABM mindset consists of describing a system from the perspective of its constituent units. A number of researchers think that the alternative to ABM is traditional differential equation modeling; this is wrong, as a set of differential equations, each describing the dynamics of one of the system's constituent units, is an agent-based model. A synonym of ABM would be microscopic modeling, and an alternative would be macroscopic modeling. As the ABM mindset is starting to enjoy significant popularity, it is a good time to redefine why it is useful and when ABM should be used. These are the questions this paper addresses, first by reviewing and classifying the benefits of ABM and then by providing a variety of examples in which the benefits will be clearly described. What the reader will be able to take home is a clear view of when and how to use ABM. One of the reasons underlying ABM's popularity is its ease of implementation: indeed, once one has heard about ABM, it is easy to program an agent-based model. Because the technique is easy to use, one may wrongly think the concepts are easy to master. But although ABM is technically simple, it is also conceptually deep. This unusual combination often leads to improper use of ABM. (Bonabeau 2002)

Agent-based modelling facilitates the implementation of tools for the analysis of social patterns. This comes from the fact that agent related concepts allow the representation of organizational and behavioural aspects of individuals in a society and their interactions. An agent can characterize an individual with capabilities to perceive and react to events in the environment, taking into account its mental state (beliefs, goals), and to interact with other agents in its social environment. There are already tools to perform agent-based social simulation but these are

usually hard to use by social scientists, as they require a good expertise in computer programming. In order to cope with such difficulty, we propose the use of agent-based graphical modelling languages, which can help to specify social systems as multi-agent systems in a more convenient way. This is complemented with transformation tools to be able to analyse and derive emergent social behavioural patterns by using the capabilities of existing simulation platforms. In this way, this framework can facilitate the specification and analysis of complex behavioural patterns that may emerge in social systems. (Pavón et al 2008)

Agent based modelling has more recently been applied to solving economic and financial problems with a specific field of study called Agent-based Computational Economics (ACE) that has been developed. Arthur (2006, p.1551) explained how agent based computational economics could further assist in understanding human behavior stating that "Standard neoclassical economics asks what agents' actions, strategies, or expectations are in equilibrium with (consistent with) the outcome or pattern these behaviors aggregatively create. Agent-based computational economics enables us to ask a wider question: how agents' actions, strategies, or expectations might react to—might endogenously change with—the patterns they create. In other words, it enables us to examine how the economy behaves out of equilibrium, when it is not at a steady state". The next section will specifically analyse the research related to the application of agent based models to the area of finance.

2.4 Agent Based Modelling in Finance

LeBaron (2000) provided a brief summary of the field of agent based computational finance with an explanation of how agent based modelling provides a platform to develop artificial markets, where human behavior can be analysed in relation to financial market transactions. LeBaron (2006) delved deeper into specifically understand the issues around investor heterogeneity in financial markets and how that impacts asset price changes. Janssen and Ostrom (2006, p.37) stated that "There is an increasing drive to combine agent-based models with empirical methods… Four categories of empirical approaches are identified in which agent-based models have been empirically tested: case studies, stylized facts, role-playing games, and laboratory experiments." This allows agent based models to replicate real world situations and to be able to provide more specific

solutions to problems. Hommes (2002) explained how an agent based model can be used with rational agents with simple technical trading rules and stylized facts like fat tails, volatility clustering, long memory and financial stress to model asset price dynamics. Lux and Marchesi (2000) also analysed volatility clustering in asset prices using agent based modelling.

While there aren't any specific agent based models that analyse M&A transaction pricing and specifically how behavioural biases impact such pricing, nonetheless, there are other studies that used agent based models to analyse M&A transactions. However, there has been research undertaken on aspects of M&A transactions like Zedan, Bullock and Ianni (2013) that talked about using agent based modelling to analyse merger waves. Wiedlich and Veit (2008) have analysed impact of mergers between large utilities in the German electricity market using agent based models. Zedan (2013) has also developed an agent based model to analyse consolidation of financial institutions, the impact on systemic risk and market stability. Aid (2009) analysed the long-run financial risk management attributes related to European utility companies by modelling the financial risks associated with these companies using an agent based model. Schmidt (2010) analysed the M&A transaction dynamics of Chinese banks that are looking to invest outside of China. Finally, while agent based modelling is becoming more important in the financial analysis of M&A transactions, it is still in its infancy and this thesis intends to use this methodology to extend its use in this field of research.

2.5 Conclusion

In conclusion, this chapter has provided a literature review of the field of M&A pricing and agent based modelling. Initially, commencing the review of research related to conventional merger & acquisition pricing models and also some empirical research related to behavioural aspects of M&A pricing. This chapter has also reviewed research in the area of agent based modelling in general and with a focus on the applications of these models in the finance area.

CHAPTER THREE

Pricing Mergers with Differential Synergies

3.1 Introduction

Mergers and Acquisitions (M&A) transactions are a negotiation of the price that the acquirer is ready to pay for the target firm and the price that the target firm believes its worth. This price is obtained from the synergies that both the acquirer and the target firm believe they will obtain from the merger. If there is a substantial difference between the perception of synergies and the final valuation, the transaction will often fall through. The target firm's valuation and perception of synergies often is impacted by behavioural characteristics of the acquirer and target firm. We can often see two firms in the same position may have different valuations and consideration of the synergies that can be obtained. This chapter reviews how synergies and the risk-averse – risk-taking behaviour of the acquirer and optimistic – pessimistic behavior of the target firm can impact this valuation. Further, we develop an agent based model to analyse this problem. In the next section, we undertake a literature review of M&A and agent based modelling literature that relates to the problem of pricing M&A transactions. After that, we review the methodology and discuss the results obtained from the agent based model to explain the outcomes of the experiment.

3.2 Differential Synergies in Merger & Acquisition Transactions

Kahneman and Tversky (1979) stated that human beings value gains more than losses, which means that a drop in the valuation of the target firm is more valuable to an acquirer than an equivalent gain in the valuation and vice versa from the target firm's perspective. This would mean that the shareholder of the target firm usually believe that the value obtained is equal or less than what they would receive and that the 52 week high stock price provides a better valuation. Shleifer and Vishny (2003) have raised the question that often firms can undertake misvaluation. This could potentially occur if the acquirer believes that it can gain greater synergies than actually occur in reality after the post-merger integration is completed. Robinson and Viswanathan (2005) and Shleifer and

Vishny (2003) found that mergers occur in waves and the valuation depends on the market condition and reason for the merger.

Explaining this further, Kiymaz and Baker (2004) stated that mergers occur to maximise synergies, while divestments occur to spin-off misaligned parts of a firm. Krummer and Steger (2008) found that these merger waves reoccur, while Bouwman (2009) acknowledged that firms often undertake herding behaviour, where overvaluation of targets can occur during market peaks. Eccels, Kersten and Wilson (1999) said that acquirers should not overvalue firms and should walk away from deals that are overvalued. However, this does not happen due to numerous behavioural reasons. We will develop an agent based model in this paper to analyse the problem of differential synergies on M&A transaction pricing. We will start by explaining the methodology in the next section of this paper.

3.3 Methodology for the M&A Transaction Pricing with Differential Synergies Model

M&A transactions occur between an acquirer and the target firm. As a result, we have built a two-person incomplete information model using MATLAB™ 2008b to analyse this game. In this model, the acquirer has a risk-averse – risk-taking behavioural characteristic, while the target firm has an optimistic – pessimistic behavioural characteristic. These characteristics are depicted in the graphs shown in this thesis below with the acquirer's behavioural characteristic shown on the y-axis, the target's characteristic shown on the x-axis and the change in price shown on the z-axis. This model is developed using a pool of thousand players that have different levels of the two behavioural characteristics, where two players (an acquirer and a target firm) are picked from this pool at random and they compete with each other and they play a thousand rounds before the average price is calculated for that game. A hundred games are played before the average price is calculated for each 0.1 increment on the acquirer's risk-averse – risk-taking and target firm's optimistic – pessimistic continuums. The behaviors (Risk and Optimism Factors) of these individuals are also assigned at random, in order to provide the uniqueness of human behavior that we see in the real world. This allows the variety of behaviors that allows for more realistic simulations when analyzing the outcomes of this psychological M&A model. Utility of the players is calculated at the end of each game before the players are replaced back into the

pool. In order to make it easy for a reader to rerun this simulation, you will find the MATLAB code for this model that is provided in Appendix A for this model.

3.4 Results of the M&A Transaction Pricing Model

In an M&A transaction where the buyer and seller perceive there to be a minimal level of synergy (See figure 3.1 below). The level of buyer and seller synergies (labelled Low, Medium & High) relate to the Risk and Optimism factors associated to the buyer and seller. These factors are evaluated on a 0.00-1.00 continuum relating to Low-High synergies. The minimum value of the Risk and Optimism factors for the buyer and seller are 0.00. These are increased for different combinations of these factors to understand how the change in a single factor can impact the result of the game.

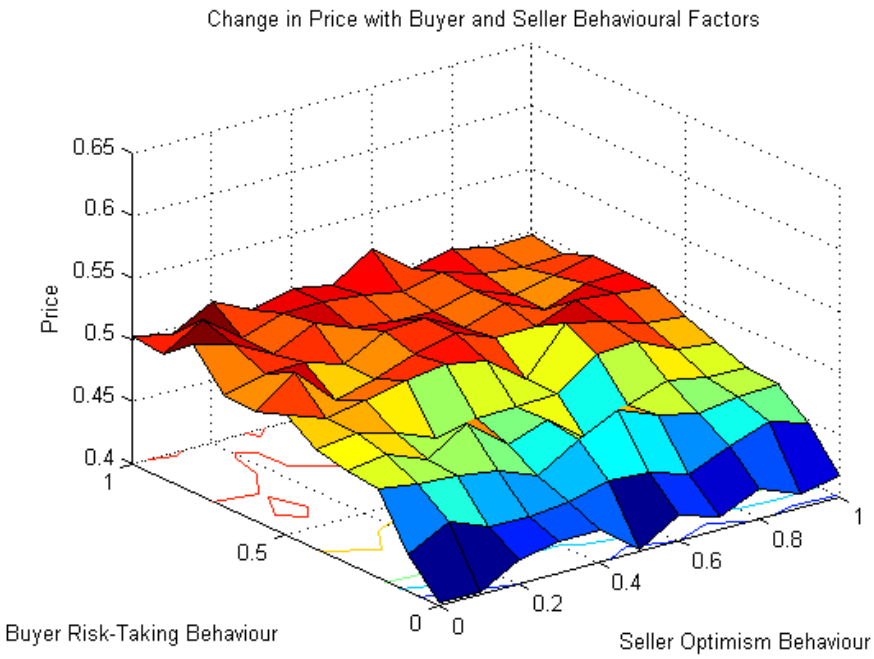

Figure 3.1. Price Dynamics in a 2-player M&A Game with Low Buyer and Seller Synergies

We notice that the acquirer's and target firm's behavioural characteristic are important in the sense that low risk-taking (acquirer) and low optimism (target) will likely lead to a failed deal. This will occur as the acquirer will perceive low levels of synergy with the target and will offer less. The target will perceive a low level of synergy and will expect less due to a low level of optimism. Where the target has a higher level of optimism, the offer will be marginally higher. When

the risk-taking behaviour of the acquirer increases, it will positively increase the price premium for the target. This occurs when the acquirer may look to pay more assuming that there could be some probability that the actual synergies may increase. In effect, this will be an overvaluation based on the existing perception of synergies by both the acquirer and target firm.

Further, if we assume that the target firm's perception of the merger synergies has increased (see figure 3.2 below), still there doesn't seem to be any specific change in the price premium provided to the buyer. It seems that if the acquirer does not perceive the increase in synergies, the acquirer will not be willing to pay a higher premium to purchase the target firm.

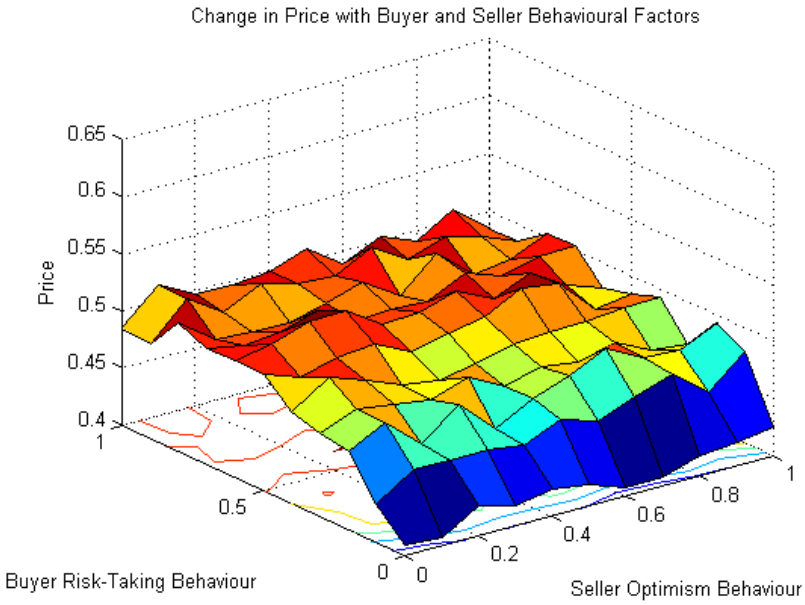

Figure 3.2. Price Dynamics in a 2-player M&A Game with Medium Buyer Synergy

However, the difference in price premium is much higher when the target firm's perception of merger synergies is high (see figure 3.3 below). The acquirer's risk-taking behaviour substantially increases the price premium (when it increases from 0.0 to 0.3). In this figure, we still notice that the target firm's perception of merger synergies has minimum (if any) effect on increasing the price offered by the acquirer. This shows that the two main considerations are the acquirer's perception of merger synergies and their risk-taking behaviour.

We can now contrast this scenario with that of a medium level of merger synergies perceived by the acquirer (see figure 3.4 below). Surprisingly, this increase in the acquirer's perception of merger synergies has not changed the overall level or gradient of the price premium. Figure 3.4 looks similar to figure 3.2, where the gradient of the graph is less than that seen in figure 3.1. In essence, when either the acquirer or the target firm believes there are medium level of merger synergies, the price premium gets to a stable equilibrium quicker (compared to figure 3.1, where it takes more time).

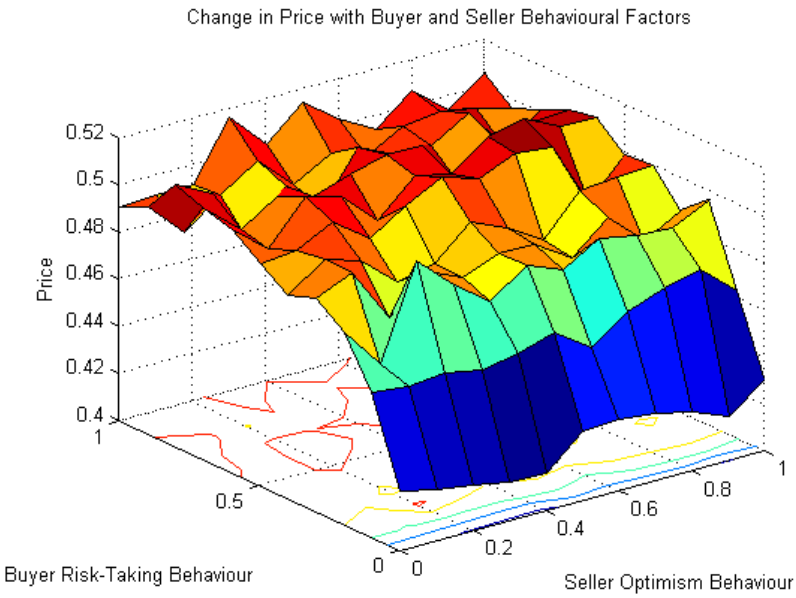

Figure 3.3. Price Dynamics in a 2-player M&A Game with High Buyer Synergy

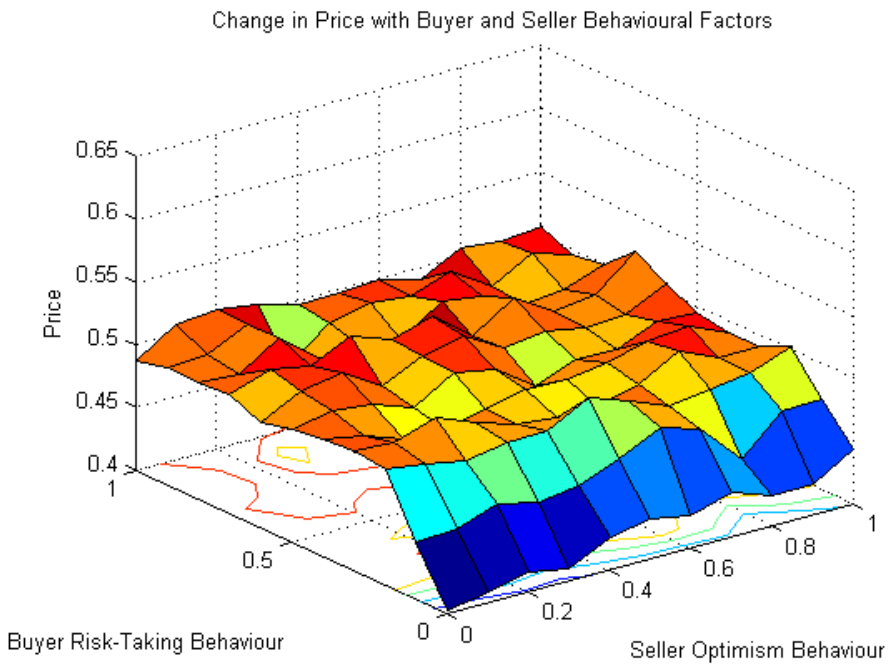

Figure 3.4. Price Dynamics in a 2-player M&A Game with Medium Seller Synergy

We can see that the acquirer's risk-taking ability has less of an effect on the gradient of the price premium graph (figures 3.2 and 3.4) when there is a perception of medium merger synergies. This may occur when the acquirer is willing to negotiate more openly with the target as they find the relationship mutually beneficial and as a result the risk-taking behaviour has a lesser effect.

In contrast, when the acquirer perceives high synergy (see figure 3.5 below), the target firm's optimistic behaviour is marginally useful as it increases the price premium. Also, the price significantly increases with an increase in the acquirer's risk-taking behaviour. The best price is obviously offered when the acquirer shows high risk-taking behaviour and the target firm shows highly optimistic behaviour.

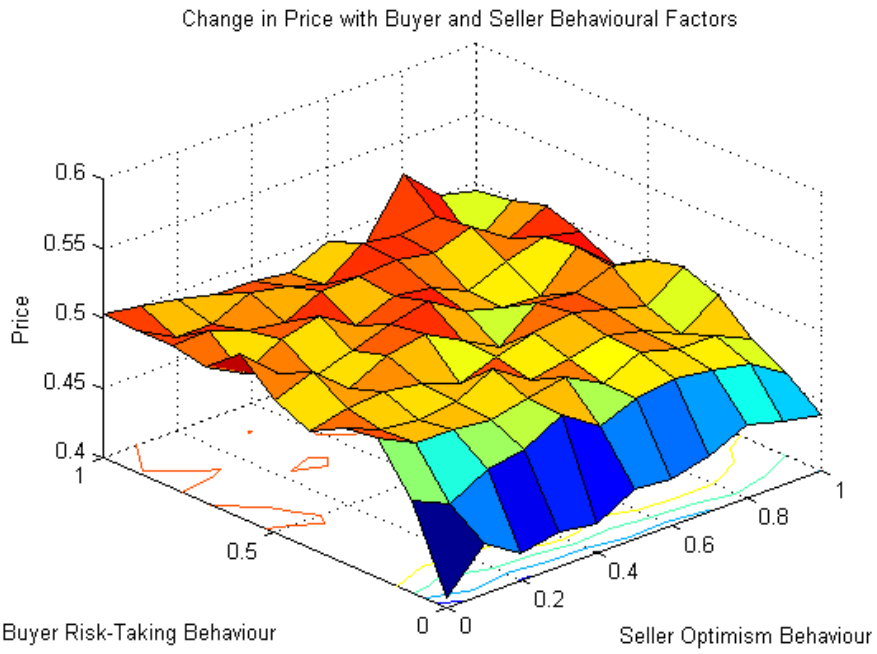

Figure 3.5. Price Dynamics in a 2-player M&A Game with High Seller Synergy

3.5 Conclusion

In summary, the pricing of M&A transactions is a complex task with some impact coming from the acquirer's and target firm's perception of potential merger synergies. Add to this the behavioural characteristics of the acquirer (risk-averse – risk-taking characteristic) and target firm (optimistic – pessimistic characteristic) it seems to become even more complicated to find out how the price dynamics will evolve. This chapter has modelled this problem using an agent based model and the results show that the acquirer's risk-taking behaviour and their perception of potential merger synergies are critical to the price offered for the target firm. The target firm's optimistic behaviour is marginally useful, mainly when the acquirer perceives high merger synergies in the M&A transaction.

CHAPTER FOUR

Pricing Mergers & Acquisitions through Business Cycles

4.1 Introduction

Behavioural finance has had significant impact on pricing of mergers and acquisitions. Baker, Pan and Wurgler (2009) have shown how investors will accept an offer near the 52 week high stock price as significant enough in a merger or acquisition scenario. However, there are numerous psychological factors that impact pricing of M&A transactions, including optimistic behaviour of sellers, risk-averse behaviour of buyers, fear, greed and similar behavioural biases. However, behavioural finance would say otherwise, as these theories show that investors react differently in falling markets compared to rising markets. Kahneman and Tversky (1979) have themselves shown that behavioural factors are biased to the downside. Humans give more weight to negative factors compared to positive factor, as reflected by the prospect theory loss aversion ratio. As a result, this chapter aims to understand if the price premium paid by buyers is different based on the buyer and seller's behaviour and if this premium differs based on the state of the business cycle when these offers are made.

4.2 Mergers & Acquisitions and Agent Based Models

Mukherjee, Kiymaz and Baker (2004) undertook a survey of CFOs and found that mergers occur in order to increase synergies, while divestures occur to concentrate on core business, while spinning off or selling non-core assets. Rhodes–Kropf, Robinson and Viswanathan (2005) have shown that merger occur in waves, and stated that this occurs due to misvaluations, where high book to market value firms buy low book to market value firms. Shleifer and Vishny (2003) also provided support for misvaluation, medium of payment that defines these mergers and reasons for merger waves to occur. While Krummer and Steger (2008) stated that these merger waves re-occur over time, Shelton (1986) found that buyer that merged or acquired seller in new but related markets obtain the most value from the merger. Bouwman (2009) found that many mergers take place at the peak of the business cycle, while these enjoy significantly higher

announcement returns (increase in stock price when the merger is announced). But, they face lower long-run returns and sub-optimal operating performance compared to mergers and acquisitions that occur in business cycle troughs. Bouwman (2009) stated that this excess number of mergers occur due to managerial herding behaviour, where excess valuations may allow managers to consider taking over other low book to market value companies. Eccels, Kersten and Wilson (1999) provided practical techniques to value merger and acquisition deals and stated that managers should walk away from overvalued deals.

While mergers and acquisitions occur at different phases of the business cycle and the behaviours of the buyer and the seller are intertwined in such decisions, it is important to analyse such situations using agent based modelling, which allows us to simulate such a scenario and understand how these behaviours impact merger and acquisition valuation. Also, how does it interact with the different business cycle phases and which part of the business cycle provides lower or higher prices and price premiums for the buyer and seller. Gilbert and Terna (2000), Duffy (2006) and Windrum, Fagiolo and Moneta (2007) explained how to build complex system models for social science experiments. While Farmer and Foley (2009) showed how agent based models can be developed to analyse economic problems, Chan, LeBaron, Lo, Poggio, Yy, and Zz, (1999) and Cont (2007) explained agent based models of financial markets using experiments.

4.3 Pricing Mergers and Acquisition and the Seller's Premium

Mergers and acquisitions occur between a buyer (acquiring firm) and seller (target firm) and can be set up as a two-player game that allows us to simulate it using agent based modelling. An agent based model is developed in this chapter to analyse the behaviour of the buyer and seller in view of finding out the price of the potential merger or acquisition transaction. This model simulates the behaviours of the buyer being on the risk-averse – risk-taking continuum and the seller being on the optimistic – pessimistic continuum. This model intends to calculate the price (in effect, the utility as defined in economics) within the two-player game between the buyer and seller. So, the price provided on the z-axis in this model is not the exact price, but simply a measure to show the change in price with the change in behavioural factors and the business cycle in this model. To clarify, the price premium (also referred to as premium or mark-up in this

thesis) refers to the increase in price compared to the different business cycle phases (trough, improving cycle after a trough and finally peak). This game is played with a pool of a thousand players with two players picked at random to play the two player game with the first being the buyer and the second the seller. They play a thousand rounds per game before the price (utility, as defined in economics) is calculated, which is portrayed in the figures provided below in this paper. Similarly, hundred games are played where the buyer and sellers are picked at random. Then, the price is averaged at 0.1 increments on the risk-taking – risk-averse continuum for the buyer and optimistic – pessimistic continuum for the seller.

4.4 Results of the Merger & Acquisition Game

As the merger game progresses, we notice that the price increases as the risk taking behaviour of the buyer increases. This potentially occurs as buyer (acquiring firm) is willing to offer a higher price for taking over the seller (target firm), refer to figure 4.1 below. We also notice that the seller's optimistic behaviour has little impact on price. However, if the seller is optimistic, then it is likely that they will decline lower offers and as a result will only accept higher offers. So, a combination of a risk-taking buyer and optimistic seller will result in the highest price being offered for the merger or acquisition deal. If the buyer wants to pay a lower price, then they should be more risk-averse and provide lower offers. On the other hand, the seller will want to be more optimistic in order to obtain higher offers from buyers and to reject lower offers. It is obviously that many deals will not go through where the combination of the buyer's and seller's behaviours does not align. The graph below only provides the potential price levels for deals that are successful, which is reflected in figure 4.1 provided below. There can be many other factors besides price that may impact on the merger or acquisition deal being unsuccessful, for example, organisational culture.

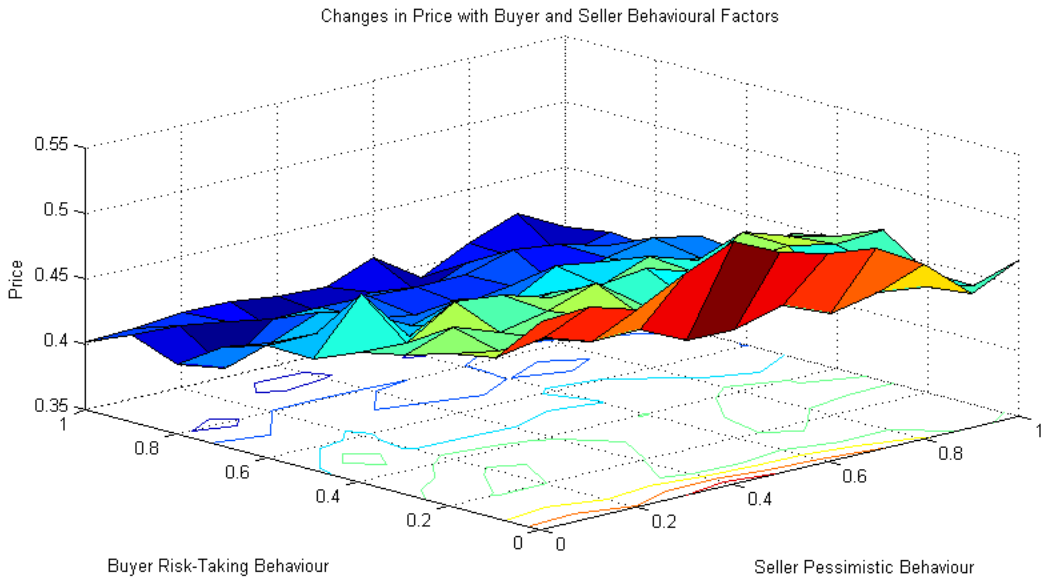

Figure 4.1. Price Dynamics in a 2-player Merger and Acquisition Game

However, this dynamic can change during business cycles as there are fewer buyers during business cycle troughs (when the economy is weak). In such a situation, sellers do not decline offers as they may be in a difficult financial situation. Buyers also know that sellers are in a difficult situation and as a result, they do not offer a higher offer to merge or acquire the seller. Figure 4.2 below reflects this price dynamics in a merger game during a business cycle trough.

In a business cycle trough, buyers are usually opportunistic and often unwilling to pay a higher price to merge or acquire a seller. This is not the same, when the business cycle turns and the economy starts improving. In an improving economy, buyers know that the price of the seller's business is increasing and a greater number of sellers will negotiate to obtain a higher price. Figure 4.3 below reflects this price dynamics in a merger game during an improving business cycle.

It is important to notice how steeply the price increases with the improvement in the risk-taking and optimistic behaviour of buyers and sellers respectively. In this scenario, the highest price obtained due to behavioural biases (when a buyer is risk-taking and seller is optimistic) is higher than the other two scenarios, when the economy is at the trough or peak. This may be the case as the value of the seller may be low in a trough and the seller may not have many options.

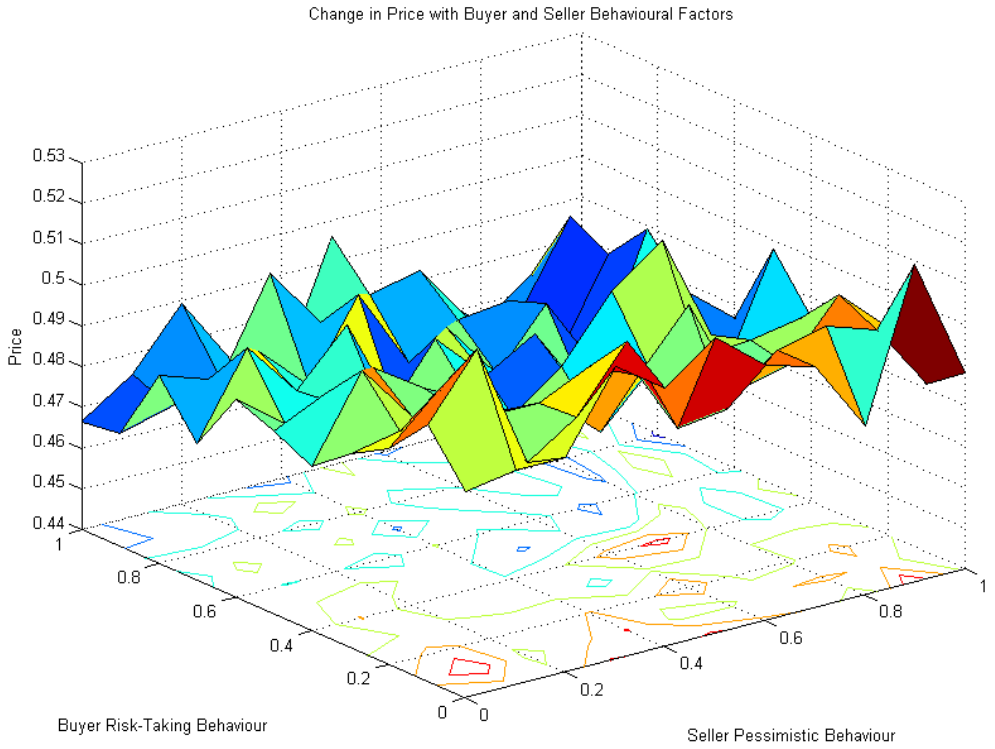

Figure 4.2. Price Dynamics in a 2-player Merger and Acquisition Game in a Business Cycle Trough

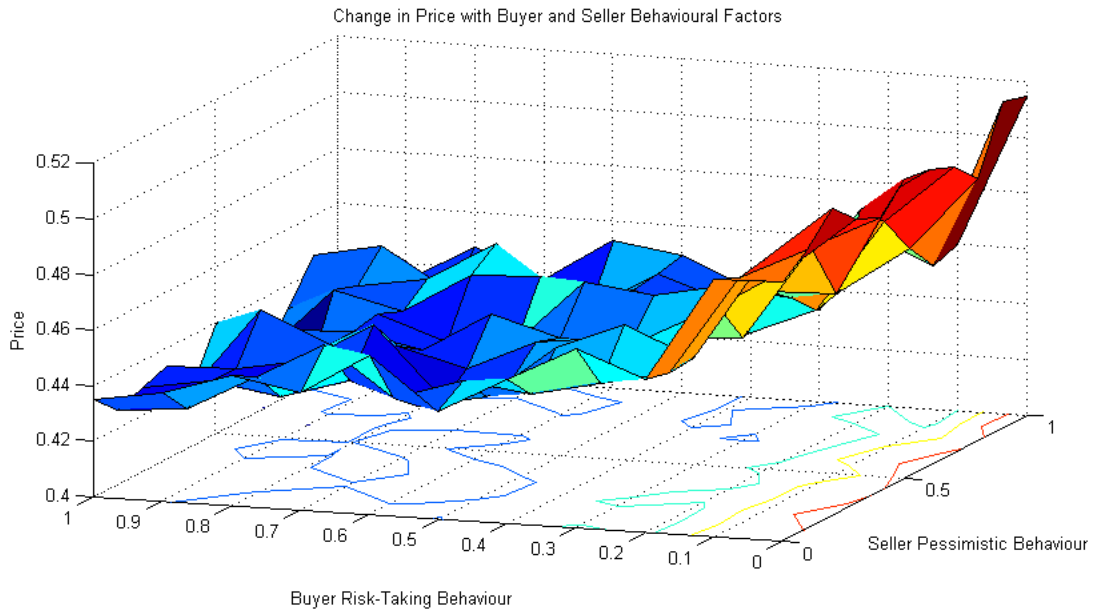

Figure 4.3. Price Dynamics in a 2-player Merger and Acquisition Game in an improving Business Cycle

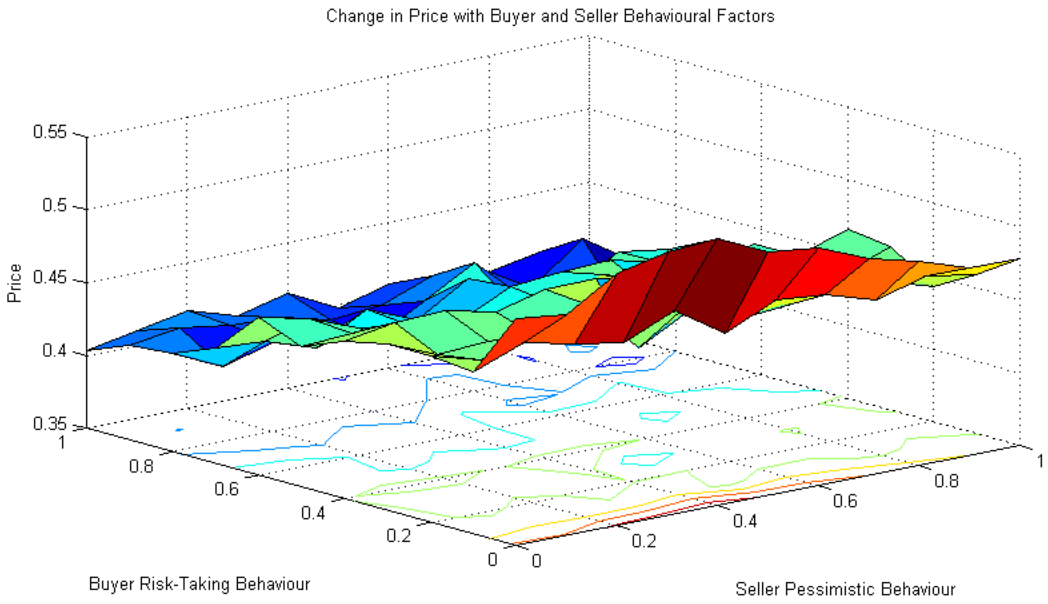

Figure 4.4. Price Dynamics in a 2-player Merger and Acquisition Game in a Business Cycle Peak

On the other hand, buyers fear of paying too high a price at a market peak and will often not pay too high a price when they are risk-taking. So, the best time to be optimistic for a seller is during an improving market. In such an instance, if the buyer is not risk-taking then the value of the seller will increase as the market improves. As a result, the buyer will be willing to pay a higher premium to undertake the merger or acquisition.

When the business cycle peaks, the potential value of company is at the highest level for that business cycle. So, it would not be wise for buyers to pay a high premium to merger or acquire the seller. As a result, the premium paid for the seller is not as high as that paid when the business cycle has bottomed and is improving from a trough. Regardless, the premium paid is highest in any condition when the buyer is risk-taking and the seller is optimistic.

4.5 Conclusion

Analysing the merger or acquisition price depends on the behaviour of the buyer and seller. In this chapter, we have only looked at the risk-taking – risk-averse behaviour of buyers and optimistic-pessimistic behaviour of sellers. Results show that optimistic sellers always receive a higher price, especially when they deal

with risk-taking buyer, who is willing to take higher risk by paying a greater price for the merger or acquisition. This increases when the business cycle is improving after it has bottomed. Premiums are lowest at the trough and peak of a business cycle. This aligns with the idea that most buyers would prefer to undertake mergers or acquisitions at the business cycle trough. Otherwise, as the business cycle improves the price and the premium (mark-up) paid to merge or acquire the seller will increase. The price will be the highest at the business cycle peak, but the premium paid by the buyer will be low (similar to what would be paid at the business cycle trough) because buyers are scared of paying higher prices as the value of the seller has peaked for that business cycle. While the buyer pays a low premium to merger or acquire the seller in the business cycle trough and peak, nonetheless, the reasons for this low premium are different.

CHAPTER FIVE

Pricing Mergers under Hostile Takeover Conditions

5.1 Introduction

Merger and acquisition transactions occur at different stages of the business cycle. However, there can be conditions where the acquirer undertakes a hostile takeover. A hostile takeover is when the acquirer tries to convince the shareholders of the organisation and bypasses the target firm's board of directors and senior management. It is an attempt to forcefully takeover the firm by obtaining shareholder approval. When pricing a merger in such a situation, the behavioural factors associated in pricing such a transaction are important. So, would it be sufficient for a hostile takeover to be possible in the same manner as any other type of merger transaction? This chapter discusses how behaviour of the acquirer and target firms impact the pricing of a hostile takeover transaction. We use agent based modelling to analyse this problem and graphically show the differences based on behavioural changes. The next section provides a brief literature review and the remaining sections develop the methodology and results of this chapter.

5.2 Pricing Mergers & Acquisitions using Agent Based Modelling

While Shleifer and Vishny (2003) stated that there is a possibility of misvaluation. Some acquirers may be willing to pay more if they believe that the target is more valuable to them compared to the price they are paying. Mukherjee, Kiymaz and Baker (2004) have found that mergers usually occur to utilise synergies and divestures result when firms consolidate their activities, thus spinning off non-core assets. Rhodes–Kropf, Robinson and Viswanathan (2005) and Shleifer and Vishny (2003) asserted that mergers occur in waves and tend to depend on market condition, which are reasons for the merger and valuation. Often tough market conditions, economies of scale or regulatory requirements may result in the commencement of a merger wave. Krummer and Steger (2008) found that merger waves re-occur overtime and Bouwman (2009) noticed that mergers often

happen due to herding behaviour that lead to merger waves. These mergers also provide a greater price premium at a business cycle peak than during troughs.

Eccels, Kersten and Wilson (1999) recommended that acquiring firms should walk away from overvalued deals rather than pursue target firms by providing higher price premiums. In a hostile takeover, acquiring firms may provide a higher offer price hoping to entice the target firm's shareholders to agree to the merger. We find that pricing mergers in practice can be quite a complicated task, as a result using an agent based modelling technique to analyse this problem seemed to be useful. Famer and Foley (2009) have identified ways to solve economic problems using agent based modelling methods, while Chan, LeBaron, Lo, Poggio, Yy, and Zz, (1999) and Cont (2007) have developed artificial markets to solve problems that relate to financial markets. Gilbert and Terna (2000), Duffy (2006) and Windrum, Fagiolo and Moneta (2007) have also built complex system models to analyse social science problems that can be leveraged to solve this two-player merger and acquisition game.

5.3 Setting up the M&A game under Hostile Takeover Conditions

A merger or acquisition occurs between an acquirer and target firm, which act as two players in a non-cooperative game, which was built in MATLAB™ 2008b as an agent based model. This model was developed to understand the interaction between the changes in price premium based on the change in the risk-averse – risk-taking characteristic of the acquirer and optimistic – pessimistic characteristic of the target firm. We see the change in the acquirer's characteristic on the y-axis and the target's characteristic on the x-axis, compared to the change in price premium (utility) on the z-axis of the graphs provided below. The definition of utility is the same as is generally used in the field of economics and is an alternative measure to the price premium provided by the acquirer to purchase the target firm. Further, this game is played with a pool of thousand players, where two players are picked up at random and they play a merger game in which they are assigned different levels of risk-averse – risk-taking and optimistic – pessimistic characteristics. These players play a thousand rounds before the price premium is calculated and averaged across these rounds. Then, a hundred games are played by different acquirers and target firms, which are also picked at random from the pool of thousand players. At the end of the hundred games, the

price is averaged for each 0.1 increment on the risk-averse – risk-taking and optimistic – pessimistic continuums.

5.4 Results of the Merger & Acquisition Game

As the merger game progresses, we notice that the price increases as the risk taking behaviour of the buyer increases. This potentially occurs as buyer (acquiring firm) is willing to offer a higher price for taking over the seller (target firm), refer to Figure 5.1 below. We also notice that the seller's optimistic behaviour has little impact on price. However, if the seller is optimistic, then it is likely that they will decline lower offers and as a result will only accept higher offers. So, a combination of a risk-taking buyer and optimistic seller will result in the highest price being offered for the merger or acquisition deal. If the buyer wants to pay a lower price, then they should be more risk-averse and provide lower offers. While, the seller will want to be more optimistic, in order to obtain higher offers from buyers and to reject lower offers. It is obviously that many deals will not go through where the combination of the buyer's and seller's behaviours doesn't align. The graph below only provides the potential price levels for deals that are successful, which is reflected in figure 5.1 provided below. There can be many other factors besides price that may impact on the merger or acquisition deal being unsuccessful, for example, organisational culture.

However, this dynamic can change during business cycles, as there are fewer buyers during business cycle troughs (when the economy is weak). In such a situation, sellers do not decline offers as they may be in a difficult financial situation. Buyers also know that sellers are in a difficult situation and as a result, they do not offer a higher offer to merge or acquire the seller. Figure 5.2 below reflects this price dynamics in a merger game during a business cycle trough.

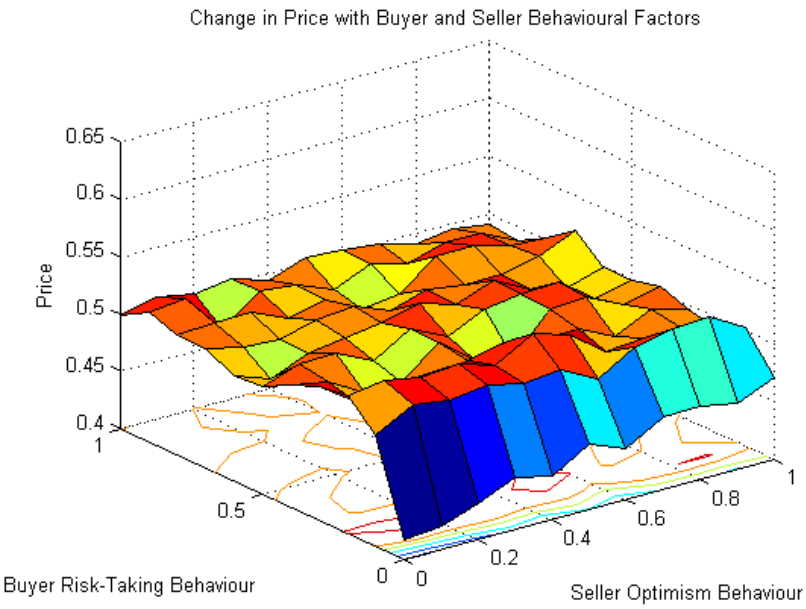

Figure 5.1. Price Dynamics in a 2-player M&A Game with Low Hostile Takeover Characteristics

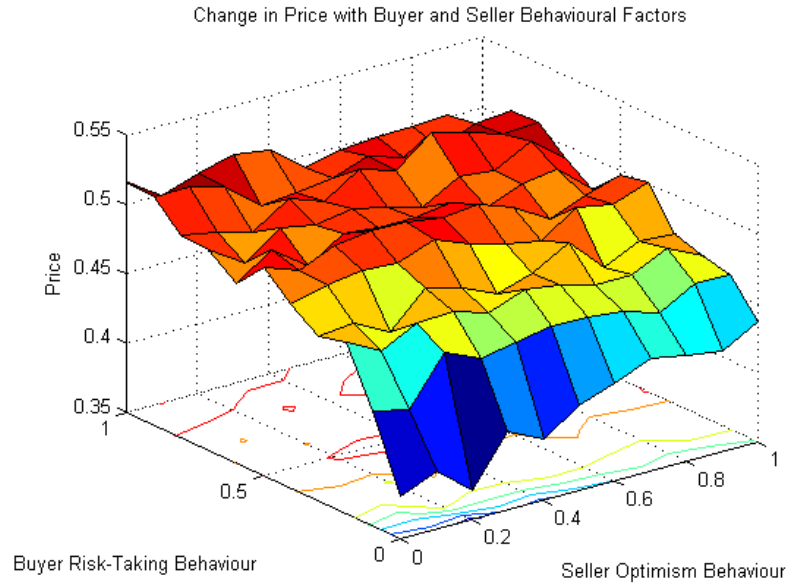

Figure 5.2. Price Dynamics in a 2-player M&A Game with Medium Hostile Takeover Characteristics

In a business cycle trough, buyers are usually opportunistic and often unwilling to pay a higher price to merge or acquire a seller. This is not the same, when the business cycle turns and the economy starts improving. In an improving economy, buyers know that the price of the seller's business is increasing and a

greater number of sellers will negotiate to obtain a higher price. Figure 5.3 below reflects this price dynamics in a merger game during an improving business cycle. It is important to notice how steeply the price increases with the improvement in the risk-taking and optimistic behaviour of buyers and sellers respectively. In this scenario, the highest price obtained due to behavioural biases (when a buyer is risk-taking and seller is optimistic) is higher than the other two scenarios, when the economy is at the trough or peak. This may be the case, as the value of the seller may be low in a trough and the seller may not have many options. On the other hand, buyers fear of paying too high a price at a market peak and will often not pay too high a price when they are risk-taking. So, the best time to be optimistic for a seller is during an improving market. In such an instance, if the buyer is not risk-taking then the value of the seller will increase as the market improves. As a result, the buyer will be willing to pay a higher premium to undertake the merger or acquisition.

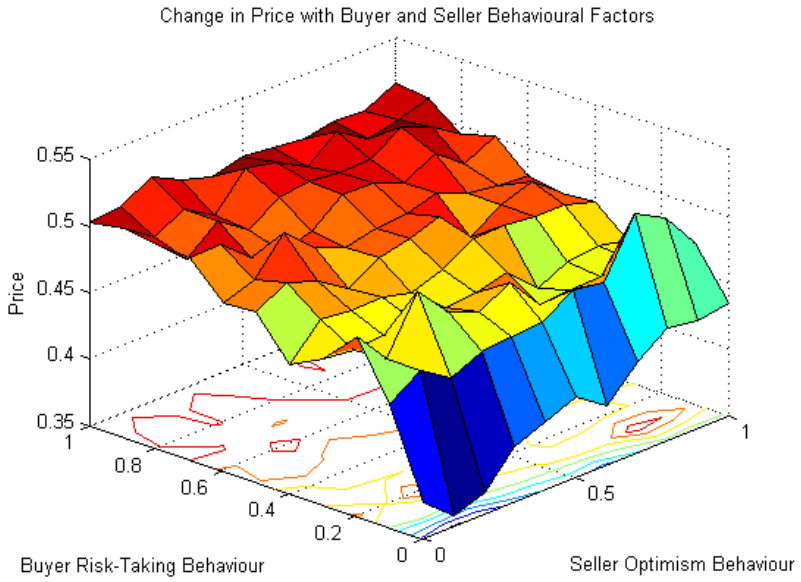

Figure 5.3. Price Dynamics in a 2-player M&A Game with High Hostile Takeover Characteristics

When the business cycle peaks, the potential value of company is at the highest level for that business cycle. So, it would not be wise for buyers to pay a high premium to merger or acquire the seller. As a result, the premium paid for the seller is not as high as that paid when the business cycle has bottomed and is

improving from a trough. Regardless, the premium paid is highest in any condition when the buyer is risk-taking and the seller is optimistic.

5.5 Conclusion

Analysing the merger or acquisition price depends on the behaviour of the buyer and seller. In this chapter, we have only looked at the risk-taking – risk-averse behaviour of buyers and optimistic-pessimistic behaviour of sellers. Results show that optimistic sellers always receive a higher price, especially when they deal with risk-taking buyer, who is willing to take higher risk by paying a greater price for the merger or acquisition. This increases when the business cycle is improving after it has bottomed. Premiums are lowest at the trough and peak of a business cycle. This aligns with the idea that most buyers would prefer to undertake mergers or acquisitions at the business cycle trough. Otherwise, as the business cycle improves the price and the premium (mark-up) paid to merge or acquire the seller will increase. The price will be the highest at the business cycle peak, but the premium paid by the buyer will be low (similar to what would be paid at the business cycle trough), as buyers are scared of paying higher prices as the value of the seller has peaked for that business cycle. While the buyer pays a low premium to merger or acquire the seller in the business cycle trough and peak, nonetheless, the reasons for this low premium are different.

CHAPTER SIX

Summary, Limitations & Suggested Extensions

6.1 Summary

Mergers & acquisitions (M&A) pricing has been a significant driver of inorganic growth. Kahnemann and Tversky (1979) have shown that human beings treat gains and losses differently. Also, Baker, Pan and Wurgler (2009) have stated that the 52-week high stock price has been seen as a significant psychological anchor for shareholders of target firms to agree to sell their stake in the company. The intent of this thesis has been to analyse M&A transaction pricing and the impact of behavioural biases on such pricing under the perception of differential synergies by the acquirer and target firm, across business cycles and in a hostile takeover condition. This thesis reviewed these issues in chapters 3 – 5 of this thesis. Results showed that psychological biases are significant in certain circumstances and should be taken into consideration when pricing M&A transactions.

6.2 Contribution to knowledge

This thesis contributes to knowledge by developing agent based simulation models to understand behavioral changes that will impact the pricing of M&A transactions. This thesis as a result adds to existing knowledge in the following ways:

1. It analyses M&A transaction pricing for behavioural biases where the acquirer and target firm have a different perception of the synergies obtained from the merger,

2. Additionally, it analyses M&A transaction pricing where behavioural biases exist across changing business cycles and under the condition of a hostile takeover.

6.3 Limitations of this research

The limitations that have been identified in this thesis are as follows:

1. **Agent Based Modelling Techniques:** there is a limitation on the number of behavioural factors that can be included in a single simulation as it complicates the analysis and it becomes hard to understand the outcomes of the analysis in the graphs.

2. **Scenario Analysis:** a few behavioral scenarios were developed in this thesis, however a significant number of additional scenarios can be developed to analyse behavioural biases in M&A transaction pricing.

3. **Behavioral Finance Biases and Transaction Costs:** there can be numerous behavioural biases or transaction costs that may distort the pricing of M&A transaction that have not been included in this analysis.

6.4 Possible applications of this research

Potential applications of the research undertaken in this thesis are as follows:

1. This model can be used as a tool by acquirers and target firms to generate a potential M&A transaction price.

2. The agent based simulation model in this thesis can be used for testing potential pricing options for M&A transaction by acquirers and target firms, before making an offer to undertake such a transaction.

3. This agent based model can be extended to include other behavioral biases impacting M&A transaction pricing and the impact of such biases can be tested.

6.5 Suggested Extensions

Suggested possible further extensions of this thesis can be developed which are explained below:

1. Extend the existing agent based model to analyse additional behavioral biases that impact M&A pricing.

2. Extend the model to understand how behavioral finance biases and transaction costs may distort M&A transaction pricing.

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APPENDIX A: MATLAB MODEL

```
N = 1000; %number of players in the game (Buyers and Sellers)
T = 100; %number of rounds in each game
Games = 100; %number of games
UtilityVector = [];
BehavioralVector = [];
UtilityMatrix = [];
BehavioralMatrix = [];
Ceiling = 1.00;
RiskFactor_Increase = 0.1;
OptimismFactor_Increase = 0.1;
BusinessCycle = 0.5;
Risk_Factor = 0.0;
Optimism_Factor = 0.0;

for a = 0:RiskFactor_Increase:Ceiling
 Risk_Factor = Risk_Factor + RiskFactor_Increase;
 UtilityVector = [];
 BehavioralVector = [];
for b = 0:OptimismFactor_Increase:Ceiling %numbers of games to be played
 Optimism_Factor = Optimism_Factor + OptimismFactor_Increase;
 X = [rand(N,1) zeros(N,1)]; %create matrix X with N rows & 2 columns
for c = 0:Games
 X(:,2) = zeros(N,1);
for d = 1:T
 PL1 = floor(1 + (N - 1)*rand(1)); %player1
 PL2 = floor(1 + (N - 1)*rand(1)); %player2
if PL1 == PL2
 PL2 = floor(1 + (N - 1)*rand(1)); % re pick player 2 to ensure it is
different from player 1
end
%calculate utility at the end of round 1
 utility1 = ((1 - X(PL1,1)) + (1 -
X(PL2,1)))*(Risk_Factor*Optimism_Factor)/2 +((Risk_Factor*X(PL1,1))-
((X(PL1,1)+X(PL2,1))*(Risk_Factor*Optimism_Factor*BusinessCycle))); %Payoff
for Player 1
 utility2 = ((1 - X(PL1,1)) + (1 -
X(PL2,1)))*(Risk_Factor*Optimism_Factor)/2 + ((Optimism_Factor*X(PL2,1))-
((X(PL1,1)+X(PL2,1))*(Risk_Factor*Optimism_Factor*BusinessCycle))); %Payoff
for Player 2

%update utility in X after round 2
 X(PL1,2) = utility1; %overwrite Utility for player 1
 X(PL2,2) = utility2; %overwrite Utility for player 2
end

 X = sortrows(X,2); %sort rows based on utility
 X(1:N/10,:) = []; %delete 10% of individuals
 Xadd = [rand(N/10,1) zeros(N/10,1)]; %add new 10% of individuals at random
 X = [X; Xadd]; %#ok<AGROW> %add new 10% individuals at random to the end
of matrix X
end
 UtilityVector = [UtilityVector mean(X(:,1))]; %#ok<AGROW>
 BehavioralVector = [BehavioralVector mean(X(:,1))]; %#ok<AGROW>
end
 UtilityMatrix = [UtilityMatrix; UtilityVector]; %#ok<AGROW>
 BehavioralMatrix = [BehavioralMatrix; BehavioralVector]; %#ok<AGROW>
end
```

```
X(N-N/10:N,:) = []; %delete newly added rows with zero utility
Buyer_Vector = 0:RiskFactor_Increase:Ceiling;
Seller_Vector = 0:OptimismFactor_Increase:Ceiling;

figure (1)
surfc (Buyer_Vector, Seller_Vector, UtilityMatrix);
xlabel('Seller Pessimistic Behaviour') %set x-axis label
ylabel('Buyer Risk-Taking Behaviour') %set y-axis label
zlabel('Price') %set z-axis label
title('Change in Price with Buyer and Seller Behavioural Factors') %set
chart title
```