INVESTIGATING THE ROLE OF REAL OPTION IN MERGERS AND ACQUISITIONS

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Investigating the Role of Real Option in Mergers and Acquisitions

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CERTIFICATE OF ORIGINALITY

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Abstract

In the thesis, I analyse the role of real option in mergers and acquisitions (M&A) in two essays. In the first essay, I examine the motivation and paring characteristics of M&A in the perspective of real option. Bradley et al. (1988) suggested that synergy is created through the capitalization of combined investment opportunities. In another aspect, the real option literature suggests that managerial discretion (or managerial flexibility) and investment opportunity are two major representative forms of real option. Therefore, I conjecture that real option must play an important role in determining synergistic value which in turn affects the acquirer's choice of targets. Applying Grullon et al.'s (2012) rationale to the estimation of a firm's real option level in the context of M&A, I find that the real option level of the acquirer gradually declines from three years to one year prior to the merger. In addition, the real option level for the target from the one year prior to the merger is significantly higher than that for the acquirer. These findings suggest that firms undertaking M&A due to lack of inherent growth usually acquire targets with more real option to facilitate future growth. In the second essay, I uncover how the firm's strategic matching characteristics impose a positive impact on the merger pairing and transaction incidence using a large M&A dataset over the period 1980 to 2006. I first show that firms with higher levels of real option are more likely to become the target while the level of real option does not determine the chance to become an acquirer. Then I show that firms with a similar real option level are more likely to form a merger. I further illustrate these findings by developing another strategic match measure based on strategic orientation and find that firms with the same strategic orientation (oriented in intellectual assets, relational assets or none of the above) are more likely to form a merger. In summary, I show that firms with similar strategic match characteristics are more likely to pair up in M&A.

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Chapter 1

Introduction

1.1 Background and motivation of the thesis

M&A mania

Ever since its first boom in 1895, global mergers and acquisitions (M&A[1]) have been through five waves so far. Especially from the 1980s on, M&A has grown exponentially both in the number of deals and the size of transaction value (as shown in figure1.1 and figure1.2). M&A has attracted lots of attention from both practitioners and academics, which can be attributed to the following reasons. First, as one of the major growth modes (e.g. organic growth, acquisitions and hybrid growth), M&A has always been an important and attractive option to managers. Studies of growth models suggest that firms cannot sustain high levels of organic growth ad infinitum as existing routines and resources may limit their ability to learn in areas beyond the current scope (Cyert & March, 1963; Nelson & Winter, 1982; Teece, 1988; Cohen & Levinthal, 1990). The organic growth firms bear the risk of exhausting their investment opportunity and

[1] The word 'merger' is defined as the consolidation or combination of one firm with another. On the other hand, the word 'acquisition' or 'takeover' is simply defined as the act of purchasing. These terms are used interchangeably under most circumstances. In this thesis, M&A refers to activities which consolidate two firms as understood in a broad sense.

innovation power. Acquisitions can offer firms an expanded investment opportunity and new knowledge to achieve future growth. In another aspect, M&A also appears more advantageous in terms of time efficiency, allowing firms to achieve large economies of scale in a much shorter time, which may further enhance their competitive position in the market. Another growth mode is hybrid which may take the form of strategic alliances or joint ventures. Desai et al. (2002) studied the formation of international joint ventures and found a trend away from minority ownership and towards whole ownership. Kogut (1991) demonstrated that forming a joint venture with a specific firm can be viewed as buying a real option for later acquisition of that firm. To sum up, while firms' selection of the three growth modes may mainly depend on their lifecycle stages, no matter which path they choose, they may most likely go into M&A somehow.

Second, the enormous size of deals and the high premium paid to the target impose significant effects on both the financial market and the wealth of participants. The high premium also causes a debate over the motives and rationality of managers' decision to undertake M&A. M&A increases market liquidity by triggering trading in the option market prior to the announcement as well as trading in the stock market around the time of the announcement. An announcement of an M&A deal usually brings about stock price fluctuations for both acquirers and targets. In addition, large sums of money are involved in the transaction, thus creating great wealth for its participants. The deal value of an individual M&A transaction can even reach up to hundreds of billions; for example, the world-famous America Online's (AOL) acquisition of Time Warner for $182 billion in 1999. Studies have shown that acquirers generally pay an average premium of 20% to 30% to acquire the target (Ferris & Petitt, 2013). However, the subsequent performance of the

combined company does not always meet the initial expectations of substantial returns. Scholars criticize that managers undertake M&A due to their hubris from a managerial psychological perspective. The hubris hypothesis of M&A suggests that managers often overestimate their abilities to run acquisitions and underestimate the difficulties in the post-merger integration process. The irrational beliefs of the profitability and benefits of a deal make managers become overly optimistic and rush into a transaction without a clear mind.

Third, M&A has lots of interesting and practical problems worth researching. Among all the unsolved M&A issues, an important and challengeable area which has received less academic attention is how to understand the optionality analysis of M&A and further incorporate it into a decision-making framework. Bruner (2004) suggested that option thinking is a fertile guide for best practices while optionality present in M&A remains largely unexplored.

The issue deserves our attention for the following reasons. First, the existence of optionality is pervasive in M&A (Schwartz & Trigeorgis, 1991). Various types of real options are embedded through the process of M&A. Managers hold the option to defer, reduce or shut down investments to mitigate the effects of a negative environment. In the meantime, they also hold the option to expand, restart or expedite investments to take advantage of a favorable environment. In addition to the tangible assets of the target, managers of acquiring firm obtain flexible discretion on a larger economic scale with more investment opportunity through acquisitions. Second, the huge uncertainty during M&A period greatly enhances the value of those embedded options, which makes them an issue that cannot be ignored. The M&A scenarios have always been highly complex

and uncertain. One of the several mainstream explanations for M&A clustering demonstrates that M&A is companies' reaction to a changing business environment due to industrial, economic, regulatory or political shocks. Under such an uncertain environment, managers' discretions on operational investment opportunities, the so-called 'real option', become more valuable. Essentially speaking, undertaking M&A can be regarded as exercising a collection of strategies. As the value of option increases with the volatility of underlying asset values, these options are quite valuable under the M&A circumstance with great uncertainty.

Recent research on real option develops important new insights that can improve decision-making. Option thinking is a fertile guide for best practices while optionality present in M&A remains largely unexplored (Bruner, 2004).

Optionality of M&A

The most prominent feature of M&A is that it always appears in waves and clusters. Studies find that the burst of M&A generally coincides with low interest rates, rising stock prices and expanding economies. While each merger wave presents its own characteristics in terms of industry focus, types of transaction (e.g. horizontal, vertical, conglomerate), breadth of the size, attitude of the bid (e.g. hostile, neutral, friendly), and the role of large blockbusters. The industry shocks theory rationalizes the waving and clustering feature of M&A and suggests that surprising changes (or shocks) in the economic environment trigger the waves of M&A. The shocks may derive from a wide range of variations in, for example, demand, technology development, globalization,

trade liberalization, taxation, accounting and government regulations. (Gort, 1969; Ravenscraft, 1987; Mitchell & Mulherin, 1996). In light of the industry shocks theory, Lambrecht (2002) further put forward a real-option framework to analyze the trigger mechanism of M&A. He demonstrated that firms have the option to make acquisitions instead of growing organically when planning for future development. In the meantime, shocks increase the uncertainty or volatility of the underlying firm's asset value and therefore the value of a merger, which induces M&As.

Real option also appears in other fields of M&A such as strategic planning, deal design and post-merger integration. For instance, in the strategic planning stage, some acquirers are inclined to buy a minority interest in the target for a seat on the board, get to know the target better through continuous observation and then either choose to complete a full acquisition to achieve synergy or drop the intended acquisition to avoid irreversible losses. In deal design, real option exists in the rights and commitments in the transaction structures (e.g. breakup terms, liquidity and control features, contingent payment schemes, and other takeover tactics such as poison pills and lockups). As for post-merger integration, the value of real option is reflected in the capability to create managerial flexibility and growth opportunity.

Bruner (2004) illustrated the forms of real option in M&A with several examples in his "Applied Mergers and Acquisitions". In the book, following the logic of dividing firm assets into assets-in-place and growth option, Bruner divided synergy into two parts: in-place synergy and real option synergy. Real option synergy takes the form of growth option synergy, exit option synergy, option to defer, option to alter an operating scale and option to switch. Growth option synergy comes from the combination of resources in a

transaction which creates the right but not the obligation to grow, which can be illustrated by examples such as R&D or creative capabilities, the matching of licenses to enter new markets with resources to do so, leases on land or mineral reserves, and access to an information base or network.

Development of real option

Real option is developed upon option concepts. Myers (1977) first put forward the concept of real option, pointing out that many corporate assets, particularly growth opportunity, can be viewed as call option. Geske (1979) further suggested that almost every opportunity with a choice whose value depends on an underlying asset can be seen as an option. Corporate investment opportunity and call option are analogous as they both endow the holder with the right but not the obligation to acquire something. Managerial flexibility is another kind of option as it gives managers the right but not the obligation to act upon assets, which enables them to capitalize on favorable future opportunity and mitigate downside losses. The analogy between financial options and corporate capital investment that create future growth opportunities has become increasingly accepted as it helps to better understand the value of capital investment.

The introduction of option thinking sheds light on the evaluation of complex and risky investment projects. The commonly applied discounted cash flow evaluation technique cannot tell managers whether to pursue a risky project which offers a below-target rate of return and may create a potentially valuable strategic opportunity or just stick with a less risky project which offers immediate benefit. Well before the

development of real option, managers made strategic investment decisions based on intuition or past experience. Critics point out that the inherent limitation of the standard discounted cash flow method lies in its incapability to capture the value of various operational or strategic options involved in investment with great uncertainty. As a result, the traditional discounted cash flow decision rule may leads to the underestimation of potential investment projects, which further result in underinvestment and eventually loss of the strategic position.

The options approach offers a good way to conceptualize or even quantify options involved in complex investments. Incorporating the real option analysis into a capital budgeting framework, managers can see a bigger picture about the value of an investment project. The option analysis framework has been applied to various investment scenarios such as research and development, natural resource investment, and land development. The early literature mainly focused on valuating individual real option in a specific scenario (McDonald & Siegel, 1986; Paddock et al., 1988; Ingersoll & Ross, 1992; Majd & Pindyck, 1987; Carr, 1988; Myers & Majd, 1990; Margrabe, 1978), while real-life investment situations are far more complex and involve a collection of interacting real options (Trigeorgis, 1993; Kogut & Kulatilaka, 1994). Even if it is able to describe the underlying stochastic process using a set of partial differential equations, there may not exist an analytic solution.

Grullon et al. (2012) found that the positive relationship between firm level stock return and changes in volatility can be explained by real options hold by the firm. The positive relationship becomes stronger when firms hold more real option. The rationale behind their explanation is that firms with real options can alter managerial operations to

benefit from the favorable business environment and mitigate the downside loss risk when face with deteriorative circumstances. Therefore, the more real options hold by the firm, the more it benefits from changing environment, which leads to the positive relationship between firm level stock return and changes in volatility. Aguerrevere (2009) divided firm assets into two parts, namely assets-in-place and growth option in the study of the effects of competition interactions on asset return. In the model setting, the sensitivity of growth option to market wide uncertainty is higher than that of assets-in-place. In addition, option value as a portion of the total firm value may vary across firms by industry and by the phase of the firms' life cycle (Tufano, 1996; Sahlman, 2008; Boer, 2002). Instead of estimating each individual real option separately, the findings of Grullon et al. (2012) offer a much easier way to estimate the overall level of real option within the firm.

Brief summary of research motivation

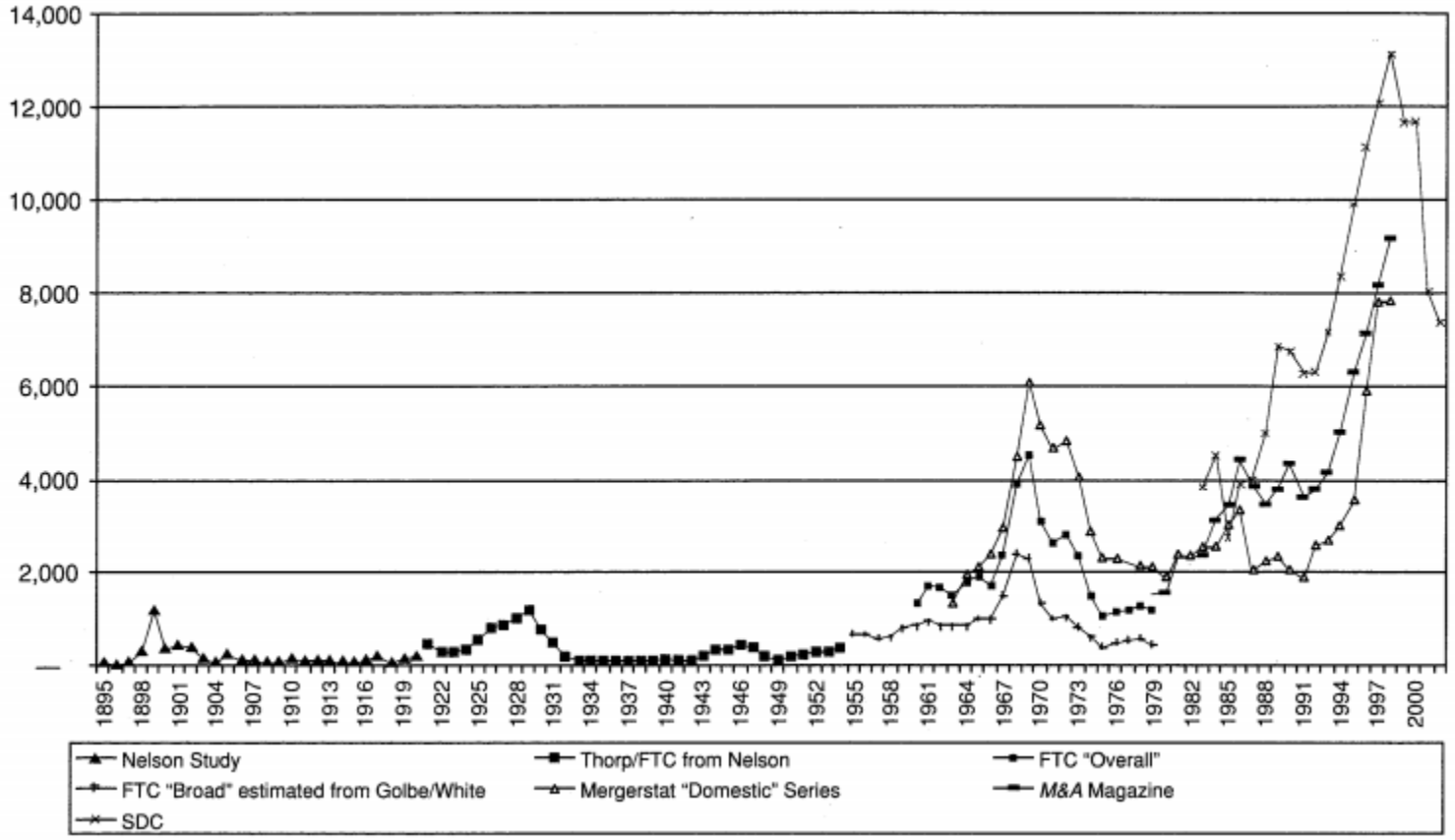
Option thinking is not new to capital budgeting investment. There is a growing awareness that many investment decisions under uncertainty can be viewed as real option problems. (Amram & Kulatilaka, 1999; Copeland & Antikarov, 2001; Schwartz & Trigeorgis, 2001). Incorporating option thinking into a traditional discounted cash flow analysis framework, managers are able to get a better understanding of project value. Until now, the real option analysis has been applied to investments such as joint ventures (Kogut, 1991), R&D (Mitchell & Hamilton,1988), emerging market (Kogut & Kulatilaka, 1994) and natural resource investments (Paddock et al., 1988; Bjerksund & Ekern, 1990;

Morck et al., 1989), while the application to M&A is relatively less. Smith and Triantis (1995) pointed out that the target firm may have several growth options that the acquiring firm lacks and considers valuable. Through a series of acquisitions over time, the acquirer can develop a collection of growth options and further enhance its competitive position. It is widely accepted that M&A abounds with real option (Bruner, 2004), while the study in this area is scant with the main focus on qualitative description or theory building due to lack of simple, applicable measurement of real option.

To practitioners, identification and evaluation of real option are like a riddle. To academics, complex investments such as M&A consist of various types of real option, and the combination of real option varies across different investment scenarios. In addition, interactions among different real options make the value of an individual real option non-additive. Therefore, the lagging in the numerical technique development limits the research method to the qualitative study or case study. The recent findings of Grullon et al. (2012) shed light on this area of study by offering a proxy for the gross level of real option within the firm. Grullon et al. (2012) found that the positive relationship between firm-level stock return and changes in volatility is due to the real option held by the firm. The more real option the firm holds, the higher the sensitivity coefficient of firm-level stock return to changes in volatility becomes. Therefore, the sensitivity coefficient can serve as a measurement proxy for the firm's gross real option level. With this simple and applicable measurement of real option, it becomes feasible to investigate how the real option level of the acquirer and the target will affect the transaction incidence and how the acquirer and the target will match each other.

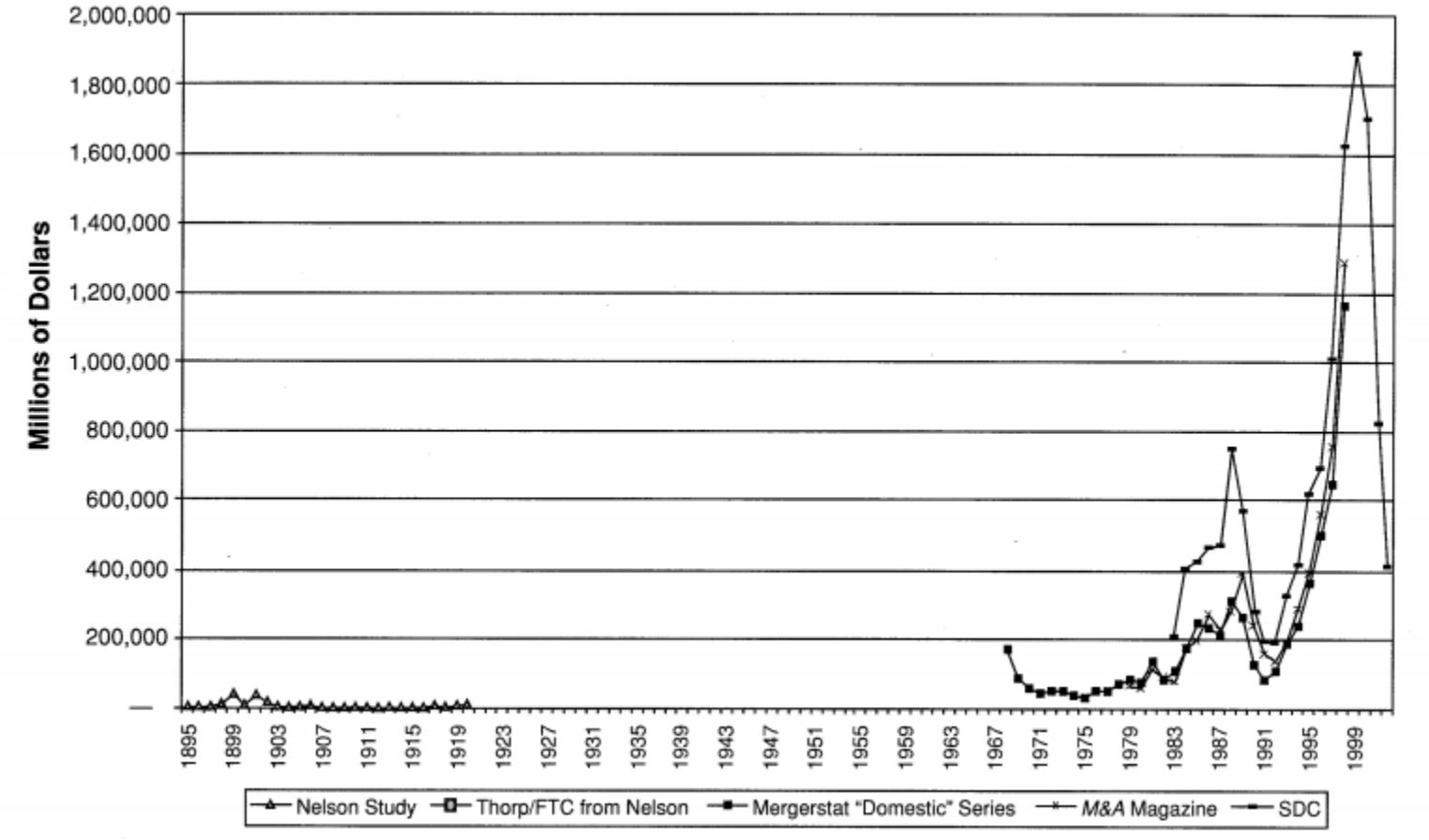
This study extends the relevant literature by adding another explanation of why companies undertake M&A from the angle of real option. Rather than giving a qualitative description, this study quantitatively shows the changes in real option levels within the firm prior to the merger. It also provides evidence that most acquirers rationally choose targets with valuable real option, which can be viewed as support of the synergy theory of M&A. More importantly, it offers quantitative insights into how managers choose targets in reality. It supplements the merger pairing literature by incorporating non-technological firms into the analysis framework. To practitioners, it offers an easy and applicable way to the proxy for firms' gross real option level, which adds another technique to the toolbox of target evaluation and proves especially practical when comparing potential targets in terms of growth option levels.

Fig. 1.1 Waves of M&A: Number of Deals per Year (Natural Scale)



Note. Cited from *Applied Mergers and Acquisitions* (p. 70) by Bruner, R. F., 2004, John Wiley & Sons

„. , Fig. 1.2 Waves of M&A: Adjusted Dollar Volume per Year (Natural Scale)



Note. Cited from *Applied Mergers and Acquisitions* (p. 71) by Bruner, R. F., 2004, John Wiley & Sons.

1.2 Design of the thesis

The whole thesis examines the role of real option in M&A from two aspects in two separate essays. Essay I mainly examines the trigger factor in M&A and the matching characteristics of bidders and targets. Essay II further investigates the ex-ante selection effect of firm-level real option on merger incidence and merger pairing. The whole thesis consists of four chapters. Chapter one briefly describes the overall motivation, background, research design, contribution of the thesis. Chapter two and chapter three are two separate essays. Chapter four makes the overall conclusions and discusses limitations of the thesis and future research directions.

Design of essay I

In the first essay, I analyze the motivation of M&A in the perspective of real option. Bradley et al. (1988) suggested that synergy is created through the capitalization of combined investment opportunities. In another aspect, the real option literature suggests that managerial discretion (or managerial flexibility) and investment opportunity are two major representative forms of real option. Therefore, I infer that real option is somehow correlated with synergistic value created in M&As and will affect acquirer's selection of targets. Applying Grullon et al.'s (2012) rationale to the estimation of firm-level real option in the context of M&A, I find that the real option level of the acquirer gradually declines from three years to one year prior to the merger. In addition, the real option level for the target in the one year prior to the merger is significantly higher than that for the acquirer. These findings suggest that firms undertaking M&A due to lack of

inherent growth opportunity usually acquire targets with more real option to facilitate future growth.

In Essay I, I first test the positive relationship between firm-level stock return and changes in volatility held within the takeover samples of 3,726 deals. Then I confirm that the positive relationship is due to the real option embedded in the firm by following Grullon et al.'s (2012) method. Showing the real option level of acquirers and target firms in three consecutive years prior to the merger, I find that the real option level of the acquirer firm declines continuously from three years to one year prior to the merger. At the same time, the real option level of the target is relatively consistent within the three years' period prior to the merger. The target's real option level is significantly higher than f the acquirer's. These findings suggest that the acquirer generally experiences a drop in either investment opportunity or managerial flexibility, which triggers the acquisition of the target to facilitate future continuous growth. In choosing the targets, the acquirer prefers firms with more real option and more consistent performance. To check the robustness of this result, I further classify acquirers by different criteria claimed to be proxies for investment opportunity and calculate the change in the real option level for them and their respective targets. The findings are consistent with those found previously. I find that the acquirer holding less real option acquires more real option intensive target.

Design of essay II

In the second essay, I discover how the firm's real option level affects its probability to become an incidence firm (either acquirer or target) and how the firm's strategic matching characteristics impose a positive impact on merger pairing and transaction incidence. I first show that firms with higher levels of real option are more likely to become the target while the level of real option does not necessarily determine the chance to become an acquirer. Then I show that firms with a similar real option level are more likely to form a merger. I further illustrate these findings by developing another strategic match measure based on strategic orientation and find that firms with the same strategic orientation (oriented in intellectual assets, relational assets or none of the above) are more likely to form a merger. In summary, I show that firms with similar strategic match characteristics are more likely to pair up in M&A.

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Chapter 2

Examine how acquirers choose their targets in a real option perspective

2.1 Introduction

Studies show that in the United States average takeover premiums have ranged from 30 to 50% of target market values in the past decades (Hayward & Hambrick, 1997). Various reasons have been attributed to takeover premiums (Roll, 1986; Shleifer & Vishny, 2003; Slusky & Caves, 1991; Moeller et al., 2005). Some scholars criticize that managers pay too much in takeovers at the expense of shareholders' benefits. Roll (1986) pointed out that bid managers infected with hubris often overestimate potential synergistic gains from a transaction and overpay for the target. While other scholars suggest that synergy is an important driven factor in high premium (Moeller et al., 2005). Bradley et al. (1988) suggest that the synergistic value is created through the capitalization of combined investment opportunity and resource redeployment. Weston and Weaver (2001, p.131) pointed out that external means of growth such as mergers and acquisitions (M&A) are triggered by lack of investment opportunity for the firm to achieve efficient internal growth. To sum up, apart from M&A made due to irrational reasons, those made by managers with the incentive to increase shareholders' benefits are generally motivated by lack of investment opportunity to facilitate future growth; synergy is achieved by capitalizing on the combined investment opportunities with a

major part coming from the targets. Following Myers' (1977) initial idea of discretionary investment opportunity as growth options[2], studies show that investment opportunities are positive related to real option (Grullon et al., 2012). In this study, I conjecture that the real option of the target is a key determinant of synergistic value in takeovers. Therefore, acquirers usually choose targets with more real option so as to achieve larger synergistic value. This study quantitatively shows that acquirers acquire targets with higher levels of real option. In addition, the acquirer owning less real option prior to the merger tends to acquire more investment opportunities.

Due to its abstract nature, it is challenging to measure synergistic value even though numerous attempts have been done to quantify it. Most quantifying studies measure synergistic gains through transaction premiums. This method is dubious since in reality managers pay premiums for various reasons and it is hard to isolate a single synergistic effect. Recently, in Barraclough et al.'s (2013) study of overpayment in takeovers, the synergistic value is inferred from stock option trading prior to the acquisition. However, an essential prerequisite of the approach is that there must exists financial option trading data for both acquirer and target firm, which reduces the sample size significantly (from 31408 to 167).

The traditional target evaluation framework widely applied to industry such as the DCF model cannot meet the requirements due to its inherent limitations in its inability to capture the value of managerial flexibility and growth opportunity. Most M&A deals are motivated by strategic objectives aiming at the future development of a company rather than immediate benefits. Because of managers' growing cognition about operations and

[2] Growth option is one type of real option. In this article, the two phrases are used interchangeably.

the changing business environment, more and more acquirers seek targets that are strategically fit for the company, which may create synergistic value upon the combination of two companies. In addition to investment opportunities, the target furnishes the acquirer with more managerial flexibility in operations.

Real option may play an important role in M&A even though it gets little attention in prevailing studies. Following Myers' idea of discretionary investment opportunity such as growth option, scholars find that investment opportunity is positively related to real option (Grullon et al., 2012). Thus, it is not difficult to infer that real option positively affects synergistic value to be created. Bruner (2004) further divided synergy into two types, namely synergy-in-place and real option synergy, which was inspired by Myer (1977), who viewed firm value as the total value of assets-in-place and growth option. Synergy generated by assets-in-place is generally foreseeable prior to the transaction, while synergy originating from growth option is more difficult to measure due to uncertainties. By acting upon the combined firm assets and capitalizing on favourable investment opportunities, the combined firm gains synergistic value that cannot be achieved alone. In doing so, synergy can be partially viewed as a collection of real options.Therefore; real option must play a more important role in determining the value of synergy in M&A.

Since the concept of real option was first put forward in 1977, the related literature has been growing tremendously in branches including concept building, applications, and valuation techniques (McDonald & Siegel, 1986; Ingersoll & Ross, 1992; Majd & Pindyck, 1987; Carr, 1988; Brennan & Schwartz, 1985; Myers & Majd, 1990; Margrabe, 1978; Kensinger, 1987; Brealey & Myers, 2000; Kester, 1984; Chung & Charoenwong,

1991). Most of the valuation studies only focus on one specific case each time and deduce analytic solutions from models on strict assumptions. However, the reality is much more complex as there are multiple interacting real options involved in investment and sometimes it is not possible to write down the set of partial differential equations describing the underlying stochastic process (Schwartz & Trigeorgis, 2001). Recently, Grullon et al. (2012) provided a new insight into the measurement of firm's real option level. They found that the positive relationship between firm-level stock return and volatility changes is due to the real option held by the firm. The rationale behind this finding is that firms with real option can mitigate downside losses and amplify good news by flexibly changing the operating strategies. The increase in the volatility of underlying process will thus impose a positive impact on firm value. Therefore, the more real option the firm holds, the more it benefits from the increase in volatility. This approach offers the possibility to study the role of real option in M&A.

By applying Grullon et al.'s (2012) rationale to the estimation of firm-level real option in the context of M&A, I study the role of real option to explain the motivation of M&A and how bidders choose targets prior to the transaction.

First, I apply Grullon et al.'s (2012) evaluation framework to the sample which consists of acquirers and targets to test whether the positive relationship between firm-level stock return and volatility changes still holds within the M&A sample. The results show that, the positive relationship of firm-level stock return and volatility changes still holds for both acquirers and targets within the M&A sample.

Second, I test whether this positive relationship between firm-level stock return and changes in volatility is driven by the real option held by the firm. I use two methods to test this relationship. The rationale is as follows. The more investment opportunities the firm possesses, the higher the proportion of the firm value is represented by real option; and the fewer investment opportunities the firm possesses, the more the firm value is represented by assets-in-place. On the other hand, as the sensitivity coefficient of stock return to changes in volatility and firm real option are positively correlated. Therefore, the higher proportion of the firm value presented by real option, the higher the real option level, resulting in a stronger sensitivity coefficient. I then adopt four proxies for investment opportunities suggested by the literature including firm size, age, R&D intensity and future sales growth. The results show that the contemporaneous relationship between firm-level stock return and changes in volatility is stronger among firms with abundant investment opportunities and is much weaker among assets-in-place firms. Following the definition of real option intensive industries by Grullon et al. (2012), I further classify targets into real option intensive and real option non-intensive based on the industries they belong to. I find that the positive relationship is significantly stronger for the real option intensive subgroup than for the real option non-intensive subgroup.

Third, after testing the applicability of Grullon et al.'s (2012) indicator of firms' real option level within the M&A sample, I investigate how the firm's real option level changes over the period of M&A. I classify the firm-years into six subgroups including three years prior to the merger and three years after the merger based on the specific time of the takeover. I find that acquirers' real option level experiences a decline in the prior merger period while targets' real option level is more consistent. In addition, the real

option level for the target in the one year prior to the merger is significantly higher than that for the acquirer, indicating that the transaction results from lack of inherent growth opportunity and acquirers usually look for targets with more real option.

Fourth, to further testify the findings mentioned above, I classify the acquirers into two subgroups for each of the investment opportunity proxies. I find that acquirers with less investment opportunity acquire targets with higher levels of real option. This finding is consistent with the previous finding that acquisitions are generally triggered by declining investment opportunities of acquirers.

The remainder of the chapter is organized as follows. Section 2 reviews the literature on M&A and real option. Section 3 develops the hypotheses. Section 4 discusses the methodology. Section 5 and section 6 report data and results. Section 7 concludes the chapter.

2.2 Background and Literature Review

Synergy

It has long been argued that synergy is the most intuitive appealing and important driven factors of M&A activities. It is very likely that the motivation to exploit more operating synergy has triggered the merger wave (Moeller et al., 2005). Synergy can be defined as the incremental value after two firms merged with each other, which is the difference between the value of the combined enterprise and the aggregate value of two stand-alone firms. It is easy to understand synergy by intuition rather than measure it accurately. In the management literature, synergy is proxied by business relatedness

(Wrigley, 1970; Rumelt, 1974; Montogomery, 1982; Palepu, 1985). While in the finance research area, synergy is usually roughly measured by market reactions around the critical time points such as the announcement date (Bradley et al., 1988; Lang at al., 1989; Servaes, 1991; Seth et al., 2000).In the study of Bhagat et al.'s (2013) study, synergy is measured by the bidder's and target's abnormal stock prices fluctuations around the time of an intervening offer from a rival firm. Luo (2005) developed an iterative system to estimate synergy as the function of weighted average of acquirer's and the target's cumulative abnormal returns around the announcement. Although market reaction as a measure of synergy is widely adopted in the research, it suffers from the problem that it does not purely reflect the synergistic effect but mix up other effects such as information

Real Option perspective

Myers (1977) first put forward the idea of viewing investment opportunities as growth option (i.e. real options). After that, the real option was well examined in various aspects from theoretical models to empirical investment scenarios. (McDonald and Siegel, 1986; Grenadier, 2002; Aguerrevere, 2009).

Most of these studies value real option by deriving analytic, closed-form solutions based on models developed upon strict assumptions. It is hard to apply those evaluation models to the valuation of real option in M&A since different kinds of real option are embedded in transactions with different strategic goals and it is infeasible to simply add up the values of different single real options.

The most recent and relevant study is Grullon et al. (2012), which proves that the positive sensitivity coefficient of firm-level stock return to changes in volatility reflects firm's real option level. They shows that the sensitivity coefficient is higher for real option intensive firms and drops significantly after firm exercise the real options. The rationale behind the positive sensitivity coefficient is that firms with more real option can take better advantage of the volatility through discretionary managerial flexibility. Therefore, an increase in the volatility will add value to firms with real options, leading to a positive coefficient between firm stock return and changes in volatility.

Real option literature suggests that investment opportunity and managerial flexibility are two major representative forms of real option. The more investment opportunities the firm possesses, the higher managerial flexibility the firm owns, the larger its real option value is.

2.3 Hypotheses Development

The literature has suggested various motivations behind takeover activities; for example, synergy effect (Healy et al.,1992) removal of underperforming management teams of the target (Martin & McConnell, 1991, Mikkelson & Partch, 1997; Denis & Kruse, 2000), industry restructuring (Mitchell & Mulherin,1996; Harford, 2005), overvaluation (Shleifer & Vishny, 2003), agency (Jensen, 1986; Harford, 1999), and hubris (Roll,1986). Each of these theories partially explains the phenomena in a qualitative way while hardly any quantitative analysis has been done. Part of the synergy literature tries to infer synergistic value from acquirers' cumulative abnormal return

around the announcement of the bid and the results are very mixed (Martynova & Renneboog, 2008), while the best part of the literature basically explains how synergy can be achieved. Bradley et al. (1988) suggested that synergistic value created in takeovers depends on how the acquirer can capitalize on the combined investment opportunities related to technological innovations and resource redeployment. Weston and Weaver (2001, p.131) pointed out that the external means of growth as M&A is triggered by lack of investment opportunity and inability to achieve efficient internal growth. In many cases, when firms grow to a certain size, internal growth becomes very time-consuming and difficult to achieve. M&A provides the opportunities of external growth for this kind of companies. Acquirers obtain discretionary investment opportunity when the majority ownership of the target is acquired and therefore combine investment opportunities to facilitate future corporate development post-merger. Klasa and Stegemoller (2007) further pointed out that M&A occurs when managers respond to changes in their investment opportunity. That is, many takeovers are the results of firms seizing growth opportunity as seen by themselves and the market. Some large companies may come to a stage where internal efficiency has been achieved and future development can no longer be sustained by internal growth. At this stage, these companies may have steady cash flow but lack growth opportunity. At the same time, small companies in the industry may create more growth opportunity due to their flexibility but lack capital required for valuable investment projects. In this situation, an acquisition can create value if the acquirer's excess capital enables the target to undertake an increased number of favorable investments. By reallocating capital and exercising growth option, both companies can achieve growth after the acquisition. This kind of 'financing-motivated' takeovers often appear in infrastructure-based or strategic industries, especially those

with high-tech and intensive R&D, or industries with multiple product generations or applications such like computers and pharmaceutical products. (Erel et al., 2012).

When the acquirer acquires more than 50% of the target's shares, it can obtain the cash flow from the target and the discretion on investment opportunity. The discretion or so-called "managerial flexibility" is valuable to the acquirer especially when faced with uncertainties. (Majd & Pindyck, 1987). As the continuous arrival of new information gradually resolve the uncertainties about business environment and future cash flow, managers can capitalize on favorable future opportunity or mitigate downside losses by altering operating strategies. When the environment is favorable, managers often choose to expand the production scale or capitalizing on more investment opportunities. Conversely, when the environment becomes adverse, managers can decrease the scale of operation or even shut down parts of the business until the conditions improve. If the business environment continues to deteriorate, managers can even abandon current operations permanently and sell capital equipment and other assets. This switching type of operating flexibility is especially significant for cross-border acquisitions in utilizing favorable situations by switching domestic and foreign markets. With the control of downside risk and seizing of favorable opportunity, firms can achieve a better performance than inflexible ones. Therefore, synergy can be regarded as a series of real options contingent on underlying operating assets of the combined company.

In addition to operating flexibility, there are some other forms of flexibility. Training and learning can create a more flexible workforce, and this flexibility constitutes a valuable real option. Similarly, at corporate level, gaining more know-how creates strategic competencies that are valuable. Examples include buying a toehold minority

interest before completing the acquisition and buying an established company (also known as ‘platform acquisition strategy’).

In summary, acquirers obtain more investment opportunity and managerial flexibility through M&A. As investment opportunity and managerial flexibility are two major forms of real option (Grullon et al., 2012), it is appropriate to regard investment opportunity and discretion as real option. As analyzed previously, takeovers s may result from lack of investment opportunity or managerial flexibility or both, and investment opportunity and managerial flexibility are two major forms of real option; therefore, acquirers’ level of real option must experience a decline before the merger.

As analyzed above, firms continuously create and exercise different kinds of real option through the merger. They exercise the option by acquiring target firms and generate new real options as a combined company that consists of the acquirer and the target post-merger, which can be roughly classified as growth option and managerial flexibility option. As those real options are embedded within firms, with the creation and exercise of those real options, firms’ value may be affected from time to time. Fortunately, recent studies about the real option-driven relationship between stock returns and volatility changes allow us to approach the value of those real options in an indirect way.

Grullon et al. (2012) pointed out that the positive relationship between firm-level stock returns and firm-level volatility is due to firms’ real option. They found that the positive volatility-return relationship is much stronger for firms with more real option and that the sensitivity of firm value to changes in volatility declines significantly after firms

exercise their real option. In other words, the sensitivity of firm value to changes in volatility can be regarded as an indicator for the level of real option embedded in the firm, which further indicates creating or exercising of real option. By undertaking M&A, firms exercise their option to invest. In the meantime, acquirers obtain the discretion to exercise the real option owned by the target and that accumulated by the combined firm.

In most cases, M&A is regarded as a growth strategy for companies that can no longer achieve efficient internal growth. In this situation, acquisition is served as a vehicle to facilitate growth in the acquiring firm. In another situation, an acquisition can also take place between a financial slack acquirer and a financial constrained target. The target firm lacks the capital to seize their investment opportunities, yet the acquiring firm may lack the growth opportunity but has excess capital. As the acquiring firm lacks investment opportunity and the target abounds with investment opportunity, the target's real option level must be higher than the acquirer's.

Before making the final bid, the acquirer investigates all the possible targets carefully and decides which one to acquire and how much to pay. In selecting desired targets, companies with the largest potential to fulfill the strategic need of the acquirer are always preferred and the acquirer is always willing to pay more for those companies. But how to judge whether the target can bring strategic value to the acquirer? Though it is difficult to make an accurate projection of the future, it is reasonable to make inferences based on the current state of the target firm since the target's advantages may turn to an enhancement treatment to the acquirer and the target's drawbacks may be eliminated after the takeover.

2.4 Methodology

Return-volatility relation

I first verify the positive relationship between firm-level excess returns and changes in volatility documented by Duffee (1995 & 2002) and Albuquerque (2012) in our sample for both acquirers and targets. Following Grullon et al. (2012), I estimate the monthly cross-sectional Fama-MacBeth (1973) regression of individual firms' excess returns on contemporaneous changes in firm-level monthly volatility, $\Delta VOL_{i,t}$, and a vector of firm characteristics, including log market equity, log book-to-market ratio, past returns and contemporaneous trading volume (based on previous asset pricing literature (e.g. Fama & French1993; Jegadeesh & Titman,1993; Cooper et al.,2008; Karpoff, 1987).The regression equation takes the following form:

$$r_{i,t} - r_{f,t} = \alpha_t + \beta_t \Delta VOL_{i,t} + \gamma_t \eta \widehat{MKT}_{\iota,t} + \overrightarrow{\delta_t} x_{i,t} + \varepsilon_{i,t} \quad (2.1)$$

The excess individual firm return is calculated as the difference between firm return $r_{i,t}$ and the monthly risk-free rate $r_{f,t}$. By following Ang et al. (2006 & 2009) ,Duffee (2002) and Grullon et al. (2012), the volatility of firm i during month t is measured as the standard deviation of firm i's daily stock return during month t, which takes the form of :

$$VOL_{i,t} = \sqrt{\frac{\sum_{\tau \epsilon t}(r_{i,\tau} - \overline{r_{\iota,t}})^2}{n_t - 1}} \quad (2.2)$$

In following Grullon et al. (2012), $r_{i,\tau}$ is the natural logarithm of firm i's stock gross return on day $\tau \in t$, $\overline{r_{\iota,t}}$ is the mean of the logarithm of firm i's daily gross stock returns during month t. The natural logarithm returns are used here to mitigate the

potential mechanical effect of return skewness (Duffee, 1995) on the relationship between returns and cotemporaneous return volatilities. The change in volatility of firm i in month t is calculated as the difference between firm i's volatility in month t and volatility in month $t-1$.

The market equity is calculated as the product of share price at the end of June and the number of shares outstanding. Book equity is calculated using stockholders' equity minus book value of preferred stock and post-retirement benefits assets if available, and plus balance sheet deferred taxes and investment tax credit if available. If a stockholder's equity is missing, I calculate the sum of common equity and preferred stock par value for substitution. If these variables are missing, I use book assets minus liabilities. When calculating the book-to-market ratio, I calculate the market value as the product of December closing stock price and the number of shares outstanding. In following Grullon et al. (2012), the returns from January to June of year t are matched with COMPUSTAT-based variables of year $t-2$, while the returns from July to December of year t are matched with COMPUSTAT-based variables in year $t-1$. Past returns are six-month buy-and-hold return over month $[t-7, t-2]$, which is calculated as $[(1+r_{t-7}) \times (1+r_{t-6}) \times \cdots \times (1+r_{t-2})] - 1$, where r_{t-i} is the stock return in month $t-i$. The contemporaneous trading volume is calculated as the monthly trading volume divided by the number of shares outstanding. The estimated coefficient on market portfolio return $\eta\widehat{MKT}_{\iota,t}$ is estimated by the following regression:

$$r_{i,\tau} - r_{f,\tau} = \alpha_{i,\tau} + \eta MKT_{i,t}\left(r_{m,\tau} - r_{f,\tau}\right) + \varepsilon_{i,\tau} \quad (2.3)$$

Where $r_{i,\tau}$ is firm i's stock return in day τ of month t, $r_{f,\tau}$ is the daily risk-free rate and $r_{m,\tau}$ is the value-weighted market portfolio return.

Proxy for real options

As analyzed previously, real option mainly takes two different forms, namely investment opportunity and managerial flexibility. In this study, I investigate real option in terms of investment opportunity. Following Grullon et al. (2012), I use four proxies for investment opportunity.

The first proxy is firm size, which is measured as the book value of firm's total assets. Myers (1977) pointed out that a firm's market value is presented by both assets-in-place and growth option (i.e. potential investment opportunities). Brown and Kapadia (2007) suggested that large firms tend to have a higher proportion of their firm value represented by assets-in-place and small firms tend to rely heavily on investment opportunity. Therefore, firm size is adopted here as an inverse proxy for a firm's investment opportunity.

The second proxy is firm age. As documented by Grullon et al. (2012), older firms tend to have more of its value presented by assets-in-place. Firm age is defined as the difference between the year the firm's stock first appears in CRSP monthly files and the year the firm's stock last appears in CRSP monthly files.

The third proxy is R&D intensity which is defined as the annual R&D expenditure over total assets. Since R&D generates investment opportunity, the firm with a relatively large R&D expenditure is expected to have more real option.

The fourth proxy if future sales growth, which is measured as the difference between the sales four years after the observation year and the sales in one year after the observation year divided by the sales in one year after the observation year. The exercise of real option may lead to the increase in sales, therefore, the future sales growth can reflect the real option level at present.

In some studies, the market to book ratio is also perceived as a proxy for investment opportunity (Adam and Goyal, 2008). As the market value captures both the value of assets-in-place and the value of investment opportunity and the book value only captures the value of assets-in-place. Therefore, the market to book ratio and firm's investment opportunities are positively correlated.

It is worth mentioning that each proxy mentioned above imperfectly reflects information with respect to investment opportunity and those proxies for investment opportunity may also be proxies for other variables. In addition, they may have empirical shortcomings as investment opportunity proxies do. For example, the market-to-book equity ratio is also a proxy for firm performance and is affected by leverage. Firms with high leverage but low growth prospects may have a market-to-book ratio higher than what is implied by investment opportunity alone. Therefore, these four proxies are tested simultaneously to mitigate potential bias.

To further investigate the driven factor in the relationship between firm-level stock return and volatility changes, I follow Grullon et al. (2012) and estimate the following regression with an intersection variable of the changes in volatility and one of the four proxies for investment opportunity.

$$r_{i,t} - r_{f,t} = \alpha_t + \beta_t \Delta VOL_{i,t} + v_t GR_{i,t} \Delta VOL_{i,t} + \gamma_t \eta \widehat{MKT}_{\iota,t} + \overrightarrow{\delta_t} x_{i,t} + \varepsilon_{i,t} \quad (2.4)$$

2.5 Data source and descriptive summary statistics

I obtain the M&A data from the SDC database. There are 134,061 deals dating from 1981 to 2006 where targets and acquirers are all US firms. The data are cited up to 2006 as I need to estimate the post-merger real option level for acquirers, which makes the final data period spanning from 1976 to 2011. I then match PERMNOs and GVKEYs with 6-digit CUSIPs from the SDC database. Among these deals, there are 49,508 where acquirers' identifying information is fully and correctly matched and 15,254 where targets' identifying information is fully and correctly matched. There are 5,215 deals where acquirers' and targets' identifying information are all fully and correctly matched. Then I delete utility and financial companies (for acquirers) with 3,726 deals left. Company financial data are found in CRSP and COMPUSTAT.

Following Fama and French (1997) and Grullon et al. (2012), I define pharmaceutical and biotechnology industries, natural resources industries, and high-tech industries as real option intensive industries.I define a related M&A in which two-digit SIC codes of acquirers and targets are the same.

Table 2.1 shows the summary statistics of acquirers and targets involved in the M&A sample as well as deal characteristics. The mean (median) of the daily firm-level stock return standard deviation is 2.82% (2.24%) for acquirers and 3.91% (3.19%) for targets, which are similar to those reported by Grullon et al. (2012) (3.17% & 2.45%). The change in volatility has a positive mean of 0.002% for acquirers and a negative mean (-0.008%) for targets. Campbell et al. (2001) demonstrated a slightly positive trend in idiosyncratic volatility during the 1962-1997 period. However, the recent study of Brandt et al. (2010) investigated a sample dating from 1926 to 2007 and found that volatility had fallen back to pre-1990s levels since 2003. They stated that the increase in idiosyncratic volatility during 1990s was more an episodic phenomenon than a time trend. The sample period in this study spans from 1976 to 2011 and therefore the level of change in volatility for acquirers and targets reported in the table is acceptable. The mean of excess return in my sample is 1.22% for acquirers and 1.29% for targets. On average, acquirers are much larger than targets in terms of firm book assets. The mean of assets value is 8,557.83 million for acquirers and 686.02 million for targets. The transaction value ranges from 3 million to 3,140 million US dollars, with an average value of 804 million. On average, transactions are financed with 84.22% cash. The average percentage acquired in the transaction is 81.21%. The competition for the target is considerably moderate. Among 95% of the deals, there is only one bidder chasing the target. Figure 2.1 shows the distribution of deal numbers in each year within the sample period from 1980 to 2006. Figure 2.2 shows the average transaction value in each year within the sample. As shown in the figure, the number of deals increases significantly since 1991 and drop significantly from 1999 to 2002, revealing the generation and collapse of the internet bubble. While the average transaction value increases since early 1990s, drops in

three consecutive years post the internet bubble burst and increase again since 2003. Following the previous definition of real option intensive industry, I further divide the M&A sample into two subsamples based on acquirer's industry (real option intensive and real option non-intensive). As shown in figure 2.1and figure 2.2, the overall M&A deals roughly equally split between the two subsamples, while the average transaction values diverge a lot from each other since 2000.

Fig. 2.1 Distribution of number of deals in each year within the sample period from 1980 to 2006

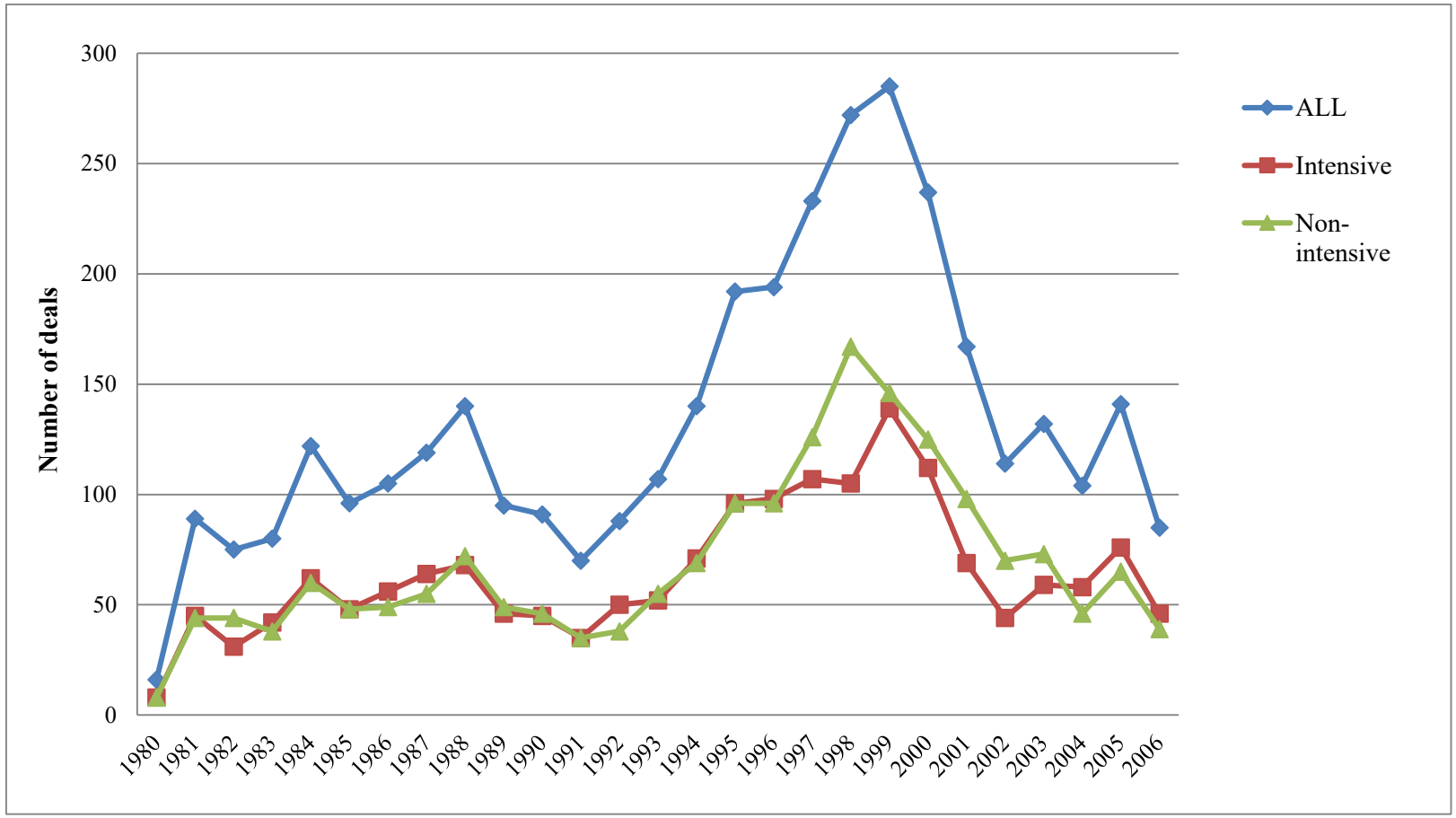

Fig. 2.2 Transaction value (mean) in each year from 1980 to 2006

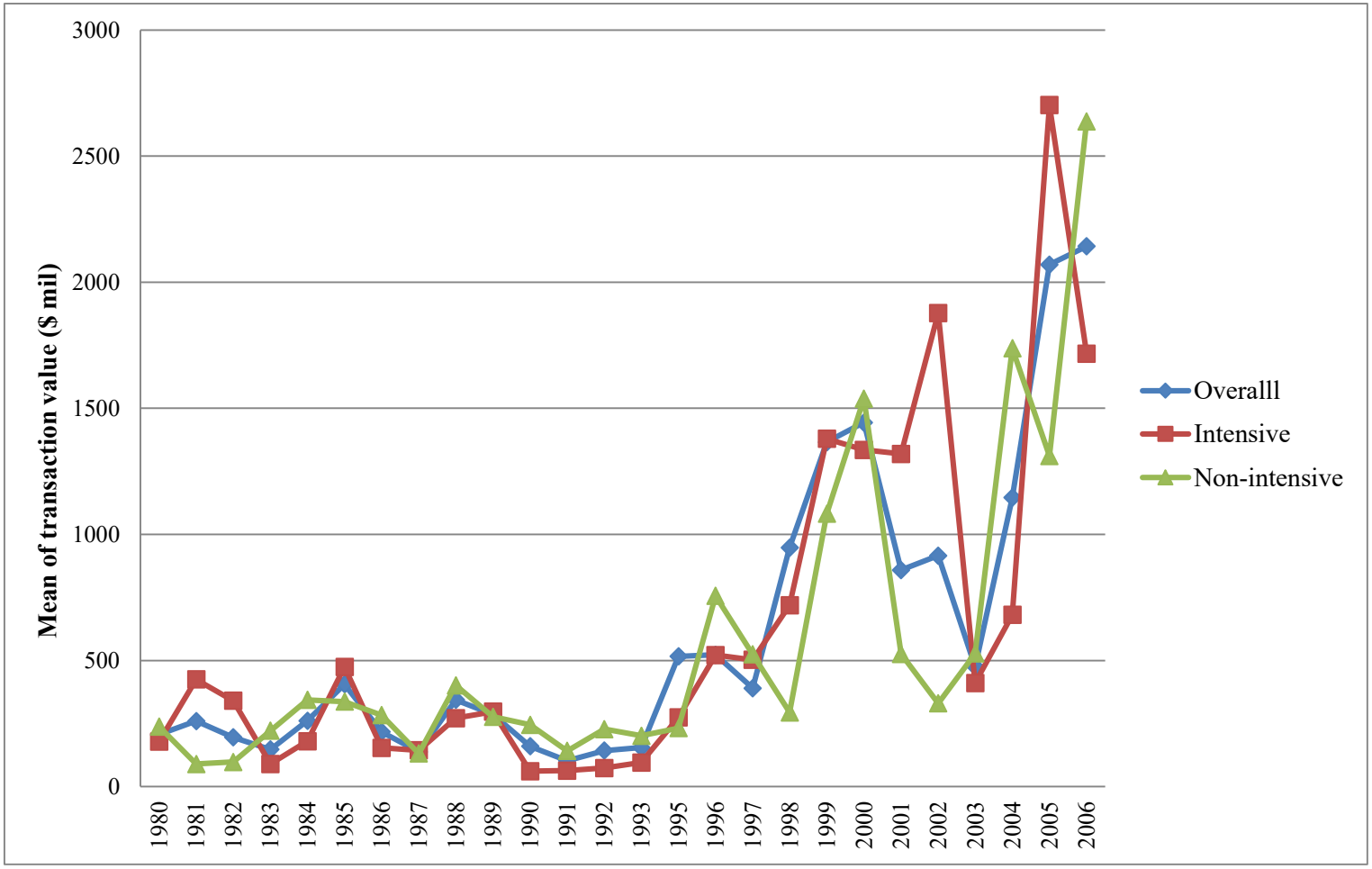

Table 2.1 Summary Statistics

This table presents summary statistics for measure of volatility, changes in volatility, and excess returns, measure of real option proxies (including assets, age, R&D intensity and future 3 year sales growth) for acquirers and targets. Returns data are from CRSP. Accounting data are obtained from COMPUSTAT. The sample period is 1/1976-12/2011. Volatility and its change refer to monthly volatility of logarithmic daily returns. A stock's excess return is the difference between its monthly return and monthly risk-free rate. Age is the difference between the first year the firm appears and the last year it appears in the COMPUSTAT.Future sales growth is the difference between the sales four years after the observation year and the sales in one year after the observation year divided by the sales in one year after the observation year .This table also presents some deal characteristics. The deal data are obtained from SDC platinum. The sample period of the transaction is 1/1981-12/2006. Transaction value is in million dollars.

	Mean	St.Dev	P5	Median	P95	# Obs.
Acquirer						
Volatility	2.819	2.178	0.966	2.242	6.545	383353
Change in volatility	0.002	1.641	-2.110	-0.013	2.132	382361
Excess return	1.223	15.402	-19.857	0.536	23.370	382398
Assets	8557.83	27905.29	31.814	1333.27	36301.00	375873
Age	34.085	18.273	9.000	30.000	63.000	3627
R&D/Asset	0.132	0.667	0.000	0.034	0.282	21761
Future sales growth	2.343	13.540	-0.366	0.334	2.843	31144
Target						
Volatility	3.913	2.987	1.034	3.188	9.186	191550
Change in volatility	-0.008	2.459	-3.299	-0.020	3.332	190035
Excess return	1.297	20.843	-25.942	-0.420	32.843	187723
Assets	686.019	4072.09	6.698	93.171	2482.00	173637
Age	14.128	10.400	4.000	10.000	37.000	3588
R&D/Asset	0.130	0.372	0.000	0.049	0.474	19194
Future sales growth	2.482	8.325	-0.449	0.367	3.665	24006
Deal						
Transaction Value	804.700	3733.02	3.000	98.881	3140.85	3328
% Cash	84.219	26.971	21.410	100.000	100.000	1567
# of Bidder	1.046	0.257	1.000	1.000	1.000	3726
% Acquired	81.206	34.198	5.940	100.000	100.000	3526
% Owned after	85.940	30.794	8.700	100.000	100.000	3531
1-day Premium	36.624	82.423	-12.000	25.920	102.220	2221
1-week Premium	40.920	72.378	-9.710	30.520	113.110	2216
4-week Premium	48.397	86.626	-11.610	36.260	130.650	2209

2.6 Empirical results and discussions

Return-Volatility relationship

The real option rationale has been applied to the study of capital budgeting investments such as natural resource investments, land development, R&D and new ventures. However, scarcely has any research been carried out to apply the real option logic to the study of M&A. As analyzed before, this may be due to the complexity and particularity of M&A as an investment. Therefore, I begin by verifying the feasibility of the return-volatility model to the M&A deal sample. In order to facilitate later analysis of the evolution of the return-volatility relationship around the time of M&A for both acquirers and targets involved in each deal, I give a ten-year time frame in which each M&A takes place with five years prior to the effective date of a transaction and five years after .Therefore, I get two separate samples spanning from 1976 to 2011 for both acquirers and targets in the initial M&A sample spanning from 1981 to 2006. Then I estimate equation (2.1) on the extended acquirers-and-targets sample. The results of the estimation are presented in Table 2.2 and Table 2.3 separately.

Table 2.2 Return-Volatility relationship for Acquirers

This table presents regressions of return-volatility relationship for acquirers within the M&A sample. The regression equation is written as firm-level excess returns on the market factor loading, log market equity, log book-to-market ratio, six-month lagged return relative to the observation month, monthly trading volume divided by the number of shares outstanding, and month-to-month changes in firm-level volatility, $\Delta VOL_{i,t}$. The sample period is 1/1976-12/2011. Table 2.2 represents the time-series means of the coefficients estimated monthly of the return-volatility relationship regression. The numbers in parentheses are t-statistics estimated using the Newey-West autocorrelation and heteroscedasticity consistent standard errors. The R-square refers to the average monthly R-square. The adjusted R-square refers to the average monthly adjusted R-square.

Market factor loading	0.0039	0.0034	0.0040	0.0035	0.0025	0.0020
	(2.59)	(2.49)	(2.68)	(2.53)	(1.80)	(1.58)
Log market equity	-0.0034	-0.0033	-0.0035	-0.0033	-0.0027	-0.0027
	(-7.40)	(-7.40)	(-7.62)	(-7.58)	(-6.20)	(6.29)
Log (B/M)	0.0154	0.0153	0.0159	0.0157	0.0148	0.0146
	(17.67)	(17.89)	(18.89)	(19.11)	(18.75)	(18.74)
Lag (6 month return)			-0.0005	0.0008	-0.0025	-0.0014
			(0.25)	(0.41)	(1.24)	(-0.71)
Trading volume					0.1565	0.1403
					(7.95)	(8.02)
ΔVolatility		0.7667		0.7718		0.7262
		(7.91)		(7.94)		(7.86)
R-square	0.089	0.125	0.102	0.137	0.138	0.168
Adjust R-square	0.083	0.117	0.093	0.127	0.126	0.155
# of months	432	432	432	432	432	432

Table 2.3 Return-Volatility relationship for Targets

This table presents regressions of return-volatility relationship for targets within the M&A sample. The regression equation is written as firm-level excess returns on the market factor loading, log market equity, log book-to-market ratio, six-month lagged return relative to the observation month, monthly trading volume divided by the number of shares outstanding, and month-to-month changes in firm-level volatility, $\Delta VOL_{i,t}$. The sample period is 1/1976-12/2011. Table 2.3 represents the time-series means of the coefficients estimated monthly of the return-volatility relationship regression. The numbers in parentheses are t-statistics estimated using the Newey-West autocorrelation and heteroscedasticity consistent standard errors. The R-square refers to the average monthly R-square. The adjusted R-square refers to the average monthly adjusted R-square.

Market factor loading	0.0014	0.0009	0.0008	0.0007	-0.0006	-0.0002
	(0.79)	(0.52)	(0.36)	(0.47)	(-0.37)	(-0.10)
Log market equity	-0.0033	-0.0031	-0.0033	-0.0033	-0.0035	-0.0028
	(-4.20)	(-3.62)	(-4.29)	(-4.03)	(-4.12)	(-3.26)
Log (B/M)	0.0160	0.0159	0.0184	0.0175	0.0155	0.0156
	(10.10)	(10.93)	(11.54)	(12.29)	(9.82)	(9.70)
Lag (6 month return)			-0.0129	-0.0115	-0.0159	-0.0122
			(-2.36)	(-2.31)	(-3.10)	(-2.46)
Trading volume					0.1633	0.1489
					(7.45)	(6.71)
ΔVolatility		1.2920		1.2451		1.1192
		(9.34)		(9.37)		(7.48)
R-square	0.113	0.172	0.135	0.190	0.182	0.228
Adjust R-square	0.053	0.110	0.064	0.117	0.101	0.149
# of months	432	432	432	432	432	432

As shown in Table 2.2 for acquirers, the contemporaneous changes in firm-level volatility are positively correlated with firm-level excess return in all specifications. The coefficient of changes in volatility is highly significant. Consistent with the common asset pricing literature, the coefficients of log market equity are significantly negative, while the coefficients of market factor loading and log book-to-market are both positive in all specifications. Table 2.3 presents estimation results for the targets. The coefficients of changes in volatility are also highly positive in all specifications. The coefficients of log book-to-market and log market equity are all as expected. For the estimation results of acquirers and targets, the R-square increases with more variables added to the regression.

At this stage, by estimating equation (2.1), I confirm that the positive relationship between firm-level excess returns and the changes in firm-level return volatility holds within my sample of acquirers and targets. However, whether this positive relationship is driven by real option held by the firm is still unknown. I try to ascertain this by dividing the acquirers into two subgroups and comparing their coefficients of changes in volatility. Table 2.4 presents the results of estimating equation (2.1) for the two subgroups.

As revealed in the table, the coefficients of changes in volatility is 1.271 for acquirers in real options intensive industries and 0.687 for acquirers in non-real option intensive industries. The difference between the two coefficients is statistically significant, indicating that the positive relationship between firm-level stock return and changes in volatility is stronger within real option intensive industries, which further suggests that this positive relationship is driven by real option held by acquirers.

Table 2.5 presents the results of estimating regression equation (2.4). The first column reports coefficients estimated for regression in which size is used as the proxy for investment opportunity. The mean estimate of β , which captures the sensitivity of firm value to changes in volatility, is positive and statistically significant. The coefficient of the interaction between firm size and changes in volatility equals -0.28, which implies that a one-unit deduction in log size is associated with 0.28 increases in the return volatility relationship. The results reported in the second column, in which age is used as the inverse proxy for investment opportunity, are also consistent with the real option theory. The results reported in the third column using log R&D intensity as another investment opportunity proxy are also consistent. The estimated coefficients shows that a one-unit increase in R&D intensity will contribute an approximately 10% increase in the sensitivity of firm value to changes in volatility. Finally, as shown in the fourth column, the positive coefficient indicates that the return-volatility relationship is significantly stronger for firms with higher future sales growth.

Table 2.4 Return-Volatility relationship for Acquirers in real option intensive industry and real option non intensive industry

This table presents regressions of return-volatility relationship for acquirers in real option intensive and non-intensive industries. The regression equation is written as firm-level excess returns on the market factor loading, log market equity, log book-to-market ratio, six-month lagged return relative to the observation month, monthly trading volume divided by the number of shares outstanding, and month-to-month changes in firm-level volatility, $\Delta VOL_{i,t}$. The sample period is 1/1976-12/2011. Table 2.3 represents the time-series means of the coefficients estimated monthly of the return-volatility relationship regression. The numbers in parentheses are t-statistics estimated using the Newey-West autocorrelation and heteroscedasticity consistent standard errors. The R-square refers to the average monthly R-square. The adjusted R-square refers to the average monthly adjusted R-square. I also report the t-statistics for the differences between the estimated coefficients of the changes in volatility for acquirers in real option intensive industries and for acquirers in real option non-intensive industries.

For Acquirer	Real option intensive industries	Real option Non-intensive industries
Market factor loading	0.0031	0.0018
	(1.07)	(1.42)
Log market equity	-0.0002	-0.0028
	(-0.32)	(-6.53)
Log (B/M)	0.0177	0.0143
	(8.38)	(18.49)
Lag (6 month return)	-0.0210	-0.0017
	(-3.31)	(-0.84)
Trading volume	0.2279	0.1342
	(3.73)	(7.81)
ΔVolatility	1.2714	0.6868
	(5.29)	(7.72)
R-square	0.470	0.167
Adjust R-square	0.360	0.153
# of months	420	432
Difference		0.5847
		(2.28)

Table 2.5 Returns, Contemporaneous Changes in Volatility, and Investment Opportunities

This table presents regressions of return-volatility relationship for all firms within the sample. The regression equation is written as firm-level excess returns on the market factor loading, log market equity, log book-to-market ratio, six-month lagged return relative to the observation month, monthly trading volume divided by the number of shares outstanding, month-to-month changes in firm-level volatility, $\Delta VOL_{i,t}$ and the interaction variable $\Delta VOL_{i,t} * Investment\ opportunites$. The four proxies for investment opportunities are book assets, firm age, R&D intensity and future sales growth. The sample period is 1/1976-12/2011. Table 2.5 represents the time-series means of the coefficients estimated monthly of the return-volatility relationship regression. The numbers in parentheses are t-statistics estimated using the Newey-West autocorrelation and heteroscedasticity consistent standard errors. The R-square refers to the average monthly R-square. The adjusted R-square refers to the average monthly adjusted R-square.

	Proxy for Investment Opportunities			
	Book Asset	Age	R&D/Asset	Future sales growth
Market loading factor	0.0023	0.0018	0.0019	0.0013
	(1.82)	(1.43)	(1.50)	(1.02)
Log market equity	-0.0026	-0.0026	-0.0026	-0.0028
	(-5.95)	(-6.18)	(-6.17)	(-6.32)
Log(B/M)	0.0144	0.0147	0.0145	0.0141
	(18.48)	(18.87)	(18.58)	(16.97)
Lag(6 month return)	-0.0014	-0.0011	-0.0010	-0.0038
	(-0.67)	(-0.53)	(-0.51)	(-1.60)
Trading volume	0.1382	0.1433	0.1418	0.1418
	(8.02)	(8.29)	(8.14)	(7.37)
ΔVolatility	2.3284	1.3849	0.8624	0.6207
	(9.96)	(3.89)	(7.61)	(6.34)
ΔVolatility *Investment Opportunities	-0.2784	-0.2053	0.1012	0.2607
	(-8.17)	(-1.98)	(2.99)	(2.45)
R-square	0.182	0.181	0.179	0.193
# of months	432	432	432	408

Evolution of Return-volatility relation around M&A

As the positive firm-level return-volatility relation is driven by real option, the relation becomes weaker when firms experience shocks to their mix of real option; and the relation becomes stronger when firms accumulate new real option. Therefore, by investigating the time-series evolution of the return-volatility relation, it can be observed how real option is accumulated and exercised. Grullon et al. (2012) pointed out that firms exercise most of their real option through investing. Firms exercise a great deal of their real option by undertaking M&A, and at the same time acquirers obtain discretion to exercise the real option owned by targets and that accumulated by the combined firm gradually. Therefore the real option level must experience a severe drop after M&A. As mentioned previously, the original M&A sample spans five years prior to the merger and spans another five years after the merger. Then I estimate the regression equation for each subgroup. I estimate equation (2.1) for the subgroups in each month and report the time-series means of the coefficient estimates along with t-statistics using the Newey-West autocorrelation and heteroscedasticity consistent standard errors of monthly coefficient estimates in parentheses. Table 2.6 reports the time-series evolution of the return-volatility relationship around the time of M&A for both acquirers and targets.

For acquirers from one (year -1) to three years (year -3) before the merger , there is a decrease in the coefficients from 0.955 to 0.647, indicating that real option has reduced during this period. From year -1 to year 1, the coefficients for acquirers drop significantly from 0.647 to 0.170. The number in the parenthesis of row ‘year 1’and column ‘difference’ is the t-statistics for the difference between the estimated coefficient of the change in volatility in year 1 and that in year -1 relative to the merger and acquisition.

Table 2.6 The Return-volatility relationship around M&A

Panel A presents the coefficient estimates of firm-level excess return on the changes in volatility from 3 years prior to the merger to 3 years after merger of both the M&A sample and matched sample for placebo test. For each acquirer (target) in a deal, I find up to three matching acquirers (matching targets) by industry and size. The matching firms are randomly selected from a pool of firms satisfied with three conditions: 1) firms are neither acquirers nor targets in the three year period prior to the merger; 2) firms are within the same industry (defined by 2 digit SIC code) as incidence firms; and 3) firm sizes are restricted within the range of two standard deviation of industry firm size mean from the incidence firm size mean. These coefficients are obtained by regressions of firm-level excess returns on the market factor loading, log market equity, log book-to-market ratio, six-month lagged return relative to the observation month, monthly trading volume divided by the number of shares outstanding, month-to-month changes in firm-level volatility, $\Delta VOL_{i,t}$.These coefficients are estimated separately for subsamples of firms-months belonging to year [-3,3] relative to the effective year of M&A. The sample period of incidence firms is 1/1976 to 12/2011. Table 2.6 represents the time-series means of the coefficients estimated monthly of the return-volatility relationship regression. The numbers in parentheses are t-statistics estimated using the Newey-West autocorrelation and heteroscedasticity consistent standard errors. The table also presents the t-statistics for the differences between the estimated coefficient of the change in volatility in year -1 and that in year 1 relative to M&A, and for the differences between estimated coefficients of the change in volatility in year -1 for acquirers and targets. Panel B presents the detailed separated regressions showing how the coefficients are estimated in Panel A.

Panel A: Time series coefficient change

M&A sample

Year since Effective	-3	-2	-1	1	2	3
Acquirers	0.955	0.718	0.647^{a}	0.170^{b}	0.193	0.373
	(7.02)	(5.28)	(4.92)	(1.20)	(1.572)	(2.34)
Targets	0.984	0.961	1.019^{c}			
	(7.56)	(6.97)	(8.73)			
Difference			0.373^{ac}	0.477^{ab}		
			(2.78)	(2.47)		

Placebo test

Year since effective	-3	-2	-1	1	2	3
Acquirers(matched)	0.891	0.803	0.908	0.802	0.714	0.669
Targets(matched)	0.743	0.762	0.815			

Panel B: Separate regressions

	Acquirer			Target		
	Year-3	Year-2	Year-1	Year-3	Year-2	Year-1
Market loading factor	0.0024	-0.0009	-0.0018	0.0023	-0.0002	-0.0017
	(1.51)	(-0.56)	(-1.04)	(1.36)	(-0.11)	(-1.00)
Log market equity	-0.0029	-0.0036	-0.0029	-0.0044	-0.0040	-0.0038
	(-4.38)	(-5.82)	(-4.19)	(-4.47)	(-3.66)	(-3.70)
Log(B/M)	0.01179	0.0155	0.0169	0.0144	0.0151	0.0165
	(8.80)	(11.50)	(13.34)	(9.49)	(10.37)	(9.88)
Lag(6 month return)	0.0010	-0.0055	-0.0056	-0.0109	-0.0105	-0.0121
	(0.27)	(-1.52)	(-1.56)	(-2.51)	(-2.33)	(-2.64)
Trading volume	0.1288	0.1300	0.0949	0.1264	0.1558	0.1750
	(5.04)	(6.27)	(4.87)	(4.39)	(5.63)	(6.50)
DVOL	0.9547	0.7182	0.6470	0.9842	0.9607	1.0185
	(7.02)	(5.28)	(4.92)	(7.56)	(6.97)	(8.73)
R-square	0.259	0.240	0.244	0.245	0.238	0.236
Adjust R-square	0.205	0.186	0.192	0.160	0.160	0.165
# of months	312	312	312	312	312	312

Then the coefficients gradually increase from 0.170 to 0.373 in three years' time. For targets from one to three years prior to the merger, the coefficients are more consistent, indicating that the levels of real option in target firms are more stable.

The t-statistic of the two-sample mean comparison test shows that the coefficient for the targets one year prior to the merger is significantly larger than that for the

acquirers, indicating that the targets are more real-option intensive than the acquirers before the merger.

In the addition placebo test I estimate the real option coefficients using a control sample. For each acquirer (target) in a deal, I find up to three matching acquirers (matching targets) by industry and size. The matching firms are randomly selected from a pool of firms satisfied with three conditions: 1) firms are neither acquirers nor targets in the three year period prior to the merger; 2) firms are within the same industry (defined by 2 digit SIC code) as incidence firms; and 3) firm sizes are restricted within the range of two standard deviation of industry firm size mean from the incidence firm size mean.

For the placebo test, I extend the sample period to [1981/1, 2011/12], which is five years later than the original M&A sample period. I then estimated equation (2.1) using the extended M&A sample and the constructed control sample. The following table show the results of coefficients evolution during prior and post-merger period for the two samples. As shown in the table, the estimated coefficients of acquirers gradually decrease in the three year period prior to the merger, while the coefficients for the matched acquirers remain rather stable during the prior merger period. The coefficient of target firm is significant larger than that of acquirer in one year before the merger, while there is no significant difference between the coefficients of matched acquirers and matched targets.

Then I divide the whole transaction sample into different subgroups using real option proxies as grouping criteria. In this section, I use three proxies: firm size, firm age, and book-to-market ratio. I calculate the average value of each proxy from three years

prior to M&A and divide the sample into two groups under each criterion. I then run the equation on each subgroup and the results are presented in Table 2.7.

As shown in the table for small acquirers, the coefficients moderately decrease from 1.039 to 0.783 over the 3-year pre-merger, indicating a decrease in real option in the firm over time. The coefficient for the targets is comparably consistent during the prior merger period. After the merger, the coefficient of the combined firm drops to 0.257, significantly less than the coefficient of one year prior to the merger. It can also be observed that the coefficient of the targets from year -1 is larger than that of the acquirers, indicating that the acquirers acquire the targets that are more real-option intensive than themselves. As for the large bidder, the coefficient is economically less than that of the small bidder, which indicates that the small bidder is more real-option intensive than the large bidder. This result is consistent with the previous analysis using assets as a real option proxy. Large firms tend to have a bigger proportion of firm value represented by assets-in-place and small firms tend to rely heavily on investment opportunity. Therefore, small firms tend to be more real-option intensive. As shown in the table, the coefficient of the target acquired by large acquirers from year -1 is 2.143, which is nearly twice as much as that of the target acquired by small acquirers, indicating that large acquirers are eager for more real-option intensive targets and that large acquirers are severely lacking in investment opportunity and must acquire targets with rich real option to facilitate the company's growth. It is also reasonable that large acquirers can afford more real-option intensive targets than small acquirers.

Table 2.7 Evolution of Return-volatility relationship around M&A for subsamples

This table presents regressions of return-volatility relationship for firms-months belonging to year[-3,3] relative to the effective year of M&A of subsamples grouped based on acquirers 'and targets 'characteristics(Panel A and Panel B). Different subsamples are constructed based on three real option proxies: firm assets, firm age and market-to-book ratio. Each of the criteria is calculated as the average of each proxy from three years prior to the M&A.The regression equation is written as firm-level excess returns on the market factor loading, log market equity, log book-to-market ratio, six-month lagged return relative to the observation month, monthly trading volume divided by the number of shares outstanding, and month-to-month changes in firm-level volatility, $\Delta VOL_{i,t}$.The sample period is 1/1976-12/2011. The table represents the time-series means of the coefficients estimated monthly of the return-volatility relationship regression. The numbers in parentheses are t-statistics estimated using the Newey-West autocorrelation and heteroscedasticity consistent standard errors. The R-square refers to the average monthly R-square. The adjusted R-square refers to the average monthly adjusted R-square.

Panel A. Criteria calculated based on acquirer's characteristics

Year since effective				-3	-2	-1	1	2	3
Assets	Small	Bidder	Coefficient	1.039	0.901	0.783^{a}	0.257^{b}	0.069	0.464
			t-statistic	6.32	5.14	4.74	1.71	0.46	1.90
		Target	Coefficient	1.144	0.993	1.083^{c}			
			t-statistic	6.64	5.75	7.04			
		Difference				0.300^{ac}	0.526^{ab}		
		t-statistic				(1.33)	(2.35)		
	Large	Bidder	Coefficient	0.620	0.656	0.463^{a}	0.399^{b}	0.211	0.346
			t-statistic	3.18	3.58	2.61	2.03	0.90	1.33
		Target	Coefficient	0.986	1.700	2.143^{c}			
			t-statistic	2.77	2.93	3.23			
		Difference				1.68^{ac}	0.064^{ab}		
		t-statistic				(2.92)	(0.24)		

Panel A. (Con't)

Year since effective				-3	-2	-1	1	2	3
AGE	Young	Acquirer	Coefficient	2.313	0.719	1.008^{a}	0.211^{b}	0.105	0.175
			t-statistic	2.53	2.81	3.39	1.02	0.62	0.68
		Target	Coefficient	1.917	0.857	0.951^{c}			
			t-statistic	2.37	4.52	4.12			
		Difference				-0.057^{ac}	0.797^{ab}		
		t-statistic				(0.15)	(2.20)		
	Old	Acquirer	Coefficient	0.783	0.682	0.633^{a}	0.269^{b}	0.173	0.329
			t-statistic	4.79	4.46	4.34	1.81	0.99	2.12
		Target	Coefficient	0.954	1.015	1.188^{c}			
			t-statistic	6.15	5.69	7.40			
		Difference				0.555^{ac}	0.364^{ab}		
		t-statistic				(2.56)	(1.74)		
M/B ratio	High	Acquirer	Coefficient	1.178	0.855	0.755^{a}	0.261^{b}	0.258	0.150
			t-statistic	6.87	5.31	4.67	1.65	1.63	0.85
		Target	Coefficient	0.921	0.994	1.165^{c}			
			t-statistic	5.36	6.14	7.90			
		Difference				0.410^{ac}	0.494^{ab}		
		t-statistic				(1.87)	(2.19)		
	Low	Acquirer	Coefficient	0.661	0.678	0.395^{a}	0.256^{b}	0.137	0.503
			t-statistic	3.40	1.76	0.42	0.41	0.65	2.05
		Target	Coefficient	0.798	0.510	0.723^{c}			
			t-statistic	3.31	2.00	3.71			
		Difference				0.328^{ac}	0.139^{ab}		
		t-statistic				(0.36)	(0.12)		

Panel B: Criteria calculated based on target's characteristic

Year since effective				-3	-2	-1	1	2	3
Assets	Small	Acquirer	Coefficient	1.027	0.806	0.846	0.166	0.143	0.376
			t-statistic	5.83	4.02	4.66	0.86	0.90	2.01
		Target	Coefficient	0.946	0.910	1.088			
			t-statistic	5.26	5.10	6.57			
	Large	Acquirer	Coefficient	0.867	0.835	0.642	0.362	0.184	-0.296
			t-statistic	4.59	4.61	3.17	2.13	1.08	-1.49
		Target	Coefficient	0.996	0.924	1.015			
			t-statistic	5.28	5.30	5.53			
M/B Ratio	Low	Acquirer	Coefficient	0.770	0.458	0.535	0.546	0.259	0.409
			t-statistic	3.06	1.33	1.00	2.61	1.30	2.07
		Target	Coefficient	0.622	0.704	0.709			
			t-statistic	2.92	4.11	4.19			
	High	Acquirer	Coefficient	1.057	0.983	0.776	0.078	0.178	0.261
			t-statistic	5.82	5.81	4.98	0.46	1.07	1.35
		Target	Coefficient	1.181	0.849	1.170			
			t-statistic	7.46	5.09	7.49			

The second proxy adopted is firm age. As stated previously, older firms tend to have less value represented by investment opportunity. The estimated coefficients of young acquirers are larger than those of old acquirers over the three-year prior-merger period, indicating that young acquirers are more real-option intensive than old acquirers. The two subgroups show the same decrease in the estimated coefficient from year -1 to year 1, indicating the exercise of real option after the merger as shown in all the previous settings. Interestingly, I find that young acquirers acquire targets that have as much real-option intensity as themselves while old acquirers acquire targets that are more real-option intensive than themselves. This result is consistent with the previous results where firms lacking in investment opportunity are eager to acquire targets with more growth opportunity

The third proxy is the market-to-book ratio. A high market-to-book ratio indicates that a firm has many investment opportunities relative to its assets-in-place. As shown in the table, the estimated coefficients of high M/B ratio acquirers are larger than those of low M/B ratio acquirers, indicating that acquirers with a high M/B ratio are likely to be more real-option intensive. I also observe the same decreasing pattern of the estimated coefficients from year -1 to year 1 within the two sub-subgroups divided by the M/B ratio level. Both high M/B ratio and low M/B ratio acquirers are after targets that are more real-option intensive than themselves. As shown in the table, the coefficient of the target acquired by high M/B acquirers from year -1 is 1.165, which is 61.13% higher than that of the target acquired by low M/B acquirers, indicating that companies with high market evaluation are more likely to acquire real option intensive targets than companies with comparably low market valuation.

In summary, the drop in the estimated coefficient from year -1 to year 1 is consistent within all the subgroups, which indicates a general exercising of real option after the merger. Within different subgroups, acquirers show different preferences for the target. Generally, acquirers are likely to acquire targets that are more real-option intensive than themselves. This is especially obvious for large and old acquirers. While young acquires are more likely to acquire targets that are almost as real-option intensive as themselves.

Additional discussions

Non-linear return-volatility relationship

To explore the non-linear relationship between excess returns and changes in volatility, I add a squared term into equation 2.1, which is written as:

$$r_{i,t} - r_{f,t} = \alpha_t + \beta_t \Delta VOL_{i,t} + \omega_t \Delta VOL_{i,t}{}^2 + \gamma_t \eta \widehat{MKT}_{\iota,t} + \overrightarrow{\delta_t} x_{i,t} + \varepsilon_{i,t} \quad (2.5)$$

I estimated the above equation for both acquirers sample and targets sample, the results are shown in the following table:

Table 2.8 Test the nonlinearity of return-volatility relationship

	Acquirers	**Targets**
$\Delta Volatility$	0.7142**	1.0660**
$\Delta Volatility^2$	3.2835	8.2035
Market factor loading	0.0014**	0.0011**
Log market equity	-0.0024**	-0.0019**
Log book to market	0.0144**	0.0150**
Past return	-0.0038	-0.0116
Trading volume	0.1347**	0.1323**
R-square	0.193	0.258
Adjust R-square	0.179	0.165
# of months	432	432

As shown in the table above, the coefficient on the square term of changes in volatility is not significant for both acquirer and target sample.

Robustness of the return volatility relationship as a proxy for real option

The previous literature find that firm size, age, market to book ratio, R&D intensity and future sales growth can be seen as proxies for investment opportunity. Each of the proxy partially reflect the real option level and none of them can serve as an accurate measure of real option level. By applying factor analysis on these five variables, I get two common factors F1 and F2. The SAS output is as follow:

Table 2.9 SAS output of factor analysis

Rotated Factor Pattern		
	Factor1	**Factor2**
Book Asset	0.42029	0.01304
Future sales growth	-0.24959	0.0738
R&D/Total assets	-0.10224	0.49211
Market to book ratio	-0.03871	0.61398
Firm age	0.82903	-0.15111

Variance Explained by Each Factor	
Factor1	**Factor2**
0.9381846	0.64760015

Based on the above information by SAS output, I define the values of F1 and F2 as follow:

F1=0.420*Size-0.249*Salesgrowth-0.102*R&D-0.039*MBratio+0.829*Age;

F2=0.013*Size+0.074*Salesgrowth+0.492*R&D+0.614*MBratio-0.151*Age;

The proportion of variance explained by F1 and F2 are 0.938 and 0.648 separately. Then I write the composite real option indicator as a combination of F1 and F2, which is

calculated as (0.938*F1+0.648*F2)/1.586; I calculated composite real option indicator for each acquirer and divided the sample into 2 subgroups (low real option group and high real option group) based on the rank of F value.

I then estimate equation 2.1 using the two subsamples of acquirers and their corresponding target subsamples. The following table reports the evolution of coefficient on changes in volatility for each subgroups:

Table 2.10 Evolution of return volatility relationship for subgroups defined by composite real option indicator

Subgroups	Year	-3	-2	-1	1	2	3
Low real option	Acquirer	0.356	0.326	0.308	0.050	0.137	0.269
	Target	0.900	0.945	0.996			
High real option	Acquirer	1.185	1.065	0.623	0.038	0.105	0.340
	Target	0.751	0.916	1.039			

As shown in the table, the coefficients of acquirers for the low real option subgroup are generally lower than those for the high real option subgroup. Generally, acquirers in the two subgroups both choose targets with higher real options and the coefficient drop significantly after the merger, which are consistent with previous findings.

2.7 Conclusion

Existing literature has offered various explanations for the motivations behind takeover activities; for example, synergy effect removal of underperforming management teams of the target, industry restructuring, overvaluation, agency and hubris. However, most of these theories explain the phenomena in a qualitative way and quantitative

analysis meets considerable obstacles. Even for the synergy theory, related quantitative work tries to infer synergy value from the cumulative abnormal return around the time of the announcement of a takeover and the results are quite mixed. This is not surprising at all since stock price reactions involve overpayment, synergy, news about bidders, standalone values of the target, and probability assessments associated with successful deals. There are scholars using option prices to infer synergistic value from M&A. However, an essential prerequisite of the approach is that there must exists financial option trading data for both acquirer and target firm, which reduces the sample size significantly (from 31408 to 167). Some previous studies pointed out that takeovers occur when managers respond to the change in their companies' investment opportunity. As investment opportunity can be seen as growth option, the decrease in investment opportunity reflects a declining level of real option in the company.

There are a number of research works focusing on the evaluation of real option. In most cases, each type of real option is typically analyzed in isolation and only analytic, closed-form solutions are found. However, in practice, various types of real option are embedded in investment, especially for complicated investment such as takeovers. Besides, interactions among different types of real option generally make their individual values non-additive. Recently, Grullon et al. (2012) found that the positive contemporaneous relationship between firm-level stock returns can be explained by the real option possessed by the firm. If a firm has more real option, it can benefit from an increase in volatility, leading to a higher sensitivity of stock return to volatility changes. When firms have high levels of real option, the positive relationship tends to be significant.

The research work by Grullon et al. (2012) not only offered an explanation for the positive relationship between firm-level stock return and volatility which was first found by Duffee (1995), but, more importantly, also shed light on the evaluation of real option. Rather than evaluating each individual real option, the findings in this research offer a new perspective in evaluating the value of various real options as a whole. Although the positive relationship between firm-level stock return and volatility cannot serve as an accurate measure of the value of real option, it can appropriately indicate the proportion of firms' real option value to firms' total value. Applying the framework in the context of M&A, I find that generally acquirers' real option levels experience a decline over the three years prior to the merger. This finding indicates that the proportion of investment opportunity of acquirers declines prior to the merger, which triggers the consequential takeover. The second finding is that the level of real option for the targets is significantly higher than that for the acquirers in the one year prior to the merger, which indicates that the acquirers want to acquire targets with more real option to facilitate their future growth. These two findings support the view that takeovers are triggered by lack of investment opportunity of acquiring companies in a quantitative way. The chapter also offers analysis of the match between bidder and target in a real option perspective, which provides further insight into measuring the synergistic match in takeovers.

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Chapter 3

Strategic matching and M&A transaction incidence

3.1 Introduction

Mergers and acquisitions (M&As) have grown rapidly in the past decades and attracted sustained attention in the academic world. The past literature on M&A investigated its various aspects including motivation, profitability and post-merger performance. Among the major three motivations suggested (i.e. hubris, agency and synergy), the synergistic effect has long been demonstrated to be the key driver of M&A.

Due to the abstract nature of synergy, the existing literature largely focuses on the qualitative description of synergy creation rather than quantitative evaluation. Some studies try to infer synergistic value from cumulative abnormal returns around the announcement date of the merger, while others criticize that abnormal returns reveal several mixed effects and cannot reflect pure synergy value. The commonly accepted argument is that synergy is created through the exploitation and redeployment of specialized resources derived from the strategic combination of two entities. Companies choose to expand via M&A rather than internal growth because M&A reduces the time needed for expansion and, more importantly, enables companies to achieve value creation which cannot be obtained on their own. Assume that managers undertaking M&A are

motivated by the fundamental aim of creating value, then their primary concerns should be the identification of potential targets that strategically fit their companies and are not overpriced. In this regard, they can make a takeover decision by balancing the expected benefits and the costs of acquisition.

Practically speaking, the cost of the target is generally known during the bidding process by the rule of net present value; the transaction is feasible as long as the cost can be offset by the value created after the takeover. While each potential target brings different types of resources and value to the acquirer, the expected synergistic value should vary across different targets. Therefore, the primary question is how to identify the potential target to form a perfectly strategic combination.

The previous literature offered some insights into how merger pairs are formed. One of the established facts about merger pairs is the one from the Q-theory of investment. The Q-theory of mergers suggests that low-valuation firms are usually acquired by high-valuation firms since the acquiring firm substitutes poor management or inefficient use of assets with capable management or efficient utilization of assets, which indicates that M&A is a channel through which capital flows to better management and better projects (Jovanovic & Rousseau, 2002; Mitchell & Stafford, 2001; Servaes, 1991). On the other hand, Rhodes-Kropf et al.(2005) found evidence that targets are on average valued much higher than firms on Compustat but lower than acquirers, which converts the ‘high buys low’ argument into ‘high buys less high’. Rhodes-Kropf and Robinson (2008) further extended the results to an even stronger form showing that firms with similar valuation ratios more likely to pair up in a merger (i.e. high buys high, median buys median and low buys low). They pointed out that asset complementarity induces

synergistic value and costly search leads to an assortative match between bidder and target.

The Q-theory of mergers suggests that most value is created by paring up the worst performing assets with the best performers. According to this theory, target firms are likely to be poorly managed in a disadvantageous position, waiting for the 'rescue' of acquirers. From this perspective, targets barely have any bargaining power over acquirers. However, the reality is that targets are usually paid for with a high premium. Apart from hubris and agency reasons, the expectations of synergistic value must be the driving force for acquirers to purchase targets even at a high premium. The synergy theory suggests that asset complementarity helps the combined firm to achieve value increments, indicating that firms with complementary assets are more likely to form merger pairs. Rhodes-Kropf and Robinson (2008) proved this argument in their 'like buys like' theory. In short, the expectation of synergy creation which originates from asset complementarity drives bidders to choose targets with more similarities to them.

While asset complementarity plays an important role in mergers, it is as abstract as synergy to a certain extent. Rhodes-Kropf and Robinson (2008) mentioned that asset complementarity can emerge from any dimension such as better production, better technology or better culture. Recently, Bena and Li (2014) showed how technological firms choose acquisition targets based on complementary characteristics. They found that technological overlaps between firm pairs have a positive effect on transaction incidence and post-merger technological output. Mizik and Jacobson (2003) provided a different view of asset complementarity. They suggested that firms may have different strategic emphasis on either value creating (i.e. innovation and production) or value appropriation

(i.e. extracting profits in the marketplace).Value creating and value appropriation activities complement with each other in firm's development. The value creating activities would generate intellectual assets (measured by R&D expenses) and relational assets (measured by advertising expenses). It is demonstrated that firm value can be enhanced through an appropriate combination of these two assets.

To examine the ex-ante selection effect of firms' complementary characteristics on transaction incidence for both technological and non-technological firms, I adopt two measures of strategic matches in this study. First, based on the work of Mizik and Jacobson (2003), I classify firms into intellectual assets-oriented and relational assets-oriented. Second, by adopting the evaluation of firms' real option level proposed by Grullon et al. (2012), I differentiate firms with real option from firms without real option. Constructing control samples and running the logit regression by Bena and Li (2014), I find that firms with the same strategic orientation and same level of real option have a better chance to form a merger.

This chapter is organized as follows. In section 3.2, I review the past related literature on merger pairs and merger premium. In section 3.3, I develop hypotheses. In section 3.4, I describe the methodology including control sample selection, key variables construction and regression methods. In section 3.5, I present the data information. In section 3.6, I discuss the empirical results of ex-ante selection effects of different strategic matches on transaction incidence.

3.2 Literature Review

Three major motivations have been suggested for takeovers: agency, hubris and synergy creation. The agency theory demonstrates that takeovers occur because managers can benefit from the combination at the expense of shareholders. The hubris hypothesis suggests that managers overestimate takeover gains and involve themselves in transactions with no prospect of synergy (Roll, 1986). The synergy motive suggests that takeovers are triggered by potential synergistic gains generated by merging the resources of acquirers and target firms.

The simultaneous existence of the above takeover motives makes each of the explanations become inconclusive. Some studies try to disentangle these motivations behind M&A by further analyzing the distribution of the total gains between acquirer and target. Berkovitch and Narayanan (1993) suggested that in a synergy-motivated takeover, the target obtain more synergy if it is able to resist the takeover or if there is a competition among potential acquirers. In this case, it can be shown that higher synergy leads to higher gains of the target. Hence, it is expected that targets and total gains are positively correlated in synergy-motivated takeovers. Conversely, if a takeover is motivated by acquirer management's self-interest and enables management to extract wealth from shareholders, there will be negative gains to acquirer shareholders. The hubris hypothesis suggests that hubris managers overestimate the gains from takeover and their ability to manage the post-merger consolidation and there seldom exist gains in takeovers. Since target gains are merely by a transfer of wealth from acquirers, there will be zero correlation between target and total gains.

It has long been argued that synergy is the key driver of M&A. Berkovitch and Narayanan (1993) tried to distinguish different motives of takeovers and empirically showed that synergistic value is the major motive for profitable takeovers. Moeller et al. (2005) demonstrated that merger waves are more likely to be driven by the motivation of exploiting operating synergies. In terms of management, managers are more interested in what kind of strategy the merger can offer for creating economic value (Salter & Weinhold, 1979).

Research in the area of synergy suggests that the value created in merger mainly come from the specialization of resources. (Jensen & Ruback, 1983; Bradley et al., 1988). Lippman and Rumelt (2003) further pointed out that the heart of business management and strategy concerns evaluation, manipulation, administration, creation and deployment of unpriced specialized resource combinations.

Within this framework it has been found that the announcement of an acquisition is generally accompanied by positive and significant changes in the combined wealth of firms (Halpern, 1973; Mandelker, 1974; Langetieg, 1978; Dodd, 1980). Bradley et al. (1988) suggested that synergistic value created in takeovers are the result of capitalization of combined new investment opportunities and redeployment of combined firm resources.

Scholars further investigate the characteristics of merger pairs for transaction incidence. Early literature suggested that better managed firms acquire poorly managed firms to eliminate inefficiencies thus creating value (Manne, 1965). Jovanovic and Rousseau (2002) extend the traditional Tobin's Q theory in merger by developing a theoretical model to reflect that high-Q firms buy low-Q firms and M&A is a channel for capital to flow to better projects and better management.

On the contrary, Rhodes-Kropf and Robinson (2008) suggested that firms with similar valuation ratios are more likely to form merger pairs. They suggests the 'like buys like' hypothesis stating that asset complementary through merger creates value. Fan and Goyal (2006) also found that vertical mergers are more profitable than diversifying ones, which shows the importance of vertical relatedness in M&A value creation.

More recently, Bena and Li (2014) demonstrated the importance of similarity by empirically showing that overlaps between firms positively affects the chance of transaction incidence. They also provided evidence that firm pairs with more prior technological linkages produce more innovation output after the merger, indicating a larger wealth effect of similarity-initiated merger pairs. Philips and Zhdanov (2013) found that instead of achieving technological innovation internally and engage in 'R&D' race with small competitors, it is more efficient for acquirers to access innovations through acquisitions of small but innovative targets.

Rhodes-Kropf and Robinson (2008) indicated that asset complementarity and costly search result in the assortative matching, which can include both tech and non-tech characteristics as long as similarities have the potential to improve efficiency after the merger.

To examine the effect of both tech and non-tech similarities on formation of merger pairs, I develop similarity measures through a real option angle. Either a technological or non-technological combination of bidders and targets will result in new growth opportunity which adds value to the combined firm after utilization.

3.3 Hypotheses Development

Real option and transaction incidence

The past literature mainly examined the innovative characteristics of firms in forming transactions. Hart and Holmstrom (2010) suggested that mergers can facilitate the coordination needs between two companies whose production functions exhibit externalities. Bena and Li (2014) showed that the degree of technological overlaps between firm pairs are positively correlated with the transaction incidence probability. They further found that acquirers are usually firms with large patent portfolios and low R&D expenses, while targets are usually firms with small patent portfolios and high R&D expenses. Their study illustrated how technological firms pair up to enhance innovation output, while takeovers can take place on many other occasions. In order to investigate the matching characteristics of non-technological firms in takeovers, I adopt real option as a measure of firm characteristics to cover both types of firm. The traditional real option literature showed that firms with high levels of real option tend to have more growth opportunity. Technological firms with more innovative power (higher R&D expenses) tend to have higher levels of real option. On the other hand, firms in the non-technological section can also have high levels of real option due to other possible growth opportunities. Overall, real option captures growth opportunity and managerial flexibility of the firm. As suggested in the first essay, acquirers tend to purchase targets with more real option (growth opportunity) to facilitate their future growth. The results also suggest that acquirers experience a downward trend in their real option level which signals a decrease in investment opportunity and in turn triggers M&A. In this analysis, firms with high levels of real option are more likely to attract the attention of acquirers.

Based on the above argument, the first hypothesis can be written as 'the likelihood of a firm to become a target increases with its real option level'.

For acquirers, even though their real option level mildly decreases prior to the transaction, it does not necessarily indicate that their real option level is low. The real option literature suggests that different types of real option interact with each other and either enhance or reduce the overall real option level when two companies merge. On the one hand, the real option level of acquirers can be low prior to the merger, leading to management's decision to achieve growth by acquiring targets' real option and acting on investment opportunities brought on by targets. On the other hand, acquirers may not necessarily be at a disadvantage in real option. Acquirers may hold plenty of real option to create more value by interacting with targets' real option. These two opposite predications of the acquirer's real option level may act synchronously and result in an inconclusive relationship between the real option level and the probability of being an acquirer.

Matching characteristics and merger pairing

It is well established that synergy is the most fundamental and important driven factor in M&A incidences and it is mostly achieved through asset complementarity. Asset complementarity can take various forms in every process of a firm's operation. Contrary to the traditional Q-theory of mergers, Rhodes-Kropf and Robinson (2008) found that bidder firms are more likely to acquire target firms with a similar valuation ratio (i.e. high buys high, moderate buys moderate and low buys low). Also, many studies suggest that vertical (related) mergers create larger wealth effects than diversifying ones (Fan & Goyal, 2006). These studies argue that similarities and relatedness are the key factors in formation of merger pairs.

Recently, Bena and Li (2014) analyzed how similarities and relatedness affect transaction incidence for technological firms through the overlap between two firms' innovation activities. The results suggested that the technological overlap between firm pairs has a positive effect on transaction incidence. They also showed that acquirers have large patent portfolios and low R&D expenses, while targets have high R&D expenses and slow growth in patent outputs. Bena and Li (2014) offered an insight into how technological companies' assets complement each other through M&A. On the other hand, Mizik and Jacobson (2003) suggested that companies' resources can complement and collaborate. They pointed out that firms may have different strategic emphasis on either value creating (i.e. innovation and production) or value appropriation (i.e. extracting profits in the marketplace).Value creating and value appropriation activities complement with each other in firm's development. The value creating activities would generate intellectual assets (measured by R&D expenses) and relational assets (measured by advertising expenses). It is demonstrated that firm value can be enhanced through an appropriate combination of these two assets. In this chapter, I test the 'like buys like' argument proposed by Rhodes-Kropf and Robinson (2008) with coverage of both technological and non-technological firms by testing the effect of firm pairs' matching characteristics on transaction incidence. I construct two measures of strategic matches in this chapter.

For the first measure, I classify firm pairs based on their relative real option levels suggested by Grullon et al. (2012). Grullon et al. (2012) found that the generally positive relationship between firm-level excess return and volatility changes is due to the real option processed by the firm. As the real option value increases with the increase in

volatility, firm value will benefit more from the increase in volatility when firms possess more real option. The sensitivity of the firm can be served as a measure of the relative realoption level for the firm. The positive coefficient of firm value to changes in volatility indicates the existence of real option embedded in the firm, while the negative coefficient reveals that the increase in volatility risks reducing firm value. Real option takes the forms of investment opportunity and managerial flexibility; firms with higher levels of real option tend to be small and innovative. The second measure is developed based on the work by Mizik and Jacobson (2003) to classify firm pairs into groups with different strategic orientation combinations (within each firm pair, firms can have the same or different strategic orientation towards either intellectual assets or relational assets).

Based on the findings of Rhodes-Kropf and Robinson (2008) and Bena and Li (2014), which suggest that similarities and relatedness help to enhance asset complementarity and lead to higher synergy value, I conjecture that firms with similar strategic orientation are more likely to form merger pairs.

In this chapter, I extend the existing literature by incorporating non-technological characteristics into the analysis framework of M&A incidence, which offers a better understanding of how different types of firms (both technological and non-technological firms) merge together.

3.4 Methodology

In this section, I develop an empirical model based on Bena and Li (2014) and construct two matching characteristic variables. By developing the matching pair

measures, I examines the relationship between firm pair characteristics and transaction incidence.

First, to test the hypothesis regarding the relationship between real option levels and transaction incidence, I run the following logit regression using cross-sectional data as of the one fiscal year before the announcement of the deal:

$$Event\ Firm_{im,t} = \alpha + \beta_1\ Real\ Option_{im,t-1} + \beta_2 Event\ Firm\ Characteristics_{im,t-1} + Deal\ Fixed\ Effect_m + \varepsilon_{im,t} \quad (3.1)$$

The dependent variable $Event\ Firm_{im,t}$ equals one when firm i is either an acquirer or target in deal m, and zero otherwise. The $Real\ Option_{im,t-1}$ is the real option level of firm i within the one fiscal year before the announcement of deal m. $Event\ Firm\ Characteristics_{im,t-1}$ include total assets, ROA, leverage, cash, sales growth rate, book-to-market ratios and stock return. The definitions of these firm characteristics are in the Appendix. For each deal, there is one observation for the acquirer (target) and multiple observations for the matched acquirers (matched targets). $Deal\ Fixed\ Effect_m$ is the fixed effect for each acquirer (target firm) and its matched acquirers (matched target firms).

To further test the hypothesis regarding matching characteristics in forming merger pairs, I run the following logit regressions using cross-sectional data as of the one fiscal year before the announcement of the deal:

$$Acquire\_Target_{ijm,t} = \alpha + \beta_1\ Match_{ijm,t-1} + \beta_2 Acquirer\ Characteristics_{im,t-1} + \beta_3 Target\ Characteristics_{jm,t-1} + \beta_4 Diversifying_{ijm} + \beta_5 Same\ State_{ijm} + Deal\ Fixed\ Effect_m + \varepsilon_{ijm,t} \quad (3.2)$$

The dependent variable $Acquire\_Target_{ijm,t}$ equals one when firm pair ij is the acquirer-target firm pair, and zero otherwise. $Acquirer\ Characteristics_{im,t-1}$ and $Target\ Characteristics_{jm,t-1}$ are firm characteristics as defined in equation (3.1). The detailed definitions are in the Appendix. $Diversifying_{ijm}$ equals one when firm i and firm j are in the same industry, and zero otherwise. $Same\ State_{ijm}$ equals one when firm i and firm j locate in the same state, and zero otherwise. $Deal\ Fixed\ Effect_m$ is the fixed effect for each acquirer (target firm) and its matched acquirers (matched target firms).

Control sample construction

In following Bena and Li (2014), I match each incident firm (acquirer or target) with five potential merger participants; therefore, there exist different pairs of firms. The dependent variable $Acquirer\_Target_{ijm,t}$ equals one when the firm pair ij is the acquirer-target pair in a real transaction, and zero otherwise.

Bena and Li (2014) construct three control samples based on the timing clustering, industry relatedness and growth opportunity characteristics. In this study, as real option level and growth opportunity are positively correlated, I construct the control sample only by time and industry. To form the timing and industry matched control sample, I find up to five matching firms for each incidence firm (acquirer or target) by the same industry (based on same two-digits SIC code) that are neither an acquirer nor a target in three years prior to the M&A.

Strategic match measure

Rhodes-Kropf and Robinson (2008) indicated that asset complementarity and costly search result in the assortative matching, which can include both tech and non-tech characteristics as long as similarities have the potential to improve efficiency after the merger. I use two different approaches to construct the match measures.

The first measure of matching is constructed based on firm's relative real option level. It is suggested that firm value can be decomposed into value of assets-in-place and value of growth options (Myers, 1977; Aguerrevere, 2009). The value composition may vary across different types of firms. Grullon et al. (2012) pointed out that real option intensive firms usually have a larger proportion of their firm value represented by growth options. Grullon et al. (2012) also found that the positive relationship between firm level stock return and firm level changes in volatility is due to the real options processed by the firm. Based on Grullon et al.'s findings, I constructed the first matching variable by grouping firms based on their relative real option level. The traditional asset pricing literature well established that the aggregate market returns are negatively correlated with aggregate market volatility (French at al., 1987; Campbell & Hentschel, 1992). There are two possible explanations for this negative relation: first, the leverage hypothesis, which suggested that the decrease in stock prices makes the firm become more leveraged and increase the volatility of stock returns; second, the increase in systematic volatility raises risk premiums and expected future stock returns, and reduces firm value, leading to a negative relationship between volatility and stock returns. Other than examining the return-volatility relationship in the an aggregate level, Grullon et al. (2012) found a positive relationship between the contemporaneous stock returns and changes in volatility

in the firm level and this positive relationship is explained by real option processed by firms. They found a bigger sensitivity coefficient of firm-level stock returns to changes in volatility for firms with more real options and the coefficient drops after firm exercise their real options. Therefore, the sensitivity coefficient can in turn served as an indicator of firms' real option level. In this study, I use this sensitivity coefficient of firm level stock return to changes in volatility as a proxy for firm's real option level and then construct the first measure of firm pair based on firms' different real option characteristics. Following Grullon et al. (2012), I estimate the sensitivity coefficient for individual firms as follow:

$$r_{i,\tau} - r_{f,\tau} = \alpha_{i,t} + \beta_{i,t}\left(r_{m,\tau} - r_{f,\tau}\right) + \gamma_{i,t}\Delta VOL_{i,\tau} + \varepsilon_{i,\tau} \quad (3.3)$$

$r_{i,\tau}$ is monthly firm-level stock return, $r_{f,\tau}$ is monthly risk-free rate, $r_{m,\tau}$ is monthly market return. $\Delta VOL_{i,\tau}$ is change in volatility for firm i in month t , which is calculated as the difference in stock volatility between month t and month $t-1$. For each firm i in month t , I estimate the above time-series regression equation using data during months $\tau \in (t-60, t-1)$. The estimated coefficient on $\Delta VOL_{i,\tau}$, $\gamma_{i,t}$ is the sensitivity of stock returns to changes in volatility. In the individual firm level, the sensitivity coefficient can be both positive and negative. When the coefficient is negative, it suggests that the real option embedded in the firm is rare and the relationship between stock returns and volatility is mainly driven by risks.

Based on the signs of the estimated sensitivity coefficients of firm-level stock returns to changes in volatility, I divided merger pairs into four categories: (+, +), (+,-), (-, +), (-,-), where (+, +) specifies a merger pair in which both acquirer and target have

positive sensitivity coefficients; (+,-) specifies a merger pair in which acquirer has a positive sensitivity coefficient and target has a negative sensitivity coefficient; (-,+) specifies a merger pair in which acquirer has a negative sensitivity coefficient and target has a positive sensitivity coefficient; (-,-) specifies a merger pair in which both acquirer and target have negative sensitivity coefficients.

The second measure of match is constructed based on a strategic emphasis (*SE*) concept developed by Mizik and Jacobson (2003). They suggested that firms may have different strategic emphasis on either value creating (i.e. innovation and production) or value appropriation (i.e. extracting profits in the marketplace).Value creating and value appropriation activities complement with each other in firm's development. The value creating activities would generate intellectual assets (measured by R&D expenses) and relational assets (measured by advertising expenses). It is demonstrated that firm value can be enhanced through an appropriate combination of these two assets. The *SE* ratio is calculated as follow:

$$SE = \frac{Advertising\ Expense - R\&D\ Expense}{Assets} \qquad (3.4)$$

When advertising expenses exceed R&D expense, the *SE* ratio becomes positive and the firm exhibit an emphasis on relational assets or the value appropriation process. When firms spend more on R&D, the *SE* ratio becomes negative and the firm exhibit an emphasis on intellectual assets or the value creating process. In this study, I first figure out the strategic orientation (*SO*) for each firm by comparing R&D expenses and advertising expenses and then construct merger pairs based on their different strategic orientations. If a firm's R&D expenses exceed its advertising expenses, then it is oriented

towards intellectual assets (labeled as '*R*', where *R* stands for R&D). On the contrary, if a firm spends more on advertising, it is regarded as relational assets-oriented (labeled as '*A*', where *A* stands for advertising). The R&D and advertising expenses data are obtained from Compustat. For those firms disclose neither R&D expenses nor advertising expenses, I put them into the group marked as no orientation towards either type of asset (labeled as '*N*', where *N* stands for no orientation). In this way, each firm pair belongs to the set {(*R,R*) , (*A,A*) , (*R,A*), (*A,R*) , (*R,N*) , (*N,R*) , (*A,N*) , (*N,A*)}. Each element in this set refers to one type of merger pair. For example, (*R, A*) refers to the combination in which the acquirer is oriented towards intellectual assets and the target is oriented towards relational assets. Based on the nine types of merger pair, I further construct different dummy variables by grouping different types of merger pair. The detailed definitions of these dummy variables are described in the part of empirical analysis.

Control Variables

Following Bena and Li (2014), control variables include $Total\ Asset$, $\Delta Sales$, ROA, $Leverage$, B/M and $Stock\ returns$. $Total\ Asset$ is calculated as the natural logarithm of firms' total assets. $\Delta Sales$ is the growth rate of sales. ROA is return on assets, which is calculated as earnings before interest, tax, depreciation, and amortization scaled by total assets. B/M is calculated as the book value of common equity divided by the market value of common equity. $Stock\ returns$ are calculated as the difference between the buy-and-hold stock return from month -14 to -3 relative to the deal announcement month and the analogously defined buy-and-hold value-weighted CRSP index return. $Same\ State$ is a dummy variable which equals one if the acquirer and

target firms are located in the same state. The dummy variable $Diversifiying$ equals to one if the acquirer and target firms are in the same industry defined by two-digit SIC codes.

3.5 Data

I obtain the M&A data from the SDC database. There were 158,702 M&A transactions announced and completed between January 1, 1980 and December 31, 2006. The targets of these deals were all US firms and the acquirers were from all over the world. Among those deals, there were 134,061 where both targets and acquires were US firms.

I then match the 6-CUSIP with GVKEY and PERMNO, which are the unique identifiers in COMPUSTAT and CRSP separately. There are 51,615 deals where the acquirers' identifiers are fully matched and 17,513 deals where targets' identifying information is fully matched.

After deleting mismatch cases, there are 49,508 deals where the acquirers' identifying information is fully and correctly matched, 15,254 deals where the targets' identifying information is fully and correctly matched. There are 5,215 deals where the acquirers' and the targets' identifying information is fully and correctly matched (i.e. their information is covered by both Compustat and CRSP).

Then I delete the deals in which the acquirers are from the utility and financial sector (SIC 4000-4999; 6000-6999). After applying all these filters, there are 3,726 deals left.

To conduct the study of transaction incidence and merger pairing, I further match each incidence firm (acquirer or target) with five matched firms following the matching method discussed in the methodology section above. Table 3.1 reports the summary statistics of deal information, characteristics of incidence firms and their respective matched firms. The statistics show that the acquirers are generally larger, more profitable than the acquirers holding less real option.

Table 3.1 Summary Statistics

The following table reports deal information, summary statistics of acquirer firms, target firms and their respective matched firms in the sample. The deal sample period ranges from 1980/1/1 to 2006/12/31. The control sample is formed by paring each incidence firm (acquirer or target) with five peer matches. The real option proxy is estimated as the sensitivity coefficient of firm level stock excess return on changes in volatility. *Total assets* is calculated as the natural logarithm of firms' total assets. *ROA* is return on asset, which is calculated as the earnings before interest, tax, depreciation, and amortization scaled by total assets. *Leverage* is total debt scaled by total assets. *Cash* is defined as cash and short-term investment scaled by total assets. *△Sales* is the growth rate of sales. *B/M* is the book value of common equity scaled by the market value of common equity. *Stock Return* is calculated as the difference between the buy-and-hold stock return from month -14 to -3 relative to the deal announcement month and the analogously defined buy-and-hold value-weighted CRSP index return.

Panel A: Deal Characteristics

	Mean	Std.	P5	Median	P95	# Obs.
Transaction Value	804.700	3733.02	3.000	98.881	3140.85	3328
% Cash	84.219	26.971	21.410	100.000	100.000	1567
# of Bidder	1.046	0.257	1.000	1.000	1.000	3726
% Acquired	81.206	34.198	5.940	100.000	100.000	3526
% Owned after	85.940	30.794	8.700	100.000	100.000	3531
1-day Premium (%)	36.624	82.423	-12.000	25.920	102.220	2221
1-week Premium (%)	40.920	72.378	-9.710	30.520	113.110	2216
4-week Premium (%)	48.397	86.626	-11.610	36.260	130.650	2209

Panel B: Incident Firms' and Matched Firms' Characteristics

	Mean	Std.	Median	Mean	Std.	Median
	Acquirers			Matched firms		
Real option proxy	0.361	2.156	0.277	0.447	2.810	0.315
Total assets	6.906	2.099	6.955	4.612	2.377	4.409
ROA	0.136	0.151	0.152	-0.001	0.503	0.076
Leverage	0.181	0.187	0.140	0.196	0.253	0.105
Cash	0.167	0.189	0.093	0.178	0.223	0.079
△Sales	0.331	0.135	1.321	0.354	2.095	0.090
B/M	0.479	0.421	0.386	0.693	1.274	0.559
Stock Return	0.158	0.845	0.021	0.000	0.760	-0.102
	Mean	Std.	Median	Mean	Std.	Median
	Targets			Matched firms		
Real option proxy	0.401	2.152	0.359	0.492	3.052	0.334
Total assets	4.782	1.925	4.635	4.605	2.376	4.399
ROA	0.023	0.325	0.100	-0.001	0.503	0.076
Leverage	0.219	0.288	0.153	0.197	0.258	0.105
Cash	0.198	0.227	0.101	0.178	0.224	0.080
△Sales	0.432	1.622	0.119	0.574	6.936	0.090
B/M	0.516	1.048	0.469	0.657	1.791	0.558
Stock Return	-0.037	0.748	-0.167	0.000	0.759	-0.102

3.6 Empirical results

Real option and transaction incidence

In this section, I conduct multivariate analyses to test the hypotheses regarding to the how firms' matching characteristics will affect the transaction incidence and merger pairing.

I first examine how the level of real option affects the probability of the firm to engage in transaction incidence by running the logit regression in equation (3.1).

Table 3.2 presents coefficient estimates from the logit regression in equation (3.1). Column (1) and Column (2) report the coefficient estimates from the samples which consist of incidence acquirers and matched acquirers, and incidence targets and matched

targets separately. The signs and sizes of the coefficient estimates of control variables are consistent with those reported by Bena and Li (2014). As shown in the table, the coefficient estimate of variable 'real option level' is significantly positive in column (2) and not significant in column (1), which indicates that targets with high levels of real option have a better chance to be acquired, which is consistent with the previous prediction. Regardless of the real option level of acquirers, firms with more real option always tend to attract more acquirers. By purchasing targets' real option, acquirers can either directly act on targets' growth option or produce more through interacting with targets' growth option. In both circumstances, acquirers can benefit from value creation achieved by exercising growth option; thus targets with high levels of real option are always attractive to acquirers. For acquirers, as stated above, the real option level does not determine the incidence probability of becoming an acquirer. When acquirer has a low level of real option, it tends to undertake M&A to acquire targets with more growth option which cannot be created by its own to facilitate growth. When the acquirer has a comparably high level of real option, it can still be stimulated by potential benefits resulting from the multiple real option interaction.

Table 3.2 Probability of becoming an acquirer (or target)

This table reports coefficient estimates from the conditional logit regression in equation (3.1). The dependent variable equals to one for the incidence firms (acquirer or target), and zero for the control firms. The control firms are matched by merger timing and industry. *Total assets* is calculated as the natural logarithm of firms' total assets. *ROA* is return on asset, which is calculated as the earnings before interest, tax, depreciation, and amortization scaled by total assets. *Leverage* is total debt scaled by total assets. *Cash* is defined as cash and short-term investment scaled by total assets. *△Sales* is the growth rate of sales. *B/M* is the book value of common equity scaled by the market value of

common equity. *Stock Return* is calculated as the difference between the buy-and-hold stock return from month -14 to -3 relative to the deal announcement month and the analogously defined buy-and-hold value-weighted CRSP index return.*, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

	Acquirer	**Target**
Intercept	-5.459***	-2.237***
Firm Characteristics		
Total assets	0.550***	0.063***
ROA	0.924***	0.248**
Leverage	-1.539***	-0.215**
Cash	0.298	0.421**
⊿Sales	0.039**	-0.050*
B/M	-0.026*	-0.015*
Stock return	0.231***	-0.116**
SIC	3.561***	3.564***
State	1.852***	2.440***
Real Option level	0.005	0.150***
Year Fixed Effect	Yes	Yes
# of Obs.	10422	7420
Pseudo R^2	0.38	0.35

Strategic Match and merger pairing

In order to test the hypothesis about strategic matching and merger pairing, I first adopt the strategic match measure developed from the work by Grullon et al. (2012). First, I measure each firm's individual real option level by estimating the regression in equation (3.3). As stated above, the estimated coefficients which capture the sensitivity of firm value to chances in volatility reveal firms' real option level. The positive coefficient indicates that firms hold a positive amount of real option which allows them to take advantage of the increased volatility. Firms with negative coefficient estimates tend to have little or no real option and experience value reduction when faced with increased volatility. Classifying firms into groups identified by the level of real option, I further construct four merger pairs in (*P, P*), (*N, N*), (*P, N*) and (*N, P*) (where *P* stands for a

'positive' coefficient and *N* stands for a 'negative' coefficient). Real option mainly takes the forms of investment opportunity and managerial flexibility. Studies have shown that small and innovative firms usually hold more real option. In this way, the real option level helps to classify firms into different groups in terms of investment opportunity and managerial flexibility. I design the first group of real option dummy as follows:

$$RO1 \text{ dummy series:} \begin{cases} RO1_1 = \begin{cases} 1, & if\ firm\ pair\ is\ (P,P) \\ 0, & otherwise \end{cases} \\ RO1_2 = \begin{cases} 1, & if\ firm\ pair\ is\ (P,N) \\ 0, & otherwise \end{cases} \\ RO1_3 = \begin{cases} 1, & if\ firm\ pair\ is\ (N,P) \\ 0, & otherwise \end{cases} \\ RO1_4 = \begin{cases} 1, & if\ firm\ pair\ is\ (N,N) \\ 0, & otherwise \end{cases} \end{cases} \tag{3.5}$$

To avoid the dummy variable trap, the above four dummies appear less than four at a time in the regression.

Table 3.3 presents coefficient estimates for the conditional logit regression in equation (3.2) using the real option dummy as the measure of strategic matches. As shown in the table, the estimated coefficients of total assets, ROA and stock returns are significantly positive, which indicates that firms with larger size, higher profitability and higher prior stock returns are more likely to be acquirers. The estimated coefficients of leverage and BM ratios are significantly negative, suggesting that acquirers tend to have lower leverage and higher stock market valuation. On the other hand, firms with smaller size, higher profitability, higher leverage, more cash, and lower prior stock returns are more likely to be targets. These findings are consistent with the prior work on M&A. (Maksimovic & Phillips, 2001; Moeller at al., 2005; Gaspar et al, 2005). The table above

also shows how different strategic matches affect the transaction incidence relative to others. It is worth mentioning that there are also two other dummy variables, SIC (same industry) and state, included in the regression. Each estimated coefficient for the strategic match dummy reflects the effect of a specific strategic match on transaction incidence compared to the excluded strategic match and merger pairs in different industries or different states.

Table 3.3 Strategic match and merger pairing

This table reports coefficient estimates from the conditional logit regression in equation (3.2) using the sample which consists of incidence firms and their respective matched firms. The dependent variable equals to one for the acquirer-target firm pairs, and zero for the control firm pairs that form the control group. Columns (1) to (8) present the coefficient estimates from conditional logit models using different strategic match measures. *Total assets* is calculated as the natural logarithm of firms' total assets. *ROA* is return on asset, which is calculated as the earnings before interest, tax, depreciation, and amortization scaled by total assets. *Leverage* is total debt scaled by total assets. *Cash* is defined as cash and short-term investment scaled by total assets. *△Sales* is the growth rate of sales. *B/M* is the book value of common equity scaled by the market value of common equity. *Stock Return* is calculated as the difference between the buy-and-hold stock return from month -14 to -3 relative to the deal announcement month and the analogously defined buy-and-hold value-weighted CRSP index return.*, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

Column	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**
Intercept	-4.593***	-4.537***	-4.512***	-4.570***	-4.514***	-4.720***	-4.588***	-4.429***
				Acquirer Characteristics				
Total assets	0.297***	0.295***	0.296***	0.295***	0.297***	0.297***	0.297***	0.297***
ROA	0.650***	0.636***	0.661***	0.638***	0.659***	0.659***	0.659***	0.659***
Leverage	-0.360***	-0.335***	-0.355***	-0.332***	-0.358***	-0.358***	-0.358***	-0.358***
Cash	0.120	0.128	0.118	0.129	0.118	0.118	0.118	0.118
△Sales	0.021	0.022	0.020	0.022	0.021	0.021	0.021	0.021
B/M	-0.166***	-0.163***	-0.166***	-0.163***	-0.167***	-0.167***	-0.167***	-0.167***
Stock return	0.080***	0.084***	0.079***	0.084***	0.079***	0.079***	0.079***	0.079***

	Target Characteristics							
Total assets	-0.212***	-0.212***	-0.210***	-0.211***	-0.211***	-0.211***	-0.211***	-0.211***
ROA	0.477***	0.477***	0.477***	0.477***	0.477***	0.477***	0.477***	0.477***
Leverage	0.427***	0.424***	0.425***	0.423***	0.427***	0.427***	0.427***	0.427***
Cash	0.215**	0.217**	0.226**	0.220**	0.219**	0.219**	0.219**	0.219**
△Sales	-0.009	-0.009	-0.008	-0.009	-0.009	-0.009	-0.009	-0.009
B/M	0.011	0.011	0.011	0.010	0.011	0.011	0.011	0.011
Stock return	-0.106***	-0.101***	-0.095***	-0.098***	-0.100***	-0.100***	-0.100***	-0.100***
SIC	3.658***	3.653***	3.666***	3.655***	3.664***	3.664***	3.664***	3.664***
state	2.139***	2.137***	2.131***	2.135***	2.134***	2.134***	2.134***	2.134***
$RO1_1$(+,+)	0.184***				0.085	0.291***	0.159**	
$RO1_2$(+,-)		-0.050			-0.074	0.132**		-0.159**
$RO1_3$(-,+)			-0.220***		-0.206***		-0.132*	-0.291***
$RO1_4$(-,-)				0.059		0.206***	0.074	-0.085
Year fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
# of Obs.	24423	24423	24423	24423	24423	24423	24423	24423
Pseudo R^2	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32

As shown in column (6), the estimated coefficients of dummies (*P, P*), (*P, N*) and (*N, N*) are all positive and significant, indicating that these firm pairs have a higher probability to engage in M&A. Among the three firm pairs, (*P, P*) has the largest and most significant coefficient and (*N, N*) has the second highest coefficient. Based on the value of the coefficient, it can be roughly inferred that the order of the transaction incidence probability from high to low is (*P, P*) (with a coefficient of 0.291), (*N, N*) (with a coefficient of 0.206) and (*P, N*) (with a coefficient of 0.132), showing that firms are more likely to combine with similar ones in terms of real option levels. It is interesting to see that the firm pair (*N, P*) is the most unlikely merger pair. Logically speaking, when firms lack investment opportunity or managerial flexibility, they tend to acquire targets which abound in them. Under this circumstance, the combination (*N, P*) should have a better chance to happen than what is shown in the result. The possible explanation for the result is that real option obtained by acquiring another company cannot be efficiently utilized when the acquirer firm has little or no real option. It can also be inferred that the possible synergistic value is created through the interactions of acquirers' and targets' real options

rather than through the simple addition of new acquired ones, which is consistent with the asset complementarity argument of synergy creation. In order to further prove the 'like buys like' argument, I define the second real option dummy as follows:

$$RO2 \text{ dummy}: RO2 = \begin{cases} 1, & if\ firm\ pair\ is\ (P,P)\ or\ (N,N) \\ 0, & otherwise \end{cases} \quad (3.6)$$

Table 3.4 Like buys like or complementary strategic orientation?

This table reports coefficient estimates from the conditional logit regression in equation (3.2) using the sample which consists of incidence firms and their respective matched firms. The dependent variable equals to one for the acquirer-target firm pairs, and zero for the control firm pairs that form the control group. *Total assets* is calculated as the natural logarithm of firms' total assets. *ROA* is return on asset, which is calculated as the earnings before interest, tax, depreciation, and amortization scaled by total assets. *Leverage* is total debt scaled by total assets. *Cash* is defined as cash and short-term investment scaled by total assets. *△Sales* is the growth rate of sales. *B/M* is the book value of common equity scaled by the market value of common equity. *Stock Return* is calculated as the difference between the buy-and-hold stock return from month -14 to -3 relative to the deal announcement month and the analogously defined buy-and-hold value-weighted CRSP index return.*, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

Intercept	-4.656***
Acquirer Characteristics	
Total assets	0.296***
ROA	0.644***
Leverage	-0.339***
Cash	0.125
△Sales	0.022
B/M	-0.165***
Stock return	0.083***
Target Characteristics	
Total assets	-0.211***
ROA	0.477***
Leverage	0.427***
Cash	0.216**
△Sales	-0.009

B/M	0.011
Stock return	-0.101***
SIC	3.658***
state	2.135***
RO2	0.190***
Year fixed effect	Yes
# of Obs.	24423
Pseudo R^2	0.3342

Table 3.4 presents coefficient estimates for the conditional logit regression in equation (3.2) using the second real option dummy as the measure of strategic matches. As shown in the table, the coefficient estimate of the dummy variable *RO2* is 0.19 at 1% significance, which indicates that firm pairs with a similar real option level are more likely to form merger pairs. Overall, the evidence shows that firms with similar strategic match characteristics are more likely to pair up in M&A.

Strategic orientation and merger incidence

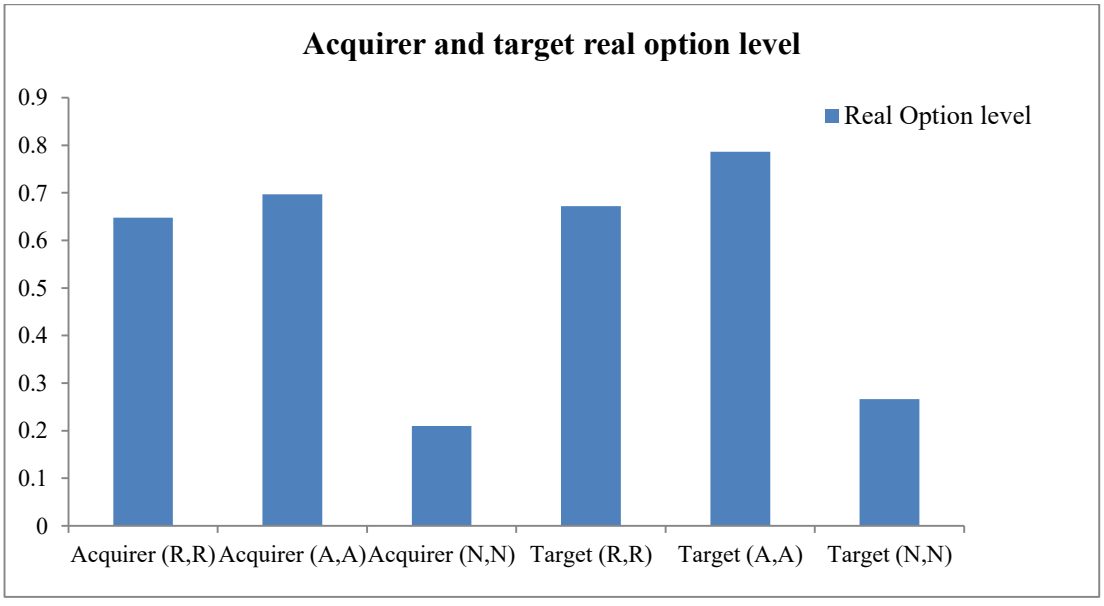
In order to better explain the 'like buys like' argument, I introduce the second measure of strategic matches. This measure is developed upon the strategic emphasis concept. As showed above, there are three possible strategic orientations for each firm: *R* (oriented towards intellectual assets), *A* (oriented towards relational assets) and *N* (no strategic orientation). The strategic orientation classification reflects the real option classification in another angle.

Table 3.5 Distribution of strategic orientation and means of real option level

The table below shows the distribution of strategic orientations for acquirers (and matched ones) and targets (and matched ones). N is the number of observations under each type of strategic orientation. Std. and Mean are standard deviations and means of real option levels. The difference row shows the difference between the mean of the real option level for different strategic orientation groups. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

Column	**(1)**	**(2)**	**(3)**
Acquirer Strategic Orientation	N	Std.	Mean
(R,R)	2679	2.807	0.648_{a}
(A,A)	1441	2.598	0.697_{b}
(N,N)	2973	2.897	0.210_{c}
Difference			0.438_{ac}^{***} 0.487_{bc}^{***}
Target Strategic Orientation	N	Std.	Mean
(R,R)	3102	3.344	0.672_{a}
(A,A)	1572	2.942	0.786_{b}
(N,N)	3162	3.259	0.266_{c}
Difference			0.406_{ac}^{***} 0.520_{bc}^{***}

Fig. 3.1 Acquirer and target real option level for different strategic matches



As shown in column (3) of table 3.5, the real option level differences between the groups (*R, R*) and (*N, N*), (*A, A*) and (*N, N*) are significantly positive for both acquirers and targets, which indicates that the real option level is significantly higher for firms with a strategic orientation towards either intellectual assets or relational assets than those without strategic orientation. Based on the classification of strategic orientation, there are nine possible combinations of acquirers and targets : (*R,R*) , (*A,A*) ,(*N,N*), (*R,A*), (*A,R*) , (*R,N*) , (*N,R*) , (*A,N*) , (*N,A*). To further test whether firms form merger pairs in the way suggested by the 'like buys like' theory or the strategic emphasis argument, I classify those individual strategic orientation dummies into several groups to generate new dummy variables. In table 6, I define the dummy variables $SO1_1$ and $SO1_2$ as follows:

$$SO1_1 = \begin{cases} 1, if\ firm\ pairs\ is\ (R,R),(A,A) or\ (N,N) \\ 0, \qquad\qquad\qquad\qquad\qquad otherwise \end{cases} \tag{3.7}$$

$$SO1_2 = \begin{cases} 1, \qquad if\ firm\ pairs\ is\ (R,A)\ or\ (A,R) \\ 0, \qquad\qquad\qquad\qquad otherwise \end{cases}$$

$SO1_1$ is constructed to capture all the 'like buys like' situations for firm pairs. $SO1_2$ exactly captures the spirit of strategic emphasis complementation suggested by Mizik and Jacobson (2003).

As suggested by the 'like buys like' theory, firms with similar characteristics are more likely to form merger pairs. Rhodes-Kropf and Robinson (2008) theoretically showed that firms with similar evaluation ratios have a better chance to form merger pairs. They pointed out that asset complementarity and costly search are the main factors in the

'like buys like' outcome. Acquirers balance the costs induced by searching for increased synergy with the diminished bargaining power before a high quality partner, which results in an equilibrium of merger pairs of similar evaluation ratios. Rhodes-Kropf and Robinson (2008) mentioned that asset complementarity can emerge from any dimension such as better production, better technology and better culture. Bena and Li (2014) further extended the 'like buys like' theory among technological firms by investigating how technological overlaps between acquirers and targets generate beneficial innovation output. The strategic orientation classification method from Mizik and Jacobson (2003) unveils the part of non-technological mergers and acquisitions.

Table 3.6 presents coefficient estimates from the conditional logit regression in equation (3.2). In column (1), the similar strategic orientation match dummy $SO1_1$ (1.141) is positive and significant at 1% level, suggesting that the matches (*R, R*), (*A, A*) and (*N, N*) have a significantly higher probability to form merger pairs than other possible combinations. In column (2) of table 3.6, I design $SO1_2$ in a way to reflect different kinds of strategic orientation complementary. The negative and significant coefficient estimate of $SO1_2$ shows that the matches (*R, A*) and (*A, R*) are less likely to form merger pairs than other strategic matches. It is worth noting that the results still hold after controlling dummies in the same industry and all the other characteristics of acquirers and targets including size, B/M and profitability.

Table 3.6 Like buys like or complementary strategic orientation?

This table reports coefficient estimates of the conditional logit regression in equation (3.2) using the sample of incidence firms and their respective matched firms. The dependent variable equals to one for the acquirer-target firm pairs, and zero for the control firm pairs that form the control group. *Total assets* is calculated as the natural logarithm of firms' total assets. *ROA* is return on asset, which is calculated as the earnings before interest, tax, depreciation, and amortization scaled by total assets. *Leverage* is total debt scaled by total assets. *Cash* is defined as cash and short-term investment scaled by total assets. *△Sales* is the growth rate of sales. *B/M* is the book value of common equity scaled by the market value of common equity. *Stock Return* is calculated as the difference between the buy-and-hold stock return from month -14 to -3 relative to the deal announcement month and the analogously defined buy-and-hold value-weighted CRSP index return.*, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

Column	**(1)**	**(2)**
Intercept	-5.1192***	-4.514***
Acquirer Characteristics		
Total assets	0.2944***	0.2964***
ROA	0.6881***	0.6503***
Leverage	-0.2364**	-0.2855***
Cash	0.0717	0.1531
△Sales	0.0237*	0.0228*
B/M	-0.1599***	-0.1648***
Stock return	0.0764***	0.0852***
Target Characteristics		
Total assets	-0.2128***	-0.206***
ROA	0.5155***	0.4758***
Leverage	0.4107***	0.4541***
Cash	0.0137	0.2589**
△Sales	-0.00913	-0.0102
B/M	0.0117	0.0125
Stock return	-0.1057***	-0.1024***
SIC	3.4865***	3.6362***
state	2.0736***	2.1199***
$SO1_1$	1.1411***	
$SO1_2$		-0.692***
Year fixed effect	Yes	Yes
# of Obs.	24423	24423
Pesuedo R^2	0.3342	0.3205

Column (1) and column (2) in table 6 synchronically show that firms with same strategic orientations dominate the formation of merger pairs. This finding is consistent with the 'like buys like' theory.

In summary, acquirers tend to choose targets sharing similar strategic orientations rather than those which allocate firm resources to the other value creating process. Additionally, firms with strategic orientation are more likely to engage in M&A. These findings support the 'like buys like' theory in terms of strategic orientation characteristics. While Rhodes-Kropf and Robinson (2008) pointed out that firms with similar valuation ratios are more likely to form merger pairs, the above evidence complements and extends the argument to more specific complementary characteristics. When two firms allocate their limited resources to the same orientation, it is likely that they have more resources overlapping. In this way, the expected synergy creation originating from complementary resources may lead to a merger. The above findings are somewhat contradictory to what was suggested by Mizik and Jacobson (2003) who argued that acquiring companies with commentary resources in a different strategic orientation helps to enhance value creation and achieve competitive advantages. It is worth to mention that the sample period in this study ranges from 1980 to 2006, while studies suggest that the objectives and characteristics for M&A activity vary across different waves, for example, the 1960s M&A activity has been characterized as diversification (Andrade et al., 2001).

3.7 Conclusion

Using a large M&A dataset over the period 1980 to 2006, I discover how strategic matching characteristics impose a positive impact on merger pairing and transaction incidence. I first show that in terms of strategic orientation, firms with the same strategic orientation (oriented towards intellectual assets, relational assets or none of the above) are more likely to form merger pairs. Then I further analyze the dominant player in a firm pair and find that firms with a specific strategic orientation are more likely to engage in a merger. Among the nine types of firm pair under the classification of strategic orientation, two firms oriented towards intellectual assets have the highest probability to form a merger.

Then I employ the real option measure as anther proxy for strategic matches. I classify the firms into four groups based on the estimated real option level using the method proposed by Grullon et al. (2012). The regression results show that firms with a similar real option level are more likely to form merger pairs. In the meantime, I find that firms with little or no real option generally do not acquire targets with real option as they may not be able to efficiently utilize the acquired real option.

In summary, our results show that firms with similar strategic matching characteristics are more likely to form merger pairs. Our findings are consistent with the 'like buys like' theory proposed by Rhodes-Kropf and Robinson (2008). I contribute to the understanding of asset complementarity by showing that firms are more likely to form merger pairs when they have a similar strategic orientation as suggested by Mizik and Jacobson (2003).

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Appendix

Firm Characteristics	
Total Asset	The natural logarithm of total assets in millions of US dollars
ROA	Earnings before interest, tax, depreciation, and amortization scaled by total assets
Leverage	Total debt scaled by total assets
Cash	Cash and short-term investment scaled by total assets
Δ *Sales*	The growth rate of sales
B/M	The book value of common equity scaled by the market value of common equity
Stock Return	The difference between the buy-and-hold stock return form month -14 to month -3 relative to the month of the bid announcement and the analogously defined buy-and-hold stock return on the value-weighted CRSP index
Strategic Match Measures	
$RO1_1$	Dummy variable, equal to one when the firm pair combination is (*P,P*)[3]
$RO1_2$	Dummy variable, equal to one when the firm pair combination is (*P,N*)
$RO1_3$	Dummy variable, equal to one when the firm pair combination is (*N,P*)
$RO1_4$	Dummy variable, equal to one when the firm pair combination is (*N,N*)
$RO2$	Dummy variable, equal to one when the firm pair combination is (*P,P*) or (*N,N*)
$SO1_1$	Dummy variable, equal to one when the firm pair combination is (*R,R*)[4], (*A,A*) or (*N,N*)
$SO1_2$	Dummy variable, equal to one when the firm pair combination is (*R,A*) or (*A,R*)

[3] (P, P) refers to the firm pair combination where the coefficients estimate which proxy for real option is both positive for the acquirer and the target, where P stands for positive. The other three combinations are (P, N), (N, P) and (N, N). N stands for negative. For example, (N, P) refers to a negative coefficient estimate for the acquirer and a positive coefficient estimate for the target.

[4] (R, R) refers to the firm pair where both the acquirer and target have a strategic orientation towards intellectual assets. The other strategic orientations are A and N, where A stands for relational assets strategic orientation and N stands for no strategic orientation.

Chapter 4

Summary of findings and future research

4.1 Summary of findings

The existing literature offers various explanations for the motivations behind takeovers; for example, synergy effect, removal of underperforming management teams of the target, industry restructuring, overvaluation, agency and hubris. However, most of these theories explain the phenomena in a qualitative way and quantitative analysis meets considerable obstacles. Even for the synergy theory, related quantitative work tries to infer synergy value from the cumulative abnormal return around the announcement date of the takeover and the results are quite mixed. It is not surprising since stock price reactions combine overpayment, synergy, news about bidders, standalone values of the target, and probability assessments associated with successful deals. There are scholars using option prices to infer synergistic value evolving from M&A. However, this approach requires financial option data on both targets and bidders and reduces the sample size dramatically (from an initial sample of 31,408 to 167 observations). Some previous studies pointed out that takeovers occur when managers respond to the change of their company's investment opportunity. As investment opportunity can be seen as

growth option, the decrease in investment opportunity reflects a declining level of real option in the company.

A number of research works focus on the evaluation of real option. In most cases, each type of real option is typically analyzed in isolation and only analytic, closed-form solutions are found. However, in practice, various types of real option are embedded in investment es such as takeovers. Besides, the interactions among different types of real option generally make their individual values non-additive. Recently, Grullon et al. (2012) found that the positive contemporaneous relationship between firm-level stock returns can be explained by real option possessed by the firm. The more real option a firm processes, the more it can benefit from the higher volatility, which results in a higher sensitivity of stock return to changes in volatility. A firm having high levels of real option tends to enjoy a significantly positive relation.

The research work of Grullon et al. (2012) offers an explanation for the positive relationship between firm-level stock return and volatility, which was first found by Duffee (1995), and more importantly, also sheds light on the evaluation of real option collections. Rather than evaluating each individual real option, the findings in this chapter offer a new perspective in evaluating the values of various real options. Although the positive relationship between firm-level stock return and volatility changes cannot serve as an accurate measure of the value of real option, it can appropriately indicate the proportion of firms' real option value to firms' total value. By applying the framework in the context of M&A, I find that acquirers' real option levels generally experience a decline over the three years prior to the merger. This finding indicates that the proportion of acquirers' investment opportunity declines over the pre-merger period, which triggers

the consequential takeover. The second finding is that the level of real option for targets is significantly higher than that for acquirers in the one year prior to the merger, which indicates that acquirers tend to acquire targets with more real option to facilitate their future growth. These two findings support the view that takeovers are triggered by lack of investment opportunity of the acquiring company in a quantitative way. In Chapter 2, I also analyze the match between bidder and target in the real option perspective, which provides further insight into measuring the synergistic match in takeovers.

Real option not only plays a role in revealing the motivation of M&A, but also offers insights into how acquirers choose targets. In Chapter 3, I mainly test the ex-ante selection effect of firms' real option level on transaction incidence and merger pairing. Using a large M&A dataset over the period 1980 to 2006, I first show that in terms of strategic orientation, firms with the same strategic orientation (oriented towards intellectual assets, relational assets or none of the above) are more likely to form the merger pair. Then I further analyze the dominant player in a firm pair and find that firms with a specific strategic orientation are more likely to engage in a merger. Among the nine types of firm pair under the classification of strategic orientation, two firms oriented towards intellectual assets have the highest probability to form a merger.

Then I employ the real option measure as anther proxy for strategic matches. I classify the firms into four groups based on the estimated real option level using the method proposed by Grullon et al. (2012). The regression results show that firms with a similar real option level are more likely to form merger pairs. In the meantime, I find that firms with little or no real option generally do not acquire targets with real option as they may not be able to efficiently utilize the acquired real option.

In summary, our results show that firms with similar strategic matching characteristics are more likely to form merger pairs. Our findings are consistent with the 'like buys like' theory proposed by Rhodes-Kropf and Robinson (2008). I contribute to the understanding of asset complementarity by showing that firms are more likely to form merger pairs when they share a similar strategic orientation as suggested by Mizik and Jacobson (2003).

4.2 Limitations and future research directions

The thesis has several limitations. First, the sensitivity coefficient of firm-level stock return to volatility changes can only serve as a proxy for the gross level of real option within the firm. It is not a rigorous measurement of real option value. The gross measure cannot distinguish different types of individual real option within the firm. It only offers an insight into how to make a general judgment whether the firm is real-option intensive or non-intensive. Besides, through the changes in the value of the sensitivity coefficient, we can infer accumulating or exercising processes of real option.

Second, in the thesis, I only examine the pre-merger selection and matching mechanism of M&A, while there are other issues to be further investigated. For example, it should be interesting to know whether the matching will result in a better firm performance in the post-merger integration. This study does not cover the post-merger performance for the following reasons. First, it takes time for companies to create and exercise real option and further realize the value addition. Second, it is also difficult to isolate the pure M&A effect from the impact of other events on the subsequent merger in

the long run. Third, it is difficult to estimate the post-merger coefficient as a proxy for the individual firm real option level year after year as it requires a sixty-month window to complete the estimation. Though there exist difficulties in examining the effect of different merger pairs on the post-merger integration process, it is still very interesting to investigate the issue. The findings of merger incidence show that acquirers are more likely to choose targets with matching characteristics. However, these findings only reveal the phenomenon but lack the in-depth study of the inherent reason behind this 'like buys like' phenomenon. Based on the findings, at least two hypotheses can be proposed. First, as it is much easier for homogeneous firms to come to a consensus, acquirers may choose targets of similar characteristics simply because they are allowed to pay a lower premium with little resistance. Second, acquirers may have a belief in creating synergistic value with targets of matching characteristics and they are even willing to pay a higher premium for this. These two hypotheses can be further tested by investigating the merger premium paid to different merger pairs.