Ph. D. Dissertation in Engineering

M&A Target Selection for Innovation

: Determinants from a Knowledge-Based Perspective

혁신 창출을 위한 M&A 대상 기업 선택 방법

: 지식기반관점에서의 성과결정요인

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Abstract

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Recently concluded M&As differ from the M&As concluded in the past. Generally, M&A is known as an instrument to increase market share, obtain economies of scale and scope, access new markets, and diversify a firm's fields of business. However, many recent M&As are conducted for the purpose of acquiring the knowledge and technologies of the target firm as the strategic importance of external technology acquisition is substantially increasing to cope with high technological and market uncertainty and rapid technology change. In academics, this type of M&A is referred to as technological M&A and is distinguished from "conventional-purpose" M&As. Technological M&As are receiving growing attention in terms of their role in creating innovation and sustaining a competitive advantage, benefits usually not obtained through non-technological M&As. Accordingly, there are ongoing discussions on how a firm utilizes technological M&As to

generate innovation and a growing body of literature examines the determinants of technological M&A's innovation creation.

Through technological M&As, firms obtain new knowledge and technology from the target firm. Newly acquired knowledge contributes to creating innovation by itself and is combined with the existing knowledge of the acquirer firm to create innovation beyond what is possible for single firm. All of this implies that innovation through technological M&As depends on the knowledge characteristics of the acquirer and target firm. Accordingly, the extant literature states that the examination of knowledge characteristics of the acquirer firm and target firm is important to predict post-M&A innovation performance. In other words, to create more and diverse innovation, firms need to identify the knowledge characteristics of both the acquirer and target to select an appropriate target.

To systematically examine factors which need to be considered in 'technological M&A target selection', this dissertation adopts multiple dimensions of both the determinants and the resulting innovation performance. First, the dissertation investigates determinants in terms of the acquirer firm, target firm, and dyadic perspectives. These three perspectives help to examine the influence of individual firm characteristics as well as of the reciprocal characteristics between the acquirer and target firm on the performance of technological M&As. In other words, they contribute to identify the characteristics of the target firm generating more post-M&A innovation, the characteristics of the acquirer firm allowing it to exploit the acquired knowledge well,

and the reciprocal characteristics creating more synergies. In contrast to this dissertation, the extant literature has the limitation of only examining the determinants from one perspective. Second, the post-M&A innovation performance of the acquirer firm is examined in terms of an increase in innovation quantity and innovation diversity. Through technological M&As, an acquirer firm intends to generate innovation beyond what is possible using its existing knowledge base. In other words, an acquirer firm is conducting technological M&As for the purpose of increasing both innovation quantity and innovation diversity. The extant literature, however, focuses only on the investigation of factors which affect innovation quantity. Therefore, an examination of the effects of determinants of the increase of both innovation quantity and innovation diversity advances the understanding of technological M&As. Throughout three chapters, by adopting these diverse perspectives, the dissertation examines three important components of 'technological M&A target selection': the basic considerations for selecting a M&A target, factors for increasing post-M&A innovation quantity and factors for increasing post-M&A innovation diversity. This approach provides a comprehensive view on 'technological M&A target selection'.

Chapter 3 examines the effects of the acquirer firm and target firm's knowledge base structure on technological M&A. Because the knowledge of the acquirer firm and target firm will be combined through the technological M&A to create innovation, the characteristics of the acquirer firm and target firm's knowledge base should be examined in advance. Also, because this approach helps to identify what kind of acquirer firm and

target firm is suitable for a technological M&A strategy, it highlights the basic considerations for M&A target selection. According to the empirical results, first, acquirer firms with knowledge in diverse fields can obtain higher post-M&A innovation quantity. Second, different from the acquirer firm, the target firms with specialized knowledge increase the post-M&A innovation quantity. Third, synergy effects from technological M&As are created when the acquirer firm has a broad knowledge base while at the same time the target firm has an expertise in a specific area. In summary, this chapter empirically proves that a technological M&A strategy, which is mostly conducted by established conglomerates to obtain the knowledge and technology of start-up firms, contributes to an increasing innovation performance.

Chapter 4 examines the factors which have a profound effect on increasing knowledge absorption and consequently increasing innovation quantity. Among the various dyadic factors, the dissertation focuses on the role of knowledge similarity and knowledge digestibility. Empirical analysis results present two findings. First, the acquirer firm needs to select an M&A target which has a modest level of similar knowledge. A high similarity between the knowledge bases of the acquirer firm and target firm provides a similar language and recognition structure helping the absorption of the acquired knowledge but reduces the quantity of acquired new knowledge. Second, more innovation can be generated when the acquirer firm selects a target firm with a digestible size of knowledge. This finding undeceives that the acquirer firm needs to select a target considering its capability of absorbing and digesting knowledge although a target firm

with a large amount of knowledge is attractive in terms of new knowledge acquisition. In summary, this chapter highlights that a firm with a large amount of knowledge completely new to the acquirer firm would seem to be a good target in terms of knowledge acquisition, but would have negative effects in terms of knowledge exploitation and ultimately decrease post-M&A innovation quantity.

Chapter 5 examines the effects of determinants of the target firm as well as dyadic perspectives on post-M&A innovation diversity. Innovation diversity, having received growing attention by recent innovation-related research, is regarded as an important option to cope with a fast changing environment. Firms utilize an external technology acquisition strategy such as technological M&A to rapidly increase their innovation diversity. Empirical results on post-M&A innovation diversity, first, show that a firm with a large amount of knowledge contributes to generating innovation in diverse fields. Second, the target firm's relatively bigger size of the knowledge base also contributes to an increase of the innovation diversity. In summary, in contrast to innovation quantity, this chapter confirms that the innovation diversity increases when an large, in relative and absolute terms, amount of knowledge penetrates into the acquirer firm and disrupts the existing routines.

Overall, this dissertation reveals factors to be considered in selecting a target for technological M&A and elucidates the relationship between technological M&A and its resulting innovation performance in terms of multiple dimensions. The dissertation provides the following key findings and contributions. First, the dissertation highlights

the importance of examination of post-M&A innovation diversity. In the environment of high technological and market uncertainty, firms have a difficultly in predicting and coping with the volatile future. Accordingly, it is important that a firm has capabilities for creating innovation in diverse fields to respond to the fast-changing environment and ensure future success. Lots of firms conduct M&A to increase their innovation diversity. Thus, it is necessary to identify the factors which affect post-M&A innovation diversity. The dissertation empirically proves that selecting a proper target firm contributes to increase post-M&A innovation diversity. Second, the dissertation emphasizes that an acquirer firm should consider the diverse dimensions of innovation and determine their priority among the dimensions in the phase of target selection. According to the findings of the dissertation, the determinants can have different effects on the different dimension of innovation performance. The relative size of the target knowledge base, in particular, has a negative effect on the increase of innovation quantity while it has a positive effect on the increase of innovation diversity. Therefore, as this dissertation did, research in this field needs to re-examine the factors which affect the post-M&A innovation quantity to identify their effect on the post-M&A innovation diversity. Third, the dissertations uncovers the effects of knowledge base structure on post-M&A innovation performance. The extant literature focused on the examination of effects of the knowledge base contents including the knowledge relatedness of the acquirer firm and target firm or the knowledge size in the new field to the acquirer firm. Because the structure of knowledge base affects the efficiency of internal R&D and external technology sourcing strategy as

well as determines the characteristics of future innovation, the examination of knowledge base structure in the context of technological M&A is necessary to select a proper target firm. In conclusion, this dissertation highlights that selecting a proper target firm is important to successfully utilize technological M&A and contributes to establishing a strategy of 'target firm selection' which is the first step of technological execution.

Keywords: technological M&A, innovation performance, innovation diversity, knowledge base, knowledge similarity, knowledge digestibility

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Chapter 1. Introduction

1.1. Backgrounds

Mergers and acquisitions (M&A) are not a new phenomenon and for a long time have been a popular instrument for the growth of firms (Trautwein, 1990). Although the number of M&A transactions fluctuates due to external factors such as economic recessions, the decay of an industry, and regulatory changes, it continues to increase in the long term. This implies that the strategic importance of M&A in sustaining firms' survival and competitive advantage is constantly increasing. Figure 1-1 shows the annual number and value of M&A transactions announced within the past 20 years.

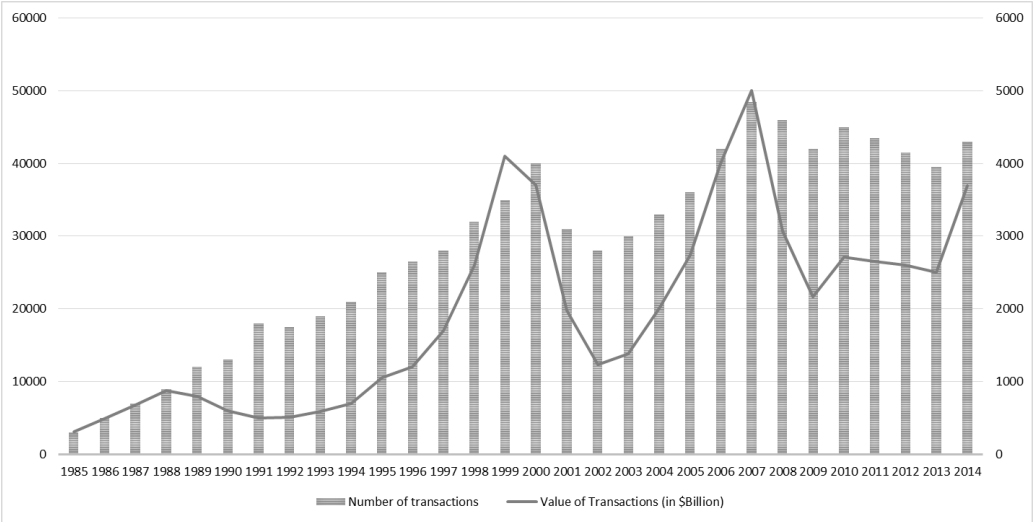

Figure 1-1. Number and value of transactions of announced mergers and acquisitions worldwide, 1985-2014.

(Source: Thomson Financial, Institute of Mergers, Acquisitions and Alliances (IMAA))

Starting from the first M&A wave in the 1890s', we can identify a total of five M&A waves, each based on different rationales. The participants of the first wave were trying to create monopolies through the formation of trusts (Banerjee & Eckard, 1998). At this time, firms did not face legal constraints in acquiring other firms due to a lack of antitrust regulation. The second M&A wave came about in the 1920s'. These M&A transactions were facilitated because the increasing enforcement of antitrust law and ended with the Great Depression. In contrast with the first M&A wave, this wave was initiated by small firms trying to increase their market share, achieve economies of scale and confront leading firms' monopolies by creating oligopolies (Stigler, 1950). In the third M&A wave, large firms acquired small firms outside of their main business to diversify their business fields (Shleifer & Vishny, 1991). In other words, M&As in this wave were conducted to pursue unrelated diversification. M&A transactions in the fourth M&A wave were different from past M&A transactions. First, related acquisitions increased dramatically due to the relaxation of antitrust regulation (Shleifer & Vishny, 1991). Second, hostile takeovers started to emerge. Third, with financial innovation, new ways of M&A transaction such as leveraged buyout (LBO) were developed (Ravenscraft, 1987). The economic globalization in the 1990s spurred the fifth M&A wave (Martynova & Renneboog, 2008). Accordingly, these M&As are characterized by their purpose of geographical expansion. Table 1-1 summarizes the key characteristics of the five M&A waves: the time period, geographic scope, rationale, drivers of wave and the acquisition types of each M&A wave.

Table 1-1. Summary of the 5 previous waves of M&A transactions

	1st M&A wave	**2nd M&A wave**	**3rd M&A wave**	**4th M&A wave**	**5th M&A wave**
Time period	1897-1903	1920-1929	1960s-1973	1980s	1990s
Geographic scope	US	US	US, UK, Europe	US, UK, Europe, Asia	US, UK, Europe, Asia
Rationale	Creation of monopolies	Creation of oligopolies	Growth through diversification	Elimination of conglomerate structures and inefficiencies	International expansion
Key drivers	Economic expansion; introduction of new legislation and industrial stock exchanges; lack of antitrust regulation	Increase in antitrust laws; economic recovery after World War I	Increases in antitrust regulation; underdeveloped external capital markets	Favorable economic conditions; financial innovations (e.g. junk bonds)	Globalization; deregulation; privatization
Acquisition types	Friendly acquisitions		Friendly and diversifying acquisitions	Related acquisitions; hostile takeovers; LBOs	Related acquisitions

Source: adapted from Ghauri and Buckley (2003)

Currently, a sixth M&A wave is hitting the world. To keep up with today's competitive business environment and short technology lifecycle, firms inevitably utilize external knowledge and technology (Chesbrough, 2006; Horwitch, 2013; Teece, 1986). Accordingly, firms conduct M&As for the purpose of obtaining external knowledge and technology and creating innovation beyond what is possible for a single firm. In academics, this is referred to as "technological M&A" and is distinguished from "conventional-purpose" M&As (Ahuja and Katila, 2001). Technological M&As are receiving growing attention in terms of their role in creating innovation and sustaining a competitive advantage, benefits usually not obtained through non-technological M&As (Ahuja & Katila, 2001; Sleuwaegen & Valentini, 2006; Wagner, 2011).

In accordance with the different M&A waves, the research focus on M&A has also changed and reflects the rationale of each M&A wave. For example, experiencing the third and fourth M&A waves, researchers were exposed to the related and unrelated M&A strategy. Accordingly, studies in the late 1980s' and early 1990s' mostly examined the effects of related and unrelated M&A on financial performance (e.g. Hopkins, 1987; Morck, Shleifer, & Vishny, 1990). The focus of late 1990s' M&A studies was placed on the determinants of cross-border acquisition success (e.g. Morosini, Shane, & Singh, 1998; Sebenius, 1998) because M&As in the 1990s' were mostly conducted for geographical expansion. M&A studies in recent years investigate how a firm utilizes technological M&As to generate innovation and a growing body of literature is examining the determinants of technological M&A's innovation creation (e.g. Ahuja &

Katila, 2001; Cloodt et al., 2006).

This dissertation examines technological M&As which are currently gaining a lot of attention from both the academic and business world. Technological M&A has become an increasingly popular mode of innovation for firms and this phenomenon is more noticeable in advanced industries, such as biopharmaceutical industry, where technological uncertainty is high. However, most M&A studies have focused on the financial objectives of M&A, e.g., the risk diversification role of M&A and synergy creation through economies of scale and scope. In other words, insufficient attention has been given to technological M&As. Therefore, a lot of studies points out the necessity of such investigation and started to examine the effects and determinants of technological M&A (e.g. Buss, 2012; Sears & Hoetker, 2014; Wagner, 2011).

However, prior research on technological M&A has the limitation of only examining the determinants and post-M&A innovation performance from one perspective. Because technological M&A is a complex transaction, it should be examined using diverse perspectives to advance the understanding. For this reason, although a number of studies on the determinants of technological M&A success have been conducted, they fall short of providing a comprehensive view. Given the recent interest in the topic, a systematic and holistic examination of technological M&A success is necessary.

1.2. Research purpose

Understanding the increasing significance of technological M&A in terms of managing external technology and creating innovation, this dissertation focuses on examining determinants of technological M&As through a knowledge-based perspective. M&A with a technological objective implies that the acquirer firm intends to absorb the knowledge of the target firm to create innovation and obtain sustainable competitive advantages. Accordingly, researches in technological M&A have highlighted that knowledge plays a central role in creating synergies between the acquirer and target firm and in the success or failure of M&A activities (Cloodt & Hagedoorn, 2012; Schön & Pyka, 2009).

Newly acquired knowledge contributes to creating innovation by itself and is combined with the existing knowledge of the acquirer firm to create innovation. Thus, characteristics of the acquired knowledge are decisive factors affecting post-M&A innovation performance. In addition, to create innovation, the acquirer firm should absorb and exploit the acquired knowledge. In other words, simply obtaining the knowledge is not sufficient for creating innovation. For this reason, characteristics of the acquirer firm's knowledge are also vital to anticipate post-M&A innovation performance. Furthermore, dyadic knowledge characteristics are another important determinant because a technological M&A is an interaction between the acquirer firm and target firm. Therefore, knowledge-based determinants of technological M&A success should be examined in terms of multiple perspectives.

To overcome the limitations of previous literature, the dissertation adopts multiple dimensions of determinants. Specifically, the dissertation investigates determinants in terms of the acquirer firm, target firm, and dyadic perspectives. These three perspectives help to examine the influence of individual firm characteristics as well as of the reciprocal characteristics between the acquirer and target firm on the performance of technological M&As. In other words, they contribute to identify the characteristics of the target firm generating more post-M&A innovation, the characteristics of the acquirer firm allowing it to exploit the acquired knowledge well, and the reciprocal characteristics creating more synergies. Thus, this dissertation adopts these perspectives in accordance with the focus of the each chapter to advance the understanding of technological M&A.

Moreover, the extant literature on technological M&A focuses only on post-M&A innovation quantity. Through technological M&As, an acquirer firm intends to generate innovation beyond what is possible using its existing knowledge base to cope with high uncertainty. In other words, an acquirer firm is conducting technological M&As for the purpose of increasing both its innovation quantity and innovation diversity. Investigations on post-M&A innovation quantity provide an ample elucidation of technological M&A success because they show how much innovation is created through M&A quantitatively. However, to advance the understanding of technological M&As, an examination of the effects of determinants of the increase of both innovation quantity and innovation diversity is necessary. The dissertation examines both these dimensions of

innovation performance.

In summary, the previous literature has adopted one dimension of determinants and performance and has disregarded the multi-facetted aspects of technological M&As (Cartwright, 2005; Cartwright & Cooper, 2012). Throughout three chapters, the dissertation empirically examines the impacts of determinants from three different perspectives on two dimensions of innovation performance and provides a comprehensive view on ‘technological M&A target selection’, one of the prominent research theme in the field of technological M&A

1.3. Research outline

The remainder of this dissertation consists of five chapters: the literature review, three empirical studies examining basic considerations of M&A target selection, factors to increase post-M&A innovation quantity and factors to increase post-M&A innovation diversity in the course of ‘technological M&A target selection’, and the overall conclusions.

Chapter 2 presents a literature review on technological M&A. This chapter, first, compares technological M&A with “conventional-purposed” M&A and provides the definition of technological M&A. Moreover, Chapter 2 introduces the determinants identified in the prior literature and elucidates the dimensions of innovation performance

that the dissertation adopts to overcome the limitations of the previous literature. Last, this chapter provides a literature review on the importance of knowledge characteristics on post-M&A innovation performance and categorizes the knowledge-based determinants in terms of the unit of analysis.

Figure 1-2 provides an overview of the three empirical studies, the main body of this dissertation. Chapters 3, 4 and 5 cover these three different empirical studies which examine basic considerations of M&A target selection, factors to increase post-M&A innovation quantity and factors to increase post-M&A innovation diversity. Each of their results contributes to identify a comprehensive view of M&A target selection.

Chapter 3 sheds light on the effects of individual characteristics of the firms on the post-M&A innovation quantity and provides implications on which kind of firms benefits from a technological M&A strategy. Through technological M&A, the resources and capabilities of the acquirer firm and target firm are combined. Accordingly, the investigation of individual firms' resource provides the basic considerations for M&A target selection. Specifically, Chapter 3 elucidates the effects of knowledge base structure of the acquirer and target firms on technological M&As. The results of that chapter show that a broad knowledge base of the acquirer firm and a deep knowledge base of the target firm have a positive impact on the subsequent innovation performance. Moreover, the interaction effect between the broad knowledge base of the acquirer firm and the deep knowledge base of the target firm is also found to increase the post-M&A innovation quantity. The results of the empirical study lead to implications related to the basic

considerations for successful technological M&A target selection.

Chapter 4 examines dyadic factors determining post-M&A innovation quantity and provides implications on what kind of target firm creates synergies with the acquirer firm. While technological M&A provides new knowledge and technology to the acquirer firm, it does not guarantee that the acquirer firm absorbs and exploits the entire acquired knowledge. Because technological M&A is a transaction between the acquirer firm and target firm, dyadic characteristics between these two firms affect the resulting knowledge transfer, exploitation and innovation creation. Accordingly, Chapter 4 examines the determinants of innovation creation through technological M&A from the perspective of both firms. Specifically, to advance the understanding of prior research which focused on the examination of the effects of a large amount of new knowledge acquisition, the technological M&As are examined by presenting dyadic perspective variables, including knowledge similarity and knowledge digestibility which affect the assimilation, transformation and exploitation processes of the absorptive capacity. The M&A experience as a moderator of dyadic characteristics and innovation quantity of technological M&A is also examined. The results of the empirical study demonstrate that knowledge similarity, knowledge digestibility, and M&A experience are significantly related to an increasing amount of innovation quantity after a technological M&A.

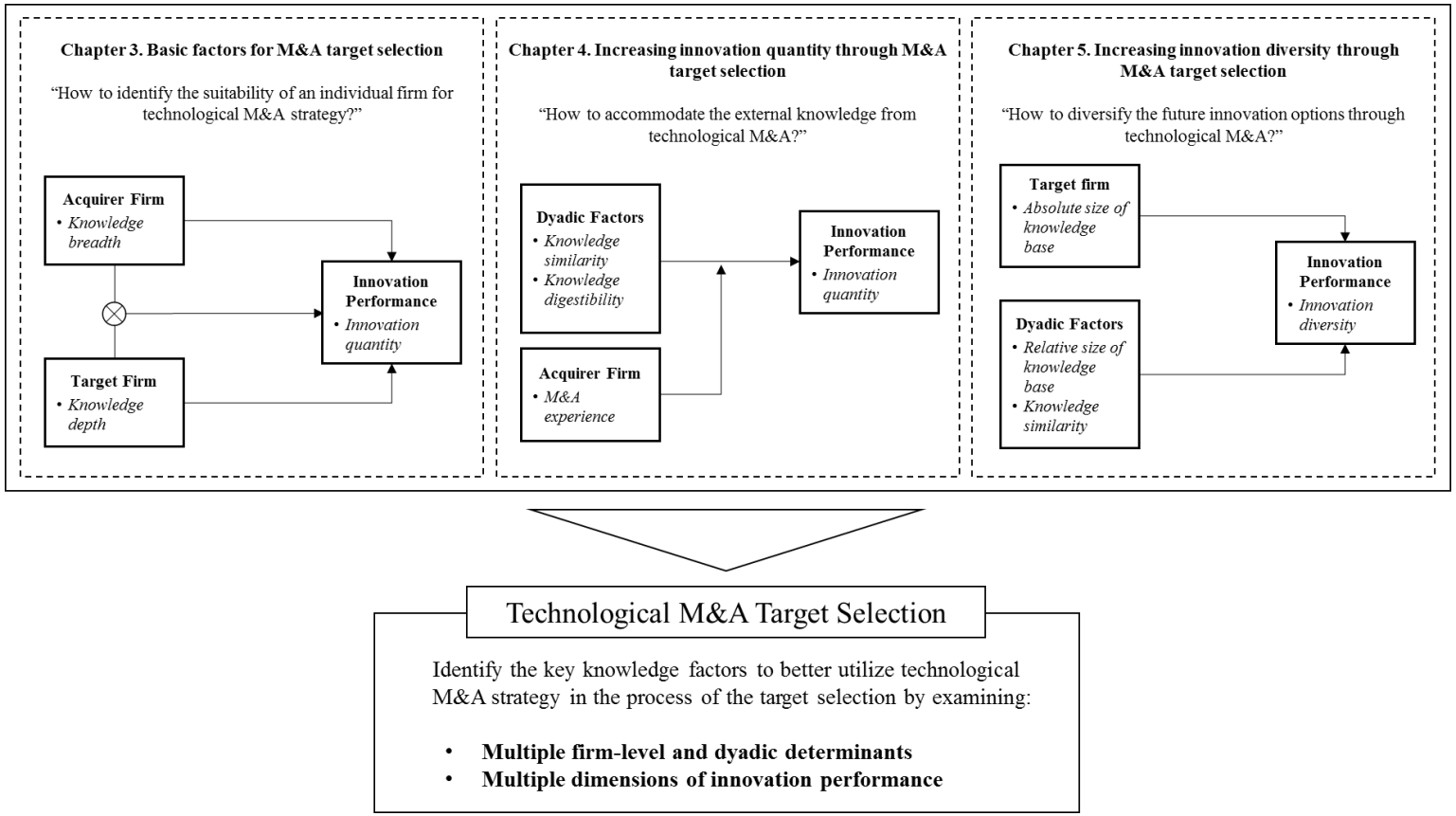

Figure 1-2. Research outline of the dissertation

Chapter 5 discusses how firms can increase their innovation diversity through technological M&As. An increasing number of firms are pursuing technological M&As to obtain knowledge in new fields and ultimately increase innovation diversity. However, prior research on technological M&As focuses only on the relationship between technological M&As and subsequent innovation quantity. Chapter 5 examines the factors that affect the post-M&A innovation diversity of the acquirer firm: the absolute size and relative size of the acquired knowledge base and the relatedness of the target and acquirer firm's knowledge bases. While the results of the empirical study confirm the positive effect of the absolute size and relative size of the acquired knowledge base on innovation diversity, the negative effect of the knowledge relatedness on innovation diversity could not be confirmed. The findings of Chapter 5 suggest that in order to increase innovation diversity, firms should select M&A targets who possess a large amount of new knowledge. Table 1-2 provides an overview of Chapter 3, 4 and 5.

Hypotheses in Chapter 3, 4 and 5 are tested in the context of the global biopharmaceutical industry. The biopharmaceutical industry is chosen for several reasons. First, this industry encourages patenting activity, thus allowing a more precise estimation of firms' innovation capability (Higgins & Rodriguez, 2006; Puranam & Srikanth, 2007). Second, the industry can be divided into several sub-industries representing distinct types of knowledge; thus, allowing diverse analysis to be undertaken within a single industry (Carayannopoulos & Auster, 2010). In addition, knowledge in the biopharmaceutical industry is tacit rather than explicit (Al-Laham & Amburgey, 2005) and uncertainty is

Table 1-2. Overview of Chapters 3, 4 and 5

	Chapter 3	**Chapter 4**	**Chapter 5**
Purpose	Gauging the basic suitability of an individual firm for technological M&A strategy	Investigating how to accommodate the acquired knowledge to increase post-M&A innovation quantity	Examining the ways to increase innovation diversity through technological M&A target selection
Unit of analysis	Acquirer firm Target firm	Dyad Acquirer firm	Dyad Target firm
Industry	Biopharmaceutical industry	Biopharmaceutical industry	Biopharmaceutical industry
Implication	While a broad knowledge base is necessary for an acquirer firm, a target firm requires an in-depth knowledge base	A modest degree of knowledge relatedness and digestible knowledge size allows a high level of knowledge absorption and M&A experience helps the acquirer firm resolve conflicts	Extensive knowledge of the target firm in the new field does contribute to expanding the boundary of innovation
Contribution	Identifies the important firm-based knowledge factors to be considered before drawing up the shortlist	Establishes technological M&A target selection criteria in terms of knowledge absorption	Highlights the role of technological M&As in diversifying future innovation option

high; thus, firms usually conduct M&A to increase their innovation capability and continually keep up with the market (Higgins & Rodriguez, 2006). For these reasons, the biopharmaceutical industry provides a good context for the study of technological M&As.

Figure 1-3 provides the number of past 20 years transactions and value of past 20 years transactions in the biopharmaceutical industry.

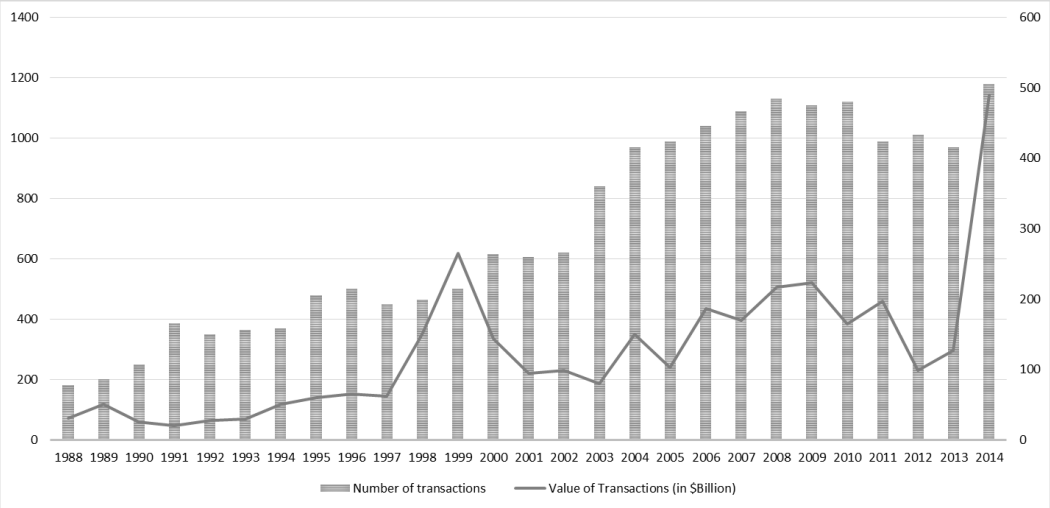

Figure 1-3. Number and value of transactions of announced mergers and acquisitions in the biopharmaceutical industry, 1988-2014.

(Source: Thomson Financial, Institute of Mergers, Acquisitions and Alliances (IMAA))

Finally, Chapter 6 summarizes the findings of the three empirical studies and provides managerial implications and academic contributions. Limitations and directions for future research are also provided in this chapter.

Chapter 2. Literature review

2.1. Technological M&A: A means of obtaining external knowledge

2.1.1. Rationales for undertaking M&A: From increasing market share to obtaining external technology

Throughout five M&A waves, M&As have changed their rationales in accordance with the environmental changes. Bower (2001) pointed out that not all M&As are alike and there are five distinct types of M&As in accordance with their rationale. Figure 2-1 elucidates Bower (2001)'s five M&A types. M&As, generally, are undertaken for purposes such as increasing market share, building economies of scale and scope, accessing new markets, and diversification (Berkovitch & Narayanan, 1993; Chakrabarti, Hauschildt, & Süverkrüp, 1994; Hagedoorn & Sadowski, 1999; Trautwein, 1990). These type of M&As tend to be conducted in old and capital-intensive industries. For example, Daimler's acquisition of Chrysler and Tesco's acquisition of Homever are examples of M&As pursuing conventional objectives. Because these types of M&As have the purpose of reducing cost and increasing sales, the performance of these M&As are mostly measured using financial data such as Return on Asset (ROA), Return on Investment (ROI), cumulative abnormal return (CAR) and stock price.

	Rationale	Example
Overcapacity	• Eliminate excess capacity for market share and efficiency	• Daimler-Chrysler
Geographic	• Expand geographically	• Tesco
Product	• Extend product line internationally	• Quaker Oats and Snapple
R&D	• Buying innovation rather than in-house R&D	• Cisco Systems • Sanofi
Convergence	• Betting on new industry emerging	• AOL and Time Warner

Figure 2-1. Types of M&A strategies.

(Source: adapted from Bower (2001) and Angwin (2012))

Different from these non-technological M&As, recently concluded M&As have focus less on immediate financial returns. Firms pursue technological M&As to intensify their research and development capabilities by absorbing the knowledge of the target firm and create innovation which could not have been generated by using only their own resources (Ahuja & Katila, 2001). Google's acquisition of Android as well as Apple's acquisition of Siri are examples of such technological M&As.

Cisco Systems is renowned for its serial technological M&As and has been known for its "Acquisition and Development (A&D)" strategy. As the term implies, Cisco Systems utilizes technological M&As to complement internal R&D and source

innovation. The product life cycle in the computer networking industry, in which Cisco Systems has participated, is postulated to just 6 months on the software side and 18 months on the hardware side (Chatman, O'Reilly, & Chang, 2005). In other words, Cisco Systems experiences a tremendous challenge to keep up with the rapid technology change. Accordingly, Cisco Systems changed its development strategy from internal R&D to buying a firm which has technologies needed. For example, Cisco Systems bought Crescendo Communications and Kalpana to develop LAN switches, a new influential technology in 1993. Starting from the acquisition of Crescendo Communications in 1993, Cisco Systems has conducted about 170 M&A transactions. In an 2015 interview with the Harvard Business Review, John Chambers, the former and iconic CEO of Cisco Systems, said that:

> "If we see the shift early enough, we can develop the new technology ourselves in our traditional R&D process. … Alternatively, we may make an acquisition. We do that often. In fact, we've done 174 acquisitions. Back in 1990s the conventional wisdom was that acquisitions in the tech industry generally fail. But we've been successful with most of ours (Chambers, 2015)."

In the biopharmaceutical industry, a sample industry of the dissertation, Sanofi is a representative example showing the impacts of technological M&A. To acquire external technologies outside of their traditional focus, they have conducted technological M&As.

Figure 2-2 shows examples of their M&As in multiple segments. In addition, according to a report published by Cepton Strategies (Cepton Strategies, 2015), global Top 20 firms in the global pharmaceutical industry have conducted a number of technological M&As to expand their knowledge base and create innovation. For example, Pfizer and Novartis, Top 1 and Top 2 firms in the global biopharmaceutical industry, acquires 11 and 21 firms from 2000 to 2012, respectively.

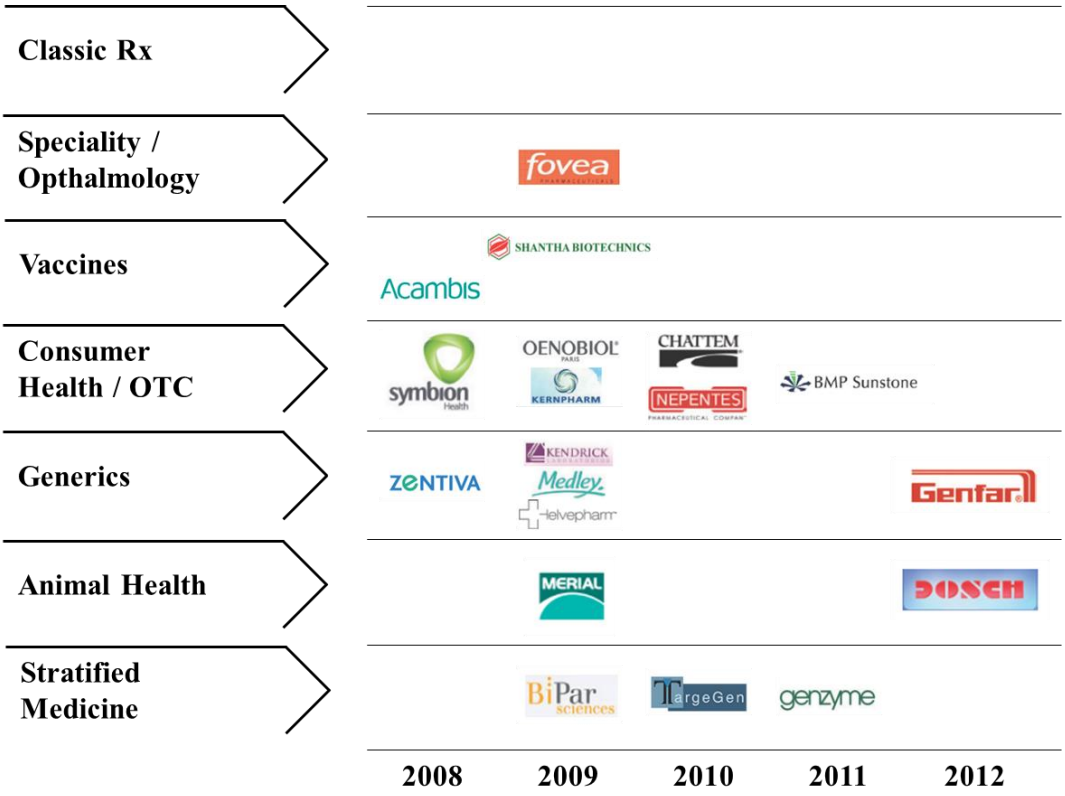

Figure 2-2. Examples of Sanofi's technological M&As

(Source: adapted from the 2015 report of Cepton Strategies)

The M&A literature also has highlighted this current trend of M&As. The literature review of De Man and Duysters (2005) stated that M&As are used to absorb external technology to cope with radically changing economies. Another M&A literature review performed by Rossi, Tarba, and Raviv (2013) found that acquiring the technologies of the target firm was a major motive of M&As in the biotechnology, ICT, electronics, and telecommunications industries and that the number of technological M&A transactions is constantly increasing. Moreover, a bibliometric study on M&As of Ferreira, Santos, de Almeida, and Reis (2014) identified that after 1991 in the M&A literature, terms such as technology innovation, knowledge and learning are increasingly used, whereas terms including restructuring, entry modes and international strategy are less investigated. This implies that knowledge, technology and innovation receive attentions from researchers in the field of M&A and technological M&As are now one of the mainstays in the M&A literature. Surprisingly, a lot of research, however, points out that so far, insufficient attention has been given to technological M&As and literature has neglected to investigate the role of technological M&A in creating innovation (Bauer & Matzler, 2014; Bena & Li, 2014; Datta & Roumani, 2015; Lodh & Battaggion, 2014; Rossi et al., 2013; Valentini, 2012; Wagner, 2011).

2.1.2. The definition of technological M&A

Technological M&As are usually conducted in high-tech industries such as the chemical industry (Ahuja & Katila, 2001), photographic equipment industry (Valentini, 2012), semiconductor industry (Wagner, 2011) and the pharmaceutical industry (Penner-Hahn & Shaver, 2005). For this reason, some research has considered technological M&As as M&As conducted in the high-tech industries (e.g. Desyllas & Hughes, 2008; Desyllas & Hughes, 2010; Sears & Hoetker, 2014). However, not all M&As in high-tech industries are undertaken for technological reasons (Sleuwaegen & Valentini, 2006). For example, Google's acquisition of Youtube and Facebook's acquisition of Instagram were carried out for the purpose of diversification and thus can be categorized as conventional-purpose M&As. Therefore, the definition of technological M&As should be clarified to identify technological M&As.

The extant literature has provided their own definitions of technological M&As (Ahuja & Katila, 2001; Cloodt, Hagedoorn, & Van Kranenburg, 2006; Valentini, 2012). For example, Ahuja and Katila (2001), a leading study on technological M&A, defined technological M&As as M&As through which the acquirer firm obtains external technological inputs for firm's innovation. Cloodt et al. (2006) designated M&As that are conducted for technological reasons with an intention to learn as technological M&As. Hussinger (2010) and Hussinger (2012) identified M&As for filling gaps in a firm's technology base and enhancing innovation capabilities with the acquired resources as

technological M&As. Valentini (2012) defined technological M&As in a similar vein. He called this type of M&A ‘technology-driven M&As’ and considered that through this type of M&A, acquirer firms obtain R&D skills, technical expertise, and specific new technologies. The research on the incidence of technological M&As also discovered that when a firm experiences a low R&D commitment and productivity, it tends to conduct technological M&As to complement internal R&D and create innovation (Desyllas & Hughes, 2008). To sum up, technological M&As are M&As that provide external knowledge and technology to the acquirer firm and contribute to post-M&A innovation creation.

Starting with the research of Ahuja and Katila (2001), there is a general consensus among researchers about the operational definition of technological M&As. Most of the extant literature has classified a M&A deal as technological if the target firm had at least one patent granted in the five-year period preceding the M&A or non-technological otherwise (e.g. Ahuja & Katila, 2001; Cloodt et al., 2006; Lodh & Battaggion, 2014). The dissertation follows this definition and identifies technological M&A transactions in the biopharmaceutical industry. Sears and Hoetker (2014) identified technological M&As in a similar but different way. They categorized M&As in accordance with the definition of firms in the SDC Platinum’s M&A database. If both acquirer and target firm were identified as high tech firms in the database, they regarded this M&A deal as technological M&A. In addition, using news articles, they excluded M&A transactions not motivated to obtain external knowledge and technology. Makri, Hitt, and Lane (2010)

adopted a more passive way to identify technological M&As. They collected all M&As in the drugs, chemical and electronics industries and eliminated M&A transactions that have a motivation on increasing market share, accessing new market and distribution and obtaining financial synergies.

2.2. Post-M&A innovation performance

2.2.1. Determinants of post-M&A innovation performance

Buying external resources and capabilities through M&As saves a substantial time to develop new resources and capabilities. Moreover, if a firm need resources that cannot be developed by its internal R&D because of insufficient technology expertise or appropriability of resources, M&A is a way to acquire those resources instantly. M&A, however, involves large investments and high risk. The failure rate of M&A is estimated between 60 to 80 percent (Puranam, Singh, & Zollo, 2003); some researchers even claim that 70 to 90 percent of M&As resulted in failure (Christensen, Alton, Rising, & Waldeck, 2011). Accordingly, in both academics and business, it is recognized that the examination of the determinants of M&A success is absolutely necessary. The meta-analysis of Schön and Pyka (2009) shows the influence of well-known determinants of post-M&A innovation performance. According to them, knowledge, firm size, management and

financial aspects are key research domains that are investigated more than one time in the previous literature. Table 2-1 shows the statistically calculated impact of each determinants from the diverse perspectives. Some determinants such as M&A propensity and accounting performance show no impact although they are examined in the multiple studies.

Table 2-1. Determinants and their impact on innovation performance

Type	Determinant	Number of studies including this variable	Trend in %
Knowledge	Motives (technological)	4	75
	Technological relatedness	9	78
	Absolute size of acquired knowledge base	4	25
	Relative size of acquired knowledge base	2	-100
	Firm heterogeneity (prior patenting)	4	100
	R&D expenditures	4	100
	Prior products	3	33
	Type of knowledge (tacitness)	2	0
Firm size	Firm age (target)	3	-67
	Absolute firm size (acquirer)	9	33
	Absolute firm size (target)	7	-43
	Relative firm size	4	100

* Source: Adapted from Schön and Pyka (2009)

Table 2-1. Determinants and their impact on innovation performance (Continued)

Type	Determinant	Number of studies including this variable	Trend in %
Financial aspects	Firm value	2	0
	Tobin's Q	2	0
	Performance and profitability	4	25
	Sales	3	33
	Liquidity	2	0
	Accounting performance	2	0
	Leverage, debt	3	-67
Management	Degree of integration	5	20
	Speed of integration	2	50
	Communication	2	100
	Formalization	3	-100
Other	M&A	8	-13
	Market relatedness	4	50
	Diversification	4	-75
	M&A experience	7	-29
	M&A propensity	4	0
	Prior relations	2	50
	Industry	4	-25
	Industry R&D intensity	4	25
	Geographic/culture distance	10	20
	Year	7	14

* Source: Adapted from Schön and Pyka (2009)

In terms of the timing of factors' decision, each of the determinants has a different duration of effects on post-M&A innovation. The determinants of the relationship between technological M&A and innovation performance can be categorized depending on the phase of the technological M&A: pre-M&A and post-M&A. In fact, the review of M&A literature found that researches in this field analyze M&A in parts rather than the whole (Calipha, Tarba, & Brock, 2010). Topics such as target selection and post-merger integration (PMI) strategies show this tendency of literature. Table 2-2 classifies the previously found determinants of post-M&A innovation performance in terms of the phase of technological M&A and research foci.

Research foci of the pre-M&A literature are mostly the target selection strategy. A target selection is the first process in conducting a technological M&A. An acquirer firm needs to precisely assess the strategic fit of the target firm to estimate post-M&A innovation performance because selecting a target means selecting external resources and capabilities to combine and recombine with the existing resources and capabilities leading to a disruption of the current status. In addition, selecting a target firm influences the remaining processes of technological M&A including due diligence and post-merger integration, which are also important to create post-M&A innovation. Therefore, a target selection strategy is peculiarly important to understand post-M&A innovation performance. The research theme of the present dissertation thus is the M&A target selection.

Table 2-2. Research foci in accordance with the M&A phase

Phase	Research focus	Determinant type	Determinant	Study
Pre-merger	Target selection	Deal itself	Deal itself	Wagner, 2011; Valentini, 2012
		Organization asset	M&A experience	Orsi et al., 2015
			Age	Buss, 2012
			Alliance experience	Porrini, 2004
			Complementary asset	Valentini and Dawson, 2010
			Organizational proximity	Ensign et al., 2013
			Difference in size	Hagedoorn and Duyster, 2002
		Knowledge asset	Characteristics of the acquirer firm	Prabhu et al., 2005; Desyllas and Hughes, 2010; Lin and Jang, 2010; Buss, 2012
			Characteristics of the target firm	Ahuja and Katila, 2001; Cloodt et al., 2006; Lin and Jang, 2010; Datta and Roumani, 2015
			Dyadic characteristics	Ahuja and Katila, 2001; Cloodt et al., 2006; Valentini and Dawson, 2010; Makri et al., 2010; Lin and Jang, 2010; Valentini and Dawson, 2010; Buss, 2012; Sears and Hoetker, 2014; Orsi et al., 2015
		Industry	Industry relatedness	Hagedoorn and Dusters, 2002; Cassiman et al., 2005; Desyllas and Hughes, 2010

Table 2-2. Research foci in accordance with the M&A phase (Continued)

Phase	Research focus	Determinant type	Determinant	Study
Pre-merger	Target selection	Network asset	Actor type	Dashti and Schwartz, 2015
			Network size of the target firm	Kang et al., 2013
			Relative network size	Kang et al., 2013
			Dissimilarity in network composition	Kang et al., 2013
		Culture	Cognitive proximity	Ensign et al., 2013
		Physical feature	Geographic proximity	Ensign et al., 2013
		Financial asset	Level of leverage	Desyllas and Hughes, 2010
Post-merger	Post-merger integration	Integration	Degree of integration	Paruchuri et al., 2006; Ranft, 2006; Lemieux and Bank, 2007
			Structural integration	Puranam et al., 2006; Puranam and Srikanth, 2007
			Inventor's social embeddedness	Paruchuri et al., 2006
		Retention	Retention of human asset	Ernst and Vitt, 2000; Ranft, 2006; Colombo and Rabbiosi, 2014

The extant literature on M&A target selection focuses on examining factors which affect innovation after the technological M&A and can be categorized depending on the determinant type. First, prior studies have shown that the technological M&A deal itself has an effect on subsequent innovation (Valentini, 2012; Wagner, 2011). These studies saw technological M&A as the process of bringing external knowledge into the acquirer firm. Accordingly, their view is that conducting technological M&A provides novel knowledge to the acquirer firm and helps to create innovation.

Second, organizational assets such as managerial experience (Orsi, Ganzaroli, De Noni, & Marelli, 2015; Porrini, 2004) and complementary assets (Valentini & Dawson, 2010) are examined to identify the difference in post-M&A innovation performance. Porrini (2004) and Orsi et al. (2015) suggested that managerial experience on external partnering including M&A and alliance experience creates a capacity to select an appropriate external sources of knowledge. However, the effect of this experience has diminishing marginal returns (Hoang & Rothaermel, 2005). Complementary assets have received attention from prior research (Valentini & Dawson, 2010). In terms of profiting from innovation (Teece, 1986), complementary assets are necessary. Hence, a target firm with complementary assets helps an acquirer firm to preserve and appropriate the uniqueness of innovation.

Third, industry characteristics are other important determinants of post-M&A innovation performance. Research on industry characteristics has mostly focused on the industry relatedness between the acquirer and target firm (Cassiman, Colombo, Garrone,

& Veugelers, 2005; Desyllas & Hughes, 2010; Hagedoorn & Duysters, 2002). This stream of research is followed by the research on related M&A and unrelated M&A in the 1990s. Using 35 M&A transactions in the international computer industry, Hagedoorn and Duysters (2002) identified that industry relatedness generates more synergies in terms of economies of scale and scope which in turn leads to the creation of more post-M&A innovation. Cassiman et al. (2005) further investigated the industry relatedness regarding shared product lines, business model and technological fields and identified similar results as Hagedoorn and Duysters (2002).

Fourth, the extant literature examined the characteristics of network assets to understand post-M&A innovation performance. H. Kang, Kim, and Song (2013), in particular, investigated the diverse dimension of network assets using 110 M&A transactions in the biotechnology industry from 2002 to 2006. According to their results, the network size of the target firm has a positive impact on post-M&A innovation performance. A target firm's network size helps access a larger external knowledge base and facilitates new partnerships leading to more knowledge recombination (Ahuja, 2000; Grant & Baden-Fuller, 2004). On the contrary, the relative network size of the target firm and dissimilarity in network composition between the acquirer and target firm negatively affect the post-M&A innovation performance. A relatively large network size and dissimilar partners in the network of the target firm give rise to substantial efforts to exploit it. Accordingly, the acquirer firm faces difficulties in innovation creation through the acquired resources.

Fifth, culture difference between the acquirer and target firm were also examined to understand the post-M&A innovation performance (Ensign, Chreim, Persaud, & Lin, 2013). Technological M&A provides the external resources to the acquirer firm, but absorption of these acquired resource requires additional attention. Close distance in terms of a firm's culture, for example, affects the realization of the synergies and assists the transfer and absorption of the acquired resources (Cartwright, 2005; Cartwright & Cooper, 2012). Hence, M&A with the target firm that has a similar culture increases post-M&A innovation performance.

Sixth, physical features such as geographical distance (Ensign et al., 2013) received attention from the previous research. Physical closeness makes interaction between the acquirer and target firm easier. Although, communication tools are well developed, they cannot replace the function and impact of actual meetings (Rallet & Torre, 1999). For this reason, Ensign et al. (2013) identified that a close physical location of the target firm increases the post-M&A innovation performance.

Seventh, some researchers assume that sufficient financial assets of the acquirer firm are necessary to create post-M&A innovation (Desyllas & Hughes, 2010). Even after the conclusion of the M&A deal, the financial capacity of an acquirer firm is still required to absorb the acquired resources and capabilities (Teece, 1986, 2006). Accordingly, a high level of debt reduces the extent of absorption of the target firm and limits innovation creation.

Last, the characteristics of knowledge assets play a decisive role on post-M&A

innovation performance (Schön & Pyka, 2009). The dissertation examines determinants from a knowledge-based perspective. Accordingly, the literature review of the determinants from the knowledge-based perspectives is provided separately in Chapter 2.3.

The literature related to the post-M&A phase mostly has discussed post-merger integration. Although this dissertation does not deal with this research theme, the extant literature examines important factors that affect post-merger integration and retention of human assets (Lemieux & Banks, 2007; Paruchuri, Nerkar, & Hambrick, 2006; Ranft, 2006). Even if an acquirer firm selects a proper target firm in the pre-M&A phase, to increase the post-M&A innovation performance, smooth post-merger integration is necessary (Puranam & Srikanth, 2007). Post-merger integration would foster the creation of innovation or hamper the process of absorption of the acquired resources leading to a decrease in innovation generation. There are two key research themes on post-merger integration:

First, researches on post-merger integration have investigated integration in terms of degree of integration (Lemieux & Banks, 2007; Paruchuri et al., 2006; Ranft, 2006), structural integration (Puranam, Singh, & Zollo, 2006; Puranam & Srikanth, 2007) and inventor's social embeddedness (Paruchuri et al., 2006). For example, Ranft (2006) identified that giving autonomy to the target firm preserves the tacit knowledge of the target firm because autonomy minimizes conflicts between the acquirer firm and target firm. Puranam and Srikanth (2007) found that structural integration helps the acquirer

firm to exploit the knowledge of the target firm, but inhibits the innovation creation through the resources from the target firm.

Second, retention of human asset is another important research theme on post-merger integration (Ernst & Vitt, 2000; Ranft, 2006). Because human assets are the knowledge reservoir of the acquired knowledge, retention of human asset is directly related to how many resources of the target firm are preserved and utilized. By testing 75 high-tech M&A transactions, Ranft (2006) found that the retention of human asset facilitates post-M&A knowledge transfer. In addition, Ernst and Vitt (2000) empirically identified that target firm inventors' departure from the company significantly reduces subsequent innovation performance of the acquirer firm.

2.2.2. Diverse dimensions of innovation performance

The previous research on technological M&As adopts diverse constructs of post-M&A innovation performance (e.g. Hagedoorn & Duysters, 2002; Makri et al., 2010; Paruchuri et al., 2006). These diverse constructs enable the examination of various dimensions of innovation performance. Although firms conducting technological M&As have the same purpose of external technology acquisition, the acquired technology can be used in different ways. For example, a firm might use the acquired technology to exploit the existing knowledge base or explore the new field of knowledge (Phene, Tallman, &

Almeida, 2012). Meglio (2009) reviewed the performance measures of M&A performance and stated that using multiple indicators of performance offers more information and allows to catch every nuance of performance difference between firms. Zollo and Meier (2008), also stated that M&A performance cannot be measured using only one construct. Therefore, to increase the understanding of post-M&A innovation performance, an examination of various dimensions of innovation performance is necessary. Table 2-3 shows examples of constructs adopted by prior literature.

Table 2-3. Constructs of innovation performance in prior literature

Performance construct	Study
R&D expenditure	Hitt et al., 1991, 1996; Cassiman et al., 2005; Cefis, 2010
Innovation quality	Paruchuri et al., 2006; Makri et al., 2010; Buss, 2012; Valentini, 2012
Innovation quantity	Ahuja and Katila, 2001; Hagedoorn and Duyster, 2002; Prabhu et al., 2005; Cloodt et al., 2006; Puranam et al, 2006; Paruchuri et al., 2006; Kapoor and Lim, 2007; Makri et al., 2010
Innovation novelty	Makri et al., 2010; Phene et al., 2012

The constructs of innovation performance can be categorized into an R&D input perspective and an R&D output perspective. The representative construct from the R&D input perspective is R&D expenditure. Because creation of innovation requires investments, early research on technological M&A adopted this construct to measure post-M&A innovation (Hitt et al., 1991; Hitt et al., 1996). However, recent literature has

found that the constructs from an R&D output perspective more accurately measure the firm's post-M&A innovation performance than the input measures because the acquirer firm often reduces duplicate R&D efforts leading to a decrease in R&D expenditure (De Man & Duysters, 2005). For this reason, recent research on technological M&A adopted the constructs from the R&D output perspective such as innovation quantity and quality to measure post-M&A innovation performance.

Innovation quantity is the most investigated dimension in the field of technological M&A literature (e.g. Ahuja & Katila, 2001; Hagedoorn & Duysters, 2002; Kapoor & Lim, 2007; Makri et al., 2010; Prabhu, Chandy, & Ellis, 2005). Technological M&As are known as a source of innovation (Kale & Puranam, 2004; McEvily, Eisenhardt, & Prescott, 2004). Accordingly, if the technological M&A is successful, the quantity of innovation is expected to increase. For this reason, the investigation of post-M&A innovation quantity explains how much innovation is created as well as how successful the M&A is. Moreover, the measurement of post-M&A innovation quantity is relatively easy, thus a lot of research adopts this concept to explain post-M&A innovation performance.

Starting from the study of Paruchuri et al. (2006), innovation quality receives increasing attention from technological M&A researchers. Di Guardo and Valentini (2007) stated that the extant literature focuses on post-M&A innovation quantity and multiple dimension of post-M&A innovation performance such as quality of innovation should be investigated. Because the effect of innovation is not same, the examination of

innovation quality advances the understanding of post-M&A innovation. However, in terms of their quantity and quality, the researches on the post-M&A innovation quality are insufficient compared to the research on post-M&A innovation quantity.

With increasing importance, the dissertation investigates the determinants of post-M&A innovation diversity. By analyzing 6106 M&A transactions during 1984-2000, Desyllas and Hughes (2008) stated that the technological M&A strategy is a viable R&D strategy to identify a diverse field of a firm's future innovation. Their findings show the importance of examining the post-M&A innovation diversity. In a similar vein, the recent work on technological M&A has started to examine the role of technological M&A in innovation creation in new fields. Makri et al. (2010) examined the effects of similarity and complementarity of scientific and technological knowledge on 'invention novelty'. The concept of 'invention novelty' shows how much innovation quantity is created in fields new to the acquirer firm. Phene et al. (2012) found that technological M&A contributes to increasing both exploitation and exploration whereas non-technological M&As are not able to enhance the exploitation and exploration of the acquirer firm. The exploration of the acquirer firm, in Phene et al. (2012)s' study, is measured as the extent of technology developed in non-core technology areas of the acquirer firm. In conclusion, the recent research highlights the importance of creating innovation in a new field after the technological M&A. However, the previous literature overlooked the reason why firms want to create innovation in a new field. In the fast changing market and under the influence of high technology uncertainty, even firms with dynamic capabilities have

difficulty in predicting the future direction of their industries. For this reason, to cope with the uncertain future, firms need to possess innovation capabilities in diverse fields to create many options which can be used depending on the direction the technological development is taking. Accordingly, to examine one of the actual purposes of conducting technological M&A, a concept measuring the diversity of innovation option seems more suitable than previously used concepts which measured the quantity of innovation in new fields. Thus, the dissertation introduces the new concept, innovation diversity, in Chapter 5.

The aforementioned constructs of innovation performance are operationalized in a different way with regard to the research. Table 2-4 provides an overview of how the previous literature measures their construct of innovation performance.

Table 2-4. Operational definition of innovation performance in the prior literature

Study	Operational definition of innovation performance
Ahuja and Katila, 2001	➢ Patenting frequency from one to four years after the deal
Hagedoorn and Duysters, 2002	➢ Number of patents after an average of six years
Puranam et al, 2006	➢ New products launches between three and 13 years after the deal
Paruchuri et al, 2006	➢ Number of patents after five years
	➢ Number of patent citation after five years
Puranam and Srikanth, 2007	➢ Patent count after three years
	➢ Patent citation after three years
	➢ Patent authorship data after three years
Kapoor and Lim, 2007	➢ Number of successful patent application per year after five years
Desyllas and Hughes, 2010	➢ The ratio of the number of patents over R&D expenditure
Makri et al, 2010	➢ Number of patents from three to five years after the deal
	➢ Number of patent citation from three to five years after the deal
	➢ Herfindahl index of patent class from three to five years after the deal
Valentini, 2012	➢ Number of patents after two years
	➢ Patent impact, generality, originality after two years
Sears and Hoetker, 2014	➢ Number of patents after three years

Source: adapted from Meglio (2009)

2.3. Technological M&A and characteristics of knowledge: Three dimension of determinants

2.3.1. A central role of knowledge in technological M&A

Technological M&As introduce a new knowledge base to the acquirer firm (Makri et al.,

2010; Uhlenbruck, Hitt, & Semadeni, 2006; Vermeulen & Barkema, 2001) and help the acquirer firm create innovation which could not have been accomplished using only the firm's existing knowledge base (Reus, 2012). However, technological M&As do not guarantee successful innovation. Although technological M&As are known to invigorate exploitation and exploration between the knowledge of the acquirer and target firms, creating innovation is a complex process that is not facilitated by simply increasing the amount of available knowledge.

To create innovation through the acquired knowledge base, learning from the target firm is required. Learning through technological M&A entails absorption and exploitation of the knowledge base of the target firm. However, this process of learning is difficult (Jasimuddin, 2012; Ranft & Lord, 2002; Yoo, Lyytinen, & Heo, 2007). For example, different culture between the knowledge base of the acquirer firm and target firm might result in Not Invented Here (NIH) syndrome (Hussinger & Wastyn, 2015; R. Katz & Allen, 1982; Lichtenthaler & Ernst, 2006) . Another problem stems from the lack of absorptive capacity of the acquirer firm. To absorb knowledge from the target firm, the acquirer firm should possess enough absorptive capacity which comes from the knowledge base of the acquirer firm (Cohen & Levinthal, 1990). The tacit nature of the acquired knowledge base could lead to the failure of learning through technological M&A. On the basis of this logic, Ranft and Lord (2002) explored the nature of the knowledge base to understand the process of M&A implementation. Yoo et al. (2007) proposed a model of knowledge transfer in the M&A context and identified that

knowledge-based factors such a tacit dimension of knowledge, incompatibilities between the knowledge base of the acquirer firm and target firm are problems in the knowledge transfer. Therefore, to examine the extent of the acquirer firm's learning, an investigation of the characteristics of knowledge base is necessary.

In addition, a firm's knowledge base affects the nature of the innovation process. For example, as creating innovation requires prior knowledge in a certain field, the newly acquired knowledge helps the firm generate innovation in the fields covered by the acquired knowledge base. Also, the technological M&A increases the possibilities of knowledge recombination. Because innovation is the result of knowledge combinations (Grant, 1996b; Kogut & Zander, 1992), combinations and recombinations within the enlarged post-M&A knowledge base allow firms to enter completely new technological fields, i.e. fields not previously covered by neither the acquirer nor the target firm. Moreover, technological M&As disrupt the existing organizational routines and enable firms to generate radically new solutions and approaches to problem solving. Firms have their own organizational routine to create innovation (Nelson & Winter, 1982). However, as this process repeats, they stick to the existing way of innovation creation and are reluctant to create innovation in a new way (Levitt & March, 1988). The newly acquired knowledge disrupts the existing routines, reduces the path-dependency of the firm and helps it to avoid falling into a competency trap. These effects put the firm in a better position to look for new technological opportunities.

The aforementioned effects are influenced by the characteristics of the

knowledge base. Based on the theoretical backgrounds of the knowledge-based view, previous literature states that dissimilar knowledge bases between firms can explain the differences in innovation performance (Bierly & Chakrabarti, 1996). For this reason, most of the foundational research on technological M&A focuses on the effects of the knowledge base characteristics to identify the determinants of technological M&A success (e.g. Ahuja & Katila, 2001; Datta & Roumani, 2015; C. H. Lin & Jang, 2010; Sears & Hoetker, 2014). The knowledge base of firms is a unique resource which is used to generate innovations (e.g. Hill & Rothaermel, 2003; Miller, Fern, & Cardinal, 2007) and is made up of the firms' technological capabilities. Carrillo and Anumba (2002) stated that the knowledge bases of the acquirer firm and target firm are the key factor in the success or failure of M&As. Jasimuddin (2012) also argued that M&A failure results from overlooking the importance of the knowledge in the acquirer firm and target firm. Moreover, Schön and Pyka (2009)'s meta-analysis of existing studies on technological M&A demonstrated that characteristics of the knowledge bases play the most important role in creating innovation. Thus, examining the knowledge bases of both firms helps to understand the relationship between firm characteristics and post-M&A innovation performance.

2.3.2. Three dimensions of knowledge characteristics

The technological M&A literature on the characteristics of knowledge base has examined three dimensions of the characteristics of knowledge base: the acquirer, target, and dyadic dimension. Table 2-5 categorizes the extant literature into these three dimension of the knowledge base.

First, some scholars argued that the characteristics of the knowledge base of the acquirer firm are central to creating innovation. Although technological M&A provides external knowledge and technology to an acquirer firm, an acquirer firm needs to absorb and exploit the acquired knowledge to create innovation. Accordingly, to better absorb and exploit the acquired knowledge, an acquirer firm should have appropriate characteristics of the existing knowledge. For example, a large size of the knowledge base gives rise to an increase in absorptive capacity which can help the acquirer firm to absorb the acquired knowledge more easily. Thus, the extant literature examined the characteristics of the acquirer firm's knowledge base. For instance, Prabhu et al. (2005) investigated the effects of knowledge breadth and depth of the acquirer firm. Desyllas and Hughes (2010) examined the role of the knowledge base size on the innovation performance because a large knowledge base contributes to absorptive capacity. A test using a sample of high-tech industries shows the positive effects of knowledge base size.

Second, studies have analyzed the effects of the target firm's knowledge characteristics on subsequent innovation (e.g. Ahuja & Katila, 2001; Cloodt et al., 2006;

Datta & Roumani, 2015; C. H. Lin & Jang, 2010). The existing knowledge base of an acquirer firm is combined and recombined with the knowledge base of the target firm. In other words, the new knowledge base after the M&A transaction would change in accordance with the characteristics of the acquired knowledge. Accordingly, the literature on technological M&A investigated the effects of the target firm's knowledge base. Ahuja and Katila (2001), by examining a sample of 72 firms' acquisitions in the chemical industry, found that the size of the target firm's knowledge base has positive effects on post-M&A innovation quantity in terms of increasing the absorptive capacity of the acquirer firm and providing economies of scale and scope in creating innovation. C. H. Lin and Jang (2010) examined the effect of the diversity of a target firm's knowledge base on post-M&A innovation quantity. However, they were not able to find any statistical significance. Recently, Datta and Roumani (2015) argued that the size, radicalness and emphasis of the target firm's knowledge base have effects on the innovation performance.

Table 2-5. Determinant from a knowledge-based perspective

Focus	Determinant	Study
Knowledge characteristics of the acquirer firm	Breadth of knowledge base	Prabhu et al., 2005; Lin and Jang, 2010
	Depth of knowledge base	Prabhu et al., 2005
	Size of knowledge base	Desyllas and Hughes, 2010; Buss, 2012
	Knowledge concentration	Buss, 2012
Knowledge characteristics of the target firm	Size of knowledge base	Ahuja and Katila, 2001; Cloodt et al., 2006; Lin and Jang, 2010
	Radicalness of knowledge base	Datta and Roumani, 2015
	Emphasis of knowledge base	Datta and Roumani, 2015
	Breadth of knowledge base	Lin and Jang, 2010
Dyadic knowledge characteristics	Relative size of knowledge base	Ahuja and Katila, 2001; Cloodt et al., 2006; Valentini and Dawson, 2010
	Relatedness of knowledge base	Ahuja and Katila, 2001; Cloodt et al., 2006; Makri et al., 2010; Lin and Jang, 2010; Valentini and Dawson, 2010; Buss,2012; Orsi et al., 2015
	Acquirer overlap	Sears and Hoetker, 2014
	Target overlap	Sears and Hoetker, 2014

Third, some literature on technological M&A has adopted a dyadic perspective to investigate the determinants of creating innovation (e.g. Bauer & Matzler, 2014; Sears & Hoetker, 2014). According to the relative absorptive capacity theory of Lane and Lubatkin (1998), it is ascertained that the absorptive capacity of a firm changes depending on its partner. In the M&A context, the different relative absorptive capacity explains the difference in the outcome of M&As with different targets. In addition, previous literature discussed that the innovation performance of a firm engaging in external technology sourcing is influenced by the relative knowledge base characteristics (Lane & Lubatkin, 1998; Zahra & George, 2002) and relative capability differences in terms of the organization perspective (Lichtenthaler, 2008). Therefore, adopting a dyadic perspective on technological M&A research increases understanding of technological M&A. Following the seminal work of Ahuja and Katila (2001) who were the first to investigate the dyadic perspectives of the knowledge base between the acquirer and the target firms, recent literature such as Makri, et al. (2010), Sears and Hoetker (2014) and Orsi et al. (2015), also demonstrated the effects of dyadic characteristics in terms of knowledge base. Ahuja and Katila (2001) and Cloodt et al. (2006) showed how the relative size of the target firm, and knowledge similarity affect subsequent innovations. According to Makri et al. (2010), technological complementarity between the acquirer and target firm is another important factor that influences subsequent innovations. More recently, Sears and Hoetker (2014) investigated the effects of the ‘acquirer overlap’ and ‘target overlap’ on post-M&A innovation performance.

The three key dimensions of the knowledge base, the acquirer, target, and dyadic dimension, contribute to advance the understanding of technological M&A. Thus, examining only one dimension of the knowledge base limits the understanding. For example, M&A literature adopting only a dyadic perspective fails to consider individual firm-level factors. Specifically, they share the common assumption that every firm can have a large innovation output if it has a strong "fit" with the target firm. However, the assumption may not be universally true. Even though the relatedness between the acquirer and target firm is strong, the characteristics of the acquirer and target firm may lead to obstacles. For example, the acquirer firm may not have a sufficient absorptive capacity to absorb the target firm's knowledge (Cohen & Levinthal, 1990; Zahra & George, 2002). Arora and Gambardella (1994) suggested that a firms' internal knowledge and selection capability are necessary to efficiently obtain external knowledge. Moreover, the characteristics of the target firms' resources might make it difficult to generate innovation from them. For instance, the target firms' resources may not be suitable for recombination with the acquirer firm's resources or make post-merger integration difficult (Fleming, 2001; Fleming & Sorenson, 2001; Grant, 1996b; Oxley, 1997). Therefore, the fit between the acquirer and target firm may not lead to synergies if the firm characteristics themselves do not allow to appropriate the potential benefits of technological M&A. In conclusion, to understand post-M&A innovation performance comprehensively, all three dimensions of knowledge base should be examined as in an integrative way. The dissertation adopted these dimensions of knowledge base depending on the focus of each

chapter to best fit their individual research objective.

Chapter 3. Basic considerations for M&A target selection[1]

3.1. Introduction

Starting from the research of Rumelt (1974), M&A literature has argued that the relatedness (in other words, fit) between the acquirer and target firms is the key antecedent to M&A success. Specifically, M&A literature mostly pays attention to the effects of the business relatedness between the acquirer and target firms (Bauer & Matzler, 2014; Kennedy, Payne, & Whitehead, 2002; Kusewitt, 1985; Rumelt, 1974), the size relatedness (Ahuja & Katila, 2001; Hagedoorn & Duysters, 2002; Hitt et al., 1991), the cultural relatedness (Bauer & Matzler, 2014; Chatterjee, Lubatkin, Schweiger, & Weber, 1992; Shimizu, Hitt, Vaidyanath, & Pisano, 2004; Stahl & Voigt, 2008), and the technological relatedness (Ahuja & Katila, 2001; Cloodt et al., 2006; Makri et al., 2010) on firm performance (Cloodt & Hagedoorn, 2012; Homberg, Rost, & Osterloh, 2009). Identifying the 'fit' between the acquirer and target firms is helpful to explain subsequent firm performance because an M&A is a combination of two firms and their respective knowledge bases. Lane and Lubatkin (1998) state that the level of interorganizational learning depends on how much both firms' knowledge bases are related. However,

[1] An earlier version of Chapter 3 was presented in Asia Association of Learning, Innovation and Coevolution Studies (ASIALICS) and has been selected for the Best Student Paper Award. Chapter 3 is now under revision in Technology Analysis and Strategic Management.

despite many years of research, studies have not delivered consistent results on the effects of relatedness (Cloodt & Hagedoorn, 2012). For example, Ahuja and Katila (2001) and Cloodt et al. (2006) suggest that a relatively small size of the target firm compared to the acquirer firm has a positive influence on subsequent innovation performance. On the contrary, Chakrabarti et al. (1994) suggest that M&A performance of the acquirer firms decreases when a large firm acquires a smaller firm. In addition, Hagedoorn and Duysters (2002) assert that a similar firm size between the acquirer and target firms helps the acquirer firm generate more innovation. These contradictory results imply that factors other than relatedness may affect the M&As' subsequent performance as well and uncovering those factors might help us to understand the performance differences between acquirer firms.

Most M&A research focused on firm relatedness shares a common assumption: Every firm could achieve good results if the acquirer firm has a good 'fit' with the target firm. However, this assumption may not be universally true. Even though the fit between the acquirer firm and target firm is strong, the acquirer firm may not possess sufficient absorptive capacity to assimilate the resources and capabilities of the target firm (Cohen & Levinthal, 1990; Zahra & George, 2002). Also, the resources of the target firm may be difficult to recombine with those of the acquirer firm and characteristics of the acquirer and target firms' resources may inhibit innovations by the acquirer firm (Fleming, 2001; Fleming & Sorenson, 2001; Grant, 1996; Oxley, 1997). Therefore, even if the fit between the acquirer and target firms is very strong, potential M&A synergies may not be fully

realized. For this reason, this paper examines the characteristics of acquirer and target firms to understand which firms are more likely to benefit from technological M&As and what makes a firm a promising target for M&As. My approach complements existing M&A literature which so far mostly focused on the fit between firms.

Of all characteristics of the acquirer and target firms, I especially pay attention to both firms' knowledge bases. Technological M&As, the focus of this paper, are conducted for the purpose of obtaining the M&A target firms' technological capabilities. A firms' technological capability constitutes the firms' own knowledge base, and a firms' knowledge base is a unique resource which is used for creating innovations (c.f. Hill & Rothaermel, 2003; Miller et al., 2007). Therefore, examining the knowledge bases of the acquirer and target firms is useful for understanding how innovations are created after the technological M&A. A M&A literature review of Cloodt and Hagedoorn (2012) also puts emphasis on the role of the knowledge base in technological M&As. For these reasons, I develop a set of hypotheses based on the idea that the knowledge base characteristics of the acquirer and target firms will affect the subsequent innovation performance of the acquirer firm. Knowledge base characteristics may have effects on how the acquirer firm incorporates the target firms' resources and capabilities. I specifically adopt the concepts of knowledge breadth and knowledge depth, known as representative concepts of the knowledge base (Cepeda & Vera, 2007): the broad knowledge base of the acquirer firm, and the deep knowledge base of the target firm have a positive impact on the subsequent innovation performance. An acquirer firm with a broad knowledge base has a large

absorptive capacity and can more easily internalize the target firm's resources and capabilities (Cohen & Levinthal, 1990; Zahra & George, 2002) while a deep knowledge base of the target firm facilitates post-M&A integration and is more conducive to innovations (Fleming, 2001; Fleming & Sorenson, 2001; Grant, 1996; Oxley, 1997).

This paper makes contributions to the existing literature. First, I clarify the type of acquirers and targets which generate better innovation performance. In other words, my paper shows the specific characteristics of successful acquirer and target firms. Second, my paper contributes to a broadening of the M&A literature which has been focused on the relationship between firm relatedness and performance. I highlight the importance of other firm specific characteristics on M&A success. Third, I empirically prove the impact of the firm's knowledge bases on subsequent innovation performance. This provides academic and managerial implications to M&A researchers and practitioners. Finally, my findings clearly explain antecedents of recent M&A success, especially in technological M&As.

My paper is organized as follows: The Theory and Hypotheses section presents the relevant M&A literature as well as my theoretical framework and hypotheses. The Methodology section describes how I tested my hypotheses using a dataset of M&A activities in the biopharmaceutical industry. The Results section reports the results of my statistical analysis. Finally, I conclude with a discussion of my results and their implications.

3.2. Research hypotheses

3.2.1. Acquirer firm knowledge base

The acquirer firm uses the M&A to obtain new knowledge resources from the target firm. However, the new knowledge of the target firm does not create innovation by itself. Rather, creating innovations depends upon how the acquirer firm utilizes the knowledge of the target firm (DeCarolis & Deeds, 1999). Thus, I examine the knowledge base of the acquirer firm to understand how the acquirer firm creates innovation. Literature on the relationship between the knowledge base and M&A performance shows the effect of knowledge depth on subsequent innovations, but fails to show the role of knowledge breadth because of a multicollinearity problem between the variables (Prabhu et al., 2005). However, Prabhu et al. (2005) suggest that the positive effect of the knowledge breadth on subsequent innovation is bigger than that of the knowledge depth even though they fail to deliver an empirical proof. In addition, Carnabuci and Operti (2013) suggest that internal R&D, rather than external knowledge sourcing, is more appropriate for a firm with a deep knowledge base. Therefore, I examine the role of the acquirer firms' knowledge breadth on post-M&A innovation performance.

The acquirer firms' absorptive capacity, a capacity to recognize, assimilate, and apply the value of new information to innovations, is necessary for utilizing new knowledge (Cohen & Levinthal, 1990). According to the DeCarolis and Deeds (1999),

the efficiency of the knowledge sourcing depends not only on the potential knowledge flows from new knowledge sources but also the firms' knowledge assimilation capabilities. This kind of absorptive capacity is referred to as potential absorptive capacity (Zahra & George, 2002). According to the absorptive capacity literature, a broad knowledge base increases the potential absorptive capacity (Schildt, Keil, & Maula, 2012; Zahra & George, 2002), because a wide range of knowledge is useful to identify and absorb knowledge (Taylor & Greve, 2006). Prior research also empirically shows that a firm with diverse knowledge has a capability to recognize the value of new knowledge and apply it (George, Kotha, & Zheng, 2008; McGrath, 1999). Even Cohen and Levinthal (1990) suggest that broad knowledge increases the efficiency of exploration. Thus, an acquirer firm with a broad knowledge base efficiently assimilates knowledge and generates more innovation (Arora & Gambardella, 1990).

Moreover, a broad knowledge base of the acquirer firm makes integration easier. As stated earlier, a broad knowledge base increases the potential absorptive capacity. Thus, a broad knowledge base plays an important role in knowledge integration, because understanding the acquired knowledge must precede knowledge transfer and integration. In addition, a wide knowledge breadth of the acquirer firm is beneficial to resource recombination as it increases the resource recombination possibilities of existing and new knowledge because the firm possesses unique technological capabilities in a range of fields (Fleming, 2001; Katila & Ahuja, 2002). Moreover, knowledge spillovers among diverse technological areas increase the productivity of innovation (Henderson &

Cockburn, 1996).

In conclusion, an acquirer firm with a broad knowledge base has a high potential absorptive capacity, a variety of knowledge to recombine, which supports post-M&A integration. This leads us to the following hypothesis.

Hypothesis 3-1. The larger the acquirer firm's knowledge breadth, the higher its post-M&A innovative performance.

3.2.2. Target firm knowledge base

Knowledge resources of the target firm are new to the acquirer firm and help it to generate innovation. However, innovation is not created through a simple quantitative increase in knowledge. Effects on the creation of innovation may vary depending on the characteristics of the knowledge. For example, Lin and Jang (2010) suggest that the knowledge breadth of the target firm affects subsequent innovation but did not present empirical proof for their argument. I follow up on their work by empirically examining the effect of the target firms' knowledge base depth on subsequent innovation.

Even though firms have promising ideas, many of them fail to innovate, and this failure is mostly attributed to a lack of sufficient expertise (B. Katz & Du Preez, 2008). Contrary to the role of knowledge breadth, knowledge depth is the existence of sufficient

expertise to successfully innovate. In other words, knowledge depth is a mandatory requirement for creating innovation. For example, Hamel and Prahalad (1994) suggest that a deep knowledge base is necessary to develop a firms' core competences and secure a competitive advantage. A pharmaceutical industry research of Henderson and Cockburn (1994) also highlights the importance of existing knowledge depth in creating new knowledge. If the acquirer firm obtains in-depth knowledge from the target firm, expertise flows in rapidly. Therefore, an target firm with a deep knowledge base contributes highly to the acquirer firm's subsequent innovation. In addition, research has shown that firms with a deep knowledge base are often the targets of M&A activities by firms which possess a broad knowledge base. According to Carnabuci and Operti (2013), a firm with a broad knowledge base usually creates innovations using external knowledge rather than internal existing knowledge. Because of the trade-off relationship between knowledge breadth and knowledge depth, a firm with a broad knowledge base usually lacks in-depth knowledge. Thus, the target firms' in-depth knowledge may have a significant effect on the acquirer firms' subsequent innovation performance.

In terms of integration, a deep knowledge base, compared with a broad knowledge base of the target firm has a number of advantages. For example, knowledge diversity increases the level of complexity of integration as well as incurs higher monitoring costs and difficulties (Oxley, 1997). Grant (1996a) also states that as the diversity of knowledge increases, integration efficiency decreases. In addition, using the NK model of Kauffman (1993), Fleming and Sorenson (2001) show that the benefits

from knowledge recombination of diverse fields decrease as diversity increases.

In conclusion, an target firm with a deep knowledge base provides the acquirer firm with expertise to jump over the innovation hurdle, and helps to facilitate post-M&A integration. This leads to the following hypothesis:

Hypothesis 3-2. The larger the target firm's knowledge depth, the higher the acquirer firm's post-M&A innovative performance.

3.2.3. Synergies stemming from the acquirer and target firms' knowledge bases

Previous research on the relationship between knowledge base and M&A performance is limited as it only examined either the acquirer or the target firms' characteristics but never both at the same time (C. H. Lin & Jang, 2010; Prabhu et al., 2005). To overcome this limitation, my study examines both firms' knowledge base and uncovers their interaction effect.

Firms usually have limited resources. Thus, unless more resources are added, increasing the knowledge breadth decreases knowledge depth and vice versa (B. W. Lin, Chen, & Wu, 2006). However, both knowledge breadth and knowledge depth are indispensable for creating innovation. For example, according to Laursen and Salter

(2006), a diverse knowledge base stimulates numerous ideas but without knowledge depth, it just touches the surface of innovations rather than drill down to the breakthrough. In summary, a firm with broad knowledge needs in-depth knowledge and a firm with deep knowledge needs knowledge breadth. Thus, an acquirer firm only characterized by either knowledge breadth or knowledge depth may take advantage of M&As to compensate its insufficiencies. The acquirer firm also could increase both its potential and realized absorptive capacity through M&A activities (Schildt et al., 2012; Zahra & George, 2002). Therefore, a combination of the acquirer and target firms' knowledge bases, which have different properties, obviously gives rise to synergies. However, as stated in Hypotheses 3-1 and 3-2, the acquirer firm absorbs and exploits the new knowledge well only when it has a high knowledge breadth and the target firm has a high knowledge depth. Accordingly, in case of an acquirer firm with a deep knowledge base and an target firm with a broad knowledge base there might also exist some synergies but the direct effects of each knowledge characteristic does not increase the acquirer firm's capabilities to innovate.

In conclusion, when an acquirer firm with a broad knowledge base conducts M&A with a firm which possesses a deep knowledge base, the resulting synergies will lead to an increased innovation performance. Hence, I predict that:

Hypothesis 3-3. Interaction effects of the acquirer firm's knowledge breadth and the target firm's knowledge depth will positively affect the post-

M&A innovation performance of the acquirer firm.

Figure 3-1 shows a conceptual diagram of the research model summarizing my hypotheses.

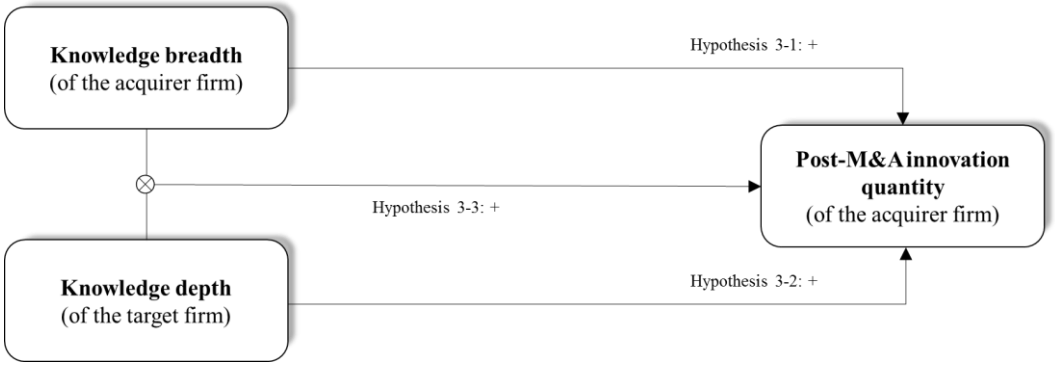

Figure 3-1. Conceptual model for Chapter 3

3.3. Methodology

3.3.1. Data and sample

I tested my hypotheses in the context of the global biopharmaceutical industry. This industry is known as a good industry to examine technological M&A and innovative activities because M&A transactions frequently occur to bolster firms' technological capabilities and firms in this industry tend to protect their capabilities through patents

(Arora, Gambardella, Hall, & Rosenberg, 2010; Higgins & Rodriguez, 2006; Puranam & Srikanth, 2007). My dataset of technological M&A transactions was compiled from SDC Platinum M&A Database, which offers a large listing of worldwide M&A activity. I collected a list of every completed M&A transactions in the biopharmaceutical industry from 2001 to 2007, and excluded transactions which did not represent a new acquisition or merger. Specifically, I excluded M&A transactions categorized as "acquisition of remaining interest" because they just represent a pure stock market deal, and are not concluded for the purpose of obtaining the target firms' resources and capabilities. I completed my dataset with financial data of the acquirer and target firms which I gathered from Datastream, which provides a comprehensive global collection of financial and Form 10-K data of firms. Furthermore, patent data from the acquirer and target firms was collected from the USPTO Database. Using the patent data of each firm, I was able to identify a subset of technological M&As following the definition of Ahuja and Katila (2001): "whether the target firm had obtained any patents in the 5 years preceding the M&A." At last, I integrated all data into a pooled cross-sectional dataset which consists of 250 M&A transactions, and 39,879 patents of the acquirer and target firms.

3.3.2. Dependent variable

The dependent variable, innovation performance, was measured using patent data. According to Griliches (1998), who investigated the usefulness of patents as an indicator for innovation, patents are a suitable proxy for showing a firm's innovative capabilities. Accordingly, literature has used the patent data to measure innovation in diverse industries, for example, the chemical industry (Ahuja & Katila, 2001), photographic equipment industry (Valentini, 2012), semiconductor industry (Wagner, 2011) as well as the pharmaceutical industry (Henderson & Cockburn, 1996; Penner-Hahn & Shaver, 2005) which is closely related to the industry of our study. In fact, Arundel and Kabla (1998) investigated the ratio of innovation patented in 19 different industries and found that in the pharmaceutical industry nearly 80% of all innovations, which is the highest ratio among the analyzed industries, are patented. Moreover, pharmaceutical companies tends to patent every possible idea, as their profit-making ability is dependent on a competitive advantage derived from any innovation they developed (Nerkar & Roberts, 2004). Following the literature, my dependent variable, subsequent innovation performance of the acquirer firm was computed as the number of granted patents which have originally been applied for the acquirer firm between the 2 year after the M&A deal and 5 years after the M&A deal. I decided on a 4-year period as most patents lose their technological value within 5 years and acquirer firms' patents from more than 5 years after the conclusion of a M&A deal are very unlikely to be influenced by the target firms'

capabilities (van de Vrande, Vanhaverbeke, & Duysters, 2009). Also, according to Hall, Jaffe, and Trajtenberg (2005), there is, on average, two year grant lag. Thus, granted patents which have originally been applied for the firm within the first 2 years after the M&A cannot be considered to be a result of the target firm's knowledge.

3.3.3. Independent variables

The independent variables in my research represent the characteristics of the acquirer and target firms. Specifically, my hypotheses cover the role of knowledge breadth of the acquirer firm and knowledge depth of the target firm on subsequent innovation performance. In addition, I investigate the interaction effect of both independent variables.

Knowledge breadth is a variable that shows how much a firms' knowledge base encompasses various research fields. The knowledge breadth variable has a bigger value as a firm has knowledge in more diverse fields. I measure knowledge breadth as the total number of granted patent classes in which a firm has originally been applied patents in a 5 year period before the M&A (Kotha, Zheng, & George, 2011; Zhang, Baden-Fuller, & Mangematin, 2007; Zhang & Baden-Fuller, 2010). In this study I am concerned with the acquirer firms' knowledge breadth only.

Knowledge depth is a variable that represents how much a firms' knowledge base is deep in a specific research area. I operationalized knowledge depth as the

maximum number of a firms' granted patents which have originally been applied in any one patent class in a 5 year period before the M&A (Kotha et al., 2011). In this study I am concerned with the target firms' knowledge depth only.

3.3.4. Control variables

I utilized six control variables that may also influence the subsequent innovation performance of the acquirer firm. First of all, prior technological capabilities of the acquirer and target firms were used as controls because these have the most obvious effect on subsequent innovation performance. Technological capabilities of both firms are computed as the number of each firms' granted patent in which a firm has originally been applied patents in a 5 year period before the M&A deal. Further, I controlled for other characteristics of the acquirer firm such as size and R&D expenditure. These variables have very large values compared to the other variables of my research. Thus, I take logarithms of each variable to increase the fit of the model. As a result, each variable is measured as the logarithm of the sum of the acquirer firm sales and R&D expenditures in the 5 years preceding the M&A. In addition, I controlled the 'fit' between the acquirer and target firms. Specifically, I controlled for technological relatedness between the two firms and operationalized it as the number of digits that are different between the main SIC codes of both firms. Finally, I controlled for M&A deal characteristics such as

overseas M&A and M&A deal type. To sum up, I enhanced reliability of the hypotheses test results by controlling characteristics of each of the acquirer and target firms, fit between both firms, and M&A transactions.

3.3.5. Empirical model specification

The dependent variable of my research measuring subsequent innovation performance was constructed as a non-negative count variable. Therefore, an OLS regression model is not suitable for my analysis because of the variable's characteristics. Generally, Poisson regression is appropriate to analyze count data. Negative binomial regression is also a well-accepted method of modeling discrete events like my dependent variable and has an ability to correct for overdispersion (Hausman, Hall, & Griliches, 1984; Hilbe, 2011)As my dependent variable shows overdispersion, I based my analysis on a negative binomial regression model.

3.4. Results

3.4.1. Descriptive statistics

Table 3-1 and Table 3-2 presents the descriptive statistics and the correlation matrix for the variables in my analysis. According to Table 3-2, the correlation between the independent variables and my control variables is relatively high: between target firm technology depth and target firm R&D capability, and between acquirer firm technology breadth and acquirer firm R&D capability. This was to be expected because technological capability and knowledge base characteristics are conceptually highly associated with each other. However, despite their natural interrelationship, high correlation between independent variables and control variables may result in a multicollinearity problem (Rea & Parker, 2012). Thus, I check the possibility of multicollinearity using variance inflation factor (VIF) analysis, and the VIF values are far below the recommended cut-off value of 10 (Kleinbaum, Kupper, Nizam, & Rosenberg, 2013; Myers, 1990). Therefore, the multicollinearity is not problematic in my analysis. Moreover, I additionally analyzed my hypotheses excluding the two problematic control variables: target firm R&D capability and acquirer firm R&D capability to provide for every contingency, and the result shows that effects of my independent variables on subsequent innovation performance is same as in the original test results.

Table 3-1. Descriptive statistics of the variables related to the basic considerations for M&A target selection

Variables	N	Mean	Std. Dev
Acquirer firm knowledge breadth	250	10.94	21.153
Target firm knowledge depth	250	15.056	21.359
Acquirer firm R&D capability	250	120.664	516.995
Target firm R&D capability	250	37.5	91.405
Acquirer firm size	250	7.785	2.254
Acquirer firm R&D expenditure	250	10.785	2.381
Technology similarity	250	3.224	1.387
Overseas M&A	250	0.12	0.325
M&A form	250	4.156	0.857
Innovation performance	250	100.168	318.671

Table 3-2. Correlations matrix of the variables related to the basic considerations for M&A target selection

Variables	1	2	3	4	5	6	7	8	9
Acquirer firm knowledge breadth	1.00								
Target firm knowledge depth	-0.009	1.00							
Acquirer firm R&D capability	0.839	-0.019	1.00						
Target firm R&D capability	-0.006	0.795	-0.023	1.00					
Acquirer firm size	0.438	0.167	0.298	0.163	1.00				
Acquirer firm R&D expenditure	0.487	0.198	0.326	0.158	0.568	1.00			
Technology similarity	0.087	-0.150	0.069	-0.250	-0.075	-0.014	1.00		
Overseas M&A	0.099	-0.033	0.046	-0.032	-0.034	0.015	-0237	1.00	
M&A form	0.008	0.088	-0.007	0.118	0.106	0.068	-0.313	-0.081	1.00

3.4.2. Analysis results

Table 3-3 presents the regression estimations from my various models. Model 1 is the base model of my analysis, including only the control variables. In Model 2, I analyze the effects of the acquirer firm knowledge breadth. Model 3 tests for the effects of the target firm knowledge depth. Model 4 analyzes the main effects of the acquirer and target firms' knowledge characteristics simultaneously. Finally, I add interaction effects between the acquirer and target firms' knowledge characteristics in Model 5.

The results of the negative binomial regressions for subsequent innovation performance are reported in Table 3-3. In every model of Table 3-3, I find evidence that a broad knowledge base of the target firm has positive effects on the subsequent innovation performance. Thus, Hypothesis 3-1 is supported ($p< 0.01$). Hypothesis 3-2 states that an increase in the target firm knowledge depth has a positive effect on the subsequent innovation performance of the acquirer firm. Consistent with Hypothesis 3-2, every model of Table 3-3 reveals the effect of the target firm's knowledge characteristics, showing that a deep knowledge base of the target firm positively affects subsequent innovation of the acquirer firm. Hence, Hypothesis 3-2 is supported ($p<0.01$). Hypothesis 3-3 suggests that interaction between the broad knowledge base of the acquirer firm and the deep knowledge base of the target firm creates positive synergies which increase post-M&A innovation. According to the results presented in Table 3-3, Model 5 reveals a significant positive interaction effect of the acquirer and target firms knowledge

characteristics on subsequent innovation performance, supporting Hypothesis 3-3.

In conclusion, all my hypotheses were confirmed and the results found to be statistically significant. These results confirm my idea that an investigation of the knowledge characteristics of the acquirer firm and target firm is very helpful to explain subsequent M&A performance. Moreover, these results help to understand which firms are more likely to benefit from technological M&As and which properties make a firm an attractive target for M&As. In addition, my research uncovers the interaction effect between the acquirer and target firms knowledge base, which has not been dealt with in previous M&A literature. Table 3-4 summarizes the hypotheses of my research and the corresponding empirical test results.

Table 3-3. Negative binomial regression results for the variables related to the basic considerations for M&A target selection

Dependent variable:	Model 1		Model 2	
Innovation Quantity	Coefficient	S.E.	Coefficient	S.E.
Control variables				
Acquirer Firm R&D Capability	0.0013**	0.0004	- 0.0002	0.0005
Target Firm R&D Capability	0.0018	0.0013	0.0019	0.0012
Acquirer Firm Size	0.2206***	0.0469	0.1854***	0.0463
Acquirer Firm R&D Expenditure	0.2416***	0.0377	0.2163***	0.0371
Technology Similarity	0.1260**	0.0601	0.1175***	0.0583
Overseas M&A	0.5292**	0.2498	0.5121**	0.2451
M&A Form	0.0498	0.0916	0.0661	0.0890
Independent variables				
Acquirer Firm Knowledge Breadth			0.0347**	0.0120
Target Firm Knowledge Depth				
Acquirer Firm Knowledge Breadth X Target Firm Knowledge Depth				
N	250		250	
Log likelihood	-1139.343		-1134.595	
Pseudo R^2	0.0883		0.0921	
LR Chi^2	220.67		230.17	
Regression *p*-value	0		0	

Notes: *p < .10; **p < .05; ***p < .01

Table 3-3. Negative binomial regression results for the variables related to the basic considerations for M&A target selection (Continued)

Dependent variable:	Model 3		Model 4	
Innovation Quantity	Coefficient	S.E.	Coefficient	S.E.
Control variables				
Acquirer Firm R&D Capability	0.0012**	0.0004	- 0.0003	0.0004
Target Firm R&D Capability	- 0.0028*	0.0016	- 0.0003**	0.0015
Acquirer Firm Size	0.2257***	0.0457	0.1865***	0.0448
Acquirer Firm R&D Expenditure	0.2347***	0.0370	0.2052***	0.0362
Technology Similarity	0.1174*	0.0607	0.1059*	0.0589
Overseas M&A	0.5354**	0.2467	0.5120**	0.2418
M&A Form	0.0635	0.0910	0.0819	0.0881
Independent variables				
Acquirer Firm Knowledge Breadth			0.0355**	0.0112
Target Firm Knowledge Depth	0.0198**	0.0068	0.0216***	0.0065
Acquirer Firm Knowledge Breadth X Target Firm Knowledge Depth				
N	250		250	
Log likelihood	-1135.549		-1129.778	
Pseudo R^2	0.0913		0.0959	
LR Chi^2	228.26		239.80	
Regression *p*-value	0		0	

Notes: *p < .10; **p < .05; ***p < .01

Table 3-3. Negative binomial regression results for the variables related to the basic considerations for M&A target selection (Continued)

Dependent variable:	Model 5	
Innovation Quantity	Coefficient	S.E.
Control variables		
Acquirer Firm R&D Capability	- 0.0002	0.0004
Target Firm R&D Capability	- 0.0025	0.0015
Acquirer Firm Size	0.1825***	0.0444
Acquirer Firm R&D Expenditure	0.2066**	0.3586
Technology Similarity	0.0992*	0.5897
Overseas M&A	0.5542**	0.2418
M&A Form	0.0701	0.0876
Independent variables		
Acquirer Firm Knowledge Breadth	0.0274**	0.0116
Target Firm Knowledge Depth	0.0145**	0.0074
Acquirer Firm Knowledge Breadth X Target Firm Knowledge Depth	0.0006*	0.0003
N	250	
Log likelihood	-1128.430	
Pseudo R^2	0.0970	
LR Chi^2	242.50	
Regression *p*-value	0	

Notes: *p < .10; **p < .05; ***p < .01

Table 3-4. Summary of the hypotheses and results for the variables related to the basic considerations for M&A target selection

Hypothesis		Test results
H3-1	The larger the acquirer firm's knowledge breadth, the higher its post-M&A innovative performance.	Supported
H3-2	The larger the target firm's knowledge depth, the higher the acquirer firm's post-M&A innovative performance	Supported
H3-3	Interaction effects of the acquirer firm's knowledge breadth and the target firm's knowledge depth will positively affect the post-M&A innovation performance of the acquirer firm	Supported

3.5. Discussion

M&As are a strong external resource sourcing strategy that helps the acquirer firm obtain market share, reputation, human resources, and facilities fast (Finkelstein, 1997). Moreover, M&As allow firms to acquire external technology and to catch up with the disruptively changing environment (Christensen & Overdorf, 2000). However, various research has shown that pursuing M&As is an extremely high risk strategy because the failure rate of M&As is around 60 to 80 percent. Thus, firm managers should pay close attention when planning and implementing M&As. I support this by examining which firms are most likely to benefit from technological M&As. Clarifying the characteristics of what constitutes a good acquirer and target firm enriches the existing M&A literature which so far focused their attention on the fit between the acquirer and target firm. My

results indicate that the acquirer firm should possess a broad knowledge base to obtain and internalize external technology efficiently. Insufficient knowledge breadth may result in difficulties to internalize knowledge because of a lack of potential absorptive capacity. In addition, I point out desirable characteristics the target firm should possess. Unlike for the acquirer firm, a target firm ideally had a deep knowledge base which helps to support the acquirer firm in increasing its innovative output. Moreover, the interaction effect of the broad knowledge base of the acquirer firm and the deep knowledge base of the target firm creates a positive synergy. In summary, the knowledge breadth of the acquirer firm helps the acquirer firm find and internalize required outside capabilities. The knowledge depth of the target firm offers the acquirer firm a stepping stone to more innovation and at the same time simplifies post-M&A integration.

My findings provide implications to managers concerned with technological M&As. First, technological M&As are good strategy for absorbing a deep knowledge base of targets whereas a broad knowledge base of the target firm makes post-merger integration difficult. However, an acquirer firm with previous M&A experiences may succeed even though the knowledge base of an target firm is diverse because of sufficient integration capabilities. According to Hitt, Harrison, and Ireland (2001), as M&A experience is accumulated, “acquisition-specific capability” increases and M&A performance is enhanced. Second, in case of the acquirer firm possessing a deep rather than a broad knowledge base, technological M&A is not recommended. The risk of M&A of an acquirer firm with a narrow knowledge base is relatively high because of its low

potential absorptive capacity. A research of Carnabuci and Operti (2013) also argues that for a firm with a deep knowledge base, internal R&D is more effective than external technology sourcing.

Chapter 4. Increasing innovation quantity through M&A target selection[2]

4.1. Introduction

Amid constant change and intense competition, firms must constantly keep up with the fast-changing market. Accordingly, rapid technology absorption skills influence the competitiveness of firms; however, firms cannot create knowledge and capabilities for survival and sustainable innovation solely within the organization (Chesbrough, 2006; K. H. Kang, Jo, & Kang, 2015; K. H. Kang & Kang, 2009; Keil, 2004; Leonard-Barton, 1995). In other words, they need to introduce knowledge from external sources. As a result, firms exploit a variety of methods, such as licensing, alliance, joint venture and M&A, to access external knowledge (Du, Wu, Lu, & Yu, 2013; Lee, 2010; Park & Kang, 2010). Among these various collaboration strategies, my research focuses on technological M&A.

Conducting an M&A with a technological objective implies that the acquirer firm intends to absorb the knowledge of the target firm to create innovation and obtain sustainable competitive advantages (Ahuja & Katila, 2001; Cloodt et al., 2006; Hamel, 2000). According to the findings of the previous technological M&A literature, major

[2] An earlier version of Chapter 4 has been accepted for publication in Asian Journal of Technology Innovation.

factors affecting the subsequent innovation performance include whether or not technological M&A is conducted (Valentini, 2012; Wagner, 2011), the characteristics of the acquirer firm (Desyllas & Hughes, 2010; Prabhu et al., 2005) and the characteristics of the target firm (Ahuja & Katila, 2001; Cloodt et al., 2006; Datta & Roumani, 2015; C. H. Lin & Jang, 2010). The findings of these studies contribute to identifying influential firm level factors that have an impact on subsequent innovation. However, analyzes focusing only on the characteristics of one firm or the M&A deal itself are unable to examine the relative characteristics between the acquirer and target firm. It has been argued that the acquirer firm's learning differs between transactions because of dyadic characteristics between the acquirer and target firm. This is explained in the concept of relative absorptive capacity (Lane & Lubatkin, 1998). Recent technological M&A research has put its emphasis on the importance of relative absorptive capacity and started to examine dyadic factors (Bauer & Matzler, 2014; Sears & Hoetker, 2014). My study follows this approach and also develops its hypotheses following a dyadic perspectives.

Among the various dyadic aspects of firm resources and capabilities of technological M&As, my study focuses on the role of knowledge similarity and knowledge digestibility. According to the framework of Zahra and George (2002), acquisition, assimilation, transformation and exploitation processes are necessary for applying knowledge to innovation. However, prior technological M&A research, which used a dyadic perspective, focused on the acquisition process (Bauer & Matzler, 2014; Sears & Hoetker, 2014) and did not examine factors which affect the assimilation,

transformation and exploitation processes of the absorptive capacity. Thus, examining the factors which affects these processes is required to better understand the performance differences between technological M&A transactions. My variables, knowledge similarity and knowledge digestibility, are representative factors which affect the absorption and integration of knowledge (Grant, 1996b; Kitching, 1967; Kogut & Zander, 1992; Ranft & Lord, 2002). In addition, I examine the moderating role of M&A experience on the relationship between the dyadic characteristics and the innovation performance of technological M&As. Acquisition-specific capabilities which are accumulated through M&A experiences allow a firm to develop capabilities that strengthen the creation of innovation through the firm's technological M&A strategy.

My research makes five contributions to unravel the link between technological M&A and innovation performance. First, I link a dyadic perspective with the framework of Zahra and George (2002). Second, I introduce the concept of knowledge digestibility to the M&A literature. This allows to examine the tacit knowledge aspects in the acquirer and target firm. Third, I examine the moderating role of acquisition-specific capabilities. My findings enable us to investigate the effect of the characteristics of the focal M&A as well as the indirect effect of prior M&A experience. Fourth, I extend the application of the M&A experience from general M&A transactions to the ever increasing domain of technological M&As (Hayward, 2002). Fifth, my study highlights that accumulating M&A experience by acquiring small firms is an efficient strategy for creating innovation.

This paper is organized as follows. The first section describes technological M&A

and presents the logical background for my hypotheses, linking them to prior research. The second section provides details of my employed research model. Using zero-inflated negative binomial regression, I test my hypotheses using data on 212 technological M&A transactions of 113 firms in the biopharmaceutical industry from 1993 to 2007. The third section presents the result of my empirical analysis, and the final section provides discussions and conclusion.

4.2. Research hypotheses

4.2.1. Knowledge similarity

Knowledge attributes of both the acquirer and target firms influence the degree of absorption and integration of the acquired knowledge. In particular, the knowledge similarity between the two firms has a close relationship with the relative absorptive capacity of the acquirer firm.

Similar technological knowledge implies that both firms share a similar language and recognition structure, which facilitates the transfer of explicit and tacit knowledge (Cohen & Levinthal, 1990; Lane & Lubatkin, 1998). Thus, technological knowledge similarity with the target firm helps the acquirer firm absorb more knowledge. Furthermore, according to Kogut and Zander (1992) and Grant (1996b), similar

knowledge supports the integration of knowledge of both the acquirer and target firms. Absorbing knowledge is not enough to create innovation; instead, absorptive capacity is necessary for integrating and assimilating knowledge (Cohen & Levinthal, 1990). Therefore, similar technological knowledge allows the acquirer firm to better utilize its relative absorptive capacity and create subsequent innovation (Lane & Lubatkin, 1998).

On the contrary, if the acquirer firm and the target firm have dissimilar knowledge bases, a gap in the R&D method or routine of innovation between the two firms occurs (Kogut & Zander, 1992). Even though the target firm has valuable knowledge, the dissimilarity disrupts the knowledge transfer, and the acquirer firm will find it difficult to absorb the acquired knowledge (Mowery, Oxley, & Silverman, 1998). In turn, difficulty in knowledge transfer would hinder knowledge integration of the acquirer and the target firm, negatively affecting the creation of innovation.

While increasing knowledge similarity makes the integration easier, it might have a detrimental effect of the actual innovation outcome. A large overlap of knowledge might not provide sufficiently new knowledge and not ‘serve as the basis for absorbing additional stimuli and information from the external environment’ (Ahuja & Katila, 2001).

In conclusion, knowledge similarity between the acquirer and the target firms affects an M&A’s subsequent innovation performance (Lane & Lubatkin, 1998; Lubatkin, 1983; H. Singh & Montgomery, 1987). Different levels of similarity of the technological knowledge between the acquirer and target firm, have positive or negative effects on the acquirer firm’s innovation performance. Hence, the following hypothesis is proposed:

Hypothesis 4-1. In technological M&As, the knowledge similarity has an inverted U-shape relationship with the acquirer firm's subsequent innovation performance.

4.2.2. Knowledge digestibility

Knowledge digestibility, first introduced by Hennart (1988), implies that the knowledge size difference between firms affects the degree of knowledge absorption between them. In the M&A context, knowledge digestibility can lead to difficulties when the target firm has a relatively larger knowledge base compared with the acquirer firm. However, a large knowledge base of the target firm might also have positive effects through broadening the knowledge of the acquirer firm. Consequently, some firms prefer the target firm to have a large knowledge base, because more knowledge leads to more innovation (Cloodt et al., 2006). In other words, a trade-off is observed in the relative size of knowledge base and innovation performance. Therefore, a closer look into whether a relatively large or small knowledge base of the target firm is better for innovation, is warranted.

Generally, the integration of the knowledge of the target and acquirer firms is easier if the relative size of the knowledge base of the acquirer firm is small (Cloodt et al., 2006; Ranft & Lord, 2002). In turn, because the acquirer firm could digest more of the

acquired knowledge, a positive effect on subsequent innovation can be expected. Conversely, if the target firm's knowledge base is relatively large compared to that of the acquirer firm, the number and complexities of new procedures, routines, and relationships required to integrate and digest the knowledge of the target firm also increase (Carayannopoulos & Auster, 2010). Therefore, when the relative size of the knowledge base compared with the acquirer firm is large, the acquirer firm requires more time, energy, and resources to absorb the knowledge of the target firm, negatively influencing the creation of innovation (Cloodt et al., 2006; Kitching, 1967; Paruchuri et al., 2006).

The relative size of the knowledge base in technological M&As has already been considered in the study of Ahuja and Katila (2001). Their focus, however, was different from the knowledge digestibility in my study. Ahuja and Katila (2001) employed the ratio of the acquirer and target firms' patents as the measure for the relative size of the target firm's knowledge base. However, as patents are explicit knowledge repositories and do not represent tacit knowledge, a more suitable way of comparing the actual repositories of knowledge and technology of the firms is required. According to Paruchuri et al. (2006), employees are repositories of knowledge and technology of the firm, and Argote and Ingram (2000) see employees as the most powerful reservoir of knowledge, because of their explicit and tacit knowledge. Therefore, knowledge digestibility, i.e., the ratio of employees between the acquirer and target firms, is a suitable concept to estimate the relative knowledge base.

In conclusion, if the target firm possesses a relatively large knowledge base, the

acquirer firm gains access to a large amount of knowledge but would have difficulty in digesting, i.e. transferring, integrating and applying it towards innovative outcomes. Therefore, for an efficient innovation outcome, the acquirer firm is required to choose its M&A targets based on the measure of digestibility. Accordingly, the following hypothesis is presented:

Hypothesis 4-2. In technological M&As, the greater the knowledge digestibility, the greater will be the subsequent innovation performance of the acquirer firm.

4.2.3. The direct effects of M&A experience

The subsequent innovation performance of the acquirer firm can be affected by the dyadic knowledge characteristics but also by acquisition-specific capability. In other words, all others factors being equal, firms that have more prior M&A experience will exhibit a better innovation performance.

Acquisition-specific capabilities from accumulated M&A experience provide knowledge that improves M&A performance (Hitt et al., 2001; Laamanen & Keil, 2008; Trichterborn, zu Knyphausen-Aufseß, & Schweizer, 2015). When the two organizations interact, conflict inevitably occurs. Acquisition-specific capability facilitates the

management of such conflicts. According to the dominant general management logic of Prahalad and Bettis (1986), acquisition-specific capability helps the acquirer firm learn to integrate and reduce the conflict of organizations. Acquisition-specific capability gained through prior M&A experience also provides a learning mechanism that facilitates the effective capture, absorption, and integration of knowledge (Hayward, 2002). Therefore, M&A experience positively affects the creation of innovation. Accordingly, the following hypothesis can be stated:

Hypothesis 4-3. In technological M&As, greater M&A experience of the acquirer firm leads to a greater subsequent innovation performance.

4.2.4. The moderating role of M&A experience

Besides the direct effect on subsequent innovation performance, M&A experience can also intensify the relationship between the dyadic characteristics and innovation performance. M&A experience is a factor related to the facilitation of knowledge absorption and integration (Hayward, 2002). In other words, M&A experience helps reduce conflict as the acquirer and target firms integrate and cooperate, effectively serving as a catalyst.

For technological M&A, prior experience, can help the acquirer firm create

innovation, because it affects the flow of technological knowledge to the acquirer firm. The direct effect of M&A experience on innovation is examined in Hypothesis 4-3. Hypothesis 4-4, meanwhile, examines the moderating role of M&A experience. The baseline hypotheses are that knowledge similarity and knowledge digestibility have a relationship with the acquirer firm's subsequent innovation performance. Acquisition-specific capability gained through prior M&A experience can intensify this relationships by facilitating the transfer and integration of knowledge from the target firm. Therefore:

Hypothesis 4-4a. In technological M&As, increasing M&A experience of the acquirer firm strengthens the relationship between knowledge similarity and subsequent innovation performance.

Hypothesis 4-4b. In technological M&As, increasing M&A experience of the acquirer firm strengthens the relationship between knowledge digestibility and subsequent innovation performance.

Figure 4-1 shows a conceptual diagram of the research model summarizing my hypotheses.

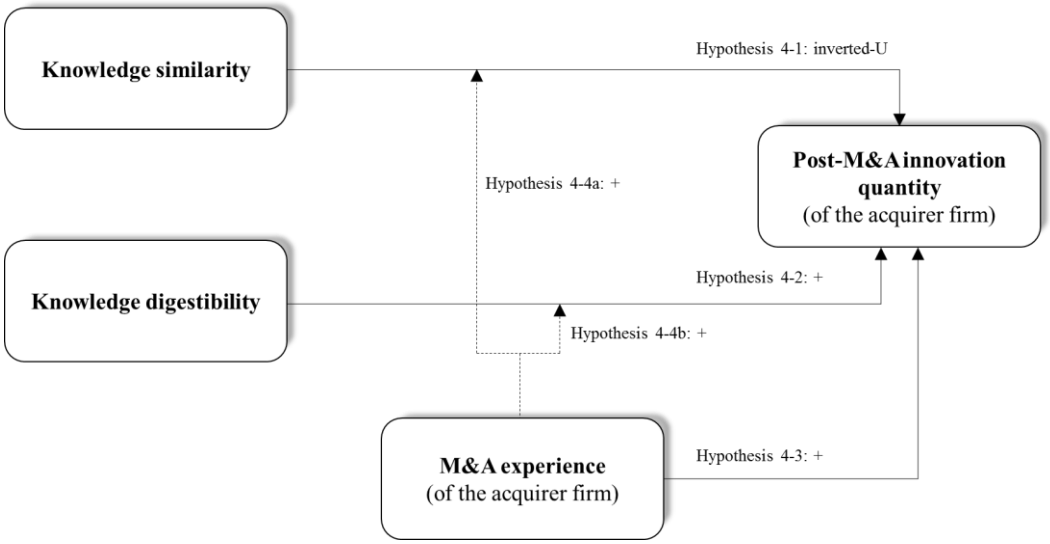

Figure 4-1. Conceptual model for Chapter 4

4.3. Methodology

4.3.1. Data and sample

My hypothesis were empirically tested on a dataset containing data of 212 technological M&A transactions of biopharmaceutical firms in a range of countries including amongst others the United States, Germany, Japan, and India. I collected data on 1,133 M&A transactions from the SDC Platinum M&A database. The SDC Platinum M&A database provides acquisition deal data in the biopharmaceutical industry. These 1,133 M&A transactions occurred from 1993 to 2007. I also obtained data on United States patent

applications and granted patent of the acquirer and target firms from 1990 to 2010 through USPTO and, in accordance with Ahuja and Katila (2001), only considered technological M&A transactions in which the target firm had been granted at least one patent in the five years preceding the M&A. The United States represents the biggest technological market in the world, and as such, this is where the highest number of patent litigations has been recorded. Thus, United States patents were used in my study because both United States and foreign companies usually apply for United States patents in order to be protected from patent infringement (Albert, Avery, Narin, & McAllister, 1991). In addition, Dosi, Pavitt, and Soete (1990) provide evidence that a United States patent is a good measure of the innovative performance of foreign firms. After examining the patents of the firms in my sample, the firms' financial data from 1990 to 2010 was obtained through the Datastream database. After excluding technological M&A transactions with missing data, the final pooled cross-sectional dataset used for my empirical analysis contained 212 technological M&A transactions conducted from 1993 to 2007 by 113 firms.

4.3.2. Dependent variable

Innovation performance The goal of this paper is to examine the impact of technological M&A on the subsequent innovation performance of the acquirer firm. Thus, the

dependent variable is the subsequent innovation performance of the acquirer firm following the M&A deal.

According to prior research, innovation output is directly related to the number of patents a firm has generated (Ahuja, 2000; Owen-Smith & Powell, 2004; Rothaermel & Hess, 2007); thus, the dependent variable is measured by the difference in the number of US patent applications which resulted in granted patents before and after the M&A for each acquirer firm (Ernst & Vitt, 2000). When using patent data, the selection of a suitable time frame for the analysis is an important issue. Generally, the technology covered by a patent loses most of its value within five years (van de Vrande et al., 2009). Thus, five years after the acquisition, the impact of knowledge from the target firm is imperceptible. While the speed of technology transition in a technologically advanced industry such as the biopharmaceutical industry is very fast, a time lag occurs between knowledge absorption and the actual patent application (Rothaermel & Hess, 2007). Therefore, the post M&A patent count for the dependent variable is based on the patents of the acquirer firm applied for one to three years after the acquisition. Similarly, a time period of one to three years before the acquisition is used to count the pre M&A patents. Due to the fact that no appropriate methodologies to deal with non-negative count values exist, I converted all negative values of my dependent variable to zero.

4.3.3. Independent variables

Knowledge similarity The study compares the patent classes present in the patent portfolios of the acquirer and target firms to measure the knowledge similarity (Carayannopoulos & Auster, 2010). When both firms hold patents in similar patent classes, the knowledge similarity between the acquirer and target firms is considered to be high. Specifically, the following formula has been employed to calculate this overlap:

$$\text{Knowledge similarity} = \frac{PC_{i,t} \cap PC_{j,t}}{PC_{i,t} + PC_{j,t} - (PC_{i,t} \cap PC_{,tj})}$$

where $PC_{i,t}$ and $PC_{j,t}$ are the patent class of the acquirer and target firms in the three years preceding the M&A at time t, respectively. Thus, the variable knowledge similarity ranges from zero to one, wherein zero implies that the acquirer and target firms share no technological background at all, and one implies that the target firm has exactly the same technological background as the acquirer firm.

Knowledge digestibility Hennart (1988), the progenitor of knowledge digestibility, measured knowledge digestibility using the ratio of the number of employees of the acquired and acquirer firms. In my study, the variable was operationalized following this definition as well. As mentioned previously, employees are repositories of knowledge and technology of the firm; thus, this variable is a suitable way to reflect the relative knowledge base of a firm. More specifically:

$$\text{Knowledge digestibility} = \frac{\text{Number of employees of the acquired firm in the M\&A } deal \text{ year}}{\text{Number of employees of the acquiring firm in the M\&A } deal \text{ year}}$$

By the definition of this variable, a higher value of knowledge digestibility makes it more difficult for the acquirer firm to capture and apply the target firm's knowledge. Given that the influence of this variable on the regression results and the intuitive understanding of its notion are opposite, careful interpretation of the results is needed.

M&A experience The independent variable M&A experience was examined in two ways, namely, in terms of its direct impact and its moderating impact on the relationships of the dyadic variables. M&A experience was measured by the number of M&A transactions of the acquirer firm preceding the M&A deal being examined. In the research, hypotheses for the moderation effect were verified by multiplying the dyadic independent variables by M&A experience, a common method of verifying the moderation effect. Specifically, (knowledge similarity * M&A experience) and (knowledge digestibility * M&A experience) were tested.

4.3.4. Control variables

Three variables were used to help control alternative explanations of the subsequent M&A innovative performance of the acquirer firm. A study by Cohen and Levinthal (1990) indicated the relationship between absorptive capacity and the creation of innovation. R&D intensity was chosen as the control variable for the study because absorptive capacity could be intensified by accumulated technological knowledge and investment in technological capability (Cohen & Levinthal, 1990). R&D intensity was measured by the R&D expenditure over sales in the year of the M&A deal. In addition, the effect of a R&D paradigm shift in the biopharmaceutical industry was controlled. After the year 2000, the average R&D expenditure in the biopharmaceutical industry increased by 14%, but the success rate of clinical demonstrations decreased from 20% to 8%. This indicates that a paradigm shift in the industry took place around the year 2000, as productivity of R&D in the biopharmaceutical industry rapidly decreased. Thus, I introduced a dummy variable in which M&A transactions before the year 2000 are coded as 0, while M&A transactions after the year 2000 are coded as 1. Furthermore, although foreign and United States firms applied for patents in the United States to guarantee protection from patent infringement, the nationalities of the firms were controlled, because national differences of the firms could affect their innovation performance. Thus, using another dummy variable, United States firms were coded as 1, while non-United States firms were coded as 0.

4.3.5. Empirical model specification

The dependent variable of the study is a countable variable, and as a result, ordinary least square (OLS) regression models could not be employed in the research. Generally, when the dependent variable is a countable variable, such as a number of events in a certain period, Poisson regression is used (Hausman et al., 1984). However, Poisson regression can be employed only when the mean of the variable is the same as the variance of the variable. Table 4-1 shows that the mean and variance of the dependent variable are quite different. Thus, Poisson regression could not be employed. Generally when the variable is countable and shows over dispersion, negative binomial regression is employed. However, the dependent variable of this study has 92 zero values out of a total of 212 values. Thus, the use of ordinary generalized linear models would make the model lose its reliability. For this reason, I employed zero-inflated negative binomial regression to verify the proposed hypotheses (Greene, 1994). I also implemented a Vuong test to evaluate the suitability of zero-inflated negative binomial regression over negative binomial regression. In the Vuong test, the z-statistic shows whether the zero-inflated negative binomial is a better choice than the negative binomial regression (Long, 1997). The result of the Vuong test showed that the p-value is 0.0000 which implies that zero-inflated negative binomial regression should be used.

4.4. Results

4.4.1. Descriptive statistics

Table 4-1 presents the correlation and descriptive statistics for the variables included in the analysis. All variables in my hypotheses have an appropriate correlation value below 0.3.

Table 4-1. Descriptive statistics and correlations matrix of the variables related to the innovation quantity increase

Variable	1	2	3	4	5	6	7	Mean	SD
R&D Intensity	1.00							1.3472	6.7716
Nation	-0.058	1.00						0.6669	0.4713
R&D Paradigm Shift	0.037	0.069	1.00					0.7972	0.4030
Knowledge Similarity	-0.048	0.008	-0.059	1.00				0.4353	0.2698
Knowledge Digestibility	0.010	0.125	0.064	0.047	1.00			0.1159	0.2215
M&A Experience	-0.098	0.100	-0.014	-0.027	-0.131	1.00		2.3113	2.9940
Innovation Performance	-0.044	-0.239	-0.050	0.199	-0.127	0.237	1.00	17.2830	45.9885

Low correlation between the variables implies that the models have a very low possibility of multicollinearity. However, as the presence of multicollinearity would cause serious problems, I conducted a variance inflation factor (VIF) test. If the value of VIF is above 10 or value of tolerance, which is one over the value of VIF or less than 0.1,

multicollinearity is very likely (Myers, 1990). According to the results presented in Table 4-2, I rule out the possibility of multicollinearity in my models.

Table 4-2. VIF test results of the variables related to the innovation quantity increase

Variable	VIF	1/VIF
R&D Intensity	1.02	0.9839
Nation	1.04	0.9638
R&D Paradigm Shift	1.01	0.9865
Knowledge Similarity	1.01	0.9909
Knowledge Digestibility	1.04	0.9583
M&A Experience	1.04	0.9599
Mean VIF	1.03	

4.4.2. Analysis results

Table 4-3 presents the results for all models using zero-inflated negative binomial regression. Model 1 reflects the effect of only the control variables. As indicated in Model 1, R&D intensity and Nationality have a strong relationship with innovation performance, but the effects from the R&D paradigm shift do not show any statistical significance. It implies that the paradigm shift seen in the biopharmaceutical industry did by itself not

affect the firms' innovation productivity. Models 2-5 show the same results for the control variables. Model 2 shows the result of the direct independent variables, and Models 3-4 show the results of the direct independent variables and moderator variables. Finally, in Model 5 the full model, containing all variables used in my analysis, is presented.

Hypothesis 4-1 argues that the knowledge similarity and innovation performance have an inverted U-shape relationship. In Table 4-3, the coefficient for knowledge similarity did not demonstrate any statistical significant result and thus Hypothesis 4-1 could not be verified. While the results in Table 4-3 did not provide a significant result, I find empirical evidence to support Hypothesis 4-1 in the results of the additional sensitivity tests, which is discussed in the section dealing with the sensitivity analysis. In my Hypothesis 4-2, a positive relationship between the knowledge digestibility of the acquirer firm and the subsequent innovation performance has been proposed. I find strong empirical evidence to support Hypothesis 4-2. As stated in the description of the independent variables, a negative coefficient of knowledge digestibility does not imply a negative impact of knowledge digestibility. According to Hennart (1988), in the definition of knowledge digestibility, the number of employees of the target firm in the M&A year is in the numerator, and so a negative coefficient of the variable represents a positive relationship between knowledge digestibility and subsequent innovation performance. The M&A experience of the acquirer firm was also expected to lead to an increased innovation performance. The coefficients of M&A experience in all models are positive and significant, thus supporting Hypothesis 4-3.

Table 4-3. Zero-inflated negative binomial regression results for the variables related to the innovation quantity increase [Type I in Table 4-5]

Dependent variable:	Model 1		Model 2		Model 3	
Innovation Quantity	Coefficient	S.E.	Coefficient	S.E.	Coefficient	S.E.
Control variables						
R&D Intensity	- 0.0370**	0.0117	- 0.0281**	0.0113	- 0.0281**	0.0113
Nation	- 0.7626**	0.2558	- 0.9947***	0.2233	- 0.9943***	0.2234
R&D Paradigm Shift	- 0.2493	0.3243	- 0.0493	0.2941	- 0.0534	0.2948
Independent variables						
Knowledge Similarity			1.1656	1.6267	1.1099	1.6462
Knowledge Similarity Squared			- 0.0622	1.5053	- 0.0644	1.5041
Knowledge Digestibility			- 1.5171***	0.4498	- 1.5122***	0.4505
M&A Experience			0.1190***	0.0304	0.1092**	0.0527
Knowledge Similarity X M&A Experience					0.0227	0.1024
Knowledge Digestibility X M&A Experience						
N(Zero obs)	212(120)		212(120)		212(120)	
Log likelihood	-417.5717		-397.2102		-397.1855	
LR Chi^2	15.35		56.07		56.12	
Regression *p*-value	0.0003		0		0	

Notes: *p < .10; **p < .05; ***p < .01

Table 4-3. Zero-inflated negative binomial regression results for the variables related to the innovation quantity increase [Type I in Table 4-5] (Continued)

Dependent variable:	Model 4			Model 5		
Innovation Quantity		Coefficient	S.E.		Coefficient	S.E.
Control variables						
R&D Intensity	-	0.0288	0.0113	-	0.0288	0.0113
Nation	-	1.0463***	0.2242	-	1.0458	0.2243
R&D Paradigm Shift	-	0.1486	0.2999	-	0.1509	0.3004
Independent variables						
Knowledge Similarity		1.1117	1.6259		1.0727	1.6439
Knowledge Similarity Squared	-	0.0557	1.4990	-	0.0586	1.4982
Knowledge Digestibility	-	1.0363**	0.5713	-	1.0348*	0.5718
M&A Experience		0.1210***	0.0308		0.1138**	0.0536
Knowledge Similarity X M&A Experience					0.0168	0.1045
Knowledge Digestibility X M&A Experience	-	0.3748	0.2787	-	0.3723	0.2789
N(Zero obs)		212(120)			212(120)	
Log likelihood		-396.3764			-396.3634	
LR Chi^2		57.74			57.77	
Regression *p*-value		0			0	

Notes: *p < .10; **p < .05; ***p < .01

However, the interaction effects between M&A experience and the two dyadic variables are not statistically significant, thereby providing no support for Hypotheses 4-4a and 4-4b. A reason for why the moderation effects show insignificant results although the direct effect of M&A on subsequent innovation performance is strongly supported, is given as follows. Haleblian and Finkelstein (1999) state that differences in M&A experience research results are caused by studies that do not classify prior M&A experience as similar or dissimilar with the M&A deal investigated. On a slightly similar note, in testing the moderation effect with the learning effect of the technological variables, a more detailed classification of M&A experience is required. Specifically, classifying M&A experience as technological or non-technological M&A experience would help to identify the interaction effects. Therefore, I expect follow-up studies to investigate the moderating role of M&A experience using a more fine grained approach.

4.4.3. Sensitivity analysis

To improve the robustness of my test results and conclude whether Hypothesis 4-1 is supported or not, my study conducted seven sensitivity analysis with various test setting.

First, I changed the measurement of the dependent variable. Besides the employed change in patenting activities, there are various other measurements of innovation performance. One of the most frequently used measurements is the number of

US patent applications which resulted in granted patents for each acquirer firm (Ahuja, 2000; Ahuja & Katila, 2001; Owen-Smith & Powell, 2004; Puranam & Srikanth, 2007; Rothaermel & Hess, 2007). I adopted this as the measurement of the dependent variable and performed additional analysis. The change of measurement gave rise to a change of the distribution of the dependent variable. The new dependent variable shows over-dispersion, but does not contain as many zero values as the original dependent variable. Accordingly, I changed the analysis model to negative binomial regression. As a result, I found support for Hypothesis 4-1 and further support for the other findings of my study. Table 4-4 shows the results of the sensitivity analysis by changing the measurement of innovation performance and using negative binomial regression.

Second, I diversified the measurement of knowledge similarity by analyzing the number of the overlapped patent classes. Previous literature have adopted the overlap of the patent classes to measure knowledge similarity, because the patent class represents the technological characteristics of the patent and there is a strong possibility that patents with similar technologies are classified within the same class (e.g. Hagedoorn & Duysters, 2002; Schildt et al., 2012). The results from this sensitivity analysis are summarized as Type III test in Table 4-5.

Table 4-4. Negative binomial regression results for the variables related to the innovation quantity increase [Type II in Table 4-5]

Dependent variable:	Model 1		Model 2		Model 3	
Innovation Quantity	Coefficient	S.E.	Coefficient	S.E.	Coefficient	S.E.
Control variables						
R&D Intensity	- 0.0400***	0.0122	- 0.0356**	0.0121	- 0.0356**	0.0121
Nation	- 0.0148	0.2373	- 0.1055	0.2273	- 0.1061	0.2242
R&D Paradigm Shift	- 0.8008**	0.2745	- 0.7148**	0.2604	- 0.7165**	0.2604
Independent variables						
Knowledge Similarity			3.5845**	1.6003	3.6640**	1.6485
Knowledge Similarity Squared			- 2.6157*	1.5071	- 2.6311*	1.5099
Knowledge Digestibility			- 2.3430***	0.5191	- 2.3385***	0.5205
M&A Experience			0.1224***	0.0400	0.1338**	0.0707
Knowledge Similarity X M&A Experience					- 0.0271	0.1380
Knowledge Digestibility X M&A Experience						
N	212		212		212	
Log likelihood	-1070.1021		-1050.385		-1050.3659	
Pseudo R^2	0.0019		0.0252		0.0253	
LR Chi^2	14.96		54.39		55.43	
Regression *p*-value	0.0019		0		0	

Notes: *p < .10; **p < .05; ***p < .01

Table 4-4. Negative binomial regression results for the variables related to the innovation quantity increase [Type II in Table 4-5] (Continued)

Dependent variable:	Model 4			Model 5		
Innovation Quantity		Coefficient	S.E.		Coefficient	S.E.
Control variables						
R&D Intensity	-	0.0366**	0.0121	-	0.0366**	0.0121
Nation	-	0.1538	0.2294	-	0.1533	0.2294
R&D Paradigm Shift	-	0.7850**	0.2667	-	0.7852**	0.2667
Independent variables						
Knowledge Similarity		3.5447**	1.5983		3.5779**	1.6476
Knowledge Similarity Squared	-	2.5529*	1.5094	-	2.5587*	1.5115
Knowledge Digestibility	-	1.8009***	0.7075	-	1.8031***	0.7081
M&A Experience		0.1281***	0.0413		0.1329*	0.072
Knowledge Similarity X M&A Experience				-	0.0117	0.1432
Knowledge Digestibility X M&A Experience	-	0.3805	0.3311	-	0.3781	0.3327
N		212			212	
Log likelihood		-1049.7308			-1049.7274	
Pseudo R^2		0.0258			0.0258	
LR Chi^2		55.70			55.70	
Regression *p*-value		0			0	

Notes: *p < .10; **p < .05; ***p < .01

Third, I changed the measurement of M&A experience to a dummy variable. While the prior measurement represents the extent of M&A experience, the new measurement would simply show whether the acquirer firm has previous M&A experience or not. I found that most of the test results exhibit the same pattern as before. The results are summarized as Type IV test in Table 4-5.

Fourth, I conducted additional sensitivity analysis using combinations of new measurements of knowledge similarity, M&A experience and innovation performance. Interestingly, the results of Type VIII test support Hypothesis 4-4a: the positive moderation effect of M&A experience on the relationship between knowledge similarity and subsequent innovation performance. Thus, in spite of the limitation that a number of tests did not demonstrate significant results on Hypothesis 4-4a, I can argue that the empirical results show support for the existence of a positive moderation effects of M&A experience. Figure 4-2 depicts the moderation effects of M&A experience.

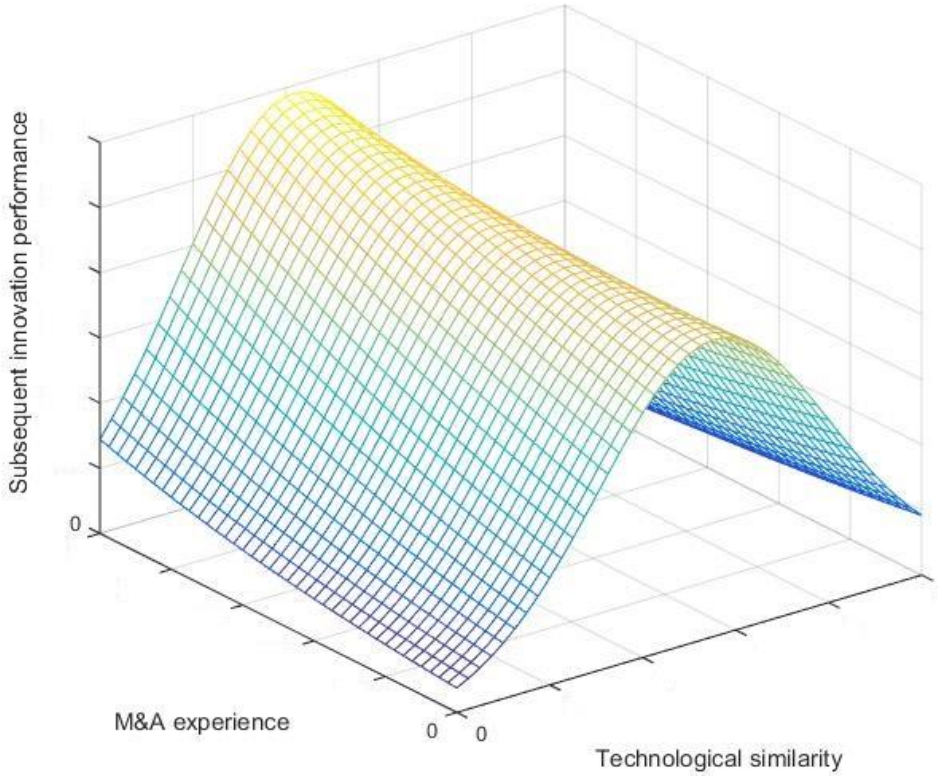

Figure 4-2. Moderating role of M&A experience between knowledge similarity and innovation quantity

Table 4-5 presents the test results of my eight different settings: the setting of the Type I test is same as the setting of Table 4-3, the setting of the Type II test is same as that of Table 4-4 and the setting of the Type III-VII tests, respectively, is changing the measurement of knowledge similarity only, changing the measurement of M&A experience only, changing the testing methodology and the measurement of knowledge

similarity and innovation performance, changing the testing methodology and the measurement of M&A experience and innovation performance, changing the measurement of knowledge similarity and M&A experience, and changing all the measurement and methodology. The exact values of the coefficients of the test results are available on request.

In summary, the results of my empirical study show an inverted U-shape relationship between knowledge similarity and innovation performance. Because a research paper, in general, concludes the support of its hypotheses with one or two tests, the significant results of 4 tests would be an evidence of hypothesis verification. In other words, in spite of the limitation which shows inconsistent results on the inverted U-shape relationship, I can argue that the inverted U-shape relationship in Hypothesis 4-1 is supported because multiple tests show the significant results on the inverted U-shape relationship. Knowledge digestibility is also related significantly to high innovation performance in accordance with the results. Dyadic determinants can be viewed as important elements, since both dyadic characteristics in the research show a strong significance. In addition, the hypothesis on the positive relationship between the M&A experience and subsequent innovation performance is supported. However, the results suggest that the M&A experience as a moderator is mostly not significant.

Table 4-5. Sensitivity analysis results for the variables related to the innovation quantity increase

Test type	Variable name	Model 1	Model 2	Model 3	Model 4	Model 5
[Type I]	Knowledge Similarity		x	x	x	x
➢ Baseline definitions and methodology same as Table 4-3	Knowledge Similarity Squared		x	x	x	x
	Knowledge Digestibility		***	***	**	*
	M&A Experience		***	**	***	**
	Knowledge Similarity X M&A Experience			x		x
	Knowledge Digestibility X M&A Experience				x	x
[Type II]	Knowledge Similarity		**	**	**	**
➢ Innovation performance: the number of patents	Knowledge Similarity Squared		*	*	*	*
	Knowledge Digestibility		***	***	***	***
➢ Negative binomial regression	M&A Experience		***	**	***	*
	Knowledge Similarity X M&A Experience			x		x
	Knowledge Digestibility X M&A Experience				x	x

Table 4-5. Sensitivity analysis results for the variables related to the innovation quantity increase (Continued)

Test type	Variable name	Model 1	Model 2	Model 3	Model 4	Model 5
[Type III]	Knowledge Similarity		**	**	**	**
➢ Knowledge similarity:	Knowledge Similarity Squared		x	x	x	x
➢ the number of overlapped patent class	Knowledge Digestibility		***	***	**	**
➢ No methodology change	M&A Experience		***	**	***	**
	Knowledge Similarity X M&A Experience			x		x
	Knowledge Digestibility X M&A Experience				x	x
[Type IV]	Knowledge Similarity		x	x	x	x
➢ M&A experience:	Knowledge Similarity Squared		x	x	x	x
M&A experience dummy	Knowledge Digestibility		***	***	***	***
➢ No methodology change	M&A Experience		**	x	*	x
	Knowledge Similarity X M&A Experience			x		x
	Knowledge Digestibility X M&A Experience				x	x

Table 4-5. Sensitivity analysis results for the variables related to the innovation quantity increase (Continued)

Test type	Variable name	Model 1	Model 2	Model 3	Model 4	Model 5
[Type V]	Knowledge Similarity		***	***	***	***
➢ Knowledge similarity:	Knowledge Similarity Squared		***	**	**	**
the number of overlapped patent class	Knowledge Digestibility		***	***	***	***
➢ Innovation performance:	M&A Experience		***	**	***	**
the number of patents	Knowledge Similarity X M&A Experience			x		x
➢ Negative binomial regression	Knowledge Digestibility X M&A Experience				x	x
[Type VI]	Knowledge Similarity		**	**	**	**
➢ M&A experience:	Knowledge Similarity Squared		*	*	*	*
M&A experience dummy	Knowledge Digestibility		***	***	***	***
➢ Innovation performance:	M&A Experience		***	x	**	x
the number of patents	Knowledge Similarity X M&A Experience			x		x
➢ Negative binomial regression	Knowledge Digestibility X M&A Experience				x	x

Table 4-5. Sensitivity analysis results for the variables related to the innovation quantity increase (Continued)

Test type	Variable name	Model 1	Model 2	Model 3	Model 4	Model 5
[Type VII]	Knowledge Similarity		**	**	**	**
➢ Knowledge similarity:	Knowledge Similarity Squared		x	x	x	x
the number of overlapped patent class	Knowledge Digestibility		***	***	***	***
➢ M&A experience:	M&A Experience		**	*	*	x
M&A experience dummy	Knowledge Similarity X M&A Experience			x		x
➢ No methodology change	Knowledge Digestibility X M&A Experience				x	x
[Type VIII]	Knowledge Similarity		***	***	***	***
➢ Knowledge similarity:	Knowledge Similarity Squared		***	***	***	**
the number of overlapped patent class	Knowledge Digestibility		***	***	***	***
➢ M&A experience:	M&A Experience		***	***	***	***
M&A experience dummy	Knowledge Similarity X M&A Experience			x		*
➢ Innovation performance: the number of patents	Knowledge Digestibility X M&A Experience				x	x
➢ Negative binomial regression						

Notes: For the readability, we reported the test result with only *(star) and did not include the test results of control variables. Marked *, ** and *** show the significance level of *p < .10, **p < .05 and ***p < .01 and the support of the suggested direction in hypotheses. Marked 'X' means no significant result. The definition of Model 1-5 follows the definition of Model 1-5 in Table 4-3.

4.5. Discussion

Since the 1990's, the number of technological M&A has substantially increased (Cassiman & Colombo, 2006). Firms, especially those in technologically advanced industries, have recently conducted numerous M&As to profit from the resulting technology acquisition and absorption (Bower, 2001). However, relatively insufficient academic attention has been given to technological M&A (Bauer & Matzler, 2014; Bena & Li, 2014; Datta & Roumani, 2015; Lodh & Battaggion, 2014; Rossi et al., 2013; Valentini, 2012; Wagner, 2011). Therefore, I examine factors that affect subsequent technological M&A innovation performance to help fill this research gap.

My findings provide managerial implications to those considering technological M&As. First, the empirical results confirm that the similar knowledge between the acquirer and target firm has both an advantage and a disadvantage on post-M&A innovation performance. In terms of the acquisition process part of absorptive capacity, an increase in knowledge similarity reduces the quantity of acquired new knowledge and gives rise to a decrease in post-M&A innovation. However, in terms of the assimilation, transformation and exploitation processes of absorptive capacity, a similar technological base provides a similar language and recognition structure which help the absorption and integration of the acquired knowledge. Therefore, the acquirer firm needs to select a M&A target which is similar enough to learn from each other, but dissimilar enough to provide new knowledge to generate new innovation.

Second, I identify the positive effects of acquiring small firms on post-M&A innovation performance. The significant effect of knowledge digestibility found in my study shows the advantage of acquiring small firms. Moreover, using the concept of knowledge digestibility, my research explains the tendency of large firms conducting technological M&As to acquire technologies of smaller firms.

Third, the positive role of the M&A experience in contributing to the creation of innovation has been identified. Acquiring small, but innovative firms not only provides technological knowledge for generating innovation but also managerial knowledge which helps to reduce conflicts and better acquire knowledge during future M&A transactions, which becomes even more important witnessing the current wave of M&As, which is mainly driven by technological M&As.

Fourth, my finding reveals that the acquisition-specific capability through accumulated M&A experience has not only direct effects but also indirect effects on post-M&A innovation. Although only one test demonstrated the supporting result of the moderation effect of M&A experience, my finding suggests that it is important for firms to keep conducting technological M&As to fully utilize the positive effects of determinants, such as knowledge similarity and knowledge digestibility, on innovation performance in the next technological M&A.

Chapter 5. Increasing innovation diversity through M&A target selection

5.1. Introduction

In today's technology and knowledge-intensive industries, fierce competition, short technology life cycles and fast changing technological paradigms increase the importance of a firm's innovation diversity (Arrow, 1962; Nelson & Winter, 1982; Schumpeter, 1942). The inherent uncertainty of such an environment makes it difficult for firms to predict future trends and, to stay competitive, forces them to generate innovation in diverse fields, i.e. increase their innovation diversity. However, increasing the innovation diversity of firms by innovating in new and unfamiliar fields is a difficult task. First, due to limited resources and capabilities, it is difficult for firms to increase innovation diversity by only relying on internal R&D (Henderson, 1993; Tushman & Anderson, 1986). Second, organizational routines can give rise to a "myopia of learning" (Levinthal & March, 1993) and can result in firms falling into a "competency trap" (Levitt & March, 1988) which makes it harder to move beyond the boundary of their existing knowledge and diversify. To obtain new knowledge, overcome the limitations of internal R&D activities and ultimately increase their innovation diversity, firms increasingly utilize external technology sourcing.

As one of several external technology sourcing modes, technological M&As are primarily seen as a tool for obtaining new knowledge that is unrelated to the firm's current knowledge (Stettner & Lavie, 2014; Vermeulen & Barkema, 2001). Compared to corporate venture capital (CVC) and alliances, acquisitions allow unrestricted and direct access to the target firm's resources and capabilities. Accordingly, more than any other external technology sourcing mode, technological M&As are a suitable choice for firms aiming to increase their innovation diversity. Nevertheless, prior research on technological M&As focus only on investigating the effect of technological M&As on the quantity of innovation such as patenting frequency (Ahuja & Katila, 2001; Cloodt et al., 2006; Hagedoorn & Cloodt, 2003; Puranam & Srikanth, 2007), the number of products launched (Puranam et al., 2006), and change in patenting activity (Ernst & Vitt, 2000) or the quality of innovation (Buss, 2012; Valentini, 2012). This study examines how technological M&As affect the subsequent innovation diversity of the acquirer firm.

The acquirer firm's knowledge base is expanded and changed through the combination with the acquired knowledge base. Because the knowledge base of a firm is an important factor in innovation creation (Hill & Rothaermel, 2003), this new knowledge base of the acquirer firm has effects on the firm's subsequent innovation. Therefore, the characteristics of the target firm's knowledge base should be examined to understand the diverse dimensions of post-M&A innovation performance. Recognizing this, more than half of the existing research on technological M&As investigate the effect of the relatedness of the acquired and acquiring knowledge bases and the absolute size

and relative size of the acquired knowledge base on post-M&A innovation quantity and quality (Hitt et al., 2009). The knowledge relatedness enables us to investigate the effects of the overlap of knowledge contents and the absolute and relative size of the acquired knowledge base help us to investigate the effects of the absolute and relative magnitude of knowledge contents. The objective of this study is to examine the effects of those three factors, i.e., relatedness of the acquired and acquiring knowledge bases and the absolute size and relative size of the acquired knowledge base, on post-M&A innovation diversity.

The results of this research present two findings on the effects of the knowledge base size on innovation diversity. First, the absolute size of the acquired knowledge base positively influences the post-M&A innovation diversity. The acquired knowledge increases the possibility of recombination between the existing and new knowledge and contributes to increase the innovation diversity. Second, the relative size of the acquired knowledge base also has positive effects on innovation diversity. Prior literature states that the quantity of innovation decreases as the relative size of knowledge base increases because it disrupts the organization routines of the acquirer firm (Ahuja & Katila, 2001; Cloodt et al., 2006). Contrary to this, in terms of innovation diversity, the disruption of existing organizational routine helps the firm to pursue new ways of innovation creation and extend their organizational boundary. In turn, the innovation diversity increases as the magnitude of newly acquired knowledge increases.

This study advances the understanding of technological M&As in several ways. First, this research emphasizes the importance of innovation diversity as a measure for the

success of technological M&As. Examining the post-M&A innovation diversity is meaningful because firms pursue technological M&As to expand their technological boundary and increase innovation diversity. In addition, the stream of recent research on technological M&A emphasizes the importance of investigating the diverse dimensions of innovation performance (Cording, Christmann, & King, 2008; King, Slotegraaf, & Kesner, 2008; Schoenberg, 2006; Zollo & Meier, 2008). Second, the study uncovers factors that increase post-M&A innovation diversity. This helps firms to identify suitable target firms when pursuing technological M&As with the goal of increasing innovation diversity. Third, my findings enable a holistic approach toward technological M&As. By adopting concepts and variables found in previous literature and investigating their effects on a new dimension of innovation performance, this study links well with previous research and contributes to a better understanding of the effects of knowledge base characteristics on post-M&A innovation performance.

This paper is structured as follows. In the first section, I present the theoretical framework of how knowledge base size and knowledge relatedness affect post-M&A innovation diversity and develop my hypotheses. In the second section, I introduce the dataset and the research methodology. I then present my empirical results and conclude with a discussion of implications, contributions, and limitations.

5.2. Research hypotheses

5.2.1. The size of the knowledge base

The integration of the target firm's knowledge changes the knowledge base of the acquirer firm. As this process is affected by the amount of knowledge to be integrated, the size of the acquired knowledge base has an influence on post-M&A activities and performance. In the context of technological M&A research, size, both absolute and relative, refers to the amount of knowledge in the acquired knowledge base which the acquirer firm did not possess prior to the M&A deal (Ahuja & Katila, 2001; Cloodt et al., 2006). This is because the overlapped knowledge which already known by the acquirer firm, does not correspond to the purpose of technological M&A, obtaining new knowledge.

Previous literature has both considered the absolute and relative size of the knowledge base. The absolute size of the acquired knowledge base is defined as the absolute quantity of the target firm's knowledge which is new to the acquirer firm. The relative size of the acquired knowledge base is the ratio between the absolute size of the acquired knowledge and the quantity of the acquirer firm's pre-M&A knowledge.

The absolute size of the knowledge base has effects on the post-M&A innovation diversity for two main reasons: First, it provides new knowledge to the acquirer firm and enables innovation creation in that fields (Ghoshal, 1987; Hitt et al., 1996). The boundary of a firm's knowledge base determines the boundary of a firm's

innovation (Hill & Rothaermel, 2003). In other words, innovation diversity increases when a firm has knowledge in diverse fields. According to Empson (2001), knowledge creation in a new field through internal R&D requires a large amount of resources and capabilities, but this huge investment does not guarantee knowledge creation success. By contrast, technological M&As enable a firm to obtain immediate control of knowledge that is completely different from its internal knowledge (Harrison, Hitt, Hoskisson, & Ireland, 1991; Kim & Finkelstein, 2009). The newly acquired knowledge readily increases the diversity of the knowledge base of the acquirer firm which in turn increases the potential for new innovation (Tushman & Rosenkopf, 1992). In addition, firms possessing diverse knowledge are capable of creating novel ideas and new combinations of knowledge and detecting new technological opportunities. As a results, they are able to create innovation in diverse fields (Taylor & Greve, 2006).

Second, as the absolute size of the acquired knowledge base increases, recombination activities are facilitated (Fleming, 2001; Katila & Ahuja, 2002). As knowledge sharing occurs between the acquirer and target firm through technological M&As, a 'kaleidoscopic thinking' is invoked and the knowledge bases of the two firms are intertwined (Kanter, 2000). When the absolute size of the acquired knowledge base is large, these effects occur more frequently. Also, an increased diversity of the post-M&A knowledge base increases the possibility of knowledge spillover between different technological areas (Fauconnier & Turner, 1999; Henderson & Cockburn, 1996). In turn, the probability of recombination increases as a firm has knowledge in diverse fields. In

addition, Carnabuci and Operti (2013), which examines the source of firms' recombination capabilities, discovers that firms tend to create innovation by recombination rather than utilize the existing set of knowledge when the knowledge in firms is diversified. Thus, the increase in the absolute size of the acquired knowledge base leads to the creation of new knowledge combinations and ultimately increases the firms' innovation diversity.

In conclusion, the absolute size of the knowledge base has positive effects on post-M&A innovation diversity by providing new-to-the-firm knowledge and fostering innovation through recombination. Hence, I predict that:

Hypothesis 5-1. The greater the absolute size of the acquired knowledge base, the greater the post-M&A innovation diversity of the acquirer firm.

In addition to the absolute size of the knowledge base, also the relative size of the acquired knowledge base affects innovation diversity through the following mechanisms: First, the acquirers' existing routines to create innovation considerably change when the relative size of the acquired knowledge base is large (Ahuja & Katila, 2001). Firms build a set of routines while they create innovation (Nelson & Winter, 1982). This set of routines creates an internal inertia which leads to firms avoiding to seek novelty and also to them becoming more standardized and specialized (Ahuja & Lampert, 2001; Dosi,

1982). As a result, innovation creation in new fields is impeded and firms are locked in a "competency trap" (Levitt & March, 1988). However, the existing routines of the acquirer firm change when the acquirer firm is exposed to the newly acquired knowledge base and the target firm's organizational routines. This is because exploring new fields of knowledge transforms the problem solving approach of a firm (Fiol & Lyles, 1985; Levinthal & March, 1993). When the relative size of the acquired knowledge base is large, the acquirer firm's exposure to a new set of routines and the possibilities of existing routine change increases. In terms of increasing innovation diversity, such a disruption of the existing routines has positive impacts because it will result in the firm reducing path-dependencies and pursuing a new perspective on innovation which makes it easier to expand the boundaries of the firm's innovation activities.

Second, the relative size of the acquired knowledge base is linked to the absorptive capacity. Zahra and George (2002) divide the absorptive capacity into four components: acquisition, assimilation, transformation and exploitation. In their model, the transformation process follows the assimilation. Todorova and Durisin (2007) reconfigure the model of Zahra and George (2002) and state that not every knowledge entails both assimilation and transformation processes. According to them, firms assimilate or transform the knowledge in accordance with the knowledge characteristics. Firms transform the knowledge when it comes from a new and unfamiliar field. The transformation process helps firms to understand the knowledge, which is new and incompatible with its current knowledge base, through a process of bisociation and

“developing new perceptual schema or changes to existing process” (Koestler, 1964; Zahra & George, 2002). On the other hand, firms assimilate knowledge which is from a similar field. The assimilation process utilizes the existing cognitive structure to understand compatible knowledge. Accordingly, it maintains the existing way of absorbing and exploiting knowledge. When the relative size of the acquired knowledge base is big, the acquirer firm needs to increase its focus on the transformation process. Through this transformation process, firms increase their innovation diversity because they develop new schema and changes to the existing innovation process.

In conclusion, the relative size of knowledge base has positive effects on innovation diversity through the change of the existing routines and utilization of the transformative component of absorptive capacity. Hence, I predict that:

Hypothesis 5-2. The greater the relative size of the acquired knowledge base, the greater the post-M&A innovation diversity of the acquirer firm.

5.2.2. The relatedness of the acquired and acquiring knowledge bases

While the size of knowledge base shows the impacts of the quantity of a target firm’s knowledge contents, the relatedness of the acquired and acquiring knowledge bases explains the effects of the overlap in knowledge contents. This is another important factor

to consider because the knowledge base of the acquirer and target firm are combined through technological M&As. Also, according to Bena and Li (2014), acquirer firms tend to acquire firms with related technologies, so it is important to examine whether the knowledge relatedness has positive effects or negative effects on subsequent innovation performance. Accordingly, prior research on technological M&As investigates the relationship between the knowledge relatedness and the quantity of innovation (Cassiman et al., 2005; Cloodt et al., 2006; Hagedoorn and Duysters, 2002). According to them, while a high knowledge relatedness has positive effects on the quantity of innovation in terms of utilizing the absorptive capacity of the acquirer firm, it reduces the opportunities for learning and the incentives for exploring diverse technological fields (Cassiman et al., 2005; Hitt et al., 1996).

The effect of the knowledge relatedness on innovation diversity is similar to that on the quantitative innovation performance. As the knowledge relatedness increases, the possibilities of learning knowledge in a new field decreases because the target firm already possesses similar knowledge as the acquirer firm (Ghoshal, 1987; Hitt et al., 1996). A study of Lodh and Battaggion (2014), which examines the effects of technological M&As on the post-M&A knowledge base of the acquirer firm, elucidates that the depth of the knowledge base increases when the knowledge base of the acquirer and target firm are highly related and the breadth of the knowledge base increases when the knowledge bases of two firms are unrelated. Accordingly, as the knowledge relatedness increases, the acquirer firm misses insights and technologies, and fails to

increase the diversity of post-M&A innovation.

In terms of recombination, an increase in the knowledge relatedness also negatively influences innovation diversity. To increase innovation diversity, recombination between the existing and new knowledge is necessary. However, an increase in the knowledge relatedness implies that the quantity of similar knowledge increases between the acquirer and target firm's knowledge base so it leads to decrease in knowledge recombination. In other words, the possible recombinations are rapidly exhausted. A study of Almeida and Phene (2004) states that cross-fertilization of ideas between knowledge bases is possible when firms possess knowledge in diverse fields. In addition, Carnabuci and Operti (2013) comment that when the knowledge bases are similar to each other, firms tend to create innovation by reusing the existing knowledge rather than by recombining the existing knowledge and new knowledge.

Firms are apt to learn within the existing knowledge boundary when the knowledge relatedness increases and this reinforces the organizational routines. An increase in the knowledge relatedness encourages the exploitation of areas in which the firm already has a prior knowledge (Nonaka, Takeuchi, & Umemoto, 1996). The path dependency arisen from this routine makes firms focus on the combination and recombination of the existing knowledge base and contributes to generate innovation in a certain field. However, it does not contribute to creating innovation in new fields and does not increase the innovation diversity.

In terms of absorptive capacity, a high knowledge relatedness negatively

influences innovation diversity as well. As the knowledge relatedness increases, the acquirer firm utilizes the “assimilation” component of absorptive capacity based on the better understanding of the existing knowledge. In other words, firms use “assimilation” rather than “transformation” when the target firm has a related knowledge base (Todorova & Durisin, 2007; Zahra & George, 2002). On the contrary, the acquirer firm absorbs the new knowledge through transformation as the knowledge relatedness decreases (Todorova & Durisin, 2007). Thus, the propensity to exploit the existing knowledge is reinforced as the knowledge relatedness increases. In turn, firms focus on generating innovation in their familiar field rather than on creating innovation in new fields.

In conclusion, as the knowledge relatedness increases, firms face difficulties to utilize the new knowledge for diverse innovation and are obsessed with the reinforcement of their existing fields. Thus, a high knowledge relatedness has negative effects on post-M&A innovation diversity. This leads to the following hypothesis.

Hypothesis 5-3. The greater the relatedness of the acquired and acquiring knowledge bases, the lower the post-M&A innovation diversity of the acquirer firm.

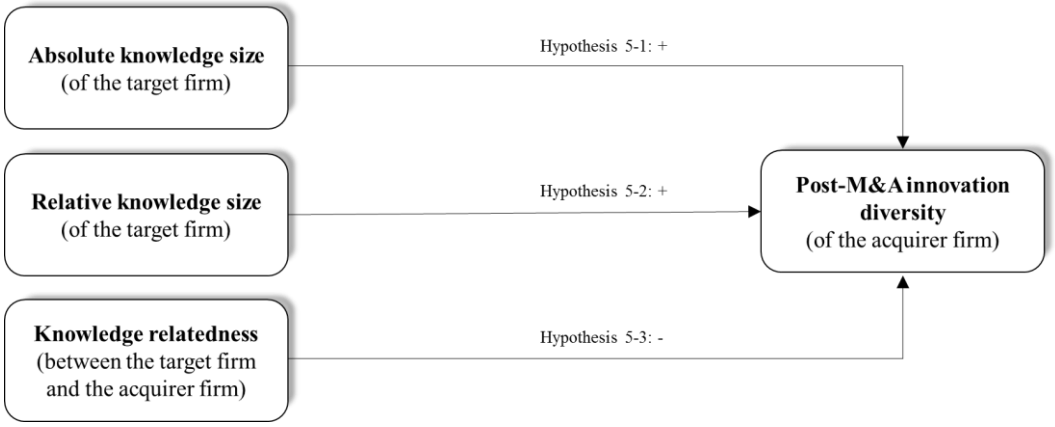

Figure 5-1. Conceptual model for Chapter 5

5.3. Methodology

5.3.1. Data and sample

To test the hypotheses, I compiled a dataset of M&A transactions from 2001 to 2007 in the biopharmaceutical industry. The biopharmaceutical industry is particularly suitable to examine technological M&As and innovation diversity. First, a significant value of M&A transactions is realized in this industry. Firms in the biopharmaceutical industry invest large amounts of resources to develop novel technology. However, it is difficult to keep up with the high technological uncertainty and fast changing circumstances by relying only on internal R&D. Accordingly, firms tend to acquire new and unfamiliar technologies from outside the firm. Second, firms in the biopharmaceutical industry have protected their innovations through patents (Higgins & Rodriguez, 2006; Puranam &

Srikanth, 2007), allowing the use of patent-based indicators for innovation outcomes. For these reasons, many research on technological M&As investigates M&A transactions in the biopharmaceutical industry (e.g. Cloodt et al., 2006; Ornaghi, 2009; Valentini, 2012).

The dataset was constructed from several sources. First, information on M&As was obtained from the SDC Platinum's Mergers and Acquisitions database. Collected M&A transactions are transactions in the biopharmaceutical industry from 2001 to 2007. After that, I excluded transactions which are categorized as "acquisition of remaining interest" because the purpose of those transactions is to strengthen corporate governance, not access the target firm's new knowledge. Second, I obtained information on the acquirer and target firms' patent activities from the United States Patent and Trademark Office (USPTO). This study uses patent information to describe the knowledge base characteristics of the acquirer and target firm as well as for measuring the post-M&A innovation diversity. Additionally, the patent data is used to categorize M&As as technological or non-technological. According to Ahuja and Katila (2001) and Wagner (2011), non-technological M&As do not affect post-M&A innovation performance. Accordingly, I have excluded all non-technological M&A transactions. Third, financial information on the acquirer firm was obtained from the Datastream database. In total, the final pooled cross-sectional dataset contains 308 M&A transactions of 138 acquirer firms.

5.3.2. Dependent variable

To accurately measure the dependent variable, this study considers two key factors: type and unit of analysis. First, the type of diversity measurement should be taken into account. The concept of diversity originates from the field of biology. In biology, the measurement of diversity is categorized into the phenotypic diversity and genotypic diversity (Morrison & De Jong, 2002). Phenotype is an observed property such as bloodtype while the genotype is the actual hereditary information of an observed property. In a similar vein, in the innovation literature, the phenotype and genotype can be categorized as its observed properties and its based technology class. This study measures the genotypic diversity to identify the actual distribution of a firm's innovation. Second, the unit of analysis should be selected in accordance with the research interest. There are a diverse measurement of diversity according to the unit of analysis: individual-level (e.g. Huang & Chen, 2010; Schildt et al., 2012), dyad-level (e.g. Jaffe, 1986; Sampson, 2007) and network-level (e.g. Phelps, 2010). Because this study examines the acquirer firm's post-M&A innovation diversity, the individual-level of measurement should be adopted. The extant literature has measured the individual-level of diversity as the number of criteria (e.g. patent class) possessed by an individual, generalized variance and entropy. The first method is simple but has the advantage of showing the absolute size of diversity. For this reason, a large number of previous literature has adopted this measurement (e.g. Kotha et al., 2011; Zhang et al., 2007). The second and third measurement gauges the diversity as a form of

distribution. The method of generalized variance, in particular, has been adopted in a diverse field of research such as linguistics (Bachi, 1955), sociology (Blau, 1977), finance (Hirschman, 1964), and biology (Simpson, 1949). Moreover, this measurement has a normalized range while the method of entropy does not (Acar & Sankaran, 1999). Accordingly, this study adopts the method of generalized variance, often referred to as the Hirschman-Herfindahl index (HHI), to measure the dependent variable.

In conclusion, the dependent variable, innovation diversity, is defined as the change in innovation diversity of the acquirer firm prior and post-M&A. This study utilizes patent data to measure innovation diversity because the patents held by a firm are a well-known proxy for its technological capabilities and innovation performance (Ahuja, 2000; Griliches, 1998; Rothaermel & Alexandre, 2009). Further, each patent has assigned patent classes, allowing us to identify the diversity of technology and innovation (e.g. Kotha et al., 2011; Wadhwa & Kotha, 2006; Wu & Shanley, 2009).

As aforementioned, the pre-M&A and post-M&A innovation diversity is computed using the Hirschman-Herfindahl index (HHI) (e.g. Argyres & Silverman, 2004; B.-W. Lin, 2011; Schildt et al., 2012; J. Singh, 2008; Wu & Shanley, 2009). Among the innovation researcher, the HHI index is frequently used to approximate the diversity and more suitable than entropy measurement because of its measurement accuracy (Acar & Sankaran, 1999). The calculation is based on the patenting activities of the acquirer firm 2-5 years after the M&A deal (post-M&A diversity) and the period 5-1 years before the M&A deal (pre-M&A diversity). Specifically, this study used the following formula to

measure innovation diversity:

$$\text{Innovation diversity} = (1 - \sum_{p=1}^{q_{t+}} \left(\frac{C_{pt+}}{N_{t+}}\right)^2) \Big/ (1 - \sum_{p=1}^{q_{t-}} \left(\frac{C_{pt-}}{N_{t-}}\right)^2)$$

where N_{t+} is the total number of patents in the acquirer firm i's knowledge base between from year t+2 to year t+5; C_{pt+} is the number of patents that were classified in technological class p from year t+2 to year t+5; and q_{t+} is the total number of 3-digit US patent classes covered by the knowledge base in year t+2 to year t+5; N_{t-} is the total number of patents in the acquirer firm i's knowledge base from year t-5 to year t-1; C_{pt-} is the number of patents that were classified in technological class p in M&A from year t-5 to year t-1; and q_{t-} is the total number of 3-digit US patent classes covered by the knowledge base from year t-5 to year t-1.

The 4-year period after the M&A deal and a 5-period before the M&A deal has been chosen as most patents lose their technological value within 5 years (van de Vrande et al., 2009). Also, patents, on average, have two year grant lag. Thus, patents granted to the firm in the first two years after the technological M&A cannot be considered to be a result of the target firm's knowledge.

5.3.3. Independent variables

Independent variables of my research are the absolute size of the acquired knowledge base and relative size of the acquired knowledge base as well as relatedness of the knowledge bases. I defined each of these variables as follows:

To measure the absolute size of the acquired knowledge base and relative size of the acquired knowledge base, I analyzed the patent classes of all granted patents applied by the acquirer and target firms from t-5 to t-1. First, I divided the acquired knowledge base into the overlapped knowledge and the non-overlapped knowledge. The USPTO classifies the patent into a patent class system according to the technical features with patents in the same patents class sharing similar technological characteristics and showing an overlap of the knowledge (Makri et al., 2010; Sampson, 2007). Hence, prior research adopts the patent class as the criterion of knowledge overlap: patents within the same class are overlapped (Carayannopoulos & Auster, 2010). The non-overlapped knowledge is considered as knowledge which is new to the acquirer firm and the absolute size of the acquired knowledge base is measured as the number of the non-overlapped patents (Ahuja & Katila, 2001; Cloodt et al., 2006). Accordingly, as the value of the absolute size of the acquired knowledge base increases, the quantity of new knowledge provided by target firm increases. The relative size of the acquired knowledge base is measured by dividing the absolute size of the acquired knowledge base by the number of patents of the acquirer firm (Ahuja & Katila, 2001; Cloodt et al., 2006).

The relatedness of the knowledge bases was also measured using patent class data. To construct this measurement, I followed the approach of Cloodt et al. (2006). The basic idea of this approach is that the number of patents with same patent classes between acquirer firm and target firm is highly related with knowledge relatedness between two firms. Accordingly, I counted the number of overlapped patents. After that, following Ahuja and Katila (2001), I divided these patents by the absolute size of the acquired knowledge base.

5.3.4. Control variables

Six control variables were included to account for possible additional effects on the change of innovation diversity resulting from the technological M&A and to increase the reliability of the test results. First, I controlled for firm size and R&D intensity of the acquirer firm. As they are known to affect the capabilities of the firm to perform internal R&D, they might have effects on the post-M&A innovation performance. Each variable was measured by the natural log of the sum of sales and R&D expenditure in the 5 years preceding the M&A deal. Second, I controlled for the characteristics of the M&A deal such as overseas M&A and M&A deal type. Additionally, target innovation diversity and the existing knowledge stock of the acquirer firm were controlled.

5.3.5. Empirical model specification

The dependent variable in the regression model is non-negative, since the variable is the ratio of innovation diversities which both take a value between 0 and 1. It is known that the use of ordinary least square (OLS) models results in inconsistent estimates when the dependent variable is non-negative. According to Amemiya (1984), the standard Tobit model (Type 1 Tobit) is adequate for such a non-negative dependent variable. I therefore analyzed my hypotheses using a Tobit regression model (Greene, 2003).

5.4. Results

5.4.1. Descriptive statistics

Table 5-1 reports the descriptive statistics for the variables used in the analysis. The correlation matrix of the variables is presented in Table 5-2. Most of the variables exhibit low correlations, except firm size with R&D expenditure, and absolute size of the acquired knowledge base with relative size of the acquired knowledge base. Not surprisingly, large firms expend more money on R&D and an increase of the absolute size of the acquired knowledge base gives rise to an increase of the relative size of the target firm’s knowledge base.

Table 5-1. Descriptive statistics of the variables related to the innovation diversity increase

Variables	N	Mean	Std. Dev
Knowledge stock	308	520.5909	1337.319
R&D intensity	308	11.7168	2.5286
Firm size	308	8.5594	2.3846
Overseas M&A	308	0.1136	0.3178
M&A type	308	5.4675	1.2008
Target innovation diversity	308	0.5632	0.2821
Absolute size of the acquired knowledge base	308	5.9220	30.7880
Relative size of the acquired knowledge base	308	0.4705	3.0817
Relatedness of the knowledge bases	308	3.2335	15.3338
Innovation diversity	308	1.3656	2.5562

Table 5-2. Correlation matrix of the variables related to the innovation diversity increase

Variables	1	2	3	4	5	6	7	8	9	10
Knowledge stock	1									
R&D intensity	0.444	1								
Firm size	0.456	0.751	1							
Overseas M&A	-0.075	-0.010	-0.059	1						
M&A type	0.001	0.080	0.071	0.014	1					
Target innovation diversity	0.219	0.320	0.274	-0.081	0.065	1				
Absolute size of the acquired knowledge base	-0.019	0.148	0.139	0.037	0.014	0.162	1			
Relative size of the acquired knowledge base	-0.059	-0.018	0.005	0.047	0.101	0.094	0.586	1		
Relatedness of the knowledge bases	0.465	0.188	0.200	0.034	-0.027	-0.200	-0.034	-0.029	1	
Innovation diversity	-0.053	-0.049	-0.016	0.020	0.059	-0.160	0.307	0.420	-0.028	1

However, the high correlation between some of the variables might result in a multicollinearity problem. To alleviate concerns about multicollinearity, I computed the variance inflation factors (VIFs) for all variables in the full model. Table 5-3 presents the VIF test results. The mean VIFs of the full models are 1.63, and also the VIF of each variable is well below the standard cut off point of 10 (Myers, 1990; Neter, Kutner, Nachtsheim, & Wasserman, 1996). Thus, it confirms that there is no multicollinearity problem with the data.

Table 5-3. VIF test results of the variables related to the innovation diversity increase

Variable	VIF	1/VIF
R&D intensity	2.49	0.4018
Firm size	2.42	0.4132
Knowledge stock	1.72	0.5820
Absolute size of the acquired knowledge base	1.62	0.6163
Relative size of the acquired knowledge base	1.58	0.6317
Relatedness of the knowledge bases	1.47	0.6799
Target innovation diversity	1.32	0.7579
M&A type	1.03	0.9732
Overseas M&A	1.02	0.9778
Mean VIF	1.63	

5.4.2. Analysis results

The results of the Tobit regressions are presented in Table 5-4. Model 1 is the baseline

model and includes all the control variables. To test my hypotheses, Models 2 to 4 introduce absolute size of the acquired knowledge base, relative size of the acquired knowledge base, and relatedness of the acquired and acquiring knowledge bases, respectively.

Hypothesis 5-1 predicted that the absolute size of the target firm's knowledge base is positively related with the innovation diversity of the acquirer firm. The absolute size of the acquired knowledge base was consistently positive and significant at the .01 (or higher) confidence level in Models 2 to 4. Thus, the results support Hypothesis 5-1 – The greater the absolute size of the acquired knowledge base, the greater the post-M&A innovation diversity of the acquirer firm.

Hypothesis 5-2 predicted that the relative size of the acquired knowledge base is positively related with the innovation diversity of the acquirer firm. From Models 3 and 4 in Table 5-4, I find a positive and significant ($p<.01$) coefficient for relative size of the acquired knowledge base, supporting Hypothesis 5-2.

In Hypothesis 5-3, I argued that the high relatedness of the acquired and acquiring knowledge bases is negatively related with the innovation diversity of the acquirer firm. In Model 4 of Table 5-4, I find a negative but not significant coefficient for the relatedness of the acquired and acquiring knowledge bases. In summary, Hypotheses 5-1 and 5-2 were supported while Hypothesis 5-3 did not show a statistical significant result. These findings confirm that an increase of the size of the acquired knowledge base relates well to an increase of the acquirer firm's innovation diversity.

Table 5-4. Tobit regression results for the variables related to the innovation diversity increase

Dependent variable:	Model 1		Model 2		Model 3		Model 4	
Innovation Diversity	Coefficient	S.E.	Coefficient	S.E.	Coefficient	S.E.	Coefficient	S.E.
Control variables								
Knowledge Stock	-0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
R&D intensity	0.023	0.101	-0.014	0.095	0.032	0.091	0.036	0.091
Firm Size	0.087	0.107	0.048	0.101	0.047	0.096	0.048	0.095
Overseas M&A	0.175	0.515	0.037	0.485	-0.045	0.461	-0.017	0.460
M&A type	0.169	0.137	0.174	0.129	0.091	0.123	0.088	0.123
Target innovation diversity	-0.832	0.622	-1.340**	0.589	-1.497***	0.561	-1.729***	0.599
Independent variables								
Absolute size of the acquired knowledge base			0.028***	0.005	0.011*	0.006	0.011*	0.006
Relative size of the acquired knowledge base					0.306***	0.058	0.308***	0.058
Relatedness of the knowledge bases							-0.012	0.011
N	308		308		308		308	
Log likelihood	-685.454		-670.397		-657.349		-656.788	
Chi-square	4.76		34.87		60.97		62.09	
Pseudo R^2	0.003		0.025		0.044		0.045	

Notes: *p < .10; **p < .05; ***p < .01

5.4.3. Sensitivity analysis

Three robustness checks were performed to ensure validity of the results: First, I addressed limitations of the employed Tobit regression model. Existing research using limited dependent variables (LDV) methods such as Tobit, Logit or Probit has problems in interpreting the estimated coefficients. According to Hoetker (2007), 64.9% of the research offer no interpretation of the independent variables' effect and 16%, which is the half of the remaining 35.1%, only offer an incomplete or incorrect interpretation of the magnitude of the independent variables' effect. To analyze and interpret the results correctly, a supplementary analysis that examines the value and significance of the independent variable's marginal effect is required (Bowen, 2010, 2012; Wiersema & Bowen, 2009). I re-examined the marginal effect of my independent variables following Bowen (2012), Bowen (2010) and Wiersema and Bowen (2009). Table 5-5 provides the marginal effect of each independent variables in the full model. The re-examined results are the same as the results reported in Table 5-4, but the values of the effects are somewhat lower. However, it is important to note that the reported findings in Table 5-4 still provide a statistically significant and valuable information on the direction of the effects, which is the most important aspect of hypotheses testing (Hoetker, 2007).

Table 5-5. Marginal effect values for Tobit regression results

Dependent variable	Coefficient	Marginal effect value
Absolute size of the acquirer firm's knowledge base	0.011*	0.005*
Relative size of the acquirer firm's knowledge base	0.308***	0.146***
Relatedness of the acquired and acquiring knowledge bases	-0.012	-0.006
Constant	0.589	
Log-likelihood	-656.788	
Chi-square	62.09	
Pseudo R-square	0.045	

Notes: *p < 0.10; **p < 0.05; ***p < 0.01

Second, although a Tobit model is recommended over OLS estimates for a dataset with non-negative samples (Gujarati, 2010), OLS may be used for confirming the results. The recent research of Wadhwa and Basu (2013) and Weigelt and Miller (2013) also use Tobit regression models and additionally use the OLS model to check robustness. It is known that OLS regression results converge to Tobit estimates when the number of zeros in the dependent variable is small (Wilson & Tisdell, 2002). Definitions of an acceptable cutoff point are analytically elusive, however research stated that until the percentages of zeros is less than 25% of the total number of observations, there is no noticeable difference in the estimates. Because my dependent variable contains only 13.9% of zeros, OLS models are deployed to ensure the robustness of my findings. The corresponding results of OLS regression (available from the authors upon request) are

fully consistent with the Tobit analysis and further confirm the validity of this study's results.

Third, based on prior research (e.g. Kotha et al., 2011; Zhang et al., 2007; Zhang & Baden-Fuller, 2010), I used the number of patent classes to construct measures of the dependent variable. Innovation diversity is frequently measured as either the number of patent classes or using the Herfindahl-Hirschman Index. The test results (available on request) are the same as those presented in Table 5-4 and Table 5-5 and confirm my results.

5.5. Discussion

Shrinking product pipelines and patent cliffs force firms in the biopharmaceutical industry to pursue technological M&As at an increasing rate. Through technological M&As, firms can obtain new and diverse knowledge and diversify their technology portfolios. This helps firms reduce risks, create profits from diverse technological fields, and generate innovations which could not have been created by only using its internal resources. Technological M&As, especially, have received attention from scholars and practitioners in terms of their role in expanding technological boundaries and creating innovation in new and diverse fields. However, because prior research focused mainly on how much innovation is created through technological M&A (Buss, 2012), little is known

about the relationship between technological M&A and subsequent innovation diversity. In addition, recent research on technological M&As emphasizes the importance of examining diverse dimensions of innovation performance. To my knowledge, this study is the first one to examine post-M&A innovation diversity.

The implications of my results can be summarized as follows: First, the empirical results confirm that post-M&A innovation diversity increases as the absolute size and relative size of the knowledge base increase. In other words, the bigger the magnitude of the newly acquired knowledge, the more diverse innovation is created. This is different to result of previous research on the impact of knowledge base size on the post-M&A quantity of innovation. According to Ahuja and Katila (2001) and Cloodt et al. (2006), the relative size of the acquired knowledge base has a negative relationship with the quantity of innovation because it disrupts the existing routines of the firm. Combining these results with my findings, one can see that acquiring a firm with a large knowledge base has positive effects on innovation diversity, but at the same time negatively affects innovation quantity. Looking for both quantity and diversity, firms can follow the strategy to acquire several modest-sized firms in different technological fields rather than acquire one big firm. Google or Cisco exemplify how firms expand their innovation diversity through multiple acquisitions of smaller firms.

Second, I found no evidence of negative effects of knowledge relatedness. It has been shown that high knowledge relatedness between two firms facilitates fast assimilation and exploitation. Also, it promotes the creation of innovation. However, as

the knowledge relatedness increases, firms tend to focus on innovation in their current fields, not increasing innovation diversity. For this reason, this study assumed that the knowledge relatedness is negatively related to post-M&A innovation diversity. Contrary to my expectations, however, I fail to find statistical evidence for my hypothesis. One reason might be that the negative effect of related knowledge is offset by the positive effect of unrelated knowledge. Prior research on technological M&As states that technological M&As improve innovation performance when knowledge relatedness is similar enough to learn from each other, but different enough to provide new knowledge to generate new innovation. In other words, the knowledge relatedness has both positive and negative effects on innovation performance at the same time. The recent M&A literature review by Hitt et al. (2012) lists a number of prior research showing no relationship between relatedness and various dimensions of innovation because of the above mentioned reason. Nevertheless, the knowledge relatedness between the acquirer and target firm provides a common cognitive base and shared norms, so that it helps both firms to better understand each other. In addition, the negative effect of the non-overlapped part, such as difficulties in absorbing, would be relieved by the positive effects of overlapped part. Therefore, regardless of my results, knowledge relatedness plays a role in the post-M&A integration.

Third, Chapter 5 provides managerial implication on how to increase innovation diversity through conducting technological M&As and how to choose a suitable M&A target. The target selection is the most important M&A process because it determines how

much knowledge is transferred and how much synergies are created between the acquirer and target firm. Lodh and Battagion (2014) state that the acquirer firm must be selective because the selection of a partner primarily transforms the knowledge base of the acquirer firm. Thus, suggesting criteria for the target selection has both academic and practical contributions. My results indicate that a firm needs to select a target with a new and diverse knowledge base and pay attention to the relative size of the acquired knowledge base to adjust the trade-off between the innovation diversity and the innovation quantity.

Chapter 6. Conclusive remarks

6.1. Summary and contributions

In conclusion, this dissertation presents factors to be considered when selecting a proper M&A target for innovation creation and elucidates the relationship between technological M&A and its resulting innovation performance in terms of multiple dimensions. The dissertation provides the following key findings and contributions: First, the dissertation highlights the importance of investigating post-M&A innovation diversity. With increasing technological and market uncertainty, firms have a difficulty in predicting the exact future. Accordingly, it is important for firms to secure innovation capabilities in diverse fields and create diverse options to prepare for future changes in their environment. Firms utilize technological M&As to obtain these innovation capabilities (Desyllas & Hughes, 2008). Thus, the investigation of factors affecting post-M&A innovation diversity is necessary. To my knowledge, this research is the first attempt to fill this research gap. Moreover, to operationalize the concept of innovation diversity accurately, this dissertation draws on the knowledge of heterogeneous fields such as biology or computer science. These efforts establish a foothold for future M&A research. Second, the dissertations identifies that the acquirer firm needs to select the primary purpose for conducting technological M&A. The findings from Chapter 4 and Chapter 5 confirm that individual determinants can have different effects on innovation performance

in terms of quantity or diversity. The relative size of the target knowledge base, in particular, has a negative effect on the increase of innovation quantity while it has a positive effect on the increase of innovation diversity. Accordingly, this dissertation shows the necessity of examining the effects of the determinants found in the previous literature on post-M&A innovation diversity and of investigating post-M&A innovation performance's multi-dimension (Meglio, 2009). Third, the dissertation presents the effects of 'knowledge structure' on post-M&A innovation performance. The extant literature focuses on the effects of "knowledge contents" such as knowledge overlap and knowledge relatedness. The concept of knowledge breadth and knowledge depth captures the structure of a firm's knowledge base and the dissertation adopts it to the M&A literature. According to previous literature, knowledge breadth and knowledge depth affect the efficiency of internal R&D and external technology sourcing strategy (Carnabuci & Operti, 2013) as well as the characteristics of future innovation (Zhou & Li, 2012). For these reason, the examination of the knowledge structure of the acquirer and target firms is required to identify the resulting innovation performance. Overall, this dissertation highlights that selecting a proper target firm is important to successfully utilize technological M&A and contributes to establishing a strategy of 'target firm selection' which is the first step of technological execution. Figure 6-1 shows the summary of the dissertation's findings.

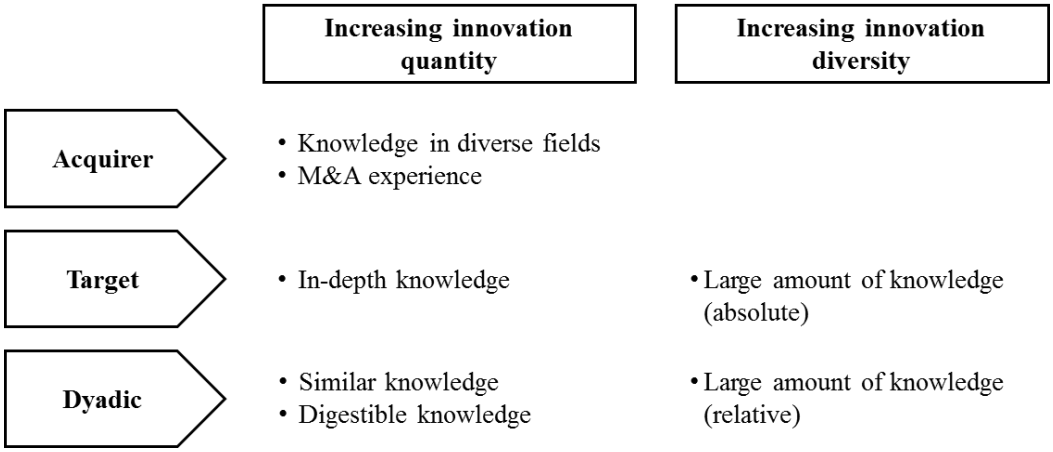

Figure 6-1. Findings of the dissertation

Furthermore, each empirical study of the dissertation provides contributions according to their findings besides the aforementioned overall contributions.

Chapter 3 contributes to the existing research on technological M&As in three ways. First, Chapter 3 links the concept of the knowledge base of the acquirer and target firm with the M&A literature. Specifically, my findings indicate that technological M&As are a good instrument for acquirer firms with a broad knowledge base to absorb the in-depth knowledge of an target firm. Moreover, I examine the interaction effect of the knowledge bases of the acquirer and target firms which previous literature on relationships between the knowledge breadth and knowledge depth and M&A success had overlooked.

Second, whereas previous research highlights the important role of relatedness in M&A success, Chapter 3 extends the point of view to the acquirer and target firm

characteristics. Previous M&A literature has limitations and was not able to conclusively identify which firms are suitable M&A acquirers and targets. The firm characteristics help researchers understand the critical link between firms' characteristics and M&A success. My results correspond well to previous studies in the same field. According to Schildt et al. (2012), who performed research on the learning between alliance partners, knowledge similarity (one example of strategic fit) between alliance partners was found to have a modest effect on learning, and technological diversity or R&D intensity (a firm specific characteristics) of a focal firm has a profound effect on learning. These results make it clear that the firms' characteristics themselves are an important factor in successful external technology sourcing. Thus, research on the firms' characteristics is valuable and should take up an important place in M&A literature.

Third, my findings are also reflected in the recent success cases of technological M&As. In many of those cases, the acquirer firms possessed knowledge in diverse technological fields and targeted firms which had a deep expertise in a specific technological field. For example, Google dominates almost 80% of the online advertisement market, helped by its acquisition of DoubleClick, which was a well-known online display advertisement firm. Moreover, also Google's successful Android mobile OS, has its origins in external technology that Google obtained when it acquired Android, Inc. Another good example is Cisco Systems, Inc., which is famous for its Acquisition & Development or known better as A&D strategy, and is known to only acquire firms that have sufficient expertise in a specific technology field (Gaughan, 2013). Therefore,

knowledge breadth and knowledge depth are suitable factors to explain the success or failure of technological M&As.

Chapter 4 makes a number of contributions to the research and understanding of technological M&As. First, the framework of Zahra and George (2002) is adopted to a dyadic perspective to overcome the limitations of previous literature which put their focus only on the acquisition process. Chapter 4 focuses on the examination of dyadic perspective factors which affect the assimilation, transformation and exploitation process of the acquired knowledge.

Second, adoption of the concept of knowledge digestibility to the technological M&A literature for the first time allows to compare the tacit knowledge between the acquirer and target firm. The knowledge transfer between the acquirer firm and target firm is difficult, because of the often tacit nature of knowledge (Cavusgil, Calantone, & Zhao, 2003; Cummings & Teng, 2003; Szulanski, 1996). Accordingly, comparing tacit knowledge between the two firms contributes to increasing the understanding of knowledge transfer, absorption and integration between firms. By adopting the concept of knowledge digestibility, I was able to examine the tacit knowledge aspects intrinsic in human resources. I broaden the application of the concept of knowledge digestibility, which has been already adopted in other collaboration strategy literature such as alliances, to the research on technological M&As. In fact, recently the term ‘acquihiring’ emerged in the business world and shows the increasing importance of human resources in obtaining external technologies and capabilities.

Third, the interaction effects between factors is identified by analyzing the moderating role of acquisition-specific capabilities. An increase in acquisition-specific capabilities through a series of M&As gives rise to the accumulation of more knowledge of how to exploit the acquired knowledge. Chapter 3 investigated the effects of M&A experience which is one of the most important factors affecting both post-M&A innovation and dyadic perspective factors simultaneously. Through this approach, I was able to show how the experience gained through previous M&As affects the performance of focal M&A directly and indirectly.

Fourth, while the investigation of the effects of M&A experience on subsequent performance was mainly conducted using samples of general M&A transactions (Hayward, 2002), I investigate the effects of M&A experience in the ever increasing domain of technological M&As. A firm that uses a technological M&A strategy tends to conduct multiple M&As rather than only one M&A. Firms in the sample of Chapter 3 conducted an average of 2.31 technological M&A transactions. Accordingly, the examination of M&A experience in the context of technological M&As is necessary to understand post-M&A innovation performance.

Fifth, Chapter 4 finds that accumulating M&A experience through acquiring comparatively small firms is efficient for creating innovation. Chapter 3 confirmed positive effects of knowledge digestibility and M&A experience. It implies that acquiring small firms and conducting multiple M&As are beneficial to create innovation in the present as well as in subsequent M&As. To summarize these findings, in terms of

knowledge digestibility, M&As with small firms show an improved performance. Moreover, because the acquisition of small firms is less burdensome than that of larger firms, it allows the acquirer to use the remaining resources to conduct other M&As to acquire new knowledge and gain further M&A experience. According to the results of my empirical analysis, the M&A experience has both a positive direct effect as well as a moderating effect. Thus, the M&A experience through multiple acquisition of small firms allows the acquirer firm to create more innovation.

Chapter 5 makes two important contributions to the research on technological M&As. First, I highlight the new role of technological M&As as a method of increasing innovation diversity by investigating how a firm generates diverse fields of innovation through technological M&As. In addition, since the objectives of technological M&A are diversified, a variety of previous literature emphasizes the importance of examining diverse dimensions of innovation (Cording et al., 2008; King et al., 2008; Schoenberg, 2006; Zollo & Meier, 2008). Chapter 5 follows this stream of research by focusing on the diversity, rather the quantity and quality of post-M&A innovation outcomes.

Second, the results of Chapter 5 complement the findings of previous technological M&A literature. Prior research on technological M&As has investigated the growth of innovation quantity and quality and the creation of radical innovation through technological M&As (e.g. Ahuja & Katila, 2001; Makri et al., 2010; Valentini, 2012). Chapter 5 establishes a foothold for expanding results of prior research by examining the effects of previously examined factors such as knowledge base characteristics on

innovation diversity.

6.2. Limitations and future research

While providing implications and contributions for M&A target selection, the dissertation has several limitations that future research in the field of technological M&A will help to address.

First, the examination of one industry may have difficulty in generalizing the implications of the findings. The three empirical studies of this dissertation adopt the biopharmaceutical industry because of its advantageous context on technological M&A and innovation performance. The biopharmaceutical industry could have been divided into several technology subcategories, each exhibiting distinct characteristics related to knowledge and capabilities (Carayannopoulos & Auster, 2010). This would enable researchers to examine the various attributes from many angles in spite of using a single industry. In addition, because high-tech industries have high technological and market uncertainty in common, the findings from one industry could be adopted to the other industry (c.f. Ahuja & Katila, 2001; Cloodt et al., 2006). However, the findings from a certain industry cannot help having the industry specific characteristics. Thus, additional work is needed to apply the findings of the dissertation to other industries.

Second, apart from innovation quantity and innovation diversity, there are a lot

more dimensions of innovation such as the division into radical innovation and incremental innovation. Although innovation quantity and innovation diversity are the most prominent dimensions of innovation performance, the examination of other kinds of innovation performance can contribute to a comprehensive understanding of technological M&A. Future research can further advance the understanding of the effects of technological M&As by introducing additional measures for innovation outcomes.

Third, the knowledge base of a firm does not only consist of technological, but also of scientific knowledge (Makri et al., 2010). In the dissertation, the term ‘knowledge’ refers to only ‘technological knowledge’. However, Makri et al. (2010) state that scientific knowledge also affects post-M&A innovation. While it is more difficult to measure than knowledge contained in patents, future research could expand the definition of the knowledge base to allow for an investigation of the effects of scientific knowledge.

Fourth, the adopted data in the each chapters are different. Due to the difference in the variables of each chapters, the required information to measure the variables is different. Accordingly, the dissertation fails to adopt the same sample between the chapters. However, because the sample is extracted from the same M&A transactions of a single industry and has a large number of observations, the results from each sample would not be very different in accordance with the central limit theorem.

Fifth, the data structure of the dissertation has difficulties to separate the effects of duplicates. Because a firm could conduct more than one M&A in one year, duplicates would arise and it hinders researchers from building a panel data structure. For this reason,

many researches, including this dissertation, construct its dataset as pooled cross-sectional data. Although it has the advantage on not removing duplicated data randomly, it has the disadvantage of being unable to separate the effects of duplicates on post-M&A innovation performance.

In addition to the overall limitation, the three empirical studies in Chapters 3, 4, and 5 also have some limitations that I hope will be addressed by future research.

Chapter 3 has a limitation on unconcerning the breadth of the target firm's knowledge base and the depth of the acquirer firm's knowledge base. The dissertation tried to examine those two factors with the currently concerned variables at first. Unfortunately, due to the measurements of the breadth and depth of knowledge base, these constructs have a high correlation with the quantity of knowledge base and I found a high correlation between the breadth and depth of the each firm. Accordingly, I excluded those two factors in the text because the examination of those two factors might give rise to the loss of test reliability. Although the measurements adopted in the dissertation are used in a number of research, this is a limitation stemming from the measurements. In addition, I searched the extant measurements adopted in the previous literature, but no measurements solve this limitation. Therefore, future research could address this issue by introducing new measurement.

Relating to Chapter 4, while some tests support the hypothesis of an inverted U-shape relationship between knowledge similarity and post-M&A innovation performance, the results were not consistent over all tests. To demonstrate and improve the robustness

of test results, Chapter 4 employed diverse measurements of the dependent variable and independent variables. Accordingly, the number of tests considerably increased and 4 out of total 8 tests show significant results. However, to increase the validity of the results, another measurement of knowledge similarity could be employed. I followed prior literature in adopting the patent class to measure knowledge similarity (e.g. Makri et al., 2010; Sampson, 2007), however, other literature has used the patent citation information between the acquirer and target firm (Sears & Hoetker, 2014). Although my research is not able to employ such a measurement because of insufficient data, future research can address this issue by adopting patent citation data to measure knowledge similarity.

In addition, in Chapter 4, since the effects of M&A experience as a moderator in the research model is verified only in one test, its role should be examined in other settings. For instance, as my study observes M&A from a dyadic perspective, M&A experience could also take a dyadic point of view, which could give rise to new implications. Specifically, in the case of the acquirer firm having prior collaboration experiences with the target firm such as through licensing, alliance and joint venture transactions, those experiences might positively moderate the relationships between knowledge similarity, knowledge digestibility, and subsequent M&A innovation performance. Therefore, further research on the innovation performance of technological M&A in other settings is needed.

Relating to Chapter 5, some factors other than knowledge base characteristics can affect post-M&A innovation diversity. Because this research is the first one to focus

on the post-M&A innovation diversity, the impacts of other important factors are still uncovered. As the Chapter 5 did, the examination of determinants previously investigated in the literature of technological M&A and innovation performance would contribute to a comprehensive view of technological M&As.

Another limitation of Chapter 5 is the measurement of independent variables. In the dissertation, I followed the extant measurement that the previous literature used. Specifically, to measure the absolute size of the target knowledge base, I counted the number of non-overlapped knowledge base of the target firm. However, the recent research of Sears and Hoetker (2014) highlights the importance of overlapped knowledge base between the acquirer firm and target firm. Although I followed the measurements of the previous literature to compare the results of the dissertation with those of the previous research, future research could address this issue and use another measurement to investigate the effect of overlapped knowledge base on post-M&A innovation performance.

Bibliography

Acar, W., & Sankaran, K. (1999). The myth of the unique decomposability: Specializing the Herfindahl and entropy measures? *Strategic Management Journal, 20*(10), 969-975.

Ahuja, G. (2000). Collaboration networks, structural holes, and innovation: A longitudinal study. *Administrative Science Quarterly, 45*(3), 425-455.

Ahuja, G., & Katila, R. (2001). Technological acquisitions and the innovation performance of acquiring firms: A longitudinal study. *Strategic Management Journal, 22*(3), 197-220.

Ahuja, G., & Lampert, C. M. (2001). Entrepreneurship in the large corporation: A longitudinal study of how established firms create breakthrough inventions. *Strategic Management Journal, 22*(6-7), 521-543.

Al-Laham, A., & Amburgey, T. L. (2005). Knowledge sourcing in foreign direct investments: an empirical examination of target profiles. *MIR: Management International Review*, 247-275.

Albert, M. B., Avery, D., Narin, F., & McAllister, P. (1991). Direct validation of citation counts as indicators of industrially important patents. *Research Policy, 20*(3), 251-259.

Almeida, P., & Phene, A. (2004). Subsidiaries and knowledge creation: The influence of the MNC and host country on innovation. *Strategic Management Journal, 25*(8/9),

847-864.

Amemiya, T. (1984). Tobit models: A survey. *Journal of Econometrics, 24*(1), 3-61.

Angwin, D. (2012). Merger and acquisition typologies: A review. *The Handbook of Mergers and Acquisitions*, 40-70.

Argote, L., & Ingram, P. (2000). Knowledge transfer: A basis for competitive advantage in firms. *Organizational Behavior and Human Decision Processes, 82*(1), 150-169.

Argyres, N. S., & Silverman, B. S. (2004). R&D, organization structure, and the development of corporate technological knowledge. *Strategic Management Journal, 25*(8-9), 929-958.

Arora, A., & Gambardella, A. (1990). Complementarity and external linkages: the strategies of the large firms in biotechnology. *Journal of Industrial Economics, 38*(4), 361-379.

Arora, A., & Gambardella, A. (1994). Evaluating technological information and utilizing it: scientific knowledge, technological capability, and external linkages in biotechnology. *Journal of Economic Behavior & Organization, 24*(1), 91-114.

Arora, A., Gambardella, A., Hall, B., & Rosenberg, N. (2010). The market for technology. *Handbook of the Economics of Innovation*, 1, 641-678.

Arrow, K. (1962). Economic welfare and the allocation of resources for invention *The rate and direction of inventive activity: Economic and social factors* (pp. 609-626): Princeton University Press.

Arundel, A., & Kabla, I. (1998). What percentage of innovations are patented? Empirical estimates for European firms. *Research Policy, 27*(2), 127-141.

Bachi, R. (1955). A statistical analysis of the revival of Hebrew in Israel. In R. Bachi (Ed.), *Scripta Hierosolymitana* (pp. 179-247). Jerusalem, Israel: Magnum Press.

Banerjee, A., & Eckard, E. W. (1998). Are mega-mergers anticompetitive? Evidence from the first great merger wave. *RAND Journal of Economics*, 803-827.

Bauer, F., & Matzler, K. (2014). Antecedents of M&A success: The role of strategic complementarity, cultural fit, and degree and speed of integration. *Strategic Management Journal, 35*(2), 269-291.

Bena, J., & Li, K. (2014). Corporate innovations and mergers and acquisitions. *The Journal of Finance, 69*(5), 1923-1960.

Berkovitch, E., & Narayanan, M. (1993). Motives for takeovers: An empirical investigation. *Journal of Financial and Quantitative Analysis, 28*(03), 347-362.

Bierly, P., & Chakrabarti, A. (1996). Generic knowledge strategies in the US pharmaceutical industry. *Strategic Management Journal, 17*(WINTER), 123-135.

Blau, P. M. (1977). *Inequality and heterogeneity: A primitive theory of social structure* (Vol. 7). NY: Free Press.

Bowen, H. P. (2010). *Total, structural and secondary moderating effects in the Tobit model and their computation using Stata*. McColl School of Business Discussion Paper Series. Queens University of Charlotte.

Bowen, H. P. (2012). Testing Moderating Hypotheses in Limited Dependent Variable and

Other Nonlinear Models Secondary Versus Total Interactions. *Journal of Management*, *38*(3), 860-889.

Bower, J. (2001). Not all M&As are alike--and that matters. *Harvard Business Review, 79*(3), 92.

Buss, P. (2012). The impact of technological acquisitions on innovation quality *Technology Transfer in a Global Economy* (pp. 143-160): Springer.

Calipha, R., Tarba, S., & Brock, D. (2010). Mergers and acquisitions: a review of phases, motives, and success factors. *Advances in Mergers and Acquisitions, 9*(1), 1-24.

Carayannopoulos, S., & Auster, E. R. (2010). External knowledge sourcing in biotechnology through acquisition versus alliance: A KBV approach. *Research Policy, 39*(2), 254-267.

Carnabuci, G., & Operti, E. (2013). Where do firms' recombinant capabilities come from? Intraorganizational networks, knowledge, and firms' ability to innovate through technological recombination. *Strategic Management Journal, 34*(13), 1591-1613.

Carrillo, P., & Anumba, C. (2002). Knowledge management in the AEC sector: an exploration of the mergers and acquisitions context. *Knowledge and Process Management, 9*(3), 149-161.

Cartwright, S. (2005). Mergers and acquisitions: An update and appraisal. In G. P. Hodgkinson & J. K. Ford (Eds.), *International Review of Industrial and Organizational Psychology* (Vol. 20, pp. 1-38): John Wiley & Sons, Ltd.

Cartwright, S., & Cooper, C. L. (2012). *Managing mergers, acquisitions and strategic*

alliances. NY: Routledge.

Cassiman, B., & Colombo, M. G. (2006). *Mergers & acquisitions: The innovation impact*. MA: Edward Elgar Publishing.

Cassiman, B., Colombo, M. G., Garrone, P., & Veugelers, R. (2005). The impact of M&A on the R&D process: An empirical analysis of the role of technological-and market-relatedness. *Research Policy, 34*(2), 195-220.

Cavusgil, T. S., Calantone, R. J., & Zhao, Y. (2003). Tacit knowledge transfer and firm innovation capability. *Journal of Business & Industrial Marketing, 18*(1), 6-21.

Cefis, E. (2010). The impact of M&A on technology sourcing strategies. *Economics of Innovation and New Technology, 19*(1), 27-51.

Cepeda, G., & Vera, D. (2007). Dynamic capabilities and operational capabilities: A knowledge management perspective. *Journal of Business Research, 60*(5), 426-437.

Cepton Strategies. (2015). Pharmaceuticals mergers and acquisitions: Mapping 15 years of M&A deals in the pharmaceuticals industry: Cepton Strategies.

Chakrabarti, A., Hauschildt, J., & Süverkrüp, C. (1994). Does it pay to acquire technological firms? *R&D Management, 24*(1), 047-056.

Chambers, J. (2015). CISCO'S CEO on staying ahead of technlogy shifts. *Harvard Business Review, 93*(5), 35-38.

Chatman, J., O'Reilly, C., & Chang, V. (2005). Developing a human capital strategy. *California Management Review, 47*(2), 138.

Chatterjee, S., Lubatkin, M. H., Schweiger, D. M., & Weber, Y. (1992). Cultural differences and shareholder value in related mergers: Linking equity and human capital. *Strategic Management Journal, 13*(5), 319-334.

Chesbrough, H. W. (2006). *Open innovation: The new imperative for creating and profiting from technology*. MA: Harvard Business School Press.

Christensen, C. M., Alton, R., Rising, C., & Waldeck, A. (2011). The big idea: the new M&A playbook. *Harvard Business Review, 89*(3), 48-57.

Christensen, C. M., & Overdorf, M. (2000). Meeting the challenge of disruptive change. *Harvard Business Review, 78*(2), 66-77.

Cloodt, M., & Hagedoorn, J. (2012). Mergers and acquisitions and firm performance. In M. Dietrich & J. Krafft (Eds.), *Handbook on the economics and theory of the firm* (pp. 391). MA Edward Elgar.

Cloodt, M., Hagedoorn, J., & Van Kranenburg, H. (2006). Mergers and acquisitions: Their effect on the innovative performance of companies in high-tech industries. *Research Policy, 35*(5), 642-654.

Cohen, W. M., & Levinthal, D. A. (1990). Absorptive capacity: a new perspective on learning and innovation. *Administrative Science Quarterly, 35*(1).

Cording, M., Christmann, P., & King, D. R. (2008). Reducing causal ambiguity in acquisition integration: Intermediate goals as mediators of integration decisions and acquisition performance. *Academy of Management Journal, 51*(4), 744-767.

Cummings, J. L., & Teng, B. S. (2003). Transferring R&D knowledge: the key factors

affecting knowledge transfer success. *Journal of Engineering and Technology Management, 20*(1), 39-68.

Datta, P., & Roumani, Y. (2015). Knowledge-acquisitions and post-acquisition innovation performance: a comparative hazards model. *European Journal of Information Systems*.

De Man, A.-P., & Duysters, G. (2005). Collaboration and innovation: a review of the effects of mergers, acquisitions and alliances on innovation. *Technovation, 25*(12), 1377-1387.

DeCarolis, D. M., & Deeds, D. L. (1999). The impact of stocks and flows of organizational knowledge on firm performance: an empirical investigation of the biotechnology industry. *Strategic Management Journal, 20*(10), 953-968.

Desyllas, P., & Hughes, A. (2008). Sourcing technological knowledge through corporate acquisition: Evidence from an international sample of high technology firms. *The Journal of High Technology Management Research, 18*(2), 157-172.

Desyllas, P., & Hughes, A. (2010). Do high technology acquirers become more innovative? *Research Policy, 39*(8), 1105-1121.

Di Guardo, M. C., & Valentini, G. (2007). Explaining the effect of M&A on technological performance. *Advances in Mergers and Acquisitions, 6*, 107-125.

Dosi, G. (1982). Technological paradigms and technological trajectories: a suggested interpretation of the determinants and directions of technical change. *Research Policy, 11*(3), 147-162.

Dosi, G., Pavitt, K., & Soete, L. (1990). The economics of technical change and international trade. *LEM Book Series*.

Du, J., Wu, D., Lu, J., & Yu, H. (2013). Knowledge networks and technological capabilities of SMEs: The role of technology strategies and its implications for knowledge service intermediaries. *Asian Journal of Technology Innovation, 21*(sup2), 80-98.

Empson, L. (2001). Fear of exploitation and fear of contamination: Impediments to knowledge transfer in mergers between professional service firms. *Human Relations, 54*(7), 839-862.

Ensign, P. C., Chreim, S., Persaud, A., & Lin, C.-D. (2013). *Proximity, knowledge transfer, and innovation in technology-based M&As.* Paper presented at the 2013 46th Hawaii International Conference on System Sciences.

Ernst, H., & Vitt, J. (2000). The influence of corporate acquisitions on the behaviour of key inventors. *R&D Management, 30*(2), 105-120.

Fauconnier, G., & Turner, M. (1999). A mechanism of creativity. *Poetics Today, 20*(3), 397-418.

Ferreira, M. P., Santos, J. C., de Almeida, M. I. R., & Reis, N. R. (2014). Mergers & acquisitions research: A bibliometric study of top strategy and international business journals, 1980–2010. *Journal of Business Research, 67*(12), 2550-2558.

Finkelstein, S. (1997). Interindustry merger patterns and resource dependence: A replication and extension of Pfeffer (1972). *Strategic Management Journal,*

18(10), 787-810.

Fiol, C. M., & Lyles, M. A. (1985). Organizational learning. *Academy of Management Review, 10*(4), 803-813.

Fleming, L. (2001). Recombinant uncertainty in technological search. *Management Science, 47*(1), 117-132.

Fleming, L., & Sorenson, O. (2001). Technology as a complex adaptive system: evidence from patent data. *Research Policy, 30*(7), 1019-1039.

Gaughan, P. A. (2013). *Maximizing corporate value through mergers and acquisitions: A strategic growth guide*. NJ: John Wiley & Sons.

George, G., Kotha, R., & Zheng, Y. (2008). Entry into insular domains: A longitudinal study of knowledge structuration and innovation in biotechnology firms. *Journal of Management Studies, 45*(8), 1448-1474.

Ghauri, P. N., & Buckley, P. J. (2003). International mergers and acquisitions: Past, present and future. *Advances in Mergers and Acquisitions, 2*(1), 207-229.

Ghoshal, S. (1987). Global strategy: An organizing framework. *Strategic Management Journal, 8*(5), 425-440.

Grant, R. M. (1996a). Prospering in dynamically-competitive environments: organizational capability as knowledge integration. *Organization Science, 7*(4), 375-387.

Grant, R. M. (1996b). Toward a knowledge-based theory of the firm. *Strategic Management Journal, 17*, 109-122.

Grant, R. M., & Baden-Fuller, C. (2004). A knowledge accessing theory of strategic alliances. *Journal of Management Studies, 41*(1), 61-84.

Greene, W. H. (1994). *Accounting for excess zeros and sample selection in Poisson and negative binomial regression models*. NYU Working Paper. New York University.

Greene, W. H. (2003). *Econometric analysis*. NJ: Prentice Hall.

Griliches, Z. (1998). Patent statistics as economic indicators: a survey *R&D and productivity: The econometric evidence* (pp. 287-343): University of Chicago Press.

Gujarati, D. N. (2010). *Basic econometrics*. Boston: McGraw-Hill.

Hagedoorn, J., & Duysters, G. (2002). The effect of mergers and acquisitions on the technological performance of companies in a high-tech environment. *Technology Analysis & Strategic Management, 14*(1), 67-85.

Hagedoorn, J., & Sadowski, B. (1999). The transition from strategic technology alliances to mergers and acquisitions: an exploratory study. *Journal of Management Studies, 36*(1), 87-107.

Haleblian, J., & Finkelstein, S. (1999). The influence of organizational acquisition experience on acquisition performance: A behavioral learning perspective. *Administrative Science Quarterly, 44*(1), 29-56.

Hall, B. H., Jaffe, A., & Trajtenberg, M. (2005). Market value and patent citations. *RAND Journal of Economics*, 16-38.

Hamel, G. (2000). Waking up IBM: How a gang of unlikely rebels transformed Big Blue.

Harvard Business Review, 78(4), 137-146.

Hamel, G., & Prahalad, C. (1994). *Competing for the future: Breakthrough strategies for seizing control of your industry and creating the markets of tomorrow*. MA: Harvard Business School Press.

Harrison, J. S., Hitt, M. A., Hoskisson, R. E., & Ireland, R. D. (1991). Synergies and post-acquisition performance: Differences versus similarities in resource allocations. *Journal of Management, 17*(1), 173-190.

Hausman, J. A., Hall, B. H., & Griliches, Z. (1984). Econometric models for count data with an application to the patents-R&D relationship. MA: National Bureau of Economic Research Cambridge.

Hayward, M. L. (2002). When do firms learn from their acquisition experience? Evidence from 1990-1995. *Strategic Management Journal, 23*(1), 21-39.

Henderson, R. (1993). Underinvestment and incompetence as responses to radical innovation: Evidence from the photolithographic alignment equipment industry. *RAND Journal of Economics*, 248-270.

Henderson, R., & Cockburn, I. (1994). Measuring competence? Exploring firm effects in pharmaceutical research. *Strategic Management Journal, 15*(S1), 63-84.

Henderson, R., & Cockburn, I. (1996). Scale, scope, and spillovers: the determinants of research productivity in drug discovery. *RAND Journal of Economics*, 32-59.

Hennart, J. F. (1988). A transaction costs theory of equity joint ventures. *Strategic Management Journal, 9*(4), 361-374.

Higgins, M. J., & Rodriguez, D. (2006). The outsourcing of R&D through acquisitions in the pharmaceutical industry. *Journal of Financial Economics, 80*(2), 351-383.

Hilbe, J. M. (2011). *Negative binomial regression*. New York: Cambridge University Press.

Hill, C. W., & Rothaermel, F. T. (2003). The performance of incumbent firms in the face of radical technological innovation. *Academy of Management Review, 28*(2), 257-274.

Hirschman, A. O. (1964). The paternity of an index. *The American Economic Review, 54*, 761-762.

Hitt, M. A., Harrison, J. S., & Ireland, R. D. (2001). *Mergers & acquisitions: A guide to creating value for stakeholders*. New York: Oxford University Press.

Hitt, M. A., Hoskisson, R. E., Ireland, R. D., & Harrison, J. S. (1991). Effects of acquisitions on R&D inputs and outputs. *Academy of Management Journal, 34*(3), 693-706.

Hitt, M. A., Hoskisson, R. E., Johnson, R. A., & Moesel, D. D. (1996). The market for corporate control and firm innovation. *Academy of Management Journal, 39*(5), 1084-1119.

Hitt, M. A., King, D., Krishnan, H., Makri, M., SCHIIVEN, M., Shimizu, K., & Zhu, H. (2012). Creating value through mergers and acquisitions. *The Handbook of Mergers and Acquisitions*, 71-113.

Hitt, M. A., King, D., Krishnan, H., Makri, M., Schijven, M., Shimizu, K., & Zhu, H.

(2009). Mergers and acquisitions: Overcoming pitfalls, building synergy, and creating value. *Business Horizons, 52*(6), 523-529.

Hoang, H., & Rothaermel, F. T. (2005). The effect of general and partner-specific alliance experience on joint R&D project performance. *Academy of Management Journal, 48*(2), 332-345.

Hoetker, G. (2007). The use of logit and probit models in strategic management research: Critical issues. *Strategic Management Journal, 28*(4), 331-343.

Homberg, F., Rost, K., & Osterloh, M. (2009). Do synergies exist in related acquisitions? A meta-analysis of acquisition studies. *Review of Managerial Science, 3*(2), 75-116.

Hopkins, H. D. (1987). Acquisition strategy and the market position of acquiring firms. *Strategic Management Journal, 8*(6), 535-547.

Horwitch, M. (2013). *Technology in the modern corporation: a strategic perspective*. NY: Elsevier.

Huang, Y.-F., & Chen, C.-J. (2010). The impact of technological diversity and organizational slack on innovation. *Technovation, 30*(7), 420-428.

Hussinger, K. (2010). On the importance of technological relatedness: SMEs versus large acquisition targets. *Technovation, 30*(1), 57-64.

Hussinger, K. (2012). Absorptive capacity and post-acquisition inventor productivity. *Journal of Technology Transfer, 37*(4), 490-507.

Hussinger, K., & Wastyn, A. (2015). In search for the not-invented-here syndrome: the

role of knowledge sources and firm success. *R&D Management*.

Jaffe, A. B. (1986). Technological opportunity and spillovers of R&D: evidence from firms' patents, profits and market value. *Academic Economic Review, 73*, 984-1001.

Jasimuddin, S. M. (2012). Knowledge management in mergers and acquisitions. In D. Faulkner, S. Terrikangas & R. J. Joseph (Eds.), *The Handbook of Mergers and Acquisitions* (pp. 454-473). Great Britain: Oxford.

Kale, P., & Puranam, P. (2004). Choosing equity stakes in technology sourcing relationships: An integrative framework. *California Management Review, 46*(3).

Kang, H., Kim, H., & Song, J. (2013). See beyond your target: When does acquired firm's ego-network enhance acquirer's innovation outputs? *Journal of Strategic Management Proceedings*, 47-73.

Kang, K. H., Jo, G. S., & Kang, J. (2015). External technology acquisition: a double-edged sword. *Asian Journal of Technology Innovation, 23*(1), 35-52.

Kang, K. H., & Kang, J. (2009). How do firms source external knowledge for innovation? Analysing effects of different knowledge sourcing methods. *International Journal of Innovation Management, 13*(01), 1-17.

Kanter, R. M. (2000). When a thousand flowers bloom: Structural, collective, and social conditions for innovation in organization. *Entrepreneurship: the social science view*, 167-210.

Kapoor, R., & Lim, K. (2007). The impact of acquisitions on the productivity of inventors

at semiconductor firms: A synthesis of knowledge-based and incentive-based perspectives. *Academy of Management Journal, 50*(5), 1133-1155.

Katila, R., & Ahuja, G. (2002). Something old, something new: A longitudinal study of search behavior and new product introduction. *Academy of Management Journal, 45*(6), 1183-1194.

Katz, B., & Du Preez, N. (2008). The role of knowledge management in supporting a radical innovation project *Methods and tools for effective knowledge life-cycle-management* (pp. 331-345): Springer.

Katz, R., & Allen, T. J. (1982). Investigating the Not Invented Here (NIH) syndrome: A look at the performance, tenure, and communication patterns of 50 R & D Project Groups. *R&D Management, 12*(1), 7-20.

Kauffman, S. A. (1993). *The origins of order: Self-organization and selection in evolution*. New York: Oxford University Press.

Keil, T. (2004). Building external corporate venturing capability*. *Journal of Management Studies, 41*(5), 799-825.

Kennedy, K. H., Payne, G. T., & Whitehead, C. J. (2002). Matching industries between target and acquirer in high-tech mergers and acquisitions. *Technology Analysis & Strategic Management, 14*(2), 149-162.

Kim, J. J., & Finkelstein, S. (2009). The effects of strategic and market complementarity on acquisition performance: Evidence from the US commercial banking industry, 1989–2001. *Strategic Management Journal, 30*(6), 617-646.

King, D. R., Slotegraaf, R. J., & Kesner, I. (2008). Performance implications of firm resource interactions in the acquisition of R&D-intensive firms. *Organization Science, 19*(2), 327-340.

Kitching, J. (1967). Why do mergers miscarry. *Harvard Business Review, 45*(6), 84-101.

Kleinbaum, D., Kupper, L., Nizam, A., & Rosenberg, E. (2013). *Applied regression analysis and other multivariable methods*. MA: Cengage Learning.

Koestler, A. (1964). *The act of creation*. London: Hutchinson.

Kogut, B., & Zander, U. (1992). Knowledge of the firm, combinative capabilities, and the replication of technology. *Organization Science, 3*(3), 383-397.

Kotha, R., Zheng, Y., & George, G. (2011). Entry into new niches: the effects of firm age and the expansion of technological capabilities on innovative output and impact. *Strategic Management Journal, 32*(9), 1011-1024.

Kusewitt, J. B. (1985). An exploratory study of strategic acquisition factors relating to performance. *Strategic Management Journal, 6*(2), 151-169.

Laamanen, T., & Keil, T. (2008). Performance of serial acquirers: Toward an acquisition program perspective. *Strategic Management Journal, 29*(6), 663-672.

Lane, P. J., & Lubatkin, M. (1998). Relative absorptive capacity and interorganizational learning. *Strategic Management Journal, 19*(5), 461-477.

Laursen, K., & Salter, A. (2006). Open for innovation: the role of openness in explaining innovation performance among UK manufacturing firms. *Strategic Management Journal, 27*(2), 131-150.

Lee, Y. J. (2010). Identification of technology transfer options based on technological characteristics. *Asian Journal of Technology Innovation, 18*(1), 1-21.

Lemieux, O. P., & Banks, J. C. (2007). High tech M&A-strategic valuation. *Management Decision, 45*(9), 1412-1425.

Leonard-Barton, D. (1995). *Wellsprings of knowledge: Building and sustaining the sources of innovation*. Boston, Masachusetts: Harvard Business School Press.

Levinthal, D. A., & March, J. G. (1993). The myopia of learning. *Strategic Management Journal, 14*(S2), 95-112.

Levitt, B., & March, J. G. (1988). Organizational learning. *Annual Review of Sociology*, 319-340.

Lichtenthaler, U. (2008). Relative capacity: Retaining knowledge outside a firm's boundaries. *Journal of Engineering and Technology Management, 25*(3), 200-212.

Lichtenthaler, U., & Ernst, H. (2006). Attitudes to externally organising knowledge management tasks: a review, reconsideration and extension of the NIH syndrome. *R&D Management, 36*(4), 367-386.

Lin, B.-W. (2011). Knowledge diversity as a moderator: inter-firm relationships, R&D investment and absorptive capacity. *Technology Analysis & Strategic Management, 23*(3), 331-343.

Lin, B. W., Chen, C. J., & Wu, H. L. (2006). Patent portfolio diversity, technology strategy, and firm value. *Engineering Management, IEEE Transactions on, 53*(1), 17-26.

Lin, C. H., & Jang, S. L. (2010). The impact of M&As on company innovation: evidence from the US medical device industry. *Scientometrics, 84*(1), 119-131.

Lodh, S., & Battaggion, M. R. (2014). Technological breadth and depth of knowledge in innovation: The role of mergers and acquisitions in biotech. *Industrial and Corporate Change*, dtu013.

Long, J. S. (1997). *Regression models for categorical and limited dependent variables* (Vol. 7). Thousand Oaks: SAGE publications.

Lubatkin, M. (1983). Mergers and the performance of the acquiring firm. *Academy of Management Review, 8*(2), 218-225.

Makri, M., Hitt, M. A., & Lane, P. J. (2010). Complementary technologies, knowledge relatedness, and invention outcomes in high technology mergers and acquisitions. *Strategic Management Journal, 31*(6), 602-628.

Martynova, M., & Renneboog, L. (2008). A century of corporate takeovers: What have we learned and where do we stand? *Journal of Banking & Finance, 32*(10), 2148-2177.

McEvily, S. K., Eisenhardt, K. M., & Prescott, J. E. (2004). The global acquisition, leverage, and protection of technological competencies. *Strategic Management Journal, 25*(8-9), 713-722.

McGrath, R. G. (1999). Falling forward: Real options reasoning and entrepreneurial failure. *Academy of Management Review, 24*(1), 13-30.

Meglio, O. (2009). Measuring performance in technology-driven M&As: Insights from a

literature. *Advances in Mergers and Acquisitions, 8*, 103.

Miller, D. J., Fern, M. J., & Cardinal, L. B. (2007). The use of knowledge for technological innovation within diversified firms. *Academy of Management Journal, 50*(2), 307-325.

Morck, R., Shleifer, A., & Vishny, R. W. (1990). Do managerial objectives drive bad acquisitions? *The Journal of Finance, 45*(1), 31-48.

Morosini, P., Shane, S., & Singh, H. (1998). National cultural distance and cross-border acquisition performance. *Journal of International Business Studies*, 137-158.

Morrison, R. W., & De Jong, K. A. (2002). Measurement of population diversity. In C. P, F. C, H. J. K, L. E & S. M (Eds.), *Artificial Evolution* (pp. 31-41). Berlin, Heidelberg: Springer.

Mowery, D. C., Oxley, J. E., & Silverman, B. S. (1998). Technological overlap and interfirm cooperation: implications for the resource-based view of the firm. *Research Policy, 27*(5), 507-523.

Myers, R. H. (1990). *Classical and modern regression with applications* (Vol. 2). Boston: Duxbury Press Belmont.

Nelson, R. R., & Winter, S. G. (1982). The Schumpeterian tradeoff revisited. *The American Economic Review*, 114-132.

Nerkar, A., & Roberts, P. W. (2004). Technological and product-market experience and the success of new product introductions in the pharmaceutical industry. *Strategic Management Journal, 25*(8-9), 779-799.

Neter, J., Kutner, M. H., Nachtsheim, C. J., & Wasserman, W. (1996). *Applied linear statistical models* (Vol. 4). Chicago: McGraw-Hill.

Nonaka, l., Takeuchi, H., & Umemoto, K. (1996). A theory of organizational knowledge creation. *International Journal of Technology Management, 11*(7-8), 833-845.

Ornaghi, C. (2009). Mergers and innovation in big pharma. *International Journal of Industrial Organization, 27*(1), 70-79.

Orsi, L., Ganzaroli, A., De Noni, I., & Marelli, F. (2015). Knowledge utilisation drivers in technological M&As. *Technology Analysis & Strategic Management*(ahead-of-print), 1-18.

Owen-Smith, J., & Powell, W. W. (2004). Knowledge networks as channels and conduits: The effects of spillovers in the Boston biotechnology community. *Organization Science, 15*(1), 5-21.

Oxley, J. E. (1997). Appropriability hazards and governance in strategic alliances: A transaction cost approach. *Journal of law, Economics, and Organization, 13*(2), 387-409.

Park, G., & Kang, J. (2010). Entry conditions, firm strategies and their relationships to the innovation performance of an emerging green industry: the case of the solar cell industry. *Asian Journal of Technology Innovation, 18*(2), 21-42.

Paruchuri, S., Nerkar, A., & Hambrick, D. C. (2006). Acquisition integration and productivity losses in the technical core: Disruption of inventors in acquired companies. *Organization Science, 17*(5), 545-562.

Penner-Hahn, J., & Shaver, J. M. (2005). Does international research and development increase patent output? An analysis of Japanese pharmaceutical firms. *Strategic Management Journal, 26*(2), 121.

Phelps, C. C. (2010). A longitudinal study of the influence of alliance network structure and composition on firm exploratory innovation. *Academy of Management Journal, 53*(4), 890-913.

Phene, A., Tallman, S., & Almeida, P. (2012). When do acquisitions facilitate technological exploration and exploitation? *Journal of Management, 38*(3), 753-783.

Porrini, P. (2004). Alliance experience and value creation in high-tech and low-tech acquisitions. *The Journal of High Technology Management Research, 15*(2), 267-292.

Prabhu, J. C., Chandy, R. K., & Ellis, M. E. (2005). The impact of acquisitions on innovation: poison pill, placebo, or tonic? *Journal of Marketing, 69*(1), 114-130.

Prahalad, C. K., & Bettis, R. A. (1986). The dominant logic: a new linkage between diversity and performance. *Strategic Management Journal, 7*(6), 485-501.

Puranam, P., Singh, H., & Zollo, M. (2003). A bird in the hand or two in the bush?: Integration trade-offs in technology-grafting acquisitions. *European Management Journal, 21*(2), 179-184.

Puranam, P., Singh, H., & Zollo, M. (2006). Organizing for innovation: Managing the coordination-autonomy dilemma in technology acquisitions. *Academy of*

Management Journal, 49(2), 263-280.

Puranam, P., & Srikanth, K. (2007). What they know vs. what they do: How acquirers leverage technology acquisitions. *Strategic Management Journal, 28*(8), 805-825.

Rallet, A., & Torre, A. (1999). Is geographical proximity necessary in the innovation networks in the era of global economy? *GeoJournal, 49*(4), 373-380.

Ranft, A. L. (2006). Knowledge preservation and transfer during post-acquisition integration. *Advances in Mergers and Acquisitions, 5*, 51-67.

Ranft, A. L., & Lord, M. D. (2002). Acquiring new technologies and capabilities: A grounded model of acquisition implementation. *Organization Science, 13*(4), 420-441.

Ravenscraft, D. J. (1987). The 1980s merger wave: An industrial organization perspective. *The merger boom, 17*, 37.

Rea, L. M., & Parker, R. A. (2012). *Designing and conducting survey research: A comprehensive guide*. CA: John Wiley & Sons.

Reus, T. H. (2012). A knowledge-based view of mergers and acquisitions revisited: Absorptive capacity and combinative capability. *Advances in Mergers and Acquisitions, 11*, 69-88.

Rossi, M., Tarba, Y. S., & Raviv, A. (2013). Mergers and acquisitions in the hightech industry: a literature review. *International Journal of Organizational Analysis, 21*(1), 66-82.

Rothaermel, F. T., & Alexandre, M. T. (2009). Ambidexterity in technology sourcing: The

moderating role of absorptive capacity. *Organization Science, 20*(4), 759-780.

Rothaermel, F. T., & Hess, A. M. (2007). Building dynamic capabilities: Innovation driven by individual-, firm-, and network-level effects. *Organization Science, 18*(6), 898-921.

Rumelt, R. P. (1974). *Strategy, structure, and economic performance*. Boston: Harvard Business School Press.

Sampson, R. C. (2007). R&D alliances and firm performance: The impact of technological diversity and alliance organization on innovation. *Academy of Management Journal, 50*(2), 364-386.

Schön, B., & Pyka, A. (2009). *Mergers & acquisitions–their impact on the innovativeness of single firms and entire industries.* Paper presented at the Thematic Meeting of the French Economic Association (AFSE),"Firms, Markets and Innovation", Sophia Antipolis.

Schildt, H., Keil, T., & Maula, M. (2012). The temporal effects of relative and firm-level absorptive capacity on interorganizational learning. *Strategic Management Journal, 33*(10), 1154-1173.

Schoenberg, R. (2006). Measuring the performance of corporate acquisitions: An empirical comparison of alternative metrics. *British Journal of Management, 17*(4), 361-370.

Schumpeter, J. (1942). Creative destruction. *Capitalism, socialism and democracy*.

Sears, J., & Hoetker, G. (2014). Technological overlap, technological capabilities, and

resource recombination in technological acquisitions. *Strategic Management Journal, 35*(1), 48-67.

Sebenius, J. K. (1998). Negotiating cross-border acquisitions. *MIT Sloan Management Review, 39*(2), 27.

Shimizu, K., Hitt, M. A., Vaidyanath, D., & Pisano, V. (2004). Theoretical foundations of cross-border mergers and acquisitions: A review of current research and recommendations for the future. *Journal of International Management, 10*(3), 307-353.

Shleifer, A., & Vishny, R. W. (1991). Takeovers in the'60s and the'80s: Evidence and Implications. *Strategic Management Journal, 12*(S2), 51-59.

Simpson, E. H. (1949). Measurement of diversity. *Nature, 163*, 688.

Singh, H., & Montgomery, C. A. (1987). Corporate acquisition strategies and economic performance. *Strategic Management Journal, 8*(4), 377-386.

Singh, J. (2008). Distributed R&D, cross-regional knowledge integration and quality of innovative output. *Research Policy, 37*(1), 77-96.

Sleuwaegen, L., & Valentini, G. (2006). Trends in mergers and acquisitions *Merger and Acquisitions - The Innovation Impact*.

Stahl, G. K., & Voigt, A. (2008). Do cultural differences matter in mergers and acquisitions? A tentative model and examination. *Organization Science, 19*(1), 160-176.

Stettner, U., & Lavie, D. (2014). Ambidexterity under scrutiny: Exploration and

exploitation via internal organization, alliances, and acquisitions. *Strategic Management Journal, 35*(13), 1903-1929.

Stigler, G. J. (1950). Monopoly and oligopoly by merger. *The American Economic Review*, 23-34.

Szulanski, G. (1996). Exploring internal stickiness: Impediments to the transfer of best practice within the firm. *Strategic Management Journal, 17*(S2), 27-43.

Taylor, A., & Greve, H. R. (2006). Superman or the fantastic four? Knowledge combination and experience in innovative teams. *Academy of Management Journal, 49*(4), 723-740.

Teece, D. J. (1986). Profiting from technological innovation: Implications for integration, collaboration, licensing and public policy. *Research Policy, 15*(6), 285-305.

Teece, D. J. (2006). Reflections on "profiting from innovation". *Research Policy, 35*(8), 1131-1146.

Todorova, G., & Durisin, B. (2007). Absorptive capacity: valuing a reconceptualization. *Academy of Management Review, 32*(3), 774-786.

Trautwein, F. (1990). Merger motives and merger prescriptions. *Strategic Management Journal, 11*(4), 283-295.

Trichterborn, A., zu Knyphausen-Aufseß, D., & Schweizer, L. (2015). How to improve acquisition performance: The role of a dedicated M&A function, M&A learning process, and M&A capability. *Strategic Management Journal*.

Tushman, M. L., & Anderson, P. (1986). Technological discontinuities and organizational

environments. *Administrative Science Quarterly*, 439-465.

Tushman, M. L., & Rosenkopf, L. (1992). Organizational determinants of technological-change-toward a sociology of technological evolution. *Research in Organizational Behavior, 14*, 311-347.

Uhlenbruck, K., Hitt, M. A., & Semadeni, M. (2006). Market value effects of acquisitions involving internet firms: a resource-based analysis. *Strategic Management Journal, 27*(10), 899.

Valentini, G. (2012). Measuring the effect of M&A on patenting quantity and quality. *Strategic Management Journal, 33*(3), 336-346.

Valentini, G., & Dawson, A. (2010). Beyond knowledge bases: Towards a better understanding of the effects of M&A on technological performance. *Advances in Mergers and Acquisitions, 9*, 177-197.

van de Vrande, V., Vanhaverbeke, W., & Duysters, G. (2009). External technology sourcing: The effect of uncertainty on governance mode choice. *Journal of Business Venturing, 24*(1), 62-80.

Vermeulen, F., & Barkema, H. (2001). Learning through acquisitions. *Academy of Management Journal, 44*(3), 457-476.

Wadhwa, A., & Basu, S. (2013). Exploration and resource commitments in unequal partnerships: An examination of corporate venture capital investments. *Journal of Product Innovation Management, 30*(5), 916-936.

Wadhwa, A., & Kotha, S. (2006). Knowledge creation through external venturing:

Evidence from the telecommunications equipment manufacturing industry. *Academy of Management Journal, 49*(4), 819-835.

Wagner, M. (2011). To explore or to exploit? An empirical investigation of acquisitions by large incumbents. *Research Policy, 40*(9), 1217-1225.

Weigelt, C., & Miller, D. J. (2013). Implications of internal organization structure for firm boundaries. *Strategic Management Journal, 34*(12), 1411-1434.

Wiersema, M. F., & Bowen, H. P. (2009). The use of limited dependent variable techniques in strategy research: Issues and methods. *Strategic Management Journal, 30*(6), 679-692.

Wilson, C., & Tisdell, C. A. (2002). OLS and Tobit estimates: When is substitution defensible operationally? : University of Queensland, School of Economics.

Wu, J., & Shanley, M. T. (2009). Knowledge stock, exploration, and innovation: Research on the United States electromedical device industry. *Journal of Business Research, 62*(4), 474-483.

Yoo, Y., Lyytinen, K., & Heo, D. (2007). Closing the gap: towards a process model of post-merger knowledge sharing. *Information Systems Journal, 17*(4), 321-347.

Zahra, S. A., & George, G. (2002). Absorptive capacity: A review, reconceptualization, and extension. *Academy of Management Review, 27*(2), 185-203.

Zhang, J., Baden-Fuller, C., & Mangematin, V. (2007). Technological knowledge base, R&D organization structure and alliance formation: Evidence from the biopharmaceutical industry. *Research Policy, 36*(4), 515-528.

Zhang, J., & Baden-Fuller, C. (2010). The influence of technological knowledge base and organizational structure on technology collaboration. *Journal of Management Studies, 47*(4), 679-704.

Zhou, K. Z., & Li, C. B. (2012). How knowledge affects radical innovation: Knowledge base, market knowledge acquisition, and internal knowledge sharing. *Strategic Management Journal, 33*(9), 1090-1102.

Zollo, M., & Meier, D. (2008). What is M&A performance? *Academy of Management Perspectives, 22*(3), 55-77.

국 문 초 록

최근의 M&A는 지난 날의 M&A와 다르다. 기존의 M&A가 시장 점유율의 확보, 규모의 경제와 범위의 경제 구축, 신시장으로의 진출 등의 목적에서 이루어졌다면 최근의 M&A는 기업 외부의 지식과 기술을 획득하기 위한 목적에서 일어나는 경우가 많다. 높아진 불확실성과 빠른 기술 변화에 대응하기 위해 적절한 외부 기술을 확보하는 것의 전략적 중요성이 높아지고 있기 때문이다. 학계에서는 이와 같은 M&A를 기술적 M&A(technological M&A)로 명명하며 기존의 M&A와 구분하고 있다. 특히 기술적 M&A는 비-기술적 M&A와 달리 M&A 후 혁신 창출에 영향을 준다는 측면에서 혁신을 통한 경쟁우위 확보에 중요한 수단으로 부상하였다. 이에 따라 기업이 기술적 M&A를 활용하여 혁신을 창출하는 과정에 대한 논의가 활발하게 진행되고 있으며, 혁신 창출을 위한 기술적 M&A 전략의 성과결정요인에 대한 연구가 주목받고 있다.

기업은 기술적 M&A를 통해 인수 기업이 기존에 가지고 있지 않았던 지식과 기술을 획득한다. 새롭게 획득한 지식은 그 자체로 혁신을 만드는데 도움을 줄 뿐만 아니라 인수 기업의 기존 지식과 결합을 통해서도 혁신을 만들게 해준다. 따라서, 기술적 M&A를 통해 어떤 혁신이 만들어지는지는 인수 기업과 피인수 기업이 어떤 지식을 가지고 있는지에 좌우된다. 이에 따라 선행 연구들은 기술적 M&A의 혁신 성과를 예측하기 위해서 M&A 전 인수 기

업과 피인수 기업의 지식 특성을 분석하는 것의 중요성을 강조하고 있다. 다시 말해, 기술적 M&A 전략을 실행하고자 하는 기업이 더 많고 다양한 혁신을 창출하기 위해서는 자신과 M&A 대상 기업의 지식 특성을 분석하고 이를 기반으로 자신에게 적합한 대상 기업을 선별해야 할 필요가 있다.

본 연구는 이와 같은 적합한 '대상 기업의 선택' 단계에서 고려해야 할 지식적 요인들을 보다 체계적으로 분석하기 위해 다양한 관점을 도입하였다. 첫째, 성과결정요인을 피인수 기업, 인수 기업, 쌍대적 관점 3가지 측면에서 파악하였다. 이 3가지 관점은 기술적 M&A의 대상 기업을 선정하는데 있어서 M&A에 참여하고 있는 개별 기업의 특성과 기업 상호 간 특성이 주는 영향을 분석할 수 있게 해준다. 다시 말해, 피인수 기업이 어떤 특성을 가질 때 혁신의 창출에 더 긍정적인 영향을 주는지 파악할 수 있게 해줄 뿐만 아니라, 인수 기업은 어떤 특성을 가질 때 피인수 기업이 가진 지식과 기술을 더 잘 활용할지, 인수 기업과 피인수 기업 간 상대적인 관점에서 둘의 시너지를 극대화하는 요인은 무엇인지를 알게 해준다. 기존 연구들은 관점을 다변화한 본 연구와 달리 하나의 관점에 한정하여 분석하는 한계를 가지고 있다. 둘째, 인수 기업의 M&A 후 혁신 성과를 양적인 증가 측면과 다양성의 증가 측면에서 살펴보았다. 인수 기업은 기술적 M&A를 통해 기존의 기술로 창출하지 못했던 혁신을 만들고자 한다. 다시 말해, 기술적 M&A를 시도하는 인수 기업은 혁신의 양적 성장과 다양성 성장 모두에 그 목적을 가지고 있다. 그럼에도 불구하고, 선행 연구들은 혁신의 양적 성장에 영향을 주는 요인들을 파악하는데 집중하고 있다. 따라서, 성과결정요인들이 혁신의 양적 성장과 다양성 성장에

주는 영향을 분석하는 것은 기술적 M&A에 대한 이해를 높여줄 수 있다. 본 연구는 이와 같은 다양한 관점을 활용하여 대상 기업을 선정하는데 있어 가장 기본적으로 고려해야 할 요소들, 혁신의 양적 성장에 영향을 주는 요소들, 혁신의 다양성 확장에 영향을 주는 요소들을 분석하며 '대상 기업의 선택'에 대한 종합적인 시각을 제공한다.

3장에서는 인수 기업과 피인수 기업의 지식의 구조가 기술적 M&A에 주는 영향을 분석한다. 기술적 M&A를 통해 인수 기업과 피인수 기업의 지식이 결합한다는 측면에서 두 기업의 지식을 분석하는 것은 가장 먼저 선행될 필요가 있다. 또한 이는 어떤 기업이 기술적 M&A 전략을 사용하는 인수 기업에 적합한지, 어떤 기업이 기술적 M&A의 대상 기업으로 적합한지를 판단하는데 도움을 주기에 대상 기업 선정 단계에서 가장 기초적으로 고려해야 할 요소이다. 분석결과에 의하면 첫째 인수 기업은 다방면에 지식을 가지고 있는 것이 혁신의 양적 성장에 긍정적인 영향을 준다는 것을 파악하였다. 둘째, 인수 기업과 반대로 피인수 기업은 다양한 지식 보다는 특정 분야에 집중된 지식을 가질 때 기술적 M&A를 통한 혁신의 양적 증가가 극대화되는 것을 확인하였다. 셋째, 인수 기업이 다방면으로 지식을 가지고 있으면서 동시에 피인수 기업이 깊이 있는 지식을 가지고 있을 때 혁신의 양적 증가에 긍정적인 시너지를 만들어 낸다는 점을 파악하였다. 종합적으로 3장의 연구 결과는 다양한 지식을 가지고 있는 대기업들이 특정 기술에 강점이 있는 벤처 기업의 지식과 기술을 획득하기 위한 전략으로 주로 사용되는 기술적 M&A가 실제로 대기업의 혁신 성과를 높이는데 긍정적인 영향을 준다는 것을 실증적으로 밝히고 있

다.

본 연구의 4장에서는 혁신의 양적 증가에 영향을 주는 요인들 중 지식의 흡수 관점에서 주요한 영향을 주는 요인들을 분석한다. 이를 위하여 4장은 쌍대적 관점에서의 대표적인 지식 요인인 두 기업 간 지식의 유사성과 소화성에 주목한다. 실증 분석 결과 첫째, 인수 기업과 적당히 유사한 분야에 지식을 가진 기업을 M&A하는 것이 중요하다는 것을 밝혔다. 인수 기업과 피인수 기업 간 높은 지식의 유사성은 인수 기업이 피인수 기업의 지식을 이해하는데 긍정적인 영향을 주지만 지식의 신규성 측면에서 인수 기업이 새롭게 배울 지식이 감소한다는 문제를 가지기 때문이다. 둘째, 인수 기업이 소화할 수 있는 크기의 지식을 가진 피인수 기업을 선택할 때 더 많은 혁신을 만들 수 있다는 것을 파악하였다. 이는 많은 지식을 가지고 있는 피인수 기업이 M&A 대상 기업으로 매력적임에도 불구하고 인수 기업의 흡수 역량을 고려한 대상 기업 선정이 필요하다는 사실을 상기시켜 주는 결과이다. 종합적으로 4장의 연구 결과는 인수 기업에게 완전히 새로운 지식을 많이 가지고 있는 기업이 지식의 획득 관점에서 좋은 대상 기업으로 보일 수 있으나 혁신을 창출하기 위한 과정인 지식의 활용 관점에서 생각해 보았을 때 오히려 부정적인 영향을 줄 수도 있다는 점을 보여준다.

5장에서는 피인수 기업과 쌍대적 관점의 주요 성과결정요인들이 혁신의 다양성 증가에 주는 영향을 분석한다. 혁신의 다양성은 최근 연구들에서 주목 받고 있는 성과 개념으로 불확실성이 높은 환경에 잘 대응하기 위하여 기업이 갖추어야 할 옵션으로 인식되고 있다. 특히 기업은 보다 빠르게 혁신

의 다양성을 높이기 위해 기술적 M&A와 같은 외부기술획득 전략을 활용하고 있다. 기술적 M&A가 혁신 다양성에 주는 영향을 분석한 결과에 의하면 첫째, 많은 지식을 가지고 있는 기업을 인수하는 것이 다방면에서 혁신을 창출하는데 긍정적인 영향을 준다는 점을 파악하였다. 둘째, 지식의 상대적인 크기 측면에서도 더 많은 지식을 가진 기업일수록 혁신의 다양성을 높이는데 더 많은 기여를 하는 것을 확인하였다. 종합적으로 5장의 결과는 혁신의 다양성은 혁신의 양과 달리 절대적으로도 상대적으로도 많은 지식이 인수 기업으로 들어와 인수 기업의 기존 루틴을 파괴하고 새로운 루틴을 만들 때에 증가할 수 있다는 것을 알려준다.

정리하면 본 논문은 기술적 M&A의 대상 기업을 선택하는데 있어 고려해야 할 요소들을 보여주며 기술적 M&A 전략과 혁신 성과 사이의 관계에 대하여 여러 측면에서 설명하고 있다. 본 논문의 연구 결과는 다음과 같은 의의를 제공한다. 첫째, 본 논문은 인수 후 혁신의 다양성에 주목해야 한다는 것을 밝혔다. 기업을 둘러싼 기술과 시장의 불확실성이 높아지고 있는 환경 속에서 미래의 변화를 정확히 예측하여 대비하는 것은 매우 어렵기에 다양한 분야에 혁신을 할 수 있는 역량을 확보하여 변화하는 미래에 가변적으로 대응할 수 있는 옵션을 만드는 것의 중요성이 높아졌다. 이에 따라 M&A를 통해서 혁신의 다양성을 높이고자 하는 기업들이 많아졌고, 인수 후 혁신의 다양성에 영향을 주는 요인을 분석하는 것이 필요하다. 본 연구는 기업이 만들어낼 수 있는 혁신의 다양성을 높이는 것이 지속가능한 경쟁우위를 확보하는데 반드시 필요하고 M&A를 통해서도 혁신의 다양성을 높일 수 있다는 것을 실증적으로

보여주었다. 둘째, 혁신 성과의 여러 측면을 고려하여 대상 기업 선정 단계부터 어떤 측면에 집중할 것인지 선택해야 한다는 것을 보여주었다. 본 연구의 연구 결과에 의하면 같은 요인이라도 혁신의 양적 성장과 혁신의 다양성 성장에 주는 영향이 다를 수 있다. 이에 따라, 본 연구가 시도한 것과 같이 혁신의 양적 성장에 영향을 준다고 알려진 요인들이 혁신의 다양성 확장에는 어떤 영향을 주는지 분석해야 할 필요가 있음을 밝혔다. 셋째, 지식의 구조가 M&A 성과에 영향을 준다는 것을 밝혔다. 기존 연구는 두 기업 지식의 연관성, 새로운 분야의 지식의 양 등 지식의 내용이 주는 영향을 분석하고 있다. 하지만 지식의 구조는 내부 R&D와 외부기술획득 전략의 효율성에 영향을 줄뿐만 아니라 미래에 창출할 혁신의 특성도 결정짓는다. 따라서, M&A 측면에서 지식의 구조를 분석하는 것은 올바른 대상 기업 선정을 위해 반드시 필요하다. 결론적으로 본 논문의 결과들은 기술적 M&A라는 새로운 M&A 전략을 성공적으로 활용하기 위해 대상 기업을 선택하는 시점에 고려해야 할 다양한 요소들을 파악하였으며 기술적 M&A 실행의 첫번째 단계인 '대상 기업 선택'을 위한 실질적 전략 수립에 기여하고 있다.

주요어 : 기술적 M&A, 혁신 성과, 혁신 다양성, 지식 기반, 지식 유사성, 지식 소화성

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