Ph. D. Dissertation in Engineering

Increasing Innovation through Alliance Portfolio Management

: Coordinating Partners, Accommodating Diversity, and Aligning Objectives

제휴 포트폴리오 관리를 통한 혁신 성과 증진

: 파트너간 조화, 다양성의 흡수, 목적 조율

February 2016

Marco JinHwan Kim

Technology Management, Economics, and Policy Program

Seoul National University

Abstract

Increasing Innovation through Alliance Portfolio Management

: Coordinating Partners, Accommodating Diversity, and Aligning Objectives

Marco JinHwan Kim
Technology Management, Economics, and Policy Program
College of Engineering
Seoul National University

With the increasing importance of innovation outcomes, alliances have become important strategic instruments allowing firms to take advantage of new knowledge for realizing innovation. For example, in some high-tech industries such as computer software and hardware, biotechnology, and telecommunications, forming alliances to support growth and innovativeness is a ubiquitous phenomenon. Firms becoming engaged in multiple simultaneous alliances face new management tasks beyond simply managing the individual alliances. Alliance and innovation literature has expanded the point of view from individual alliances and their resulting performance to also consider the alliance portfolio – all the alliances conducted by a firm – and how to manage and use it to

generate performance.

Considering the interests in the extant literature and the significance of tasks relating to alliance portfolios, this dissertation includes three different components of alliance portfolio management, namely, ‘coordinating partners’, ‘accommodating diversity’, and ‘aligning objectives’. It is important to realize that these components both individually and collectively contribute to the firm’s innovation outcome. Each component, however, requires a different portfolio management strategy to obtain the best outcome: In terms of coordinating partners, as firms increase the size of their alliance portfolios, the innovation outcome is largely depending on partners’ relationships. In terms of accommodating diversity, firms need to increase their alliance experience and proximity to their partners to accommodate diverse knowledge from their alliance portfolios. In terms of aligning objectives, for more effective innovation, firms should embrace the ambidexterity in their alliance portfolios and support their alliances with an appropriate innovation intent. This dissertation empirically examines the effects of the constituents of each component on innovation outcome to research the influence of alliance portfolio management on realizing innovation.

When firms build up their alliance portfolios, they have to coordinate the relationships among their partners as well as the size of their alliance portfolios. The relationships, which include cooperative as well as competitive ties among the focal firm’s partners, affect the flow of knowledge within the focal firm’s alliance portfolio and thus influence the amount of benefits the focal firm gains from its alliance resources.

Employing the resource-based view and a social network perspective, Chapter 3 examines the impact of network resources in alliance portfolios on the focal firms' innovation performance and how structural and competitive embeddedness in alliance portfolios positively or negatively moderates this impact. Results verify that a larger alliance portfolio leads to an improved innovation performance of the focal firm, but, at the same time, relationships among the focal firm's partners are found to affect the link between alliance portfolio size and focal firm performance. Specifically, in terms of structural embeddedness, a cooperative and densely tied portfolio strengthens the positive impact of alliance portfolio size on the focal firm's innovation performance. In terms of competitive embeddedness, a portfolio with severe competition among the partners weakens the positive impact and leads to a reduced innovation performance. These findings suggest firms to increase their alliance portfolio size and, at the same time, to keep an eye on their portfolios' two-sided network characteristics, i.e., the connectivity and competition among their partners.

Firms also need to be able to accommodate the diverse knowledge within their alliance portfolios. While an alliance portfolio which consists of diverse partners is usually beneficial to the focal firm, the maximum level of diversity that a firm can handle is determined by its extensive absorptive capacity. Chapter 4 examines the relationship between alliance portfolio diversity and innovation performance and how the absorptive capacity, developed by the focal firm's alliance experience and the proximity of knowledge between the focal firm and its alliance portfolio, moderates this relationship.

Empirical results verify an inverted u-shape relation between alliance portfolio diversity and focal firms' innovation performance. However, with accumulated alliance experience and higher proximity to partners, focal firms can accommodate more diversity in their alliance portfolios, which contributes to an improved innovation performance. These findings suggest that the maximum level of alliance portfolio diversity which contributes to innovation performance is limited, however, firms can learn to take advantage of higher diversity by building up their alliance experience and placing relatively proximate partners in their alliance portfolios.

Finally, firms should align the goals of their alliance portfolios so that they can enhance the effectiveness of their innovation outcomes. Collaborative decision making through alliances contributes to a profound understanding toward market needs and market adaptation. The evaluation of the collaborative output by collaborators with different backgrounds also increases the practicality and marketability of the resulting innovations. Thus, alliance portfolios do not only contribute to immediate innovation outcomes but can also serve to increase innovation effectiveness as well. Chapter 5 investigates the influence of alliances which aim to obtain new knowledge, i.e. exploratory alliances, on firms' innovation effectiveness. Moreover, this chapter examines some external and internal conditions which strengthen the influence of such alliances on innovation effectiveness. The results of the empirical study verify a positive relationship between the commitment to exploratory alliances and innovation effectiveness as measured by the percentage of revenue from new products. It is also confirmed that

exploitative alliances and internal innovation intent positively moderate this relationship. These findings suggest that firms' alliance portfolios can be aligned for more effective innovation outcomes through external and internal efforts. Externally, firms should organize ambidextrous alliance portfolios, and, internally, firms need to support their alliance objectives with relevant innovation intents.

In conclusion, this dissertation highlights major building blocks of alliance portfolio management that contribute to the focal firm's innovation outcome. This dissertation provides a number of important findings and implications corresponding to each component of alliance portfolio management: First, this dissertation confirms the moderation effect of partners' relationships on the link between alliance portfolio size and innovation performance and thus suggests firms to pay attention to coordinating their partners. Next, this dissertation investigates the role of alliance experience and proximity in accommodating diversity. This integrative approach to accommodating diversity shows how firms can learn to benefit from diversity in their alliance portfolios. Finally, this dissertation confirms the role of ambidextrous alliances and internal innovation intent in aligning alliance portfolios. This finding suggests firms to balance different types of alliances, i.e., exploratory and exploitative alliances, and to support alliances by integrating them into the companywide strategy. Overall, this dissertation shows that with proper alliance portfolio management, a firm's alliance portfolio is an important strategic element which contributes to the sourcing of external knowledge and realizing innovation.

Keywords: alliance portfolio management, innovation performance, alliance partner, embeddedness, alliance portfolio diversity, ambidexterity

Student Number: 2009-21083

Contents

List of Tables

List of Figures

Chapter 1. Introduction

1.1. Backgrounds

Alliances have become significant strategic instruments allowing firms to take advantage of new knowledge for realizing innovation. As shown in the example of alliances in the micro-electronics industry in Figure 1, in some high-tech industries such as computer software and hardware, biotechnology, and telecommunications, forming alliances to support growth and innovativeness is a ubiquitous phenomenon. Firms simultaneously engaging in multiple alliances face new management tasks beyond simply

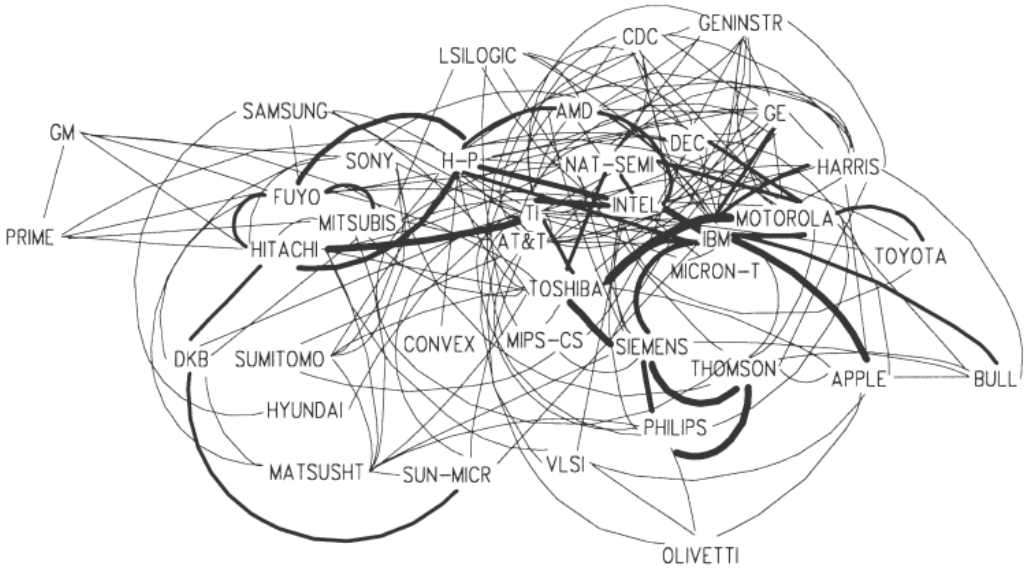
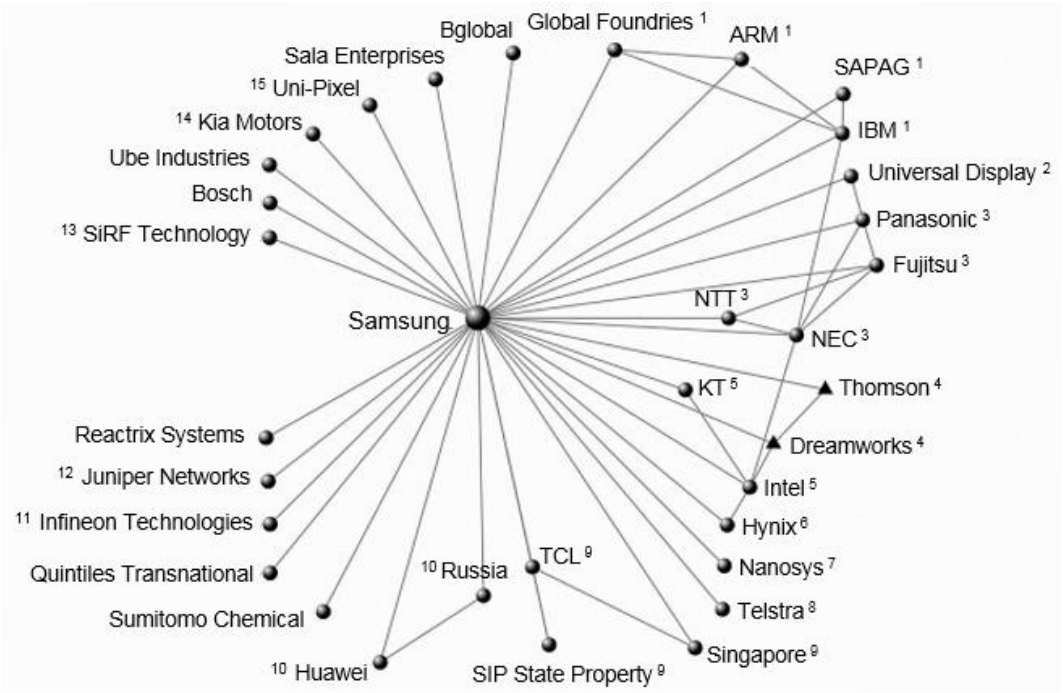


Figure 1. Alliances in the micro-electronics industry. Source: MERIT-CATI Database (as cited in Duysters, De Man, & Wildeman, 1999).

managing the individual alliances. For managing individual alliances, firms' strategy is focused on selecting partners based on individual fit and exchanging bilateral knowledge (Duysters et al., 1999). However, for managing multiple alliances, firms should pay more attention to the interdependency between the individual alliances and their potential positive or negative synergies (Lichtenthaler & Lichtenthaler, 2004).

In order to address the issues stemming from managing multiple alliances at the same time, alliance and innovation literature has expanded the point of view from individual alliances and their resulting performance to considering the "alliance portfolio" and how to manage and use it to generate performance. Previous literature has achieved an adequate consensus on the definition of an alliance portfolio – all the alliances conducted by a firm –, however, exhibits different perspectives on its definition. According to the perspectives and aims of the extant studies, an alliance portfolio is understood as a list of all ongoing alliances of a focal firm (Bae & Gargiulo, 2004; Hoffmann, 2005, 2007), an egocentric social network of a focal firm (Baum et al., 2000; Rowley et al., 2000) or the accumulated alliance experience of a focal firm (Reuer et al., 2002; Reuer & Ragozzino, 2006). For example, Figure 2 shows the alliance portfolio of Samsung Electronics during the 2008-2011 period. Based on the social network perspective, this figure also contains the ties between Samsung Electronics' partners.

Adopting theses different perspectives and definitions, a broad range of theoretical lenses has been used to study alliance portfolios in previous literature. They are social network theory (e.g. Ahuja, 2000a, 2000b; Baum et al., 2000; Gulati, 1999; Stuart, 2000),



1	Semiconductors	6	Semiconductor R&D	11	Mobiles chips in Germany
2	LED	7	Nanotech screens/batteries	12	Mobile security
3	Chips for mobiles	8	Real time IPTV	13	GPS
4	3D movies	9	LCD	14	Tablets in cars
5	3D over air	10	4G	15	LCD

Figure 2. Alliances of Samsung Electronics during the 2008-2011 period. Source: Shipilov (2013, Sep 26).

resource-based view (e.g. Chung et al., 2000; Lavie, 2006) and resource dependency theory (e.g. Bae & Ggargiulo, 2004; Ozcan & Eisenhardt, 2009), organizational learning (e.g. Anand & Khanna, 2000; George et al., 2001; Kale et al., 2002) including exploration and exploitation perspectives (e.g. Lavie & Rosenkopf, 2006; Rothaermel, 2001), transaction cost economics (e.g. Goerzen, 2007; Goerzen & Beamish, 2005), etc. For an

increased understanding of alliance portfolios from diverse perspectives, most prior studies integrate two or more theoretical lenses and examine the cause and effect relationships relating to alliance portfolios.

Recently alliance managers and scholars' interests are centered on the systematic management approach required for operating an effective alliance portfolio. This approach is not only constrained to the holistic approach toward an alliance portfolio (e.g. Bamford & Ernst, 2002; Duysters et al., 1999; Hoffmann, 2005; Parise & Casher, 2003), which pursues a positive synergy between partners and the global optimum within the portfolio, but also includes an extensive process for building and managing an alliance portfolio which helps to effectively acquire external knowledge, turn it into an increased performance and thus contribute to the sustainability of the focal firm. In a similar vein, some seminal studies in alliance portfolio literature suggest ideas for managing an alliance portfolio as a whole. For example, Parise and Casher (2003) suggest an alliance portfolio model which starts from the designing of the alliance portfolio and ultimately embraces individual alliance factors and portfolio management factors. Hoffmann (2005) suggests an alliance management system that involves the co-ordination and monitoring of the portfolio as well as the whole portfolio strategy. In a later work, Hoffmann (2007) also suggests a typology of alliance strategies which includes shaping, adapting, and stabilizing an alliance portfolio. In a review paper of Wassmer (2010), this trend in alliance portfolio literature is reflected and the extant studies are classified as focusing on the emergence, configuration, or management of alliance portfolios. One can clearly state

that the emphasis on a systematic and strategic approach toward managing alliance portfolios has been greatly increased during recent years.

1.2. Research purpose

With an increasing significance of and need for technology management, this dissertation is focused on technology alliances and firms' technology alliance portfolios. Technology alliances are a major tool for acquiring valuable external knowledge or creating new knowledge. Depending more on external resources in the open innovation era (Bae & Gargiulo, 2004; Ozcan & Eisenhardt, 2009), firms acknowledge the significance of technology alliances more than ever before. The aim of this dissertation is to systemize the management of technology alliance portfolios that contributes to increasing innovation outcomes in diverse ways. Through investigating diverse aspects of the portfolio management, the present dissertation expects that firms are better able to understand the integrative way of how to manage their alliance portfolios and in turn become better at realizing innovation.

Integrating the approaches found in the extant literature and tasks relating to managing technology alliance portfolios, this dissertation classifies alliance portfolio management into three different components, namely, coordinating partners, accommodating diversity, and aligning objectives. It is important to realize that these

components both individually and collectively contribute to the innovation outcome. Each component, however, requires a different portfolio management strategy to obtain the best outcome: In terms of coordinating partners, firms should not only increase the size of their alliance portfolios, but also, to utilize them as an innovation tool, coordinate the relationships between their partners. In terms of accommodating diversity, firms need to increase their alliance experience and pay attention to the knowledge gap between them and their alliance partners to accommodate diverse knowledge from their alliance portfolios. In terms of aligning objectives, for more effective innovation, firms should embrace the ambidexterity in their alliance portfolios and support their alliances with an appropriate innovation intent. This dissertation empirically examines the effects of the constituents of each component on innovation outcome to research the influence of alliance portfolio management on realizing innovation.

1.3. Research outline

The main body of this dissertation consists of three different parts: the literature review, three different empirical studies corresponding to each component of alliance portfolio management, and the overall conclusions.

Chapter 2 covers the literature review. Specifically, this chapter introduces the extant approach toward alliance portfolio management and how it relates to the approach

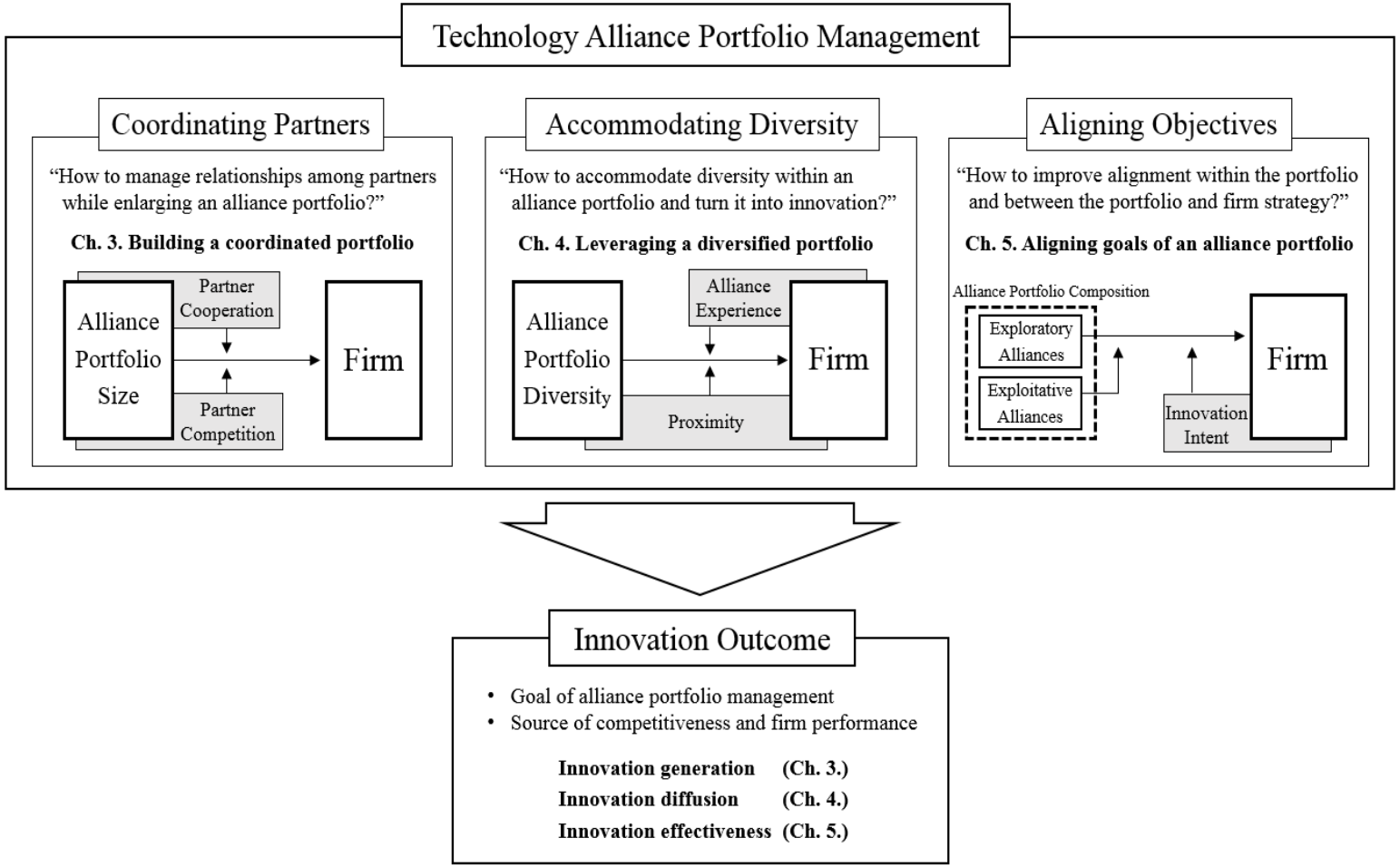


Figure 3. The key components of alliance portfolio management for increasing innovation.

of this dissertation. Moreover, Chapter 2 introduces the theoretical backgrounds of the subsequent empirical studies of this dissertation and connects the arguments of this thesis with the realm of the extant literature.

Three different empirical studies are covered in Chapters 3, 4, and 5. Figure 3 provides an overview of the three components of alliance portfolio management that correspond to the different empirical studies of this dissertation.

Focusing on the relationships between alliance partners, Chapter 3 discusses the coordination of alliance partners and provides implications on how to form and grow alliance portfolios. When firms build up their alliance portfolios, they have to take care of the relationships among their partners as well as the size of their alliance portfolios. The relationships, which include cooperative as well as competitive ties among the focal firm's partners, affect the flow of knowledge within the focal firm's alliance portfolio and thus influence the amount of benefits the focal firm gains from its alliance resources. Employing the resource-based view and a social network perspective, Chapter 3 examines the impact of network resources in alliance portfolios on the focal firms' innovation performance and how structural and competitive embeddedness in alliance portfolios positively or negatively moderate this impact. Results verify that a larger alliance portfolio leads to an improved innovation performance of the focal firm, but, at the same time, relationships among the focal firm's partners are found to affect the link between alliance portfolio size and focal firm performance. Specifically, in terms of structural embeddedness, a cooperative and densely tied portfolio strengthens the positive

impact of alliance portfolio size on the focal firm's innovation performance. In terms of competitive embeddedness, a portfolio with severe competition among the partners weakens the positive impact and leads to a reduced innovation performance. These findings suggest firms to increase their alliance portfolio size and, at the same time, to keep an eye on their portfolios' two-sided network characteristics, i.e. the connectivity and competition among their partners.

Chapter 4 discusses how to fully leverage diversified alliance portfolios and turn them into innovation. While an alliance portfolio which consists of diverse partners is usually beneficial to the focal firm, the maximum level of diversity that a firm can handle is determined by its extensive absorptive capacity. To improve their absorptive capacity, firms need to build up alliance experience and manage the knowledge distance between them and their alliance partners. Chapter 4 examines the influence of alliance portfolio diversity on innovation performance and how the focal firm's alliance experience and the proximity of knowledge between the focal firm and its alliance portfolio moderate this influence. Empirical results verify an inverted u-shape relation between alliance portfolio diversity and focal firms' innovation performance. However, with accumulated alliance experience and higher proximity to partners, focal firms can accommodate more diversity in their alliance portfolios, which contributes to an improved innovation performance. These findings suggest that the maximum level of alliance portfolio diversity which contributes to innovation performance is limited. However, firms can learn to take advantage of higher diversity through accumulated alliance experience and proximate

partners.

Focusing on the innovation effectiveness achieved by ambidextrous alliance strategy and internal innovation intent, Chapter 5 discusses the alignment of alliance portfolios. Collaborative decision making through alliances contributes to a profound understanding toward market needs and market adaptation. The evaluation of the collaborative output by collaborators with different backgrounds also increases the practicality and marketability of the resulting innovations. Thus, alliance portfolios do not only contribute to immediate innovation outcomes but can also serve to increase innovation effectiveness as well. Chapter 5 investigates the influence of alliances which aim to obtain new knowledge on firms' innovation effectiveness. Moreover, by aligning their alliance portfolios in diverse ways, firms can enhance the effectiveness of their innovation outcomes. Thus, this chapter examines some internal and external organizational factors which strengthen the influence of alliances on innovation effectiveness. The results of the empirical study verify a positive relationship between the commitment to exploratory alliances and innovation effectiveness as measured by the percentage of revenue from new products. It is also confirmed that exploitative alliances and internal innovation intent positively moderate this relationship. These findings suggest the importance of ambidexterity within the alliance portfolios and the need for an alignment of firms' strategic intents with their alliance objectives.

Finally, Chapter 6 provides a summary of the results of this dissertation and concludes with a discussion of implications, limitations, and directions of future research.

Chapter 2. Literature review

2.1. Alliance portfolio management

2.1.1. The definition of alliance portfolios

Initial studies relating to multiple alliance phenomenon, mainly conducted by social network theorists, focused on the alliance network per se as a unit of analysis. This approach is useful for understanding the process of how the whole network grows and develops (e.g. Gulati & Gargiulo, 1999), but lacks implications for individual performance within the network. Later studies, which still choose a whole alliance network as a unit of analysis (e.g. Schilling & Phelps, 2007), made further efforts to provide implications on the individuals' performance within the network. However, they have not sufficiently reflected idiosyncratic characteristics of the constituent individuals and the associated performance (Barney, 1991; Peteraf, 1993). Moreover, the whole network approach cannot fully incorporate diverse alliance partners of individual firms from different industrial backgrounds because an alliance network has been usually considered within a single industry. As exemplified in the figures in Chapter 1, by solely identifying the alliance network in the micro-electronics industry (Figure 1), Samsung electronics' entire alliance partners from a wide array of industries (Figure 2) and their influences cannot be captured. Thus, to overcome such limitations of the whole network

approach and to provide firm-specific implications, scholars in management and strategy literature (e.g. Baum et al., 2000; Rowley et al., 2000) have paid more attention to a focal firm's direct ties with different partners, i.e., its alliance portfolio (Wassmer, 2010). Such an individual level of analysis contributes to understanding how a firm's unique web of contacts (its egocentric "universe") affects its power, advancement, perceptions and attitudes as well as the social support toward it (Morrison, 2002; Walker, Wasserman, & Wellman, 1993).

For the specific definition of an alliance portfolio, previous studies have achieved an adequate consensus – all the alliances conducted by the focal firm –, however, according to the fields they are stemming from, also exhibit different perspectives on what exactly constitutes an alliance portfolio. The most common approach to define an alliance portfolio is viewing it as the aggregate of all strategic alliances of a focal firm (Bae and Gargiulo, 2004; George et al., 2001; Hoffmann, 2005, 2007; Lavie, 2007; Lavie and Miller, 2008; Marino et al., 2002). Studies in network literature define an alliance portfolio as the focal firm's egocentric alliance network which includes all direct ties with the partner firms and ties between the focal firm's direct partners (Baum et al., 2000; Rowley et al., 2000; Ozcan and Eisenhardt, 2009). Organizational learning literature focuses on alliance experience and defines an alliance portfolio as a focal firm's accumulated alliance experience which includes past as well as ongoing alliances (Anand and Khanna, 2000; Kale et al. 2002; Reuer et al. 2002; Hoang and Rothaermel, 2005; Park and Kang, 2010).

This dissertation adopts these different points of view on the definition of an alliance portfolio and uses them according to the purpose of each chapter. In Chapter 3, to focus on the structural and competitive embeddedness in alliance portfolios, the egocentric network approach is used to define each focal firm's alliance portfolio. Chapter 4 highlights learning through alliances and, though it does not exhaustively include past alliances, adopts the organizational learning perspective in order to define the alliance portfolio. In Chapter 5, the information of all alliance partners including alliance type, e.g. technology or other type of alliances, is collected in order to examine the influence of exploratory and exploitative alliances.

2.1.2. A holistic approach toward alliance portfolios

Firms simultaneously engaging in multiple alliances face new management tasks beyond simply managing the individual alliances. In a multi-alliance situation, on top of individual alliance outcomes, alliance managers have to pay more attention to the overall success of alliances (Fricke & Shenhar, 2000). Table 1 compares different managerial perspectives relating to an individual alliance and an alliance portfolio. While individual alliances pursue a local optimum at the alliance level, the alliance portfolio approach pursues the global optimum at the portfolio level. This difference is mainly attributable to the fact that the local rationality can lead to the positive or negative influence on other

alliances (Lichtenthaler & Lichtenthaler, 2004). Due to this interdependency, managing an alliance portfolio involves a higher complexity than managing a single alliance and, hence, requires a holistic approach across all alliance partners. Firms should continuously monitor the influence of individual alliances on each other and the overall performance of alliance portfolios and change the configuration of their portfolios in order to generate a positive synergy and avoid conflicts (Duysters et al., 1999; Hoffmann, 2005; Parise & Casher, 2003).

Table 1. Different perspectives on managing individual alliances and an alliance portfolio

	Individual Alliance	**Alliance Portfolio**
Objective	Local optimum	Overall optimum
Strategic focus	Individual partner fit Bilateral knowledge exchange Manage alliances as separate contracts	Portfolio fit Knowledge leverage across partners Manage alliances as a set of competences
Complexity	Relatively low	High due to the interdependency
Opportunities/ Threats	Limited to the individual alliances	Potential positive or negative synergies
Top management involvement	Top management initiates and evaluates	Top management moderates and prioritizes

Source: Duysters et al. (1999), Lichtenthaler & Lichtenthaler (2004), etc.

For a more systematic and holistic approach towards alliance portfolio management, it is required for firms to have a superior management perspective which

incorporates the individual alliance strategy and alliance portfolio strategy into the realm of corporate strategy (Duysters et al., 1999). In case of managing a single alliance, the top management of firms initiates the alliance and evaluates the outcomes of the alliance in the final stage of the alliance. However, with the superior perspective, the top management pays more attention to the interplay of individual alliance strategy, alliance portfolio strategy, and corporate strategy. Hence, at a corporate level, they prioritize the alliance portfolio strategy and continuously moderate their alliance portfolios.

2.1.3. Theoretical lenses used in alliance portfolio research

A broad range of theoretical lenses from the strategy literature has been used to study alliance portfolios in previous literature. Table 2 introduces these theoretical lenses and related prior studies. Major theoretical pillars in alliance portfolio literature are social network theory (e.g. Ahuja, 2000a, 2000b; Baum et al., 2000; Gulati, 1999; Stuart, 2000), resource-based view (e.g. Lavie, 2006; Vassolo et al., 2004) and organizational learning (e.g. Anand & Khanna, 2000; George et al., 2001; Kale et al., 2002) including the exploration and exploitation perspectives (e.g. Lavie & Rosenkopf, 2006; Rothaermel, 2001). As shown in Table 2, around these major pillars, a number of prior studies integrate two or more theoretical lenses and examine the cause and effect relationships relating to alliance portfolios (Wassmer, 2010).

Table 2. Theoretical backgrounds applied to alliance portfolio literature

Theoretical background	Related studies (selected)
Resource-based view	Ahuja (2000a, 2000b), Eisenhardt & Schoonhoven (1996); Lavie (2006), Park et al. (2002), Vassolo et al., (2004)
Knowledge-based view	Kale et al. (2002), Lorenzoni & Lipparini (1999)
Social network theory	Ahuja (2000a, 2000b), Baum et al. (2000), Goerzen (2007), Goerzen, & Beamish (2005), Gulati (1998, 1999), Koka & Prescott (2002), Powell et al. (1996), Stuart (2000), Walker et al. (1997)
Relational view	Dyer & Singh (1998), Gulati et al. (2000)
Organizational learning	Anand & Khanna (2000), Deeds & Hill (1996), George et al. (2001), Gulati (1999), Hoang & Rothaermel (2005), Kale et al. (2002), Powell et al. (1996), Stuart (2000)
Exploration/exploitation	Lavie & Rosenkopf (2006), Rothaermel (2001)
Contingency theory	Hoffmann (2007)
Dynamic capabilities	Kale et al. (2002), Lorenzoni & Lipparini (1999)
Agency theory	Reuer & Ragozzino (2006)
Real options	Vassolo et al. (2004)
Evolutionary economics	Kale et al. (2002)
Transaction cost economics	Goerzen (2007), Goerzen & Beamish (2005)
Coevolutionary perspective	Hoffmann (2007)

Source: Hoffmann (2007), Wassmer (2010), etc.

Consistent with the approach in previous literature, this dissertation also adopts diverse theoretical backgrounds at the same time and increases the understanding relating to the major issues in each chapter. Chapter 3, to study the effect of network resources and how the embeddedness affects the outcome of the alliance portfolio, adopted the resource-based view and social network theory. Based on resource-based view, transaction cost economics and related contingency theory, Chapter 4 presents the pros and cons of alliance portfolio diversity. Furthermore, Chapter 4 examines the role of alliance experience and knowledge proximity in leveraging diversified alliance portfolios, hence, theoretical lenses such as organizational learning and knowledge-based view are adopted. In Chapter 5, focusing on the alignment of alliance portfolios through an ambidextrous strategy, the exploration and exploitation perspectives are adopted. Across the Sections 2.2. to 2.4. of this dissertation, these theoretical backgrounds are directly related with the research questions of subsequent chapters.

2.1.4. Alliance portfolio management and its components

Beyond a holistic approach toward alliance portfolios, alliance managers and scholars' interests are focused on a specific process for configuring and managing an alliance portfolio which leads to a positive synergy between alliances, allow the focal firm to effectively acquire external knowledge, and ultimately turn it into an increased

performance of the focal firm. Some influential studies in alliance portfolio literature suggest such processes toward managing alliance portfolios as follow:

Parise and Casher (2003) propose an alliance portfolio model which consists of "alliance portfolio design", "individual alliance factors", and "alliance portfolio management". These different constituents of the alliance portfolio model interact with each other and ultimately affect the success of each alliance and the portfolio as a whole. They suggest that, in terms of alliance portfolio design, firms should examine the impact of each alliance on one another and continuously change the composition of their alliance portfolios. Relating to individual alliance factors, they focus on trust in alliance relationships and highlights learning opportunities in alliance relationships. For alliance portfolio management, they point out the alignment of strategic objectives between the alliance portfolio and the corporation and attempt to introduce a measure for the overall portfolio performance.

In case of Hoffmann (2005)'s conceptual study of "how to manage a portfolio of alliances", he proposes tasks of alliance portfolio management which include "portfolio co-ordination", "portfolio monitoring", and "portfolio strategy". The aim of portfolio co-ordination is to utilize synergies among different alliance partners and, at the same time, to avoid conflicts among these alliances. Portfolio monitoring allows the focal firms to investigate the reasons why the performance of their alliance portfolios falls short of expectations and systemize the processes of learning from the alliance portfolios through routinization and formalization. Portfolio strategy is focused on the balance between

exploration and exploitation alliances and aims for the alignment of alliance strategy, business strategy and corporate strategy.

Further, to cope with a complex and changing environment, Hoffmann (2007) classifies alliance strategies into “shaping strategy”, “adapting strategy”, and “stabilizing strategy”. Shaping strategy refers to expanding alliance portfolios centered on core exploration alliances which contribute to developing new opportunities in a certain field. Meanwhile, the goal of adapting strategy is broadening the resource base of alliance portfolios through “probing alliances” in diverse fields (Kogut & Kulatilaka, 1994) and increasing the strategic flexibility of alliance portfolios. Finally, stabilizing strategy highlights the role of exploitation alliances, which commercialize resources and capabilities gained through exploration (Koza & Lewin, 1998).

The aforementioned studies are based on different perspectives of managing alliance portfolios, however, they provide a similar approach on how to manage an alliance portfolio. Parise and Casher (2003) and Hoffmann (2005), throughout their approaches, suggest firms to scrutinize the interdependency among different alliances and learning mechanisms for absorbing knowledge in their alliance portfolios, and finally, to align their alliance portfolios per se and have them go along with their business or corporate level strategy. These approaches are fairly related to the main research topics of this thesis, i.e., how to coordinate individual alliances in terms of a portfolio, how to fully capture learning opportunities from a diversified alliance portfolio, and how to align the objectives of an alliance portfolio across a variety of organizational levels. On top of that,

as described above, Hoffmann (2007) emphasizes several alliance portfolio strategies - shaping, adapting and stabilizing - which are respectively similar to the coordination, diversity accommodation and object alignment of an alliance portfolio in the present dissertation.

Arranging the approaches of managing alliance portfolios found in the extant literature, this dissertation discusses three integrative components of technology alliance portfolio management. First, in terms of coordinating partners, while expanding alliance portfolios, firms should explore new technology opportunities and, at the same time, pay attention to the interdependency among their alliance partners. Second, in terms of accommodating diversity, firms should acquire external knowledge through their diversified alliance portfolios and monitor the smooth knowledge transfer from their portfolios. Third, in terms of aligning objectives, firms should stabilize their alliance portfolios through ambidexterity and have them align with the business or corporate level strategy. Table 3 compares these three components of alliance portfolio management with the approach in the extant studies. Although not the prior approach exactly coincides with each component in the present dissertation, a high level of affinity between them is identified and corroborates the claims of the present dissertation.

Additionally, Table 3 includes major streams of alliance portfolio literature, the emergence, configuration and management of alliance portfolios, identified in a review paper of Wassmer (2010) and also compares these streams with the components of alliance portfolio management of the present dissertation. The emergence of alliance

Table 3. Comparison of alliance portfolio management approaches between prior studies and the management components described in the present dissertation

Prior studies	Alliance Portfolio Management Components		
	Coordinating Partners	**Accommodating Diversity**	**Aligning Objectives**
Parise & Casher (2003): Alliance Portfolio Model	alliance portfolio design individual alliance factors	individual alliance factors	alliance portfolio management
Hoffmann (2005): Tasks of alliance portfolio management	portfolio co-ordination	portfolio monitoring	portfolio strategy
Hoffmann (2007): Typology of alliance strategies	shaping strategy	adapting strategy	stabilizing strategy
Wassmer (2010): Classification of alliance portfolio research	emergence configuration	configuration management	management

portfolios is about why and how firms build alliance portfolios. The configuration stream deals with multiple dimensions of alliance portfolios such as size, breadth, density, partner characteristics, etc. The management of alliance portfolios mainly focuses on firms' alliance capability and how to simultaneously manage multiple alliances.

2.2. Enlarging and coordinating alliance portfolios

2.2.1. The size effect of alliance portfolios

Based on a broad range of theoretical backgrounds, resource-based view, social network theory and basic economic theory, previous literature discusses how alliance portfolio size affects the focal firms' performance (Wassmer, 2010). An initial stream of research suggests that alliance portfolio size contributes to explaining the performance differential among firms (Wassmer, 2010) and confirms a positive relationship between the number of alliance partners and firms' innovation outcomes such as patenting rates (Shan et al., 1994) or new product development (Deeds & Hill, 1996). Larger alliance portfolios allow firms to access more network resources and thus contribute to an increased innovation performance. However, alliance portfolio size alone might not be a sufficient predictor for performance (Wassmer, 2010). A later stream of research raises the possibility of diminishing returns from alliance portfolio size. Studies in this stream suggest that, in addition to size, alliance portfolio breadth (Ahuja, 2000a, Gulati, 1999), efficiency (Baum

et al., 2000) and alliance partner quality (Stuart, 2000; Stuart et al., 1999) can serve as suitable predictors for firm performance. Therefore, for firms, having access to diverse and quality partners and an efficient portfolio configuration are as or even more important for the performance than alliance portfolio size alone (Wassmer, 2010).

2.2.2. Embeddedness in alliance portfolios

In chapter 3, in the formation stage, this dissertation focuses on the social network characteristics of alliance portfolios. A number of social network studies, for the theoretical background, have adopted an embeddedness lens. The key argument of embeddedness is that actors' actions and outcomes are influenced by the relationships that surround them (Baum and Dutton, 1996; Dacin et al., 1999; Granovetter, 1985). Specifically, network embeddedness describes a firm's social structure, the extent to which it is connected to others and how those other firms are interconnected to each other (Granovetter, 1992; Nahapiet & Ghoshal, 1998). Some researchers describe the influence of embeddedness as follows. Granovetter (1985) suggests that an actor's social surroundings facilitate or constrain his or her economic actions. Strategic actions of a firm are determined not only by its internal context but also by its social context (Echols & Tsai, 2005; Gulati & Gargiulo, 1999). In line with this stream, researchers focus on holistic characteristics (i.e. structural embeddedness, sectoral embeddedness, etc.) of

alliance portfolios and how they affect a firm's new alliance formations. For example, Garcia-Pont and Nohria (2002) suggest that structural embeddedness in an alliance network affects the likelihood of alliance formation between firms in the network, and Hagedoorn (1993) suggests that firms' sectoral embeddedness affects their propensity to engage in new alliances. Contrary to the somewhat positive view of the role of embeddedness in alliance formations, some researchers suggest possibilities of decreasing opportunities for new alliances under conditions of increasing social embeddedness (Burt, 1992; Duysters, Hagedoorn, & Lemmens, 2003; Hagedoorn, Letterie, & Palm, 2007; Uzzi, 1997).

Moreover, the embeddedness perspective suggests that the interfirm network influences the flow of knowledge and resources among them (Chen, 1996; Gnyawali and Madhavan, 2001). Within its alliance portfolio, the focal firm has a structural advantage which provides it with simultaneous access to its network resources and this advantage increases with the portfolio size (Zukin and DiMaggio, 1990; Gulati, 1998). At the same time, relationships among the focal firm's partners also affect the flow of resources within the portfolio. Specifically, the flow of knowledge within the alliance portfolio is influenced by the extent to which partners are interconnected with each other (structural embeddedness) and how partners compete with each other (competitive embeddedness).

In conclusion, relationships among a firm's partners determine the flow of knowledge within its alliance portfolio and affect its innovation performance. Therefore, firms should not only focus on increasing their portfolios but, at the same time, consider

the relationships among their partners as an important configurational factor of their portfolios.

2.2.3. The influence of structural embeddedness

The structural embeddedness perspective suggests that a superior position in a cooperative network translates into resource advantages (Gnyawali and Madhavan, 2001). Previous literature exemplifies variables related to structural embeddedness such as structural holes (Burt, 1992), centrality (Freeman, 1979; Bonacich, 1987; Ibarra, 1993; Podolny, 1993), structural equivalence (Burt, 1987), and density (Coleman, 1988). Gnyawali and Madhavan (2001) classify them into the structural properties of firm-level, pair-level and network-level and point out the density as a network-level structural variable. Density in this context refers to the extent of interconnectedness among the actors in a network. In Chapter 3, this dissertation investigates how the extent of interconnections among partners affect the flow of resources within an alliance portfolio and, therefore, among the variables related to structural embeddedness, focuses on the density.

The existing views toward the effects of network density are divergent. A dense network is advantageous in building up absorptive capacity of actors within the network but at the same time limits novelty creation within the network (Gilsing et al., 2008).

Specifically, a dense alliance portfolio provides the following advantages to the focal firm. First, in the case of a large technological distance between the focal firm and one of its partners, another partner, tied to the first one, complements the focal firm's absorptive capacity and helps to narrow down the technological gap (Gilsing & Nooteboom, 2005). Connections among the focal firm's partners increase the similarity of their knowledge base and allow the focal firm to easily absorb and understand its partners' knowledge (Gilsing et al., 2008). Second, the focal firm may easily judge the reliability of information from its partners through its dense alliance portfolio (Gilsing and Nooteboom, 2005). Triangulations which consists of the focal firm and its partners allow the focal firm to objectively evaluate the acquired novelty from each partner (Rowley et al., 2000). Third, a dense alliance portfolio facilitates the build-up of trust based on a reputation mechanism and coalitions to constrain opportunism (Gulati, 1995a, b; Hagedoorn & Duysters, 2002). These advantages are also suggested by Coleman (1999)'s network closure theory and become more effective in the case of high uncertainty of technology development (Nooteboom, 1999, 2002).

However, the dense portfolio may lead to a number of disadvantages to the focal firm. First, it inhibits the inflow of novel and diverse knowledge. In a dense network, due to knowledge spread, 'everyone knows what everyone knows' (Gilsing et al., 2008). Therefore the novelty of knowledge accessed by the focal firm declines and this in turn decreases the innovation performance (Gilsing et al., 2008). Second, there is a risk of undesirable spillovers which makes the focal firm reluctant to share valuable knowledge

with other partners in the portfolio. This restricts the focal firm's ability to appropriate novelty in its alliance portfolio (Gilsing and Nooteboom, 2005). Third, a dense network may create a strong behavioral pressure which forces the actors to conform rather than to be radically different (Kraatz, 1998). Therefore, a dense alliance portfolio may force the focal firm into coalitions with existing partners and to show loyalty toward them and, therefore, imposes restrictions on entering relationships with new and more innovative partners (Buchko, 1994; Nooteboom, 1999; Duysters and Lemmens, 2003; Gulati et al., 2000).

2.2.4. The influence of competitive embeddedness

Competitive embeddedness is a theoretical concept which accounts for how competitive relations affect alliance formations. Competitive relations refer to firms competing for limited resources or targeting the same market and include direct rivalry and indirect rivalry (McPherson, 1983). In previous literature in the field of competitive embeddedness, Trapido (2007) builds on the co-opetition concept (Brandenburger & Nalebuff, 1996) and explores how the likelihood of cooperation between two firms is influenced by their direct rivalry. Gimeno (2004) emphasizes that various network perspectives such as indirect ties have not been fully adopted to account for the relationship between competitive relations and alliance formations in existing literature.

Accordingly, Gimeno (2004) explores the likelihood of cooperation between two firms in case of their indirect rivalry. When two firms with high niche overlap have a common partner, they are considered to be substitutes in the common partner's point of view and cannot appropriate rents from the partner.

Competitive embeddedness in this dissertation differs from existing competitive embeddedness literature in two perspectives. First, existing literature highlights the impact of a focal firm's rivalry (direct or indirect) on its alliance formations. Trapido (2007) pays attention to the alliance link formation between a focal firm and its direct rival (Figure 4) while Gimeno (2004) pays attention to the alliance link formation between a focal firm and its rival's partner (Figure 5). In the meantime, this dissertation, in Chapter 3, pays attention to the impact of rivalry between a focal firm's partners on the focal firm's alliance formations (Figure 6). This dissertation is interested in competitive relations among partners of a focal firm and how these competitive relations affect the focal firm's alliance formations with existing or new partners. Second, the aforementioned differences between existing literature and this dissertation lead to going beyond analyzing dyadic relationships of a focal firm and instead to focus on the focal firm's alliance portfolio as the unit of analysis. As depicted in Figure 6, within the portfolio, rivalries can take place across many partners of a focal firm and potentially affect all the alliance links of the focal firm.

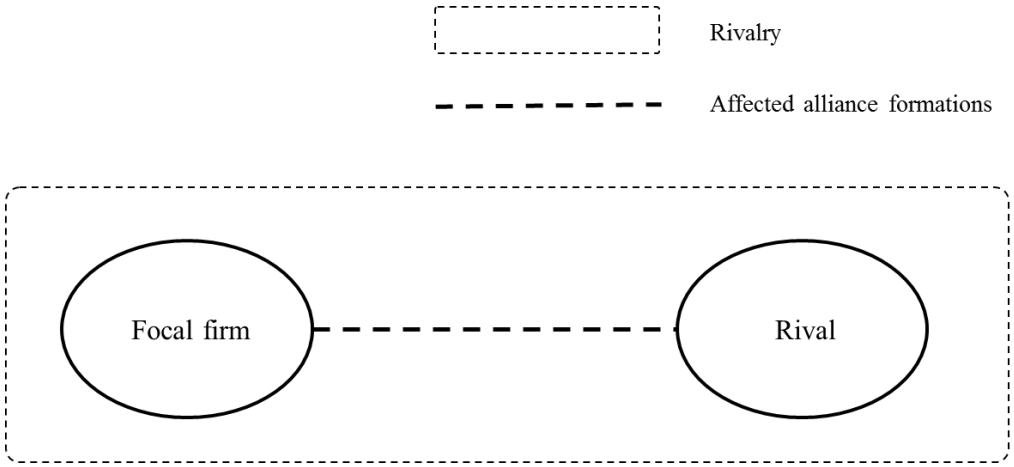


Figure 4. The influence of competitive embeddedness in Trapido (2007).

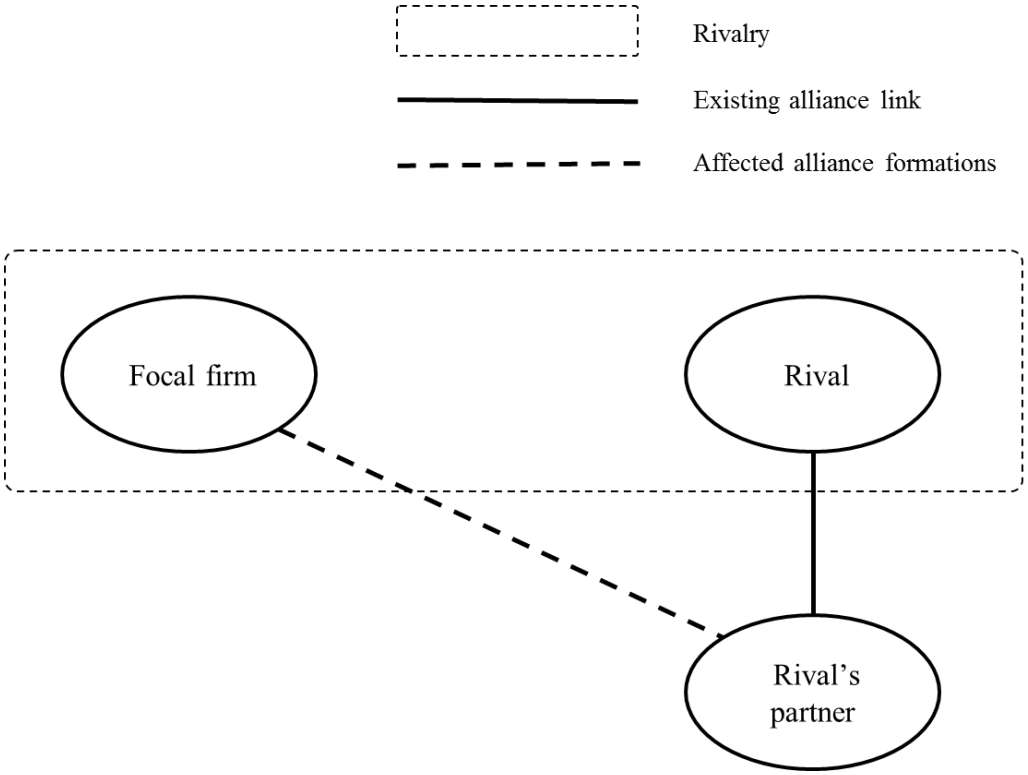


Figure 5. The influence of competitive embeddedness in Gimeno (2004).

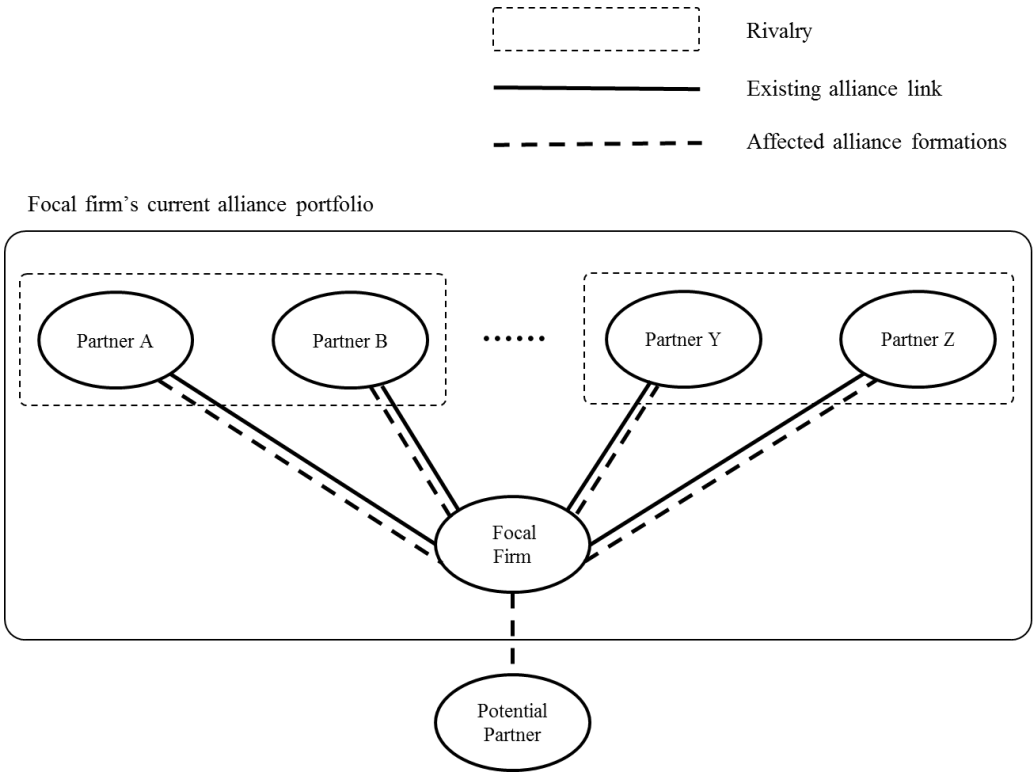


Figure 6. The influence of competitive embeddedness in the present dissertation.

2.3. Accommodating diversity of alliance portfolios

2.3.1. Alliance portfolio diversity and its influences on firm performance

Alliance portfolio diversity is defined as the level or the distribution of differences among types of a firm's alliance partners, for example, the industry the partners are involved in, their governance or organizational forms, their functions in a value chain and technologies they are possessing (Bruyaka & Durand, 2012; Oerlemans et al., 2013). The

extant studies have introduced these various dimensions of alliance portfolio diversity and examined their influences on firm performance. For example, Yamakawa et al. (2011), focusing on the functional diversity, find a negative relationship between a high proportion of exploitative ties and firms' return on assets. Jiang et al. (2010) show that greater organizational and functional diversity and lower governance diversity in alliance portfolios lead to a higher net profit of the focal firms, while partner diversity exhibits a non-linear relationship with net profit. Lavie and Miller (2008) suggest a sigmoid influence of international and geographical diversity on firms' financial performance.

Relating to the partner diversity, as shown in Jiang et al. (2010), a number of prior studies confirm a non-linear or a curvilinear relation between the diversity and firm performance, especially the innovation outcome. This relationship can be explained by the extended resource-based view (Lavie, 2006) and organizational economics (Belderbos et al., 2006). At a low level of portfolio diversity, firms become surrounded by partners that possess similar resources and capabilities and have limited opportunities to acquire complementary and novel knowledge (Faems et al., 2005). As a result, the outcomes of alliance portfolio would exhibit a relatively low level of innovativeness. In the meantime, at an intermediate level of portfolio diversity, firms can avoid the overlap of knowledge among alliance partners and have an increased access to complementary and novel knowledge (Oerlemans et al., 2013). Moreover, a moderate level of alliance diversity diminishes intra-portfolio competition costs (Belderbos et al., 2006) and does not give rise to extremely complex managerial issues (Bruyaka and Durand, 2012). Thus firms are

most able to take advantage of the benefits from their alliance portfolios. As the level of portfolio diversity further increases, managerial costs (e.g. the costs of coordination, monitoring and communication, and the probability of opportunism) derived from the higher level of diversity surpass the benefits of a diversified alliance portfolio (Bapuji et al., 2011; Chen et al., 2011). Too much diversity of the knowledge inflow takes up firms' attention and prevents them from capturing the appropriate knowledge at the right time (Koput, 1997).

Network theory and transaction cost economics are also able to account for the pros and cons relating to alliance portfolio diversity. Diverse alliance ties allow firms to have access to a variety of ideas and perspective which would not available to firms with similar and redundant ties (Goerzen & Beamish, 2005). Moreover, surrounded by diverse alliance ties from different backgrounds, the focal firm would act as an information channel and take advantage of the centralized information flow in the middle of its portfolio (Burt, 1980; 1992). Other network theorists shed light on the value of ties outside a network of strong relationships and recommend actors to continuously seek for new partners based on their empirical findings (Granovetter, 1973; Lin, 1981). However, Burt (1992) suggests a 'budget equation' which determines optimal network redundancy and advises on a trade-off between the network benefit generated by new ties and the time and energy called for to maintain such valuable relationships. Transaction cost theory (Coase, 1937; Williamson, 1985), according to the level of diversity, sequentially explains how the cost of managing alliance portfolio diversity develops. Increasing the diversity

requires an initial search cost because valuable partners would generally reside outside of the focal firm's neighborhood or known circle of contacts (Rangan, 2000). Once a new partnership is established, due to the lack of trust and unfamiliarity of processes and routines between the parties, additional costs of monitoring the new partner arise (Hitt, Hoskisson, & Ireland, 1994). Finally, as the focal firm's alliance portfolio becomes more diverse, a 'dominant logic' of senior management, which only figured out the surface of its diverse partners, can act as a liability in managing the increased diversity and result in irrelevant management decisions (Prahalad & Bettis, 1986). Consequentially, the marginal benefits of alliance portfolio diversity become overwhelmed by the marginal costs of diversity (Goerzen & Beamish, 2005). Moreover, the cost of arranging an additional transaction (alliance) equals or surpasses the cost of acquiring relevant resources and capabilities via internal development or open market exchange (Williamson, 1985).

2.3.2. From alliance experience to building alliance capabilities

Experience is regarded to be a key concept in capability development and shapes future firm capabilities since they are not easily acquirable through the spot market (Heimeriks & Duysters, 2007; Helfat, 2000; Teece et al., 1997; Zollo & Winter, 2002). Iterative experience in an activity fosters organizational learning and creates inferences for future

engagements in the activity (Levitt & March, 1988). The stored experience might be encoded in routines and is retrieved and activated when certain stimuli are commenced (Nelson & Winter, 1982). Via simplification and specialization, routines that result from experience are likely to improve performance in future similar activities (Barney, 1991; Levinthal & March, 1993). Hence, a number of prior studies (e.g. Ingram & Baum, 1997; King & Tucci, 2002; Simonin, 1997) confirms the positive association between experience and firm performance in various empirical settings.

Concerning the role of alliance experience, as firms build up their alliance experience, they formulate standardized solutions of implementing alliances and become more effective at managing alliances than less experienced firms (Das & Teng, 2002; Heimeriks & Duysters, 2007). The specific mechanism which harnesses alliance experience and turns it into alliance capability initiates from individuals in an organization (Anand & Khanna, 2000). The build-up of experience makes the individuals to be accustomed to implementing alliances. Hence, the firm exploits the individuals' experiences and synthesizes them into an alliance capability at the organization level through a formalized process (Cohen & Levinthal, 1990).

2.4. Innovation effectiveness and aligning alliance portfolios

2.4.1. The significance of innovation effectiveness

While most innovation literature pays attention to an organization's innovation outcomes, recent literature has begun to approach the whole innovation process which spans key activities ranging from creating novel knowledge to its commercialization (Bogers and West, 2012; Dervitsiotis, 2010, Lee & Kelly, 2008; Loewe & Dominiquini, 2006). Especially, Dervitsiotis (2010) suggests that the innovation process is not complete until new ideas turn into valuable products and generate cash flow. In line with this new stream of research, the concept of innovation effectiveness became more important. Klein and Sorra (1996) describe innovation effectiveness as "the benefits an organization receives as a result of its implementation of a given innovation" and suggest that organizations might even fail in obtaining the benefits of innovation in the course of implementing it. Thus, innovation effectiveness is a concept which highlights the actual influence of a given innovation and its practical performance. Dervitsiotis (2010) proposes a number of measures for innovation effectiveness such as speed to market, percentage of current revenue from innovations of the last two to three years, or level of innovation project risk. This dissertation focuses on how much a given innovation contributes to the actual firm sales and, in chapter 5, adopts "percentage of revenue from innovation" as the measure of innovation effectiveness.

2.4.2. From alliances to innovation effectiveness

This dissertation acknowledges the significance of innovation effectiveness and complements the extant alliance literature which deals with the effects of alliances on innovation performance. Most previous literature highlights the effects of strategic alliances on immediate innovation outcomes such as the number of patent applications, whereas some literature pays attention to the financial performance of alliance strategies such as market value (Lavie, Kang, & Rosenkopf, 2011; Mouri, Sarkar, & Frye, 2012) and return on assets (Yamakawa et al., 2011). A few recent studies (e.g. Beers & Zand, 2014; Faems et al., 2005) introduce "turnover from new products" as a dependent variable which reflects the performance of strategic alliances but are still lacking in their understanding of why strategic alliances affect innovation effectiveness and how to strengthen this relationship.

This dissertation focuses on exploratory alliances and examines their influence on innovation effectiveness. Following March (1991)'s approach of exploration and exploitation, exploration aims to develop more innovative outputs compared to firms' existing business or products but introduces a great deal of uncertainty because it challenges the status quo. Exploratory alliances, which are an extension of the concept of exploration to the realm of strategic alliances, represent strategic alliances for new technology learning such as collaborative basic R&D (Lane & Lubatkin, 1998; Rothaermel, 2001). What matters for the performance of exploratory alliances is not only how innovative the outcome is, but also whether the firm is able to overcome the uncertainty and turn the innovation into actual firm performance, i.e. revenue. Given their

linkage with firm performance and innovation, examining the influence of exploratory alliances, rather than exploitative alliances, on innovation effectiveness provides a range of academic and practical contributions.

2.4.3. Exploratory and exploitative alliances and innovation

Exploration is a concept related to capturing or creating new knowledge (Lavie & Rosenkopf, 2006; March, 1991; Rothaermel & Deeds, 2004) and focuses on absorbing external knowledge that firms do not possess (Rosenkopf & Nerkar, 2001). Thus, sufficient absorptive capacity and responsiveness to uncertainty are required to help absorb and integrate the new knowledge (Cohen & Levinthal, 1990; Lavie & Rosenkopf, 2006; McGrath, 2001). Considering these characteristics, successful exploration generally results in more radical innovation than exploitation.

On the other hand, exploitation, another type of learning firms are engaged in, focuses on improving firms' existing knowledge bases or technologies (Hoang & Rothaermel, 2010; March, 1991; Rothaermel & Deeds, 2004). Exploitation is often coupled with the expectation of short-term results and pursues the improvement of existing products or services instead of a radical change.

Extending the concept of exploration and exploitation from the realm of intraorganizational learning to that of interorganizational learning (e.g. Grant & Baden-

Fuller, 2004; Holmqvist, 2003; Lane & Lubatkin, 1998), previous literature has introduced new domains relating to the characteristics of the knowledge source. For example, Lavie and Rosenkopf (2006) suggest three different domains for exploration and exploitation at the level of alliances, namely, function, structure, and attribute. In case of the function domain, upstream alliances in a business value chain (e.g. R&D alliances which generate new knowledge) are regarded to be exploratory, and, on the other hand, downstream alliances in the value chain (e.g. marketing or production alliances which leverage existing knowledge) are regarded to be exploitative. The structure domain examines inter-firm networks and distinguishes forming new ties between firms (exploration) from repeating prior ties (exploitation). Finally, forming alliances with a new type of partners, in terms of organizational attributes (e.g. size, industry focus, etc.), is regarded to be exploratory and, in the same vein, forming alliances with similar partners is regarded to be exploitative.

Exploratory alliances allow firms access to new knowledge and opportunities, hence contributing to radical innovation unprecedented in the firms or market (Faems et al., 2005; Lavie & Rosenkopf, 2006; Rothaermel, 2001). On the contrary, exploitative alliances focus on increasing efficiency and adapting to market needs, hence, contributing to incremental innovation that improves existing processes or the quality of existing products (Rothaermel & Deeds, 2004; Levinthal & March 1993).

Chapter 3. Building a coordinated portfolio[1]

3.1. Introduction

There are a number of motivations for interfirm alliances such as reducing transaction costs (Kogut, 1988) and uncertainty (Kogut, 1991) or improving the competitive positioning (Gimeno, 2004; Kogut, 1988; Silverman and Baum, 2002). Moreover, alliances allow firms to access their partners' resources (Chung *et al*., 2000; Das and Teng, 2000; Eisenhardt and Schoonhoven, 1996; Lavie, 2006), to learn from their partners (Inkpen, 2000; Kogut, 1988) and to create value and innovation. As firms build up their own alliance portfolio, a collection of alliance partners, they gain access to a larger resource stock and earn greater benefits (George *et al*., 2001; Gulati, 2007; Hoffmann, 2007, Lavie, 2006). Previous literature has empirically verified that a larger alliance portfolio leads to a better innovation performance (Ahuja, 2000a; Baum *et al*., 2000).

Alliance portfolio research differs from previous alliance research in that it can be understood from a social network perspective. Therefore, a number of previous literature (e.g., Baum et al., 2000; Ozcan and Eisenhardt, 2009; Rowley et al., 2000) define an alliance portfolio as a firm's egocentric alliance network. Previous alliance portfolio literature with a social network perspective has several characteristics. First, it focuses mainly on the structural characteristics of alliance portfolios and examines structural

[1]An earlier version of this chapter has been accepted for publication in International Journal of Innovation Management, and is scheduled to be published in August 2015.

variables which bring positive outcomes to the focal firms of the portfolios (Gnyawali and Madhavan, 2001; Walker et al., 1997). Second, it pays attention to the influence of the existing alliance network on firms' further alliance formations (Goerzen, 2007; Gulati, 1995a; Gulati and Gargiulo, 1999; Walker et al., 1997). Third, so far, while adopting a common social network perspective, the existing literature does not provide a consistent theoretical background.

The present study also focuses on the social network perspective of alliance portfolios and complements the existing research. In doing so, this study adopts an embeddedness lens, a basic premise in social network literature, and aims to suggest a balanced view toward the influence of alliance portfolios on their focal firms. Specifically, this chapter examines the impact of network resources in alliance portfolios on focal firms' innovation performance and how structural and competitive embeddedness in alliance portfolios positively or negatively moderate this impact. As a result, this chapter is able to verify that a larger alliance portfolio leads to an improved innovation performance of the focal firm, but, at the same time, relationships among the focal firm's partners were found to affect the relationship between alliance portfolio size and focal firm performance. In terms of structural embeddedness, a cooperative and densely tied portfolio strengthens the positive impact of network resources on the focal firm's innovation performance. In terms of competitive embeddedness, a portfolio with severe competition among the partners weakens the positive impact and leads to a reduced innovation performance.

This chapter makes several contributions to alliance portfolio literature and provides implications for alliance managers. First, the present study highlights the usefulness of embeddedness as a tool for understanding the relationships among partners in an alliance portfolio and suggest researchers and managers to care about two-sided embeddedness in configuring alliance portfolios. Second, this chapter clarifies the context in which the network density outweighs structural holes in line with the debate originating from the different views of Coleman (1988)'s social capital theory and Burt (1992)'s structural hole theory. Third, the present study compares the impact of the breadth and depth of competitive relations among partners in alliance portfolios and provide specific advice on how to expand and configure alliance portfolios to improve the firm's performance. These contributions allow deeper insights into the social network perspective and management of alliance portfolios.

The remainder of Chapter 3 is organized as follows: First, based on the theoretical background of structural and competitive embeddedness, this study develops hypotheses which link alliance portfolio size, firms' innovation performance and moderating variables related to structural and competitive embeddedness. Second, employing negative binomial regression, this study tests the hypotheses using data on 1863 technology alliance cases in the biopharmaceutical industry. Finally, this study presents the empirical results and conclude with a discussion of implications, limitations, and directions of future research.

3.2. Research hypotheses

3.2.1. The relationship between network resources and innovation performance

Firms ally with diverse partners and build up their alliance portfolios because it allows them to gain access to their partners' resources, expand their learning and grow their businesses (Lavie, 2007). This explains why previous literature considers expanding alliance portfolios a significant issue in terms of alliance portfolio configuration and suggests the positive impact of alliance portfolio size on focal firms' innovation performance (Ahuja, 2000a; Baum et al., 2000; Shan et al., 1994).

Specifically, the benefits of larger alliance portfolios are as follows. First, multiple partners increase knowledge sharing (Berg et al., 1982). When firms collaborate for technology development, the outcome is available to all partners (Ahuja, 2000a). Thus, the collaboration provides firms a greater amount of knowledge and technology than independent R&D activities, and the effect of collaboration increases with the number of partners.

Second, collaborations with multiple partners allow the focal firm to access complementary skills (Richardson, 1972; Arora and Gambardella, 1990). Technology development often requires the simultaneous use of different sets of skills and knowledge in the innovation process (Arora and Gambardella 1990; Powell et al., 1996). However,

developing and maintaining diverse sets of competencies in an environment of rapid technological change is difficult for an individual firm (Mitchell and Singh, 1996). Under such circumstances, collaborations allow firms to have an access to their partners' knowledge to complement their existing knowledge base and thereby enhance their innovation performance (Ahuja, 2000a).

Third, multiple collaborations enable firms to take advantage of scale economies (Ahuja, 2000a). Technology development demands various resources such as research manpower, knowledge base and capital. In the case of collaborations, firms combine their resources and share an increased output. Especially, if the technology output is characterized by increasing returns, the impact of the collaborations improves significantly (Ahuja, 2000a). As firms collaborate with an increasing number of partners, they take advantage of a great deal of resources and improve their innovation performance.

Therefore, other things being equal, the present study suggests:

Hypothesis 3-1. A firm's innovation performance increases with the size of its alliance portfolio.

3.2.2. The role of structural embeddedness in alliance portfolios

A dense alliance portfolio can be seen to have both advantages and disadvantages. Previous literature is inconclusive on whether a dense or a sparse network is most advantageous for the actors' innovation performance (Bae and Gargiulo, 2004). For example, McEvily and Zaheer (1999) confirm the positive relationship between alliance networks with many structural holes and firms' capabilities. On the contrary, Ahuja (2000a) confirms the positive relationship between network closure and the likelihood of the firm's innovation. Based on this literature, some scholars account for the contradictory predictions with a contingency approach and examine the context in which a certain form of network prevails (e.g., Rowley et al., 2000). The present study is not biased toward a specific form of network and aims to examine how the network structure of alliance portfolios interacts with the amount of network resources through an opposite set of hypotheses. Therefore, other things being equal, the present study suggests:

Hypothesis 3-2a. An increase in network density within a firm's alliance portfolio will strengthen the positive relationship between alliance portfolio size and innovation performance.

Hypothesis 3-2b. An increase in network density within a firm's alliance portfolio will weaken the positive relationship between alliance portfolio size and innovation performance.

3.2.3. The role of competitive embeddedness in alliance portfolios

Gimeno (2004) argues for an application of the network perspective not only to alliance relations but also to competitive relations. This is due to the fact that just like within alliance relations, where there are direct and indirect partners, also competitive relations consist of direct and indirect relations (such as rivals' rivals, or rivals' partners). Thus, competitive embeddedness, which is derived from the competitive relations surrounding the actors, also affects the actors' actions and outcomes like other types of embeddedness. Competitive relations are defined as the niche overlap in which firms seek the same resources or target the same markets or customers (Gimeno, 2004; McPherson, 1983). Previous literature suggests that the overlap of firms' resource requirements translates into their competitive relations (Baum and Mezias, 1992; Hannan and Freeman, 1977, 1989). Thus, within a focal firm's alliance portfolio, partners' alliances with the focal firm in the same business field can be viewed as an overlap of resource requirements and imply competitive relations.

The reasons why competitive relations among partners within an alliance portfolio negatively influence the focal firm's innovation performance are as follows: First, the competitive relations prevent active knowledge sharing within an alliance portfolio and deteriorate the competitiveness of the portfolio. Dyer and Hatch (2004, 2006) suggest that the competitive advantage of an alliance portfolio originates from the smooth transfer of explicit and tacit knowledge among the focal firm and partners. According to this view,

the alliance portfolio functions as a knowledge sharing network which contributes to the focal firm's innovation performance. However, in case of competitive relations among the partners, they are wary of knowledge spillovers via the focal firm and sharing collaborative outputs with other partners of the focal firm and do not actively participate in the alliances with the focal firm. Second, competitive relations among partners deteriorate trust within an alliance portfolio and increase concerns about the cooperation. Within a network with low trust, alliances are considered to offer a number of opportunities for cheating such as 'stealing partners' technology', 'providing poorer quality investments on joint projects', and 'not fulfilling ex ante commitments' and, thus, successful resource sharing is not possible (Ahuja, 2000a). Moreover, the focal firm faces difficulties in coordinating its relationships with its partners who are wary of the opportunistic behavior of the focal firm and its partners (Gulati and Singh, 1998). Finally, the competitive relations might also affect the successful resource sharing by inhibiting fine-grained information transfer and joint problem solving activities (Uzzi, 1997).

In conclusion, focal firms of alliance portfolios are not able to fully utilize the advantage of their network resources in case of competitive relations among their partners. Therefore, other things being equal, the present study suggests:

Hypothesis 3-3. An increase in competitive relations among a firm's alliance partners will weaken the positive relationship between alliance portfolio size and innovation performance.

To describe the outline of this study more clearly, Figure 7 shows a diagram that summarizes the research model and hypotheses of Chapter 3.

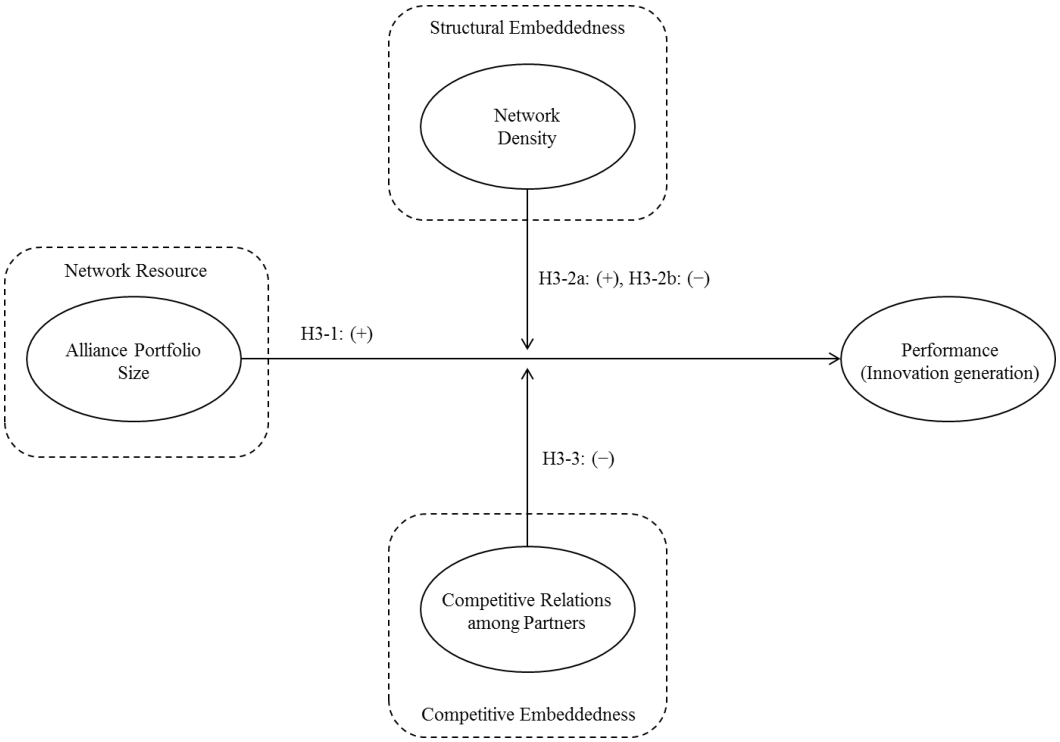


Figure 7. The conceptual model for Chapter 3.

3.3. Methods

3.3.1. Data and sample

To test the hypotheses, I compiled data on the alliance portfolios of US biotechnology firms. The collection of the data was performed as follows: First, I collected information on technology alliances formed between US biotechnology firms and multinational pharmaceutical companies from 2002 to 2004 through the Bioscan database. A three-year window for defining an alliance portfolio was adopted in line with the extant alliance literature (e.g. Stuart et al., 2007) that focused on the biopharmaceutical industry. To select technology alliances, I referred to the qualitative section of the Bioscan database, which describes each alliance in detail, and confirmed the technology focus of the alliances in my sample while excluding those that have a purpose other than technology development (e.g. manufacturing and equity investment) from my dataset. In the next step, I added firm statistics such as R&D expenditure from the Datastream database. Finally, I added patent information provided by the US Patent and Trademark Office. I counted the number of patents filed by each focal firm to measure their technological capabilities and ex post innovation performance. In total, excluding cases with missing information, I collected 1,863 technology alliance cases of 125 focal firms.

High-tech industries are characterized by frequent alliances and growth from innovation (Hagedoorn, 2002). The biopharmaceutical industry shows high alliance tendencies and accounts for about 20 percent of alliances formed in high-tech industries

(Hagedoorn, 1993). Therefore, the biopharmaceutical industry is an ideal setting to study alliance networks and the consequent innovation performance and a number of researchers have chosen this industry when doing research on related issues (Baum et al., 2000; Deeds and Hill, 1996; Powell et al., 1996; Shan et al., 1994; Vassolo et al., 2004). In addition, the highly competitive environment of the biopharmaceutical industry, where rents accrue to the first-mover firm that makes a discovery (Malik, 2012; Vassolo et al., 2004), makes it an appropriate setting to study competitive embeddedness. Especially during 2005-2006, the period I selected for capturing innovation performance, the biopharmaceutical industry exhibited a record growth, nearly 20 percent or more year over year growth for the sales of biologic drugs. Finally, empirical tests within a single industry do not need to control for industry effects and thus raise the reliability of the results (Brouthers and Hennart, 2007).

3.3.2. Dependent variable

The dependent variable, *innovation performance*, is the number of US patent applications filed by each focal firm of my dataset from 2005 to 2006. I focused on the amount of technological outputs, i.e. the generation of innovation, which firms consider innovative at the time of their inventions and counted the number of patents filed as implemented in previous literature (e.g. Brouwer and Kleinknecht, 1999; Cheung and Lin; 2003). As patents are likely to correspond to activity immediately preceding the patent application, I

used a one-year lead with respect to influences of the independent and control variables as used in previous literature (e.g., Ahuja, 2000a; Cheung and Lin, 2004). By measuring the application count over a two year period, I allowed sufficient time to capture the outcome of the technology alliances and at the same time can reduce the effects of unexpected annual variations which might affect a firm's patenting activities.

3.3.3. Independent variables

Network relationships have been described as network resources (Gulati, 1999). Accordingly, a number of previous studies count the number of partners in alliance portfolio to measure the overall level of network resources (e.g., Ahuja, 2000a; Baum *et al*., 2000; Deeds and Hill, 1996; Shan *et al*. 1994). Likewise in the present research, *portfolio size*, the variable to represent the level of network resources, is defined as the number of technology alliance partners of a firm during the 2002-2004 period.

To measure network density, I followed an approach used in previous literature (e.g. Rowley et al., 2000) and excluded the focal firm and its relationships and solely considered the interconnections among a focal firm's partners. Scott (1991: 75) also suggests that '[i]n an egocentric network it is usual to disregard the focal agent and his or her direct contacts, concentrating only on the links which exist among these contacts'. Therefore, I defined network density as the number of existing ties in each alliance

portfolio (other than those involving the focal firm), divided by the total possible number of ties among its partners (Rowley et al., 2000).

$$\textit{Network density} = t / n(n-1) / 2 \qquad \text{[Equation 3-1]}$$

t: the number of ties in an alliance portfolio (excluding all ties to the focal firm)

n: the number of firms in the portfolio (excluding the focal firm)

Because network density shows the presence or absence of ties among alliance partners, it is an appropriate measure of both the absence of structural holes in an alliance network and of its closure (Bae and Gargiulo, 2004; Borgatti, 1997; Burt, 2000; Podolny and Baron, 1997). Besides, in the present case, the measure for structural holes is regarded to be less relevant in that it figures out the number of hole position nodes rather than the whole connectivity of a network, hence, exhibits a high correlation with alliance portfolio size, which causes a multicollinearity problem in a statistical model (Bae & Gargiulo, 2004). Thus, network density was analyzed using alliance ties among the focal firm's partners in each alliance portfolio between 2002 and 2004.

To measure the level of competitive relations in detail and to test its influence empirically, I introduced the concept of breadth and depth. The concept is necessary to account for single-point competition in one market field and multipoint competition in more than one market field (Barnett, 1991). Competitive relations within an alliance

portfolio also can intensify broadly across a variety of fields (breadth) and deeply in certain fields (depth). Thus I introduced the breadth and depth concept to measure how competitive relations build up in each alliance portfolio and to analyze their influence in more detail. Diverse sub-sectors in the biopharmaceutical industry related to the field of products (e.g. cancer, cell therapy, vaccines, etc.) are appropriate to measure the breadth and depth of competition. I investigated the purpose of each alliance between the focal firms and their partners. The Bioscan database relates each alliance with its purpose which corresponds to at least one or, sometimes, multiple business fields. Therefore I could measure the breadth and depth of competitive relations in the level of business fields. Specifically, the breadth of competitive relations is the scope of rivalry in an alliance portfolio. When target business fields of each alliance between a focal firm and its partners overlap across many different fields, the competitive relations in an alliance portfolio become broader. Therefore, the breadth is measured by counting the number of business fields in an alliance portfolio in which at least two partner firms are in competitive relations. The depth of competitive relations is the extent of rivalry within the business fields covered by the alliance portfolio. When target business fields of each alliance between a focal firm and its partners overlap in the same business, the competitive relations in an alliance portfolio become deeper. Therefore, the depth is measured by dividing the total competitive relations (the number of entire dyadic competitive relations) in an alliance portfolio by the number of competing business fields (breadth). In the present study breadth and depth were analyzed for the alliance portfolios

consisting of alliances formed between the focal firms and their partners between 2002 and 2004.

Figure 8 shows an example of how breadth and depth are defined and measured in this study. The focal firm's alliance portfolio in this example consists of partner firms A, B, and C. The target business fields of each alliance are described next to the tie between the focal firm and each partner. For example, partner A seeks the focal firm's technology in the cell therapy, cancer and vaccines field. The dotted boxes describe competitive relations between partners within this portfolio. For example, Partner A and B compete with each other in this alliance portfolio because their target business fields through the alliances with the focal firm coincide with each other in the field of vaccine development. The breadth of competitive relations in this portfolio is simply the number of competing fields. Since partners are competing in the vaccines and cancer fields, the breadth in this example is 2. There are a total of two dyadic competitive relations in this portfolio. As mentioned earlier, Partner A and B compete with each other in the vaccine field. Also, Partner A and C compete with each other in the cancer field. To measure the depth, I should divide these two dyadic competitive relations by the breadth of this portfolio. Consequently, the depth of competitive relations in this portfolio is 2 over 2, simply 1.

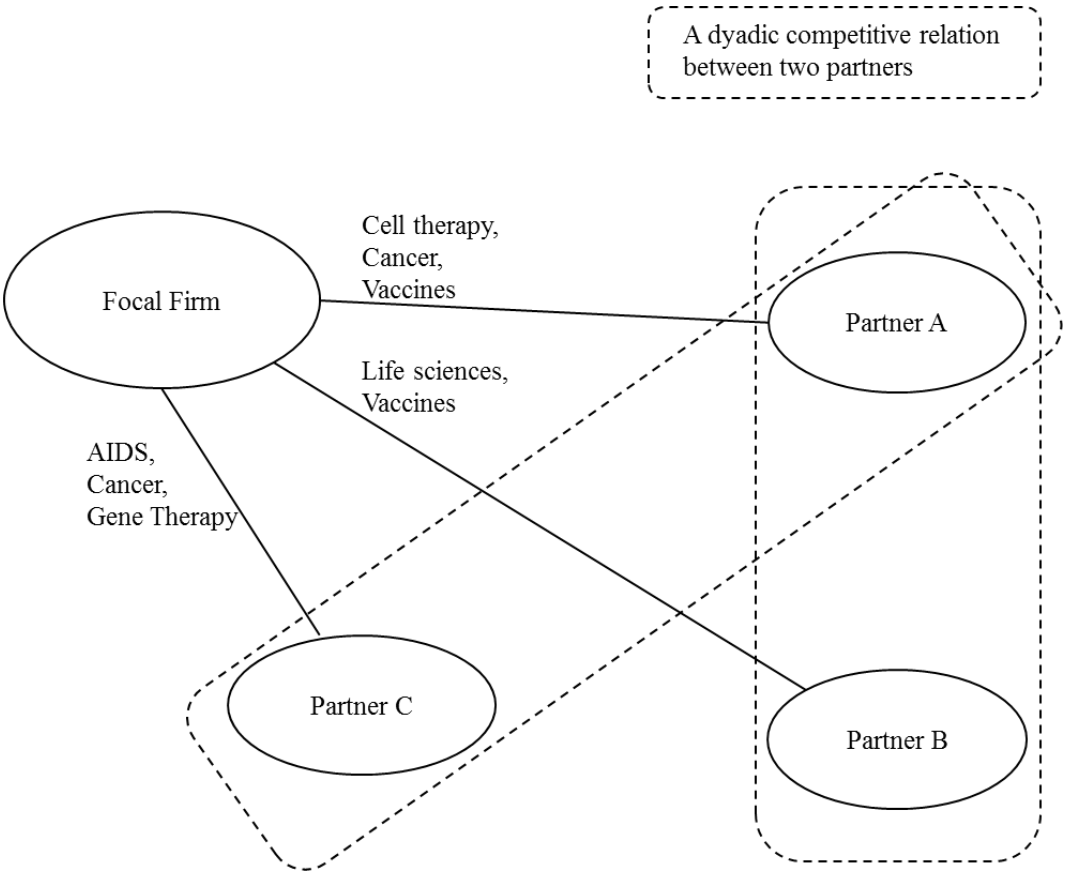


Figure 8. An example of competitive relations among a focal firm's partners.

3.3.4. Control variables

I added six control variables which describe some characteristics of the focal firms and may directly affect the dependent variable. First, technological capability is measured by counting the total number of US patent applications filed by each focal firm until 2004.

Previous literature suggests that the patenting record can be understood as a firm's technological stature (Narin et al., 1987; Trajtenberg, 1990), and counts the number of cumulative patents field by a firm to measure its technological capability (Park and Kang, 2013; Silverman, 1999). Second, R&D expenditure is the logarithm of a focal firm's averaged annual expenditure for R&D during the period of 2002-2004. Third, prior M&A experience is a dummy variable coded as 1 (previous experience) or 0 (no experience). Fourth, prior manufacturing alliance experience is coded as 1 (previous experience) or 0 (no experience). M&A experience and manufacturing alliance experience of focal firms might lead to opportunities for accessing external knowledge outside their existing network and thus might affect the dependent variable. Fifth, firm age measures the number of years between the year a focal firm's recorded its first sales and 2004. Finally, the IPO (Initial Public Offering) distinguishes public companies (coded as 1) from private companies (coded as 0). Compared to private companies, the ownership of public companies is decentralized and public companies have to publicize their information and performance. Therefore their strategy and decision making would be different from those of private companies. In summary, I controlled for a few variables to increase the reliability of the test results and examine the direct effects of network resource and embeddedness on the focal firms' innovation performance.

3.3.5. Empirical model specification

In the current study, the dependent variable is innovation performance which is proxied by the number of patent applications. Therefore, the dependent variable is for discrete events and has a positive integer value. Besides, the dependent variable shows an over-dispersion distribution. The standard deviation, 210.20, is greater than the mean value, 59.43, as indicated in Table 4. In the case of a dependent variable with over-dispersed count data, negative binomial regression is appropriate to analyze the model (Barron, 1992; Cameron and Trivedi, 1986; Ranger-Moore et al., 1991).

Table 4 presents a summary of descriptive statistics and correlations among the variables. Some variables show relatively high correlations (higher than 0.6) with other variables. Thus, I conducted an additional variance inflation factor (VIF) analysis to examine whether a multicollinearity problem exists. I excluded moderating variables (products of main effect variables) from the analysis because multicollinearity can be ignored when the high variance inflation factors are caused by the inclusion of products or powers of main effect variables in the model (Allison, 2012). Table 5 presents the result of the VIF analysis and it can be seen that portfolio size exhibits the highest value (3.84). There is no multicollinearity problem when the VIF value is less than 10 (Hair et al., 1995). Therefore, I concluded that the correlations among variables in the present study do not lead to a multicollinearity problem.

Table 4. Descriptive statistics and correlations matrix for Chapter 3.

Variables	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Mean	SD
Technological capability	1.00														98.096	329.28
R&D expenditure	0.50	1.00													1.55	0.75
M&A experience	0.22	0.05	1.00												0.07	0.26
Manufacturing alliance	0.25	0.19	0.07	1.00											0.22	0.42
Firm age	0.32	0.42	0.14	0.18	1.00										9.18	4.83
IPO	0.11	0.10	-0.00	0.14	0.20	1.00									0.78	0.41
Portfolio size	0.12	0.30	0.16	0.36	0.23	0.12	1.00								5.26	3.15
Network density	-0.11	-0.22	-0.12	-0.31	-0.23	-0.07	-0.71	1.00							0.50	0.23
Breadth	0.12	0.18	0.22	0.33	0.06	0.08	0.61	-0.37	1.00						1.45	1.27
Depth	-0.00	-0.01	-0.01	-0.00	-0.04	0.08	0.42	-0.24	0.09	1.00					2.73	9.58
Portfolio size × Network density	0.17	0.07	0.20	0.07	0.05	0.07	0.06	0.41	0.23	0.03	1.00				2.11	0.28
Portfolio size × Breadth	0.09	0.25	0.10	0.30	0.16	0.09	0.81	-0.42	0.78	0.12	0.10	1.00			10.06	19.58
Portfolio size × Depth	-0.01	-0.00	-0.02	-0.01	-0.03	0.07	0.41	-0.22	0.06	0.99	-0.00	0.13	1.00		27.01	151.16
Innovation performance	0.98	0.48	0.25	0.25	0.33	0.11	0.13	-0.12	0.14	-0.00	0.18	0.10	-0.01	1.00	59.43	210.20

Table 5. VIF test results of Chapter 3

Variables	VIF
Technological capability	1.51
R&D expenditure	1.63
M&A experience	1.13
Manufacturing alliance	1.28
Firm age	1.36
IPO	1.07
Portfolio size	3.84
Network density	2.08
Breadth	1.84
Depth	1.41
Average	1.72

3.4. Results

Table 6 presents the results from the negative binomial regression. The following analysis of the results is based on Model 3 of Table 6 which includes all variables and shows greater likelihood compared to the other models.

The portfolio size is positively related with the focal firms' future innovation performance and this relationship is significant ($p<0.1$). Therefore Hypothesis 3-1 of the

Table 6. Negative binomial regression results of Chapter 3.

Depend variable:	Model 1		Model 2		Model 3	
Innovation performance	Coefficient	S.E	Coefficient	S.E	Coefficient	S.E
Control variables						
R&D expenditure	1.0284***	0.1915	0.9992***	0.1866	0.9132***	0.1813
Technological capability	0.0024***	0.0007	0.0024***	0.0007	0.0026***	0.0006
M&A experience	0.2654	0.3831	0.0882	0.3940	-0.4086	0.4010
Manufacturing alliance	-0.2256	0.2496	-0.3947	0.2659	-0.6421**	0.2630
Firm age	-0.0253	0.0219	-0.0304	0.0214	-0.0500**	0.0219
IPO	0.3568	0.2476	0.3646	0.2474	0.4843**	0.2415
Independent variables						
Portfolio size			0.0769*	0.0455	0.2355*	0.1433
Network density					-1.4651	1.2871
Breadth					0.1172	0.1633
Depth					-0.2044*	0.1126
Portfolio size × Network density					1.3510*	0.7807
Portfolio size × Breadth					-0.0461**	0.0181
Portfolio size × Depth					0.0104	0.0071
N	125		125		125	
Log likelihood	-495.013		-493.477		-484.802	
Pseudo *R*^2	0.1263		0.1291		0.1444	
LR Chi^2	143.18		146.25		163.60	
Regression *p*-value	0.0000***		0.0000***		0.0000***	

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

present study is supported. This result implies that a focal firms' innovation performance increases when they have more partners in their alliance portfolios.

Furthermore, interaction terms (products of the main effect variable and moderating variables) are introduced to examine whether structural embeddedness and competitive embeddedness strengthen or weaken the positive influence of alliance portfolio size on the focal firms' innovation performance. They are Portfolio size × Network density, related to structural embeddedness, and Portfolio size × Breadth as well as Portfolio size × Depth, related to competitive embeddedness.

First, the coefficient of Portfolio size × Network density is positive and significant ($p<0.1$). Therefore Hypothesis 3-2a is supported and Hypothesis 3-2b is not supported. This result implies that dense alliance portfolios contribute more to the focal firm's innovation performance than sparse ones. When focal firms increase their alliance portfolio size, they should also aim to have their partners increase the collaboration with one another for better innovation performance.

Second, among the variables relating to competitive relations among the partners, only Portfolio size × Breadth exhibits a significant coefficient. The coefficient of Portfolio size × Breadth is negative and significant ($p<0.05$). Therefore Hypothesis 3-3 is supported. This result implies that competitive relations among partners within an alliance portfolio lessen the positive effect of alliance portfolio size on innovation performance. Especially, when target business fields of each alliance between a focal firm and its partners overlap across many different fields, the resulting competition

significantly weakens the contribution of alliance portfolio size to innovation performance.

The coefficients of some control variable also show significant values. Expectedly, the influence of R&D expenditure and technological capability on innovation performance is positive and highly significant ($p<0.01$). Firms with manufacturing alliance experience and older firms (firm age) show less innovation performance. Public companies (IPO) show better innovation performance than private firms.

3.5. Discussion

This chapter empirically confirms the positive influence of alliance portfolio size on innovation performance that has been suggested in previous literature (Ahuja, 2000a; Baum et al., 2000; Shan et al., 1994). The positive relationship between alliance portfolio size and innovation performance originates from knowledge sharing, complementarity and scale economies within alliance portfolios (Ahuja, 2000a; Arora and Gambardella, 1990; Berg et al., 1982; Richardson, 1972). In addition to this empirical test, the present study conveys three key findings and related theoretical implications.

First, this study finds a positive moderating effect of structural embeddedness and a negative moderating effect of competitive embeddedness. Specifically, increasing network density within an alliance portfolio strengthens the relationship between the

portfolio size and innovation performance, and broad competitive relations among a focal firm's partners weaken this relationship. These findings clarify how synergies and conflicts occur within an alliance portfolio and how they affect the focal firm. The synergies and conflicts within an alliance portfolio arise from the independencies of the focal firm' partners and make the overall value of the portfolio greater or smaller than the sum of the value of each alliance in the portfolio (Parise and Casher, 2003; Vassolo et al., 2004). Despite their significance, previous literature on the synergies and conflicts has not sufficiently examined the process of how they arise and has not empirically verified their effects (Wassmer, 2010). With an embeddedness lens, the present study suggests that dense cooperative relationships among partners lead to synergies in an alliance portfolio and broad competitive relationships among partners lead to conflicts in the portfolio, and that these cooperative and competitive relationships, respectively, positively and negatively affect the focal firm's innovation performance. Through investigating cooperative and competitive ties of partners, these relationships were operationalized and their effects were empirically verified. Furthermore, this study suggests the relationships among partners as another configurational factor of alliance portfolios which affects the focal firm's innovation performance together with factors suggested in previous literature such as portfolio size (Ahuja, 2000a; Baum et al., 2000; Shan et al., 1994), portfolio breadth (Ahuja, 2000a, Gulati, 1999), efficiency (Baum et al., 2000) and alliance partner quality (Stuart, 2000; Stuart et al., 1999).

Second, it is more beneficial for focal firms to form dense alliance portfolios

compared to sparse ones. What constitutes a social structure for enabling one type of action may be disabling others (Podolny and Baron, 1997). Therefore, the more advantageous network structure, a dense network or a network with many structural holes, is likely to be contingent on what actors aspire to enable through it (Ahuja, 2000a). The present study, in the case of technology alliances in the biopharmaceutical industry, suggests that dense alliance portfolios contribute more to the focal firms' innovation performance compared to portfolios with many structural holes. This is in agreement with previous literature which specifies the context in which a dense network outweighs structural holes. Ahuja (2000a) suggests that, in the case of interorganizational collaborations, benefits of trust building, sharing collaboration routines, and blocking opportunism that result from a group of cohesive interconnected partners outweigh the disadvantages of not having the diverse information that is yielded from many structural holes within a firm's alliance portfolio. Further, many interlocking ties facilitate the cooperation and contribute to standard setting in high-tech industries (Kogut et al., 1995; Oliver, 1990). The biopharmaceutical industry is also characterized by the significance of strategic preoccupancy of technology (Kim, 2013). Thus, the cooperation through cohesive alliance portfolios leads to better technology performance in the industry. On the contrary, structural holes matter when firms have diverse partners from different industries and provide brokering among them (Ahuja, 2000a). Therefore, the samples of previous literature, which support the significance of structural holes, tend to include portfolios composed of firms from various industries. For example, Hargadon and Sutton

(1997) investigate the role of product-development consulting firms that bridge structural holes between clients in different industries. The present study investigates technology collaborations within the biopharmaceutical industry and, therefore, does not correspond to a context in which structural holes prevail.

Third, competitive relations among a focal firm's partners across many different business fields deteriorate the innovation performance of the focal firm. Previous literature suggests that alliance portfolio breadth is one of the significant factors which explain the benefits firms achieve from their alliance portfolios (Ahuja, 2000a; Gulati, 1999). However, although a focal firm has a number of partners in a broad range of fields, it cannot fully take advantage of its alliance portfolio in case of competition among the partners across those fields. It is because they are not willing to actively participate in alliances with the focal firm when they are put in competitive relationships with each other and seek the same resource of the focal firm (Khanna et al, 1998). Thus, the present study suggests that competition among a focal firm's partners across a broad range of fields deteriorates the advantage the focal could enjoy from their diverse alliances. Moreover, this also reduces the efficiency of an alliance portfolio, another significant factor which accounts for alliance portfolio performance (Baum et al., 2000), due to the high costs of coordinating the portfolio (Bamford and Ernst, 2002; Gulati and Singh, 1998). In a similar vein, Lavie (2007) investigated the influence of 'multilateral competition', the extent to which the partners in an alliance portfolio are considered competitors of each other. He suggests that multilateral competition among partners

increases the focal firm's relative bargaining power over its partners, and eventually positively affects firm performance. The multilateral competition concept is similar to the depth of competitive relations in the present study because both consider competition among the focal firm's partners in an alliance portfolio and their concentrating competition in a single field. The result of the present study finds no negative influence of the depth on focal firms' performance and does not deviate much from Lavie (2007)'s finding. Additionally, the present study focuses on the competitive relations among the focal firm's partners across diverse fields (breadth) and, due to the high costs of coordination and the depletion of management resources, finds their negative influence on the focal firm's performance. This result complements the findings of previous literature and sheds a light on different perspectives relating to intra-portfolio competition and its consequences on firm performance.

Fourth, despite the possibility of a curvilinear or inverted-u shape relationship between alliance portfolio size and firm performance (e.g. Deeds & Hill, 1996), the present study is focused on a positive relationship between the portfolio size and performance. More specifically, the focus of the present study is the relationships among a firm's alliance partners and how they can strengthen or deteriorate the positive side of alliance portfolio size. This study still acknowledges the diminishing return of alliance portfolio size on firm performance and suggests that one of the present findings, the negative moderating effect of the breadth of partner competition, can also contribute to the curvilinear relationship.

Chapter 4. Leveraging a diversified portfolio

4.1. Introduction

The advantages of collaborative R&D and the exchange of technological resources lead to an increasing number of technological alliances among firms. Technological alliances allow firms to combine their own knowledge with that of their partners and contribute to solving more complex problems, reducing the cost of R&D and more rapidly adapting to changing markets (De Man & Duyster, 2005). To obtain more advantages from alliances, a firm is usually involved in multiple alliances with different partners at the same time (Gulati & Singh, 1993) and creates what is referred to as an alliance portfolio. Recognizing the importance of the access to the diverse knowledge and resources of different alliance parters, scholars and practitioners have increasingly paid attention to "alliance portfolio diversity", one of the major characteristics of alliance portfolios (Goerzen & Beamish, 2005; Hoffmann, 2007; Koka & Prescott, 2008). A diverse alliance portfolio generates various growth options (Powell et al., 1996; Vassolo et al., 2004), provides enterepreneurial opportunites (Ozcan & Eisenhardt, 2009) and expertise, and, hence, contributes to improving the focal firm's innovation performance (Belderbos et al., 2004; Faems et al., 2005).

However, to fully realize the opportunities provided by their alliance portfolios, managerial attention by the focal firms is required in order to effectively absorb the

diverse knowledge. Alliance portfolio diversity, on one hand, encourages the focal firms' innovativeness and allows them to prepare for technologically turbulent environments (Baum et al., 2000; Dutta & Weiss, 1997; Lee et al., 2001), but, on the other hand, incurs additional costs related to the management of diverse relationships and prevents the smooth transfer of knowledge (Goerzen & Beamish, 2005; Koka & Prescott, 2008). Moreover, among the diverse knowledge in alliance portfolios, firms might find it difficult to identify which is valuable knowledge, i.e. knowledge with the highest innovation potential (Koput, 1997). Considering these advantages and potential drawbacks of diversified portfolios, managers and scholars need to understand the mechanisms of effective alliance portfolio management to sufficiently absorb the benefits of diversity.

Existing literature investigating the relationship between alliance portfolio diversity and firm performance has either shown inconclusive results or an inverted u-shape (e.g. Duysters et al. 2012; Vasudeva & Anand, 2011) and also highlighted the significance of alliance portfolio management. Previous literature has, however, not directly focused on capturing the value of diversity or conveyed a thorough understanding of how to absorb it. A stream of literature relating to alliance portfolio diversity focuses on the purpose of diversity and examines the differential effects of alliance portfolio diversity on different types of firm performance (De Leeuw et al., 2014; Oerlemans et al., 2013). Another stream of literature investigates the impact of alliance portfolio diversity relating to the firms' internal knowledge creation (Srivastava & Gnyawali, 2011; Wuyts & Dutta, 2012).

This literature suggests that a firm's internal knowledge creation pattern, e.g., patent citation pattern, might "indirectly" affect how it utilizes the diverse knowledge in its alliance portfolios. However, it does not place its attention on more proactive ways of absorbing the diverse knowledge in alliance portfolios, for example, by suggesting how firms should manage their alliance portfolios or by explaining how firms could directly link their internal knowledge with the external knowledge.

This study emphasizes a more explicit and comprehensive approach to alliance portfolio management and aims to understand how to better absorb diverse knowledge from alliance portfolios for an increased innovation performance. This study especially focuses on the firms' alliance experience to deal with different alliance tasks and the firms' ability to recognize valuable knowledge residing in multiple alliances. Previous literature also acknowledges the significance of both alliance experience and the ability to recognize relevant knowledge in alliances (Goerzen & Beamish, 2005; Koka & Prescott, 2008; Wuyts & Dutta, 2012). Recent literature (e.g. Duysters et al., 2012; Van de Vrande, 2013) has started to introduce these concepts to dealing with alliance portfolio diversity, however, it falls short of reaching an integrative understanding on managing alliance portfolio diversity. The present study, focusing on the value of an integrative approach, examines the relationship between the level of alliance portfolio diversity and the focal firms' innovation performance. This study also examines whether the firms' alliance experience and the proximity of knowledge between the focal firms and their alliance portfolios contribute to improving the performance. These two different concepts

respectively correspond to “task knowledge” and “content knowledge”, terms used to designate a different set of knowledge constructs (Alexander et al., 1991), of forming alliances and help firms to accommodate more diversity in their alliance portfolios. As a result, this study verifies an inverted-u shape relation, consistent with a number of previous literature, between alliance portfolio diversity and the focal firms’ innovation performance. Moreover, positive moderating effects of alliance experience and proximity on the relationship between alliance portfolio diversity and innovation performance are verified.

This chapter makes several contributions to alliance portfolio literature and provides implications for alliance managers. First, this study corroborates the arguments found in previous literature and suggest an inverted u-shape relation between firms’ alliance portfolio diversity and their innovation performance. Especially, this study operationalizes innovation performance using the weighted patent counts of focal firms and highlights the impact and diffusion aspects of innovation driven by alliance portfolio diversity. Second, this study suggests that the ability to successfully leverage the diversity of alliance portfolios is determined by the firms’ alliance experience and proximity to their partners. Firms can learn to take advantage of higher diversity through accumulated alliance experience and proximate partners. Third, following a contingency perspective on the influence of alliance portfolio diversity (e.g. Schilke & Goerzen, 2010; Schilling & Phelps, 2007; Wassmer, 2010; Wuyts & Dutta, 2012), this study suggests that focal firms’ alliance experience and proximity to their partners play a critical role in explaining

performance variation across firms.

The remainder of chapter 4 is organized as follows: First, based on the theoretical background, this study develops hypotheses which link alliance portfolio diversity, alliance experience, knowledge proximity of alliance portfolios, and innovation performance. Second, employing negative binomial regression, this study tests the hypotheses using data on 396 R&D alliance cases in the biopharmaceutical industry. Finally, this study presents the empirical results and conclude with a discussion of the implications of this chapter.

4.2. Research hypotheses

4.2.1. The impact of alliance portfolio diversity on firm performance

Alliance portfolio diversity serves the focal firms' innovation in several ways. First, alliance portfolio diversity provides the focal firm diverse knowledge and experience which contribute to their thinking "out of the box" (Levinthal & March, 1993; Levitt & March, 1988, Vasudeva & Anand, 2011). Thus previous literature empirically confirms that firms with diverse alliances lead to their successful performance (Baum, et al., 2000; Powell, et al., 1996). Accumulated knowledge and experience through technological cooperation with partners from different backgrounds directly affects the focal firms' knowledge, a major source of innovation, and consequentially their innovation outcomes

(Hargrave & Van de Ven, 2006; Tushman & Anderson, 1986). Second, combinations of diversity from alliance portfolios generates valuable innovation opportunities. Combining a different set of resources and capabilities of different alliance partners produces a number of different outcomes. Attempting various combinations, focal firms detect complementarities and synergies among them which lead to superior innovation performance (Belderbos et al., 2006; Nieto & Santamaria, 2007). Third, alliance portfolio diversity enables the focal firms to address technological and environmental diversity. Hoffmann (2007) highlights the role of high levels of dispersion in alliance portfolios and suggests that they contribute to strategic flexibility and ability of focal firms to handle a high level of technological uncertainty. Thus, with timely and appropriate technological solutions, they sustain their innovativeness and survive in a volatile environment (Ozcan & Eisenhardt, 2009). Fourth, alliance portfolio diversity prevents the overlap of partner capabilities, ideas and knowledge which might lead to a subadditive alliance portfolio (Anand et al., 2007; Vassolo et al., 2004). The addition of redundant knowledge to the portfolio makes no unique contribution to the focal firm's knowledge base and does not improve the quality of innovation outcomes (Duysters et al., 2012).

At the same time, alliance portfolio diversity has several drawbacks. First, complicated tasks due to alliance portfolio diversity leads to managerial challenges (Duysters & Lokshin, 2011). Dealing with different types of partners requires a great deal of focal firms' internal resources and prevents them from generating performance from the knowledge they have earned through their partners. Second, in case of low

compatibility among diverse partners, the diversity takes up focal firms' learning resources and reduces their overall knowledge utilization (Vassolo et al., 2004). Thus, firms cannot fully utilize the advantage of alliance portfolio diversity. Third, alliance portfolio diversity detracts focal firms' attention to identify valuable knowledge. According to attention based view, alliance portfolio diversity generates information overflow. Koput (1997) suggests that information overflow leads firms to consider only few ideas and, even more, has them choose irrelevant ones among those ideas at a wrong time or place. Finally, in case of higher diversity in alliance portfolios, focal firms have difficulty in knowledge management varying from partners to partners and fail to block knowledge spillover to their different partners (Jiang et al., 2010).

Considering the pros and cons of alliance portfolio diversity, firms need to carefully control the diversity level of their alliance portfolios. Vasudeva and Anand (2011) suggest that, beyond a certain point, the advantages of diversity such as learning opportunities are not effective any longer or even decrease. Even more, in case of higher diversity, focal firms have difficulty in strategically aligning the goals of diverse alliances and monitoring the whole portfolio (Hoffmann, 2005). Too little diversity is also less beneficial as is too much diversity because of the reduced exposure to alternative decisions, greater redundancy of knowledge and underutilization of latitudinal absorptive capacity (Duysters et al., 2012). In sum, at both extremes, alliance portfolio diversity impedes sufficient learning opportunities of focal firms and leads them to a decreased innovation outcomes.

Hence, this study suggests firms to avoid too low or high levels of alliance portfolio diversity and to adopt a medium level of portfolio diversity for an increased innovation performance. The present study therefore hypothesizes:

Hypothesis 4-1. A firm's innovation performance exhibits an inverted U-shape relation with its alliance portfolio diversity.

4.2.2. The role of alliance experience on absorbing the diversity

Alliance experience is defined as lessons and know-how obtained by a firms' prior alliances (e.g. Gulati, 1995b; Kale & Singh, 1999; Kale et al., 2002; Reuer et al., 2002). The obtained lessons and know-how are pervaded into the organization and work as a routine which deals with similar tasks in the future (Heimeriks & Duysters, 2007; Nelson & Winter, 1982). The accumulated experience develops into firms' capabilities because they are not easily attainable through the spot market (Teece et al., 1997). Thus, with an increased alliance experience, firms become more able to process alliance tasks and learn how to generate performance from them. The positive relationship between experience and firm performance is also verified by a number of empirical studies (e.g. Ingram & Baum, 1997; King & Tucci, 2002; Simonin, 1997).

Specifically, firms' alliance experience enable them to understand "critical

processes and issues in alliance management" (Heimeriks & Duysters, 2007). Prior alliance experience includes a series of alliance tasks from selecting partners, exchanging knowledge, and to generating performance. Firms learn from the experience and become more able to manage each step of alliance tasks. This learning effect would especially increase in case of R&D alliances due to the ambiguity and uncertainty of the high-technology context (Harrigan, 1988; Mody, 1993).

Moreover, there are several more advantages of alliance experience which ultimately contributes to firm performance. Alliance experience enables firms to develop their "common perspectives" and, hence, to understand and absorb knowledge from new alliances more effectively (Grant, 1996; Nonaka, 1994). Thus useful knowledge builds up inside of the firms and become the source of innovation performance. Various alliance experience also provides lessons of how to structure and manage their alliance portfolios as a whole. Simultaneously forming alliances with different partners, focal firms would face conflict situations between their partners (Vassolo et al., 2004) and learn how to ease and manage the conflicts as they are more exposed to such situations (Mohr & Spekman, 1994). In other words, alliance experience is not simply constrained to the management of individual alliances but also linked with managing the entire alliance partners which leads to the synergy between them and ultimately contributes to generating an increased performance. Few prior studies (e.g. Hoang & Rothaermel, 2005) suggest a curvilinear relationship between alliance experience and firm performance. However, this study suggests the role of alliance experience is still valid and critical in case of complex

alliance portfolios as Lai et al. (2010) have shown in their study.

As firms have more alliance experience, they are likely to establish a dedicated alliance function within the organization (Kale et al., 2002). This function contributes not only to coordinating activities and allocating responsibilities but also to gathering and dispersing lessons from alliance experience (Heimeriks et al., 2007). Moreover, it nurtures common practices in the process of alliances (Goerzen, 2005; Kale et al., 2002). Eli Lilly, one of the sample firms in this study, established an Office of Alliance Management in late 1999, during the focal period of this study, and was paid off by its role of "integrator, intermediary and catalyst for best practice performance" (Sims et al., 2001). Previous empirical studies (e.g. Kale et al., 2002) also support the relationship between the cumulative number of alliances and establishing a dedicated alliance function. This function leads to a more coordinated approach of firms to managing their alliance portfolios and an increased benefit from the portfolios.

Thus alliance experience mitigates aforementioned drawbacks of diverse pools of alliance partners and help firms to adopt more diversity. It is difficult for firms to grasp the know-how of successful alliances and apply this to new alliances with little experience. However, as firms build up a great deal of alliance experience, they recognize inherent differences of each alliance which appear similar and become more able to learn from them (Duysters et al., 2012; Reuer et al., 2002). Higher levels of alliance experience facilitate firms to perceive causes and effects of specific actions, recognize the patterns (Duysters et al., 2012) and ultimately contribute to absorb knowledge from their diverse

alliance portfolios.

Hence, this study suggests firms to increase the level of alliance experience to adopt more diversity in their alliance portfolios that turns into the source of innovation. The present study therefore hypothesizes:

Hypothesis 4-2. A firm's alliance experience positively moderates the relationship between innovation performance and alliance portfolio diversity such that higher levels of alliance experience will increase the portfolio diversity that maximizes innovation performance.

4.2.3. The role of knowledge proximity on absorbing the diversity

While alliance experience enables firms to have a better understanding of diverse alliance "tasks", proximity between a focal firm and its partners facilitates the absorption of diverse "contents" of alliances.

Previous literature suggests the significance of proximity in multifaceted ways. From an innovation perspective, major characteristics of technology alliance portfolios are technological competences of alliance partners and how much they are in line with those of the focal firm (e.g. Cantwell & Colombo, 2000; Rothaermel and Boeker, 2008). Lane and Lubatkin (1998) and further research in line with them (e.g. Mowery et al.,

2002) suggest that relative or partner-specific absorptive capacity is dependent on the similarity of the partners' knowledge bases. Especially, in the biopharmaceutical industry, it is demonstrated that firms that have the same knowledge base are more likely to partner with each other and exhibit better performance (Lane & Lubatkin, 1998). Ahuja (2000b) also finds that greater technological similarity between alliance partners improves their patenting performance.

In case of high levels of proximity between firms and their alliance portfolios, firms are better able to use their learning resources to adopt a wide array of knowledge in the portfolios (Vasudeva & Anand, 2011). Vasudeva and Anand (2011) subdivide firms' absorptive capacity into latitudinal (relating to processing and using diverse knowledge) and longitudinal (relating to processing and using distant knowledge) absorptive capacity which share the learning resources of firms. They, hence, confirm a trade-off relation between latitudinal absorptive capacity and longitudinal absorptive capacity in terms of knowledge utilization. At a lower level of technological distance (a higher level of proximity), firms are allowed to concentrate more learning resources on latitudinal absorptive capacity that maximizes utilizing knowledge of alliance portfolios which consists of diverse partners.

Hence, this study suggests firms to increase the level of proximity to their alliance portfolio. This enables firms to adopt more diversity in their alliance portfolios that turns into the source of innovation. The present study therefore hypothesizes:

Hypothesis 4-3. A firm's proximity to its alliance portfolio positively moderates the relationship between innovation performance and alliance portfolio diversity such that a higher proximity will increase the portfolio diversity that maximizes innovation performance.

The outline of this study is shown in Figure 9, which summarizes the research model and hypotheses of Chapter 4.

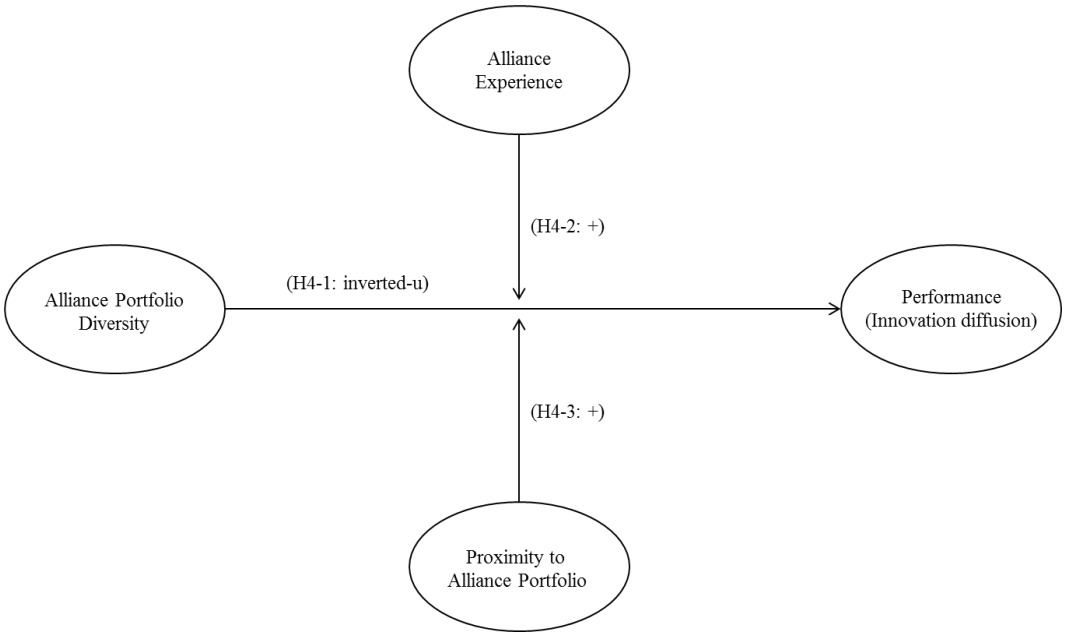


Figure 9. The conceptual model for Chapter 4.

4.3. Method

4.3.1. Data and sample

To test the hypotheses, I collected R&D alliance records of US biopharmaceutical firms during the 1998-2002 period. The biopharmaceutical industry is characterized by a strong tendency to form alliances and accounts for about 20 percent of all alliances formed in high-tech industries (Hagedoorn, 1993) as firms in this industry see within- and cross-industry alliances as a suitable way to address high development cost and rapidly changing technology (Luo & Deng, 2009; Powell et al., 1996). Therefore, the biopharmaceutical industry is an ideal setting to study R&D alliances and their impacts on the firms, e.g. on innovation performance (Lin et al., 2012). A number of prior studies have chosen this industry when doing research on alliance portfolios (Baum et al., 2000; Deeds & Hill, 1996; Powell et al., 1996; Shan et al., 1994; Vassolo et al., 2004).

There are several reasons why, studying the alliance portfolio diversity of firms operating in the biopharmaceutical industry, it is appropriate to focus on the period of 1998-2002.

First, the number of R&D collaborations during this period had unprecedentedly increased due to the advent of general purpose technologies (GPTs) such as genomics and post-genomic techniques, bio-informatics, high-throughput screening and combinatorial chemistry (Riccaboni & Moliterni, 2009). Since the early 1990s, the number of R&D collaborative agreements started to sharply increase to the point where the number of

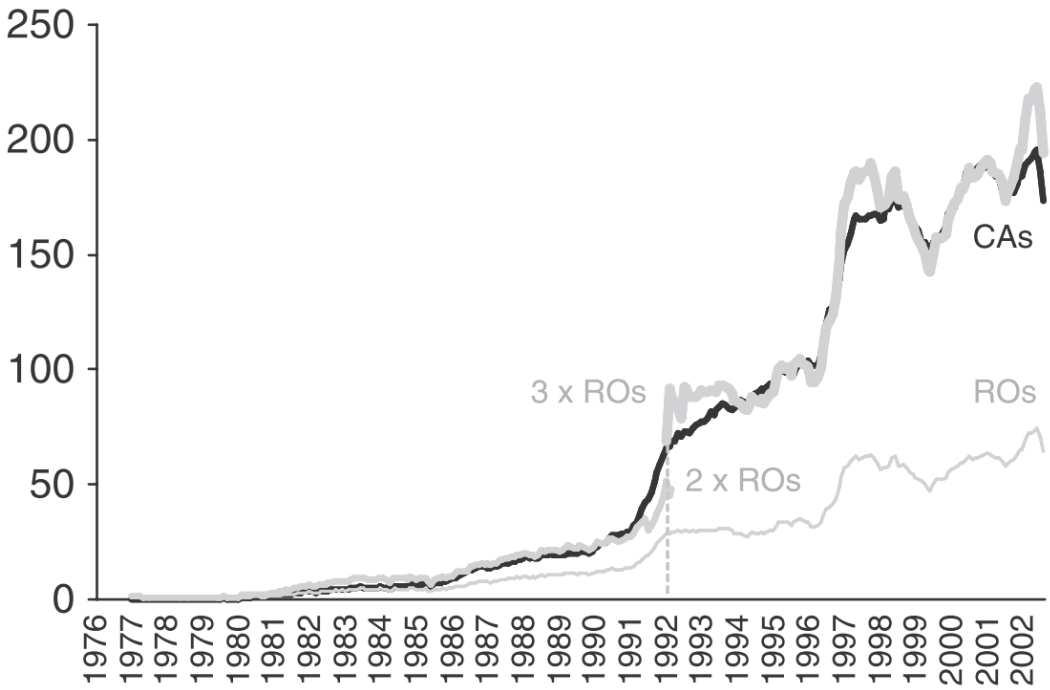


Figure 10. Number of new R&D collaborative agreements (CAs) and research organizations (ROs) entering the network each month, 1976-2002. Source: Riccaboni & Moliterni (2009).

newly entered alliances exceeded the number of new entrants in the biopharmaceutical industry by a factor of three as can be seen in Figure 10. The peaking collaboration rate during the late 1990s and the early 2000s provides a sufficient number of data points to investigate the effect of alliance portfolio characteristics.

Second, as Figure 11 shows, during this period, a substantial portion of the R&D alliances in the biopharmaceutical industry were exploration-focused. Dedicated biotechnology firms applied their general purpose technologies to multiple drug development areas through their horizontal business models (Riccaboni & Moliterni,

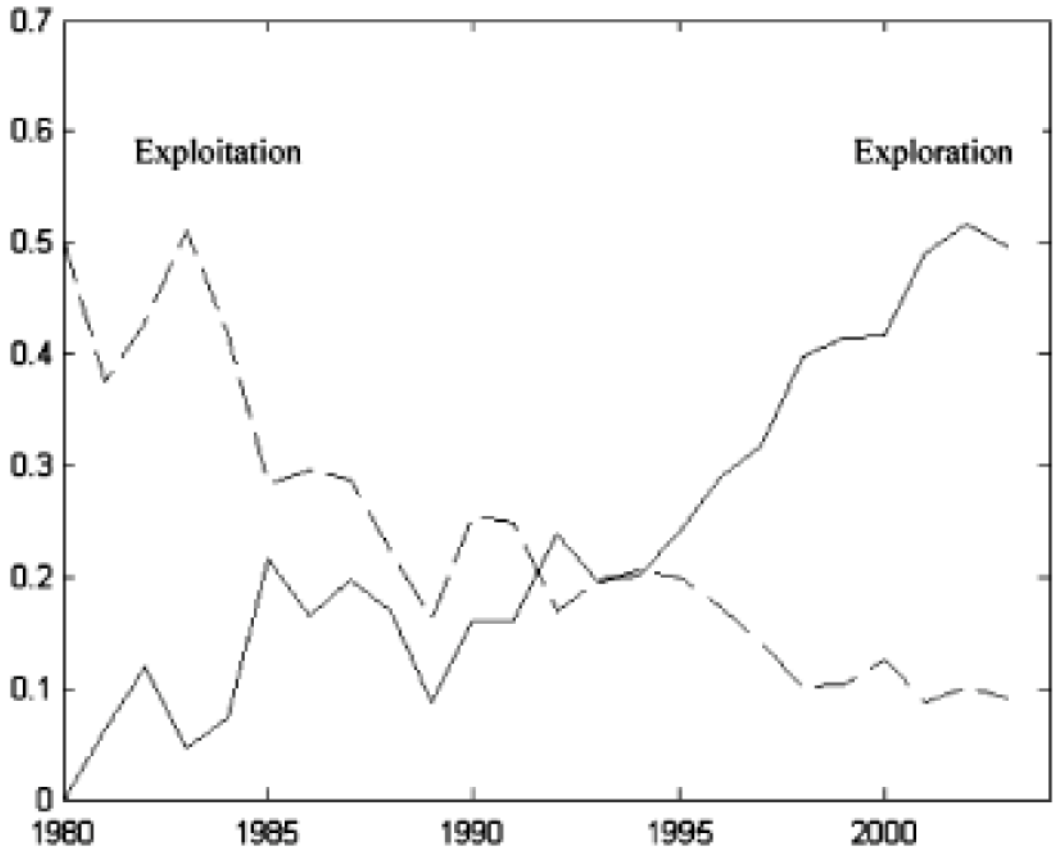


Figure 11. Proportion of R&D alliances by type: exploration versus exploitation. Source: Riccaboni & Moliterni (2009).

2009). This fact indicates that during this period, firms were exposed to more diversity in their alliance portfolios, hence increasing the suitability of the data for the research on alliance portfolio diversity.

Third, the previously experienced double-digit industry growth rate (on average 11.1 percent annually from 1970 to 2002) of the biopharmaceutical industry began to stagnate during the mid 2000s (Gassmann et al., 2008). For example, for the first time in

the firm's recent history, Pfizer posted negative revenue growth for 2005 and 2006. Many pharmaceutical giants made the implementation of cost cutting programs a top priority during this period. This pressure to reduce costs had impacts on the firms' ability to maintain and increase the previously seen levels of diversity in their alliance portfolio.

The collection of the data was performed as follows: First, I compiled alliance portfolios of US biopharmaceutical firms, i.e. firms in SIC class 283, from the Securities Database Corporation (SDC) Database on Joint Ventures and Alliances. This database includes all types of alliances records collected from SEC filings, industry and trade journals, and news reports since 1988 and allows large-scale empirical studies on alliances (Anand & Khanna, 2000; Sampson, 2004). To identify R&D alliances, I refered to the Activity Code and Activity Description section of each alliance case which describe the purpose of the alliance. Most cases included multiple alliance purposes such as research and development, licensing, manufacturing and distribution, at the same time. I excluded alliance cases which do not include the purpose of research and development and with the remaining alliances built the R&D alliance portfolios of each firm in the dataset. Second, I added financial information of each focal firm such as sales and R&D expenditure collected from the COMPUSTAT database. This database provides financial and market information on over 90,000 securities which include active and inactive firms throughout the world (Lin et al., 2012). Finally, I added patent information of each focal firm provided by the US Patent and Trademark Office (USPTO), which issues over 150,000 patents annually to organizations and individuals worldwide and maintains a

publicly available database of all US patents. I collected the information on patents filed by each focal firm to approximate their knowledge stock and ex post innovation performance. The patenting activities of firms in the biopharmaceutical industry also provides the reason for focusing only on US firms. A preliminary analysis of the patent data showed that non-US firms tend to file for patents in other countries as much as, or sometimes even more than, in the US. Therefore, I decided to exclude non-US firms from the dataset in order to avoid dealing with different country-depending patenting patterns, which might affect the analysis, and, at the same time, to remove other unobserved heterogeneity among firms from different countries.

Throughout the aforementioned data collection process, I focused on larger firms and refined the dataset due to several reasons. First, due to the frequent M&A activities during the observation period, for some, mostly smaller, target firms, complete financial or patent information was not available. Second, activities such as the establishment of alliances and the filing of patent applications were sometimes accomplished by subsidiaries of large pharmaceutical corporations. Each corporation exhibits a different level of this pattern, thus, to capture the entire activities of large corporations, the alliance and patent related information were consolidated on the parent company level as it was already done in some previous studies (e.g. Van de Vrande, 2013). Third, some information of small or privately owned firms were missing in my dataset and could not be retrieved from other sources. For that reason, previous studies on alliances often focused on the larger companies in an industry (e.g. Ahuja, 2000b; Gulati, 1995b; Keil et

al., 2008). The final dataset for the empirical analysis consists of 396 R&D alliance cases of 69 focal firms.

4.3.2. Dependent variable

The dependent variable, *innovation performance*, focusing on the diffusion effect of innovation, was measured by employing the concept of weighted patent count which incorporates both the number of each focal firm's granted patent applications as well as their forward citations. Patents are closely related to the firms' technological competitive advantage which drives innovation and results in profitability (Henderson & Cockburn, 1994). By counting forward citations as well as the number of the firms' own patent applications allows the study to reflect the value and quality of innovation (Trajtenberg, 1990). Empirical evidence also shows a strong association between the "ex post citations" of a patent and the value of the invention (Trajtenberg, 1990) and it is generally assumed that more important patents have more forward citations and vice versa (Van de Vrande, 2013).

I operationalized the weighted patent counts (*WPC*) as follows: Each patent i is weighted according to its forward citations C_i, The weighted patent count of each focal firm j can be calculated using Equation 4-1 below, which is based on the formula of Trajtenberg (1990) but has been adopted to fit the characteristics of the dataset used in

this study:

$$WPC_j = \sum_{i=1}^{nj}(1 + C_i) \qquad \text{[Equation 4-1]}$$

Adopting the four-year post-alliance window found in Sampson (2007), who also employed weighted patent counts to measure innovation performance, focal firms' patents were collected during the 2003-2006 period. This lagged measure also contributes to reducing the likelihood of embellishing performance from one unusual year (Tanriverdi, 2006). Considering a contemporaneous relationship between a firm's R&D efforts and patent applications (e.g. Hausman et al., 1984), I decided to additionally include the focal firms' patent applications in 2002 and their associated forward citations. Patents applied for by the focal firms prior to 2002 might have been the outcome of previous R&D efforts and alliances not investigated by this study and thus I have regarded them as knowledge stock and controlled their impact on the focal firms' innovation performance.

Forward citations were collected until the year 2010. Thus, forward citations are necessarily truncated for patents applied in later years. During the observation period, patents applied for in 2006, for example, will have received less forward citations than patents applied for in 2002. However, Lanjouw and Schankerman (1999) suggest that, considering the initial expectations about the quality of a patented innovation, it is not necessary or even helpful to consider citations received over very long time spans.

4.3.3. Independent variables

Alliance portfolio diversity. To measure the diversity in a firm's alliance portfolio, I used the primary Standard Industrial Classification (SIC) codes, the 4-digit industry code assigned to each partner firm in the SDC database. Firms from the same industry tend to have similar resources, routines, and tacit knowledge relating to markets, operation processes, and managerial expertise (Wang & Zajac, 2007). Thus, the SIC code provides a reasonable indication of similarities and differences in partners' resources and knowledge and has been widely used in strategy literature to classify firms according to their resources and knowledge (e.g. Cui & O'Connor, 2012; Wang & Zajac, 2007). To create an alliance portfolio diversity measure based on the firms' SIC codes, I employed the Blau Index of Variability (Blau, 1977). The Blau Index has been extensively used in previous literature (e.g. Vasudeva & Anand, 2011; Van de Vrande, 2013) to measure the level of heterogeneity of constituents, identified by categorical variables, within a group (Jiang et al., 2010). The diversity of each alliance portfolio can be calculated using Equation 4-2 below:

$$\text{Alliance Portfolio Diversity} = 1 - \sum\left(\frac{n_i}{N}\right)^2 \qquad \text{[Equation 4-2]}$$

, where n_i represents the cumulative number of partners belonging to SIC code i and N represents the cumulative number of all partners of a focal firm during the 1998-2002 period. This variable ranges from 0 (a perfectly homogeneous alliance portfolio) to 1 (a perfectly heterogeneous alliance portfolio with partners spread evenly among the different SIC codes). Focal firms' alliance portfolios in the final dataset included 41 different SIC codes, representing diverse fields including medicinal chemicals, diagnostic substances, testing laboratories, etc.

Alliance experience. I counted the number of alliances formed by each focal firm during the 1998-2002 period to measure the level of their alliance experience. Considering the sharp increase in the number of alliances during the 1998-2002 period and their exploration-biased characteristics compared to the prior period, I followed the procedure of a number of recent studies (e.g. Duysters et al., 2012; Heimeriks, 2010) which measured the level of R&D alliance experience in the same period as the alliance portfolio diversity. Contemporaneous experience is better suited to help a firm process tasks which are similar to the ones it is currently working on, and this is in line with one of the aims of this study, the examination of the role of task knowledge.

Proximity. To measure proximity between each focal firm and their alliance portfolios, in line with the measure for the alliance portfolio diversity, I focused on the primary SIC codes of these firms. By measuring alliance portfolio diversity based on the SIC codes, the absolute level of knowledge distribution in each alliance portfolio, regardless of the focal firm, can be captured. On top of that, by measuring the proximity

based on the SIC codes as well, the relative level of knowledge distance between a focal firm and its alliance portfolio can be operationalized. Adopting the method of Jiang et al. (2010), I assigned a score of zero to four points to each alliance relationship within a portfolio during the 1998-2002 period according to the following conventions: ‘4’ for an alliance formed with a partner having the same four-digit SIC code; ‘3’ for the same three-digit SIC code; ‘2’ for the same two-digit SIC code; ‘1’ for the same one-digit SIC code, and ‘0’ if the two companies share no common first digit in their respective SIC codes. The proximity level of a whole alliance portfolio relative to the focal firm is the average of the score for each alliance in its portfolio.

4.3.4. Control variables

R&D expenditure. As the focal firms’ innovation efforts concurrent with its alliance activities might affect the innovation output, I controlled the focal firms’ R&D expenditure. Specifically, each focal firm’s annual R&D expenditure during the 1998-2002 period was averaged and the variable was log-transformed due to its spread of values.

Firm size. I also controlled the size of the focal firms as it is correlated to the amount of resources firms can utilize. Specifically, each focal firm’s annual sales during the 1998-2002 period was averaged and the variable was log-transformed.

Prior patents. I counted the number of granted US patents applied for by each focal firm during the 1998-2001 period. Patents are one of the best means for representing firms' technological capabilities (Sampson, 2007; Silverman, 1999) and, thus, a firm's recent patent stock might affect the subsequent patenting output in terms of both quantity and quality. Moreover, simple patent counts have shown to be a good measure of innovative inputs and are strongly associated with R&D spending (Sampson, 2007; Trajtenberg, 1990).

Ongoing alliances. I also took into account alliances to capture their concurrent effects in the period during which the patenting performance is measured. Thus, I counted the number of alliances each focal firm implemented during the 2003-2006 period. Some extant studies (e.g. Sampson, 2007) also capture this effect of later alliances on patent applications in the same period.

4.3.5. Empirical model specification

The dependent variable of this study is weighted patent counts and thus has a non-negative integer value. Poisson regression is appropriate to test such data, but in my case, the dependent variable exhibits over-dispersion and violates the underlying assumption of the Poisson model, i.e. the equality of the mean and variance of the event count (Luo & Deng, 2009; Lin et al., 2012). In the case of a dependent variable with over-dispersed

count data, negative binomial regression is an appropriate method to analyze the model (Barron, 1992; Cameron & Trivedi, 1986; Ranger-Moore et al., 1991). The negative binomial regression can also handle the dependent variable with a large number of zeros (Lin et al., 2012), a natural outcome among the count data, however, some prior studies (e.g. Park et al., 2015), in case of a large number of zeros, tested such models through zero-inflated negative binomial regression. In the case of my dataset, there were few zero values for the dependent variable, thus, I did not have to consider employing zero-inflated negative binomial regression.

4.4. Results

Table 7 presents a summary of the descriptive statistics and the correlations among the variables including the interaction terms, the products of different independent variables. Some variables exhibit relatively high correlations (higher than 0.6) with other variables. Thus, I conducted an additional variance inflation factor (VIF) analysis to examine whether a multicollinearity problem exists. I excluded the interaction terms from the analysis because multicollinearity can be ignored when the high variance inflation factors are caused by the inclusion of products or powers of main effect variables in the model (Allison, 2012). Table 8 presents the result of the VIF analysis and it can be seen that *R&D expenditure* exhibits the highest value (5.76). There is no multicollinearity problem

Table 7. Descriptive statistics and correlations matrix for Chapter 4.

Variables	1	2	3	4	5	6	7	8	9	10	11	Mean	SD
R&D expenditure	1.00											4.62	2.04
Firm size	0.88	1.00										5.31	3.17
Prior patents	0.68	0.63	1.00									153.32	227.36
Ongoing alliances	0.54	0.50	0.52	1.00								4.63	7.65
Alliance portfolio diversity (Diversity)	0.41	0.36	0.35	0.35	1.00							0.48	0.25
Alliance experience (Experience)	0.61	0.50	0.70	0.59	0.50	1.00						4.64	3.85
Proximity	0.11	0.03	0.04	0.07	-0.42	0.08	1.00					2.36	1.02
Diversity_Sqaured	0.44	0.38	0.38	0.42	0.96	0.57	-0.40	1.00				0.29	0.18
Diversity × Experience	0.59	0.50	0.67	0.61	0.62	0.98	-0.02	0.70	1.00			2.67	2.98
Diversity × Proximity	0.50	0.41	0.39	0.40	0.72	0.59	0.20	0.66	0.63	1.00		1.02	0.68
Innovation performance	0.67	0.64	0.70	0.54	0.34	0.72	0.09	0.38	0.72	0.45	1.00	792.92	1229.11

Table 8. VIF test results of Chapter 4.

Variables	VIF
R&D expenditure	5.76
Firm size	4.59
Prior patents	2.58
Ongoing alliances	1.71
Alliance portfolio diversity	2.02
Alliance experience	2.80
Proximity	1.52
Average	3.00

when the VIF value is less than 10 (Hair *et al*., 1995). Therefore, I concluded that the correlations among variables in this study do not lead to a multicollinearity problem.

Table 9 presents the results from the negative binomial regression. In each model I have included the control variables. Model 1 contains only the control variables.

In Model 2, *Alliance portfolio diversity (Diversity)* alone does not show any significant influence on the focal firms' innovation performance. However, in Model 3, *Alliance portfolio diversity (Diversity)* is positively associated with the focal firms' innovation performance and this relationship is significant ($p<0.01$). In the meantime, *Diversity_Squared* is negatively related to the focal firms' innovation performance and this relationship is also significant ($p<0.01$). This result implies an inverted u-shape relationship between *Diversity* and innovation performance. As firms pursue diversity in their alliance portfolios, their innovation performance increases up to a certain level of

diversity and then decreases afterward with even higher diversity. Thus, Hypothesis 4-1 of this study is supported.

Across Models 4 to 7, I added the moderating variables, *Alliance experience (Experience)* and *Proximity*, and their interactions with the main effect variable, *Diversity*, to examine how *Experience* and *Proximity* moderate the relationship between *Diversity* and innovation performance. The moderating variables by themselves exhibit no significant effects on the focal firms' innovation performance or mixed results. However, the interaction term, *Diversity* × *Experience*, exhibits a positive and significant ($p<0.1$) coefficient. This result implies that higher levels of alliance experience facilitate firms to accommodate more diversity in their alliance portfolio, which maximizes innovation performance and supports Hypothesis 4-2 of this study. The interaction term, *Proximity* × *Experience*, also exhibits a positive and significant ($p<0.05$) coefficient. This result implies that higher levels of proximity between a firm and its partners facilitate the firm to accommodate more diversity in its alliance portfolio, which maximizes innovation performance and supports Hypothesis 4-3 of this study.

The coefficients of some control variable also show significant values. Expectedly, the influence of *R&D expenditure*, *Firm size*, and *Prior patents* on innovation performance is positive and significant throughout all models.

Table 9. Negative binomial regression results of Chapter 4.

Depend variable:	Model 1		Model 2		Model 3	
Innovation performance	Coefficient	S.E.	Coefficient	S.E.	Coefficient	S.E.
Control variables						
R&D expenditure	0.2436*	0.1331	0.2265*	0.1350	0.2387*	0.1290
Firm size	0.1521**	0.0763	0.1581**	0.0766	0.1439*	0.0744
Prior patents	0.0022**	0.0009	0.0021**	0.0009	0.0024***	0.0009
Ongoing alliances	-0.0033	0.0205	-0.0057	0.0209	0.0139	0.0221
Independent variables						
Alliance portfolio diversity (Diversity)			0.3900	0.6178	4.2189***	1.5275
Diversity_Squared					-5.8999***	2.2037
Alliance experience (Experience)						
Proximity						
Diversity × Experience						
Diversity × Proximity						
N	72		72		72	
Log likelihood	-498.013		-497.819		-494.451	
Pseudo *R*^2[a]	0.0705		0.0709		0.0772	
LR Chi^2	75.59		75.98		82.72	
Regression *p*-value	0.000***		0.000***		0.000***	

[a] The pseudo-R squared value in table 9 is McFadden's pseudo R-squared. According to Long and Freese (2006), the pseudo R-squared of negative binomial regression does not carry the same meaning as the R-squared in OLS regression (the proportion of variance for the response variable explained by the predictors). But when comparing two models using the same data, McFadden's pseudo R-squared would be higher for the model with the greater likelihood.

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

Table 9 (Continued). Negative Binomial Regression Results of Chapter 4.

Depend variable:	Model 4		Model 5		Model 6		Model 7	
Innovation performance	Coefficient	S.E.	Coefficient	S.E.	Coefficient	S.E.	Coefficient	S.E.
Control variables								
R&D expenditure	0.2426*	0.1361	0.3038**	0.1376	0.26119**	0.1229	0.3341***	0.1264
Firm size	0.1456*	0.0765	0.1394*	0.0764	0.1358*	0.0715	0.1254*	0.0713
Prior patents	0.0021**	0.0010	0.0017**	0.0009	0.0021**	0.0009	0.0017**	0.0008
Ongoing alliances	0.0008	0.0244	-0.0054	0.0216	0.0090	0.0232	0.0021	0.0208
Independent variables								
Alliance portfolio diversity (Diversity)	4.4984***	1.5260	5.3891***	1.5623	0.2389	2.5042	1.4807	2.3743
Diversity_Squared	-6.6537***	2.2865	-10.1712***	2.8785	-4.6865*	2.3998	-8.1994***	2.9140
Alliance experience (Experience)	0.0523	0.0487	-0.3494*	0.2068	0.0091	0.0480	-0.3705*	0.1943
Proximity	-0.0278	0.1292	-0.0340	0.1248	-0.4627*	0.2481	-0.4258*	0.2232
Diversity × Experience			1.0467*	0.5394			0.9863**	0.5028
Diversity × Proximity					1.2163**	0.5045	1.1343**	0.4616
N	72		72		72		72	
Log likelihood	-493.879		-491.956		-490.518		-488.572	
Pseudo *R*^2[a]	0.0783		0.0818		0.0845		0.0882	
LR Chi^2	83.86		87.71		90.58		94.47	
Regression *p*-value	0.000***		0.000***		0.000***		0.000***	

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

The moderating role of alliance experience is depicted in Figure 12. In this three-dimensional diagram, it is shown that how firms' alliance experience affects the relationship between the firms' alliance portfolio diversity and their innovation performance. Basically, regardless of alliance experience, the relationship between alliance portfolio diversity and innovation performance is inverted-u shaped, i.e. the innovation performance peaks at a medium level of alliance portfolio diversity. However, with an increased alliance experience, firms' innovation performance peaks at a higher level of alliance portfolio diversity that indicates the positive moderating role of alliance experience in absorbing diversity within alliance portfolios. Besides, the peak point of innovation performance becomes higher in case of higher alliance experience and corresponding maximum alliance portfolio diversity tolerable.

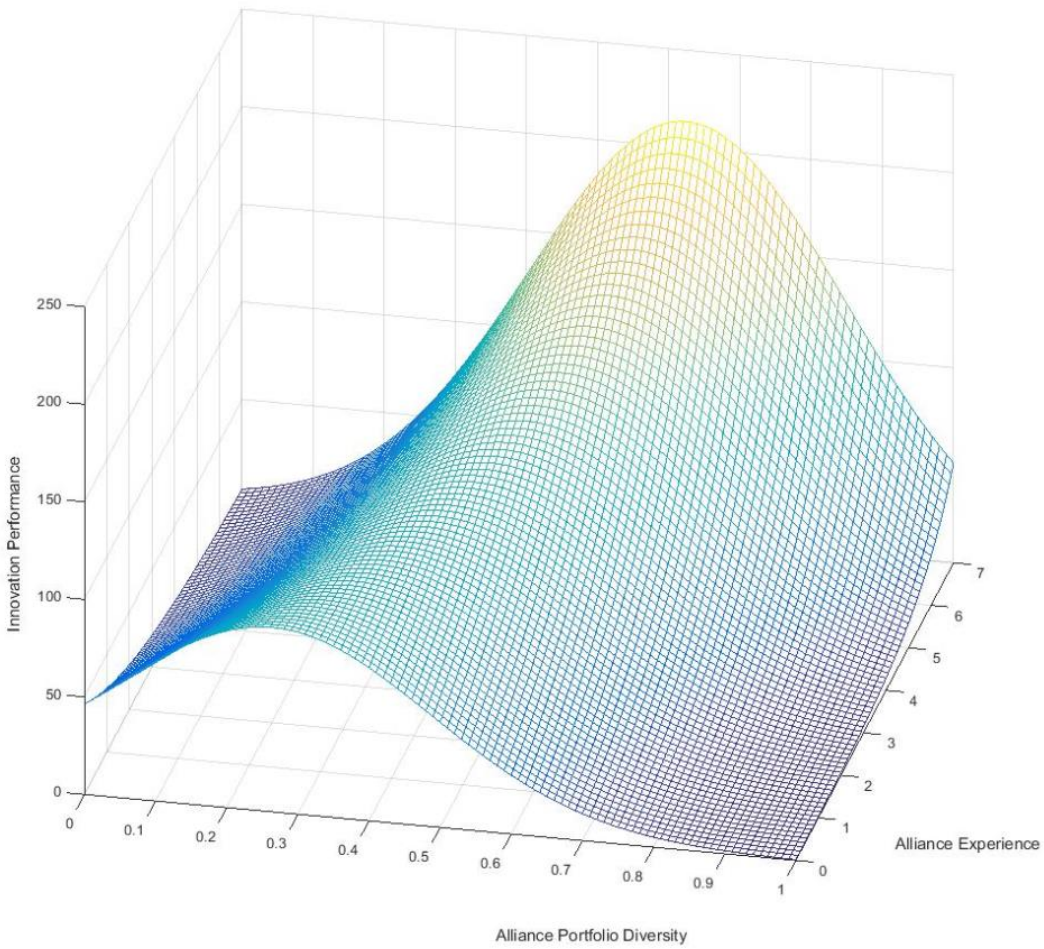


Figure 12. The moderating role of alliance experience between alliance portfolio diversity and innovation performance

4.5. Discussion

This chapter contributes to alliance portfolio and organizational learning literature by highlighting the significant role of alliance experience and proximity on handling alliance portfolio diversity and improving innovation performance. The findings of this chapter

are closely associated with the issues in the extant literature as follows:

First, this study introduces a concept of task knowledge and content knowledge, thus, specifying the constituents of knowledge relating to implementing alliances. Across diverse fields of social science, scholars have attempted to reveal the configuration of knowledge. Alexander et al. (1991) is one of the seminal studies relating to this endeavor and points out two major planes of knowledge interacting with each other, i.e. conceptual knowledge and metacognitive knowledge. The conceptual knowledge represents "an individual's knowledge of ideas, or concepts" while metacognitive knowledge refers to "the part of one's acquired world knowledge that has to do with cognitive matters" (Alexander et al., 1991; Flavell, 1987). In short, conceptual knowledge refers to an object per se while metacognitive knowledge refers to the context surrounding the object. One of the major blocks of conceptual knowledge is content knowledge while task knowledge is one of the major blocks of metacognitive knowledge (Alexander et al., 1991). This study uses these concepts for an integrative understanding of knowledge relating to implementing alliances. For a successful alliance strategy, both content knowledge, which facilitates the understanding of knowledge transferred or created through alliances, and task knowledge, which facilitates conducting repeated alliance tasks, are critical. The moderating effects of both content knowledge, i.e. knowledge proximity to partners, and task knowledge, i.e. alliance experience, on dealing with a diversified alliance portfolio are empirically verified in the present study.

Second, the findings of this chapters advocates a contingency perspective relating

to alliance portfolios. According to the contingency perspective, the benefits from alliance portfolio diversity are not equal to all firms, and previous literature (e.g. Schilke & Goerzen, 2010; Schilling & Phelps, 2007; Wassmer, 2010) observed the varying effects of alliance portfolio diversity on firms. However, the extant literature does not come to a conclusion regarding the origin of this contingency (Wuyts & Dutta, 2012). To account for this contingency, the main approach in this chapter is based on a comprehensive organizational learning perspective relating to processing alliances. A stream of previous literature (Bettis & Prahalad, 1995; Kogut & Zander, 1992; Levinthal & March, 1993; Wuyts & Dutta, 2012) suggests an interesting argument that extends internal knowledge creation pattern to leveraging extramural knowledge, but, does not exactly point out what kind of knowledge or capabilities firms should possess to absorb diversity from alliance portfolios. Thus, this study separates the alliance related knowledge into task knowledge and content knowledge, respectively attainable through repeated alliance experience and narrowing down the gap between firms and their partners, and examine how they moderate the relationship between alliance portfolio diversity and the firm's innovation performance. To absorb a higher level of diversity and turn it into an increased innovation performance, the result of this chapter suggest firms to increase their alliance experience and proximity to their partners. This result provides a reasonable explanation for the contingency relating to the effects of alliance portfolio diversity and complements the extant alliance portfolio and organizational learning literature.

Third, the present study confirms an inverted u-shape relationship between alliance

portfolio diversity and firm performance, suggested in previous literature, in a different empirical setting and corroborates the extant argument. In prior studies, the u-shape relation has been empirically verified by using different sets of dependent variables including new product development (De Leeuw et al., 2014; Oerlemans et al., 2013), drug approval (Wuyts & Dutta, 2012), an exhaustive alliance portfolio performance (Duysters et al., 2012), and knowledge utilization (Vasudeva & Anand, 2011). In this chapter, for the dependent variable, this study focuses on the quantity and quality of the innovation outcomes, measured by weighted patent counts, and show that the u-shape relation is still valid in a different setting. Moreover, the period in which this study tested the hypotheses is worthy of attention. To measure alliance portfolio diversity, this study collected alliance records in the biopharmaceutical industry around the year 2000, in which the number of alliances had sharply increased compared to the prior period and the purpose of alliances was mainly exploration. Thus, this period is appropriate to study the effects of alliance portfolio diversity and the results of the present study contribute to generalizing the inverted u-shape relation between alliance portfolio diversity and firm performance.

On top of the findings and contributions of the present study, relating to the influence of alliance portfolio diversity, further discussion on the source of the diversity or configuration of alliance portfolios is required. Specifically, firms' alliance strategy can affect the diversity of their alliance portfolios. If firms aim to explore new development opportunities and actively shape their environment (shaping strategy), to acquire new technologies and lead the market, they place core exploration alliances in their alliance

portfolios (Hoffmann, 2007). Conversely, if they aim to reactively adapt to their current environment (adapting strategy), they place several low-cost probing alliances in their portfolios and make careful follow-up investments depending on the environmental development (Brown & Eisenhardt, 1997; Hoffmann, 2007). As a result, firms' alliance portfolio diversity tends to become lower in case of a shaping strategy and tends to become higher in case of an adapting strategy. Hence, interpreting firms' innovation performance without understanding their alliance strategy may lead to an erroneous conclusion. For example, pursuing an adapting strategy, a firm might intend an extra level of diversity in its alliance portfolio and would take a temporarily low level of innovation outcome for granted. I expect future research to operationalize these alliance strategies and include them in investigating the influence of alliance portfolio diversity. This would allow for an unbiased approach to interpreting innovation performance driven by the diversity.

Chapter 5. Aligning goals of an alliance portfolio

5.1. Introduction

Strategic alliances are essential tools for firms in that they facilitate absorbing new knowledge and encourage innovation (Hagedoorn, 1993; Park & Kang, 2013). The extant literature highlights a variety of causal relations between strategic alliances and innovation performance. For example, previous research has shown the positive influence of the number of alliance partners on the innovation output such as patent applications and new product developments (Ahuja, 2000a; Deeds & Hill, 1996). On top of that, Stuart (2000) suggests that the collective characteristics of alliance partners affect a focal firm's patenting performance. Another stream of research classifies alliances according to their objectives (i.e. exploration and exploitation) and suggests that they have an effect on different domains of new product development (Rothaermel, 2001; Rothaermel & Deeds, 2004; Hoang & Rothaermel, 2010). Likewise, many researchers focused on immediate innovation outcomes such as patenting performance and new product development and confirmed the effect of strategic alliances on such outcomes. Existing literature, however, has not sufficiently examined the effects of strategic alliances on the effectiveness or the practicality of innovation such as its contribution to firm sales. To understand innovation performance in a more profound way, it is required to focus not only on the immediate output of innovation activities but also on the entire process from knowledge creation to

how it generates cash flow (Dervitsiotis, 2010; Lee & Kelly, 2008; Loewe & Dominiquini, 2006). Klein and Sorra (1996) suggest the significance of innovation effectiveness which indicates the organizational benefit achieved from implementing innovation.

Strategic alliances can also contribute to innovation effectiveness as well as immediate innovation outcomes. Diverse knowledge of different parties increases the innovativeness of the collaborative output. Moreover, the evaluation of the collaborative output by collaborators with different backgrounds also increases the practicality and marketability of the resulting innovations. Especially exploration focused alliances are advantageous not only to novel creations but also to innovation effectiveness because they contribute to sourcing new knowledge, verifying internal knowledge and checking the general prospect toward emerging technology. Previous literature (e.g. Alter & Hage, 1993; Thrasher, Craighead, & Byrd, 2010) also suggests that collaborative decision making contributes to a profound understanding toward market needs and market adaptation. Likewise, despite the big role of strategic alliances for successful innovations, except for some initial steps (e.g. Beers & Zand, 2014; Faems, Looy, & Debackere, 2005), the extant literature has not yet sufficiently examined the influence of alliances on innovation effectiveness.

The objective of this study is to investigate the influence of alliances which aim to obtain new knowledge and technology on firms' innovation effectiveness. Moreover, this study examines some internal and external organizational characteristics which strengthen the influence of alliances on innovation effectiveness. Specifically, this study focuses on

entirely new innovation (new to the focal firms or new to the market) and, thus, the influence of exploratory alliances that are known to influence radical innovation (Koza & Lewin, 1998; Faems et al., 2005). The results of the present empirical study finds a positive effect of the commitment to exploratory alliances on innovation effectiveness measured by percentage of revenue from new products (Dervitsiotis, 2010). This study also confirms that firms' another external behaviors (exploitative alliances) and internal innovation intent positively moderate this relationship.

This chapter makes several contributions to innovation and alliance literature: First, the results of the present study suggest the influence of exploratory alliances not only on the number of new technology and products developed but also, more importantly, on the firms' innovation effectiveness. Second, this study adopts the criticism of recent literature (e.g. Kratzer, Gemuenden, & Lettle, 2008; Yamakawa, Yang, & Lin, 2011) that boundary conditions or interactions with organizational characteristics has not been sufficiently covered by existing alliance literature and investigate some internal and external driving factors which increase alliance performance. Finally, this study investigates the Korean manufacturing sector during its peak growth rate (2002-2004) after the 1997 Asian Financial Crisis and provides a case of successful collaboration and innovation strategy to other countries' manufacturing sectors.

The remainder of Chapter 5 is organized as follows: First, this study explains the significance of innovation effectiveness and how it is affected by strategic alliances. This study develops hypotheses which link innovation effectiveness with exploratory alliance

activity as well as moderating factors related to the firms' alliance propensity and strategic intent. Second, employing ordinary least square regression, this study tests the hypotheses using Korea Innovation Survey (KIS) data on 364 Korean manufacturing firms. Finally, the study presents the empirical results and conclude with a discussion of implications, limitations, and directions for future research.

5.2. Research hypotheses

5.2.1. Exploratory alliances and innovation effectiveness

Exploratory alliances contribute to innovation effectiveness in a number of ways:

First, multilateral participation in a given innovation project results in an increased innovativeness and marketability. By participating in exploratory alliances, firms are able to access knowledge of diverse partners and to rigorously evaluate the ongoing innovation project relating to its practicality from diverse standpoints. Thus, innovation projects created through alliances are likely to be more influential and marketable. Compared to within-firm exploration, exploratory alliances provide firms with a number of advantages such as sourcing external knowledge, verifying internal knowledge and examining the market outlook for specific technologies. Previous literature (e.g. Alter & Hage, 1993; Thrasher et al., 2010) also suggests that decision making through collaborations enhances the understanding of customer needs and market adaptability.

Second, exploratory alliances provide complementary assets which can turn innovation projects into a commercial success (Faems et al., 2005; Hagedoorn, 1993; Teece, 1986). For example, in the biopharmaceutical industry, biotechnology firms or pharmaceutical companies form exploratory alliances with hospitals and research institutes in order to develop technology applicable to new drugs. During the collaboration, the firms are able to take advantage of their partners' technicians and research manpower, clinical tests and test equipment. As a result, the firms are able to estimate the effectiveness of their innovation outcomes as well as to improve their technology.

Third, collaborations facilitate the transfer of codified and tacit knowledge (Ahuja, 2000a; Doz & Hamel, 1997; Eisenhardt & Schoonhoven 1996). Compared to an indirect access to a certain technology through patent citations or informal sources, forming an alliance with the inventor or the provider of a certain technology would allow the transfer of the tacit side, as well as the codified side, of the knowledge. Thus, firms would be able to appreciate the true value of the technology and successfully commercialize it.

Therefore, the present study suggests:

Hypothesis 5-1. A higher importance of exploratory alliances for a firm's innovation activities leads to an increased innovation effectiveness.

This study predicts not only a positive effect of exploratory alliances on innovation

effectiveness, but also examines the influence of firms' other alliance activities and internal intent which can positively moderate this relationship: First, from the viewpoint of ambidexterity (March, 1991; Levinthal & March, 1993), this study examines the moderating effect of exploitative alliances on the relationship between exploratory alliances and innovation effectiveness. Next, in line with the stream of research (e.g. Dickson & Weaver, 1997; Kratzer et al., 2008; Yamakawa et al., 2011) which points out the scarcity of interactions between alliance strategy and organizational characteristics in the extant literature, this study examines the moderating effect of firms' innovation intent on the relationship between exploratory alliances and innovation effectiveness.

5.2.2. The role of ambidexterity on innovation effectiveness

Unlike exploration, exploitation focuses on efficiency and aims to improve the performance of processes and products (Levinthal & March, 1993; March, 1991). Similarly, exploitative alliances, e.g. alliances with customers, business service providers, and suppliers, improve the productivity of businesses (Koza & Lewin, 1998; Rothaermel, 2001; Rothaermel & Deeds, 2004). In exploitative alliances firms have access to complementary assets for commercialization and can expect faster and more predictable outcomes compared to exploratory alliances (March, 1991). March (1991) emphasizes the significance of ambidexterity in implementing exploration and exploitation and suggests

that they complement each other and increase each other's effectiveness in contributing to firm performance. Ambidextrous organizations can expect a synergy between exploration, which contributes to innovativeness in capabilities and outputs, and exploitation, which focuses on prompt sales and commercialization (March, 1991; Levinthal & March, 1993). By employing an ambidextrous alliance strategy, firms are able to develop new capabilities and radically new technology through exploratory alliances and, at the same time, use exploitative alliances to make the resulting innovation more effective in the market (Faems et al., 2005; Koza & Lewin, 1998; Rothaermel, 2001). Thus, exploitative alliances increase the market adaptiveness and productivity of the innovation process and contribute to strengthening the influence of exploratory alliances on the firms' innovation effectiveness. Therefore, the present study suggests:

Hypothesis 5-2. A higher importance of exploitative alliances for a firm's innovation activities will positively moderate the relationship between its focus on exploratory alliances and innovation effectiveness.

5.2.3. The role of strategic fit on innovation effectiveness

Previous literature considers internal support and managers' support for the firm's activities as an important factor in the innovation process (Lee & Kelly, 2008; Loewe &

Dominiquini, 2006). When a beneficial firm behavior or strategy, e.g. a strategy to use exploratory alliances for innovation, is identified, the top management team needs to allocate the firm's resources accordingly. Positive outcomes will be stronger when the firm's actions and strategic intent are aligned. This not only supports firm's behavior (Yamakawa et al., 2011), but also sustains competitive advantage (Porter, 1996). Porter (1980) suggests that a firm's internal strategic orientation decides how to allocate its resources and categorizes strategic orientation into cost leadership and differentiation. A differentiation strategy aims at creating new capabilities to differentiate the firm's services or products in order to obtain a competitive advantage (Hill, 1988). Firms which adopts such a differentiation strategy show strong intent to continuously search for new technologies which help them respond to changing markets and launch new products (Koza & Lewin, 1998; Yamakawa et al., 2011). Exploratory alliances focus on such a search for new technologies, which is why they have been linked with the firm's intent toward innovation described above (Gilsing & Nooteboom, 2006; Yamakawa et al., 2011).

In previous literature, innovation intent has been linked to commitment to learning and risk-taking propensity (Gatignon & Xuereb, 1997; Sinkula, Baker, & Noordewier, 1997; Verona, 1999; Yang, 2012). As these two factors grow, innovation capability will increase and the firm will grow (Yang, 2012). A firm which is strongly committed to learning is more likely to possess state-of-the-art technology that further increases its innovation capabilities (Gatignon & Xuereb, 1997). Therefore, the more the firm's culture is committed to learning, the higher will be its productivity and profitability (Wick &

Leon, 1993). Risk-taking propensity indicates how much risk top managers are willing to accept to gain a competitive advantage (Miller, 1983). Because firm growth always entails risk (Canals, 2001), it is important for managers to foster a culture of risk-taking in order to achieve innovation (Jassawalla & Sarshittal, 2002). In summary, firms with a higher innovation intent are less risk-averse and in a better position to obtain higher innovation outcomes from their exploratory alliance activities.

Therefore, the present study suggests:

Hypothesis 5-3. The firm's innovation intent will positively moderate the relationship between its focus on exploratory alliances and innovation effectiveness.

To describe the outline of this study more clearly, Figure 12 shows a diagram that summarizes the research model and hypotheses of Chapter 5.

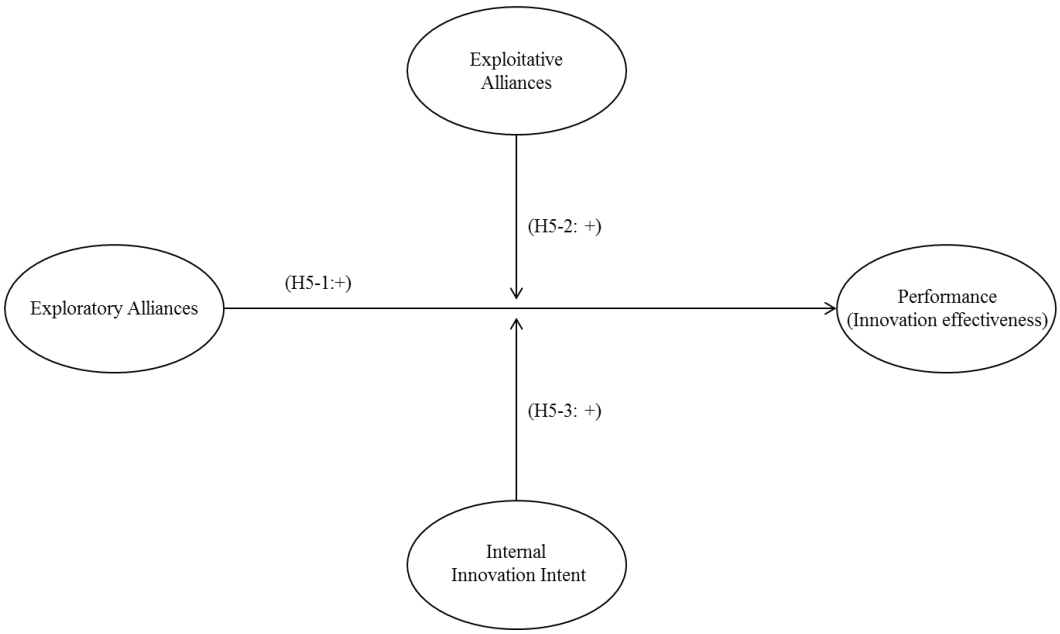


Figure 13. The conceptual model for Chapter 5.

5.3. Method

5.3.1. Data and sample

The empirical analysis is based on data from the "Korean Innovation Survey 2005: Manufacturing Sector (KIS)", which is a survey undertaken by the Korean Science & Technology Policy Institute (STEPI). The employed questionnaire and methods of the survey follow the standards set forth in the third edition of the Oslo Manual published by the Organisation for Economic Cooperation and Development (OECD). KIS contains a

multitude of questions related to the firms' use of external knowledge sources, R&D collaborations and the firms' innovation outcomes.

Table 10. Sample composition by industry.

Industry	Frequency	Percent
Food products and beverages	24	6.59
Textiles	14	3.85
Wearing apparel and fur	2	0.55
Leather products and footwear	2	0.55
Wood and cork (not furniture)	2	0.55
Pulp, paper and paper products	6	1.65
Printing (except publishing and reproduction of recorded media)	4	1.10
Coke, refined petroleum products and nuclear fuel	5	1.37
Chemicals and chemical products	54	14.84
Rubber and plastic products	18	4.95
Non-metallic mineral products	10	2.75
Basic metals	15	4.12
Fabricated metal products (except machinery and equipment)	27	7.42
Machinery and equipment	54	14.84
Office, accounting and computing machinery	3	0.82
Electronic components (including semiconductors)	21	5.77
Television, radio and communication equipment	40	10.99
Medical, precision and optical instruments, watches, clocks (instruments)	15	4.12
Motor vehicles	30	8.24
Other transport equipment	10	2.75
Furniture, other manufacturing n.e.c.	8	2.20
Total	364	100

STEPI collected 2738 filled out questionnaires from 4507 firms which were selected as the targets for the survey based on a population of Korean firms identified by a prior survey of the Korean National Statistical Office. In the present study, a sub sample of 364 firms is used due to the need to exclude samples which were missing information on the variables selected for the empirical analysis. The firms in my sample are operating in a number of different industries as shown in Table 10.

In the present study I used innovation effectiveness, the percentage of a firm's revenue stemming from innovative products to measure the performance of firms. The continuous variable in my dataset had an almost normal distribution and thus, unlike other studies based on innovation survey data such as Faems et al. (2005), I did not need to censor the data and was able to use OLS regression for the analysis.

5.3.2. Dependent variable

The dependent variable in the present study is the firm's *Innovation effectiveness*. Among the measures of innovation effectiveness suggested by Dervitsiotis (2010), I decided on using the percentage of current revenue from recent innovations as the measurement for innovation effectiveness in the present study. I defined the percentage of revenue stemming from recent innovation activities as the revenue in 2004 from both innovations which were new to the market and innovations which were not new to the market, but

new to the firm in the 2002-2004 timeframe. My approach is similar to the one used by Faems et al. (2005) who used the proportion of turnover attributed to both new and improved products as a measurement for firms' innovation effectiveness.

5.3.3. Independent variables

The independent variables *Exploratory alliance* and *Exploitative alliance* are based on the evaluation of different external entities with respect to their contribution to the firm's innovation in the 2002-2004 time period. In the KIS survey I used the responses in the "Collaboration" part of the KIS questionnaire. The relevant question is "Please evaluate the contribution of your partner for innovation activity for the past three years", and firms responded on a 5-point Likert scale according to the contribution of the respective partners. They marked 5 points if the collaboration partners' contribution was very useful, and 1 point if their contribution was not useful. To measure the contributions from exploratory alliances, I calculated the average value of the evaluation from three categories: private research institutes, universities and institutes of advanced studies, and government-funded research centers. Previous literature discusses the role of such institutions in the creation of new technologies which can be used by firms in the development of innovative products (Peters, Groenewegen, & Fiebelkorn, 1998; George, Zahra, & Wood, 2002) and my approach is in line with that of previous studies using

innovation survey data such as the one by Faems et al. (2005). Following the approach I used in evaluating the contributions from exploratory alliances, for exploitative alliances I calculated the average value of the evaluation from the following three categories: customers, business service providers (technology, legal, accounting or consulting), and suppliers (raw materials, components, software, and services). The classification of these kinds of collaborations as exploitative rather than exploratory follows the approach found in Faems et al. (2005) and is in line with previous literature which also deals with firms' collaboration with customers and suppliers (Brown & Eisenhardt, 1995; Schoonhoven & Jelinek, 1997). My variable *Innovation intent* was also derived from the KIS data. In the survey, firms were asked to rate the objectives for the innovation related activities they performed between 2002 and 2004. Individual objectives were rated on a five-point scale, my measurement is the average of the importance of product diversification and the opening up of new markets as objectives of the firms' activities.

5.3.4. Control variables

The empirical analysis includes four control variables: *R&D intensity*, *Firm size*, *Firm age*, and *Geomarket*. A firm's technological innovation outcome is affected by its absorptive capacity, which can be measured by the firm's R&D intensity (Cohen & Levinthal, 1990). I defined *R&D intensity* as the total expenditures on internal and

external R&D in 2004 divided by the firm's total sales in 2004. Another variable that might have an effect on the firm's innovation is its size. I defined *Firm size* as the logarithm of the total number of employees at the end of 2004. As startups are often shown to be more active in pursuing innovation than incumbent firms, I controlled for the age of the firms by introducing the *Firm age* control variable. It is a dummy variable that is coded as 1 if the age of the firm was less than five years at the time of the survey and 0 if it was established more than five years before. A further dummy variable, *Geomarket*, was introduced to control for an international orientation of the firm. It was coded as 1 if the firm had customers from abroad and 0 if the firm was only serving customers in Korea in the 2002-2004 time period. Additionally I included industry dummy variables to account for the fact, that although all the firms in my sample are classified as manufacturing firms, they are operating in a range of different industries.

5.4. Results

Table 11 shows a summary of the descriptive statistics and the correlations among the variables used in the present study. The correlations are relatively low, however I performed an additional variance inflation factor test (VIF test). The results of this calculation are summarized in Table 12 and the low values (average of 1.22) show that this study does not have any problems with multicollinearity.

Table 11. Descriptive statistics and correlations matrix for Chapter 5.

Variables	1	2	3	4	5	6	7	8	9	10	Mean	SD
R&D intensity	1.00										0.08	0.54
Firm size	-0.15	1.00									5.12	1.31
Firm age	0.26	-0.15	1.00								0.07	0.44
Geomarket	0.04	0.30	-0.08	1.00							0.73	0.44
Exploratory alliance	0.08	0.14	0.01	0.11	1.00						1.39	1.23
Exploitative alliance	-0.01	0.18	0.01	0.06	0.33	1.00					1.42	1.35
Innovation intent	0.02	0.12	-0.01	0.04	0.23	0.23	1.00				3.61	1.38
Exploratory alliance x Exploitative alliance	0.01	0.20	-0.01	0.10	0.75	0.75	0.22	1.00			2.52	4.11
Exploratory alliance x Innovation intent	0.09	0.16	0.02	0.12	0.93	0.36	0.44	0.74	1.00		5.12	5.29
Innovation effectiveness	0.18	-0.03	0.10	0.05	0.30	0.19	0.16	0.32	0.34	1.00	43.40	26.85

Table 12. VIF test results of Chapter 5.

Variables	VIF
Firm size	1.32
Firm age	1.18
Geomarket	1.25
R&D intensity	1.12
Exploratory alliance	1.27
Exploitative alliance	1.23
Innovation intent	1.15
Average	1.22

Table 13 shows the results of the OLS regression models. In each model I have included the control variables as well as industry dummies. Model 1 contains only the control variables and it can be seen that, just as expected, a firm's R&D intensity has an influence on the innovation effectiveness. The other control variables did not show any significant effects. Model 2 analyzes the baseline hypothesis, which predicts positive effects of exploratory alliances on innovation effectiveness. The results show the parameter to be significant and positive, confirming Hypothesis 5-1.

Model 3 includes exploratory and exploitative alliances as well as the interaction between the two of them. Exploitative alliances by themselves do not show a significant

Table 13. Ordinary least square regression results of Chapter. 5.

Depend variable:	Model 1		Model 2		Model 3		Model 4		Model 5	
Innovation effectiveness	Coefficient	S.E	Coefficient	S.E	Coefficient	S.E	Coefficient	S.E	Coefficient	S.E
Control variables										
R&D intensity	7.44***	2.66	6.10**	2.55	6.53*	2.51	5.66**	2.52	6.12**	2.49
Firm size	0.45	1.17	-0.33	1.13	-0.77	1.11	-0.64	1.11	-0.99	1.11
Firm age	7.98	5.53	8.29	5.29	7.65	5.20	8.14	5.21	7.75	5.15
Geomarket	3.70	3.42	2.84	3.27	2.95	3.21	2.86	3.22	2.98	3.18
Independent variables										
Exploratory alliance			6.45***	1.12	1.25	1.92	-2.87	3.50	-5.70	3.58
Exploitative alliance					-0.99	1.69			-1.28	1.72
Exploratory alliance x Exploitative alliance					2.19***	0.79			2.07**	0.81
Innovation intent							0.10	1.27	0.48	1.29
Exploratory alliance x Innovation intent							2.32***	0.87	1.81**	0.88
Industry Dummies	Included		Included		Included		Included		Included	
N	364		364		364		364		364	
R^2	0.13		0.21		0.24		0.24		0.26	
F-Statistic	2.10***		3.53***		3.92***		3.83***		4.05***	

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

result, however the interaction between them, i.e. a firm following the concept of ambidexterity, has a significant positive effect on innovation effectiveness. Of interest is that in Model 3, as well as in Model 4, the effect of exploratory alliances, the baseline hypothesis, is insignificant while the moderation effects are confirmed. However, as Baron and Kenny (1986) point out, whether the main effects for predictor (in the present case exploratory alliance) and moderator (exploitative alliance or innovation intent) are significant or not, is not directly relevant for testing the moderator hypothesis.

Model 4 confirms Hypothesis 5-3 which stated that the firm's innovation intent positively moderates the relationship between exploratory alliances and innovation effectiveness. Both Hypotheses 5-2 and 5-3 are also confirmed in Model 5 which contains all the variables used in the present study.

5.5. Discussion

This chapter empirically verifies the positive influence of a firm's exploratory alliance activity on its innovation effectiveness. Levinthal and March (1993) characterize exploration as "the pursuit of knowledge, of things that might come to be known". It is commonly seen as a difficult and future oriented task, whose payoffs for a firm will not be immediate. Exploitation, on the other hand, "the use and development of things already known" (Levinthal & March 1993), is commonly understood to lead to an

immediate noticeable impact on the firm's performance. Following that thought, previous literature has found evidence for the positive impact of exploitative alliances on the innovation output of firms as measured e.g. by the number of new products developed or the approval rate of new pharmaceutical drugs (Rothaermel, 2001; Hoang & Rothaermel, 2010). Unlike these prior studies, this study focuses on innovation effectiveness, which captures the contribution of new to the firm and new to the market products to the firm's actual sales. Using this approach allowed me to show that exploratory alliances increase the firms' innovation effectiveness. Exploitative alliances, on the other hand, did by themselves not show any effect on the innovation effectiveness and were significant only in combination with exploratory alliances. This result contributes to the research on the effects of ambidexterity in alliances on the firms' performance (e.g. Lavie et al., 2011; Raisch, Birkinshaw, Probst, & Tushman, 2009).

Relating to pursuing ambidexterity in the realm of alliances, the extant literature suggests diverse ways of ambidextrous strategy which contribute to maximizing firm performance and the debate for a predominant one is still going on. The strategy appears in a variety of forms such as pursuing ambidexterity within an individual alliance (Colombo, Doganova, Piva, D'Adda, & Mustar, 2014), pursuing an ambidextrous alliance portfolio, i.e. different partners serve different roles, exploration or exploitation (Bahemia & Squire, 2010; Faems et al., 2012; Lavie et al., 2011), pursuing ambidexterity across an organizational boundary, e.g. internal exploitation and external exploration, (Ferrary, 2011; Hoang & Rothaermel, 2010; Russo & Vurro, 2010) and the fit or alignment rather

than balance across an organizational boundary (Yamakawa et al., 2011). Among these streams of research, the findings of the present study offer further support for certain perspectives. First, the present result shows the effectiveness of pursuing an ambidextrous alliance portfolio by confirming an increasingly positive effect of exploratory alliances on innovation effectiveness in case of implementing exploitative alliances together. Furthermore, the present result also suggests the importance of aligning the objectives of alliances with relevant internal intents. For an increased innovation effectiveness, internal innovation intent toward developing new markets and product diversification, regarded as consequences of exploration, should accompany exploratory alliances which aim to acquire new technology.

The findings of the present study further contribute to existing alliance literature by verifying the positive interaction between alliance behaviors and relevant boundary conditions. Lin, Yang and Arya (2009) state that considering relevant boundary conditions is important in understanding the performance of strategic alliances. They are especially important as different boundary conditions can lead to a different optimal mix of exploitative and exploratory alliance activities (Mc Namara & Baden-Fuller, 2007). The present study empirically verifies the relationship between exploratory alliances and a firm's innovation effectiveness and looks at how this relationship is moderated by the firm's exploitative alliances and the innovation intent of the organization. Previous literature falls short of explaining the effects of the interaction of alliance activities with the firm's behavior and strategic orientation (Yamakawa et al., 2011). Consequently, the

present work contributes to prior literature which has neglected the role of internal and external constraints and helps to embrace a more holistic understanding of which firm behaviors contribute to innovation performance.

By testing the hypotheses on a sample of Korean manufacturing firms during the 2002-2004 period, this study sheds light on the successful innovation strategy of firms during the recovery from an economic crisis. South Korean firms suffered heavily from the 1997 Asian financial crisis but after a bailout from the International Monetary Fund (IMF), the Korean economy experienced a fast recovery. During the 2002-2004 time period, the Korean manufacturing sector grew at an average annual rate of eight percent (The Bank of Korea, 2014). The present study investigates the collaborative behavior of Korean manufacturing firms and its impact on the firms' innovation performance which contributed to their fast growth and the rapid recovery from the crisis. The findings of the present study might contribute to the understanding of suitable innovation strategies in manufacturing sectors of other emerging countries which undergo a period of rapid economic growth or are undergoing a turnaround after experiencing a period of economic hardship.

Chapter 6. Conclusive remarks

6.1. Summary and contributions

In conclusion, the present dissertation highlights major building blocks of alliance portfolio management that sequentially contribute to the focal firm's innovation performance. Firms build their alliance portfolios, absorb knowledge from their portfolios, and finally optimize their portfolios to obtain a more effective innovation outcome. The dissertation provides following a number of significant findings and implications corresponding to each stage of alliance portfolio management. First, the dissertation confirms the moderation effect of partners' relationships on the link between alliance portfolio size and innovation performance and thus suggests firms to pay attention to their partners' perspectives in the stage of forming alliance portfolios. Second, the dissertation confirms the role of alliance experience and proximity in the absorption of knowledge stage. This integrative approach to absorbing knowledge shows how firms can learn to benefit from diversity in their alliance portfolios. Third, the dissertation confirms the role of ambidextrous alliance portfolios and internal innovation intent in optimizing innovation outcomes. This finding suggests firms to balance different types of alliance, i.e. exploratory and exploitative alliances, and to support alliance activities by integrating it into the companywide strategy. Overall, the dissertation shows that with proper alliance portfolio management, a firm's alliance portfolio is an important strategic element which

contributes to the sourcing of external knowledge and consequently realizing innovation.

In addition to the aforementioned overall contributions, each chapter of the present thesis provides managerial implications corresponding to their findings.

Based on the findings of Chapter 3, this thesis suggests firms to increase their alliance portfolio size and, at the same time, to keep an eye on the two-sided characteristic of their portfolios, which is the connectivity and competition among their partners. As firms obtain more alliance partners, they might experience positive effects on their innovation performance as a result of increasing connectivity, but might also be confronted with the negative influence of competition within their portfolio. Therefore, firms should foster collaborations among their partners and, at the same time, avoid the overlap of partners around the same business fields.

Specifically, this thesis suggests alliance managers to increase the network density within their alliance portfolios. If firms ally with their indirect partners (partners' partners), they can increase both the size and network density of their alliance portfolios and, consequentially, their innovation performance. Another way of fostering interconnections within an alliance portfolio is to develop joint projects which involve the focal firm and multiple partners from within the portfolio. These joint projects are likely to result in more ties among the focal firm's partners (higher network density) and can lead to an increased innovation performance of the focal firm by fostering active knowledge sharing between the multiple parties.

This thesis also suggests alliance managers to restrict competitive relations across

broad fields in their alliance portfolios. Chapter 3 subdivides the measure of competitive relations into breadth and depth and verifies the negative influence of competitive relations across broad fields on the innovation performance of focal firms. Focal firms face difficulties in absorbing knowledge throughout portfolios that include competitive relations across a number of (broad) fields. In such case, alliance portfolios turns into a conflict pool rather than a resource pool and do not significantly contribute to the focal firms' innovation performance. Accordingly, when firms increase their alliance portfolios, they should form alliances with the most suitable partner in each field rather than with many partners in the same field.

The findings of Chapter 4 suggest that firms examine their status which allows them to effectively embrace the diverse knowledge obtained through alliances without incurring large cost to handle it. Pursuing a medium level of diversity in alliance portfolios is generally beneficial for firms and results in an increased innovation performance. However, pursuing too much diversity in alliance relationships, without a sufficient level of alliance experience or proximity to alliance partners, is likely to lead to a decreased innovation performance. Thus, this thesis recommends firms to gradually increase the level of diversity in their alliance portfolio as they build up alliance experience and monitor their proximity to alliance partners. This approach of building alliance portfolios will increase the level of diversity firms can accommodate and allow them to utilize the inflow of diverse knowledge for generating new innovation. In line with this approach, establishing a dedicated alliance management function is an efficient

way of improving learning from alliances. This function, throughout the organization, gathers and disperses lessons from prior and ongoing alliances in a systematic way, and nurtures common practices in the process of forming and managing alliances. This allows firms to employ their accumulated know-how, stay focused on a systemized procedure of alliance management, and successfully absorb knowledge from their alliance portfolios.

In sum, the lessons from Chapter 4 highlight the importance of management resources and capabilities relating to alliance portfolios. Building up alliance experience and configuring a proximate alliance portfolio would enrich these resources and capabilities. The increased management resources and capabilities essentially provide room for firms to handle the drawbacks of too much alliance diversity and ultimately contribute to an increased innovation performance by allowing the firms to fully leverage the advantages of alliance portfolio diversity.

Chapter 5 provides two key recommendations for managers who are concerned with planning and coordinating a firm's alliance strategy: The importance of ambidexterity, i.e. the balancing of both exploratory and exploitative alliances, and the need for an alignment of the alliance objectives with the firm's organizational intent.

The results of Chapter 5 suggest that simultaneous exploration and exploitation in alliances are necessary to achieve innovative effectiveness. Even in case of radical innovation (products which are either new to the firm or new to the market), exploitative alliance activity contributes to increasing the firm's innovation efficiency, i.e. increase the percentage of total sales stemming from such innovative products. Despite the difficulties

in simultaneously using a firm's limited resources for both exploration and exploitation, due to their conflicting requirements for resources and capabilities, ambidexterity matters for an effective innovation and should be considered when deciding on an alliance strategy which can foster innovation and enable the firm to benefit from its outcomes.

Chapter 5 has further shown the importance of aligning organizational intent and the alliance objective. Following an open innovation paradigm, the business environment fosters strategic alliances. These alliances can be classified by their objectives as either exploratory or exploitative ones. To achieve a better performance from their alliance activities, firms need to align their organizational intent with their alliance objective. The results show that firms which have a clear organizational intent of pursuing innovation for the purpose of product diversification or the opening up of new markets experienced a higher effectiveness of their exploratory alliances. This thesis thus suggests for managers to align the firm's intent and to put strong organizational support in accordance to the alliance objectives to maximize the returns from the alliances activities.

6.2. Limitations and future research

Despite the contributions and implications the present thesis provides, it still involves some limitations.

Chapter 3 and 4 focus on the biopharmaceutical industry and provide implications

on effectively managing technology alliance portfolios. The findings obtained from a single industry may have difficulty in applying to another industry. Furthermore, frequent M&As among pharmaceutical firms provide only a limited number of final data points during a long span of time (e.g. 72 firms are tested in Chapter 4), a problem also faced by prior studies of alliance portfolios in the biopharmaceutical industry (e.g. Hoang & Rothaermel, 2005). Thus, I acknowledge limited generalizability of the results of the present dissertation. Nonetheless, the biopharmaceutical industry is one of the best possible choices for testing the hypotheses of this dissertation due to following reasons:

First, in terms of knowledge flow, the biopharmaceutical industry is more dynamic than other technology-oriented industries (Arora & Gambardella, 1994; Malik, 2012; Stuart, Ozdemir, & Ding, 2007). Thus, this industry shows high alliance tendencies and accounts for about 20 percent of alliances formed in high-tech industries (Hagedoorn, 1993). Therefore, the biopharmaceutical industry is an ideal setting to study alliance formations and their antecedents (Rothaermel & Boeker, 2008), as if Bower and Christensen (1995), inspired by fruit flies studies in biology, did research on product life span through the hard-disk-drive industry.

Second, the highly competitive environment of the biopharmaceutical industry, where rents accrue to the first-mover firm that makes a discovery (Malik, 2012; Vassolo et al., 2004), is appropriate to study competitive relations among partners. Moreover, diverse sub-sectors in the biopharmaceutical industry related to the field of products (e.g. cancer, cell therapy, vaccines, etc.) are appropriate to measure the breadth and depth of

competition.

Third, as described in Chapter 4, biopharmaceutical firms in my dataset try to obtain cutting edge knowledge in a variety of industries and are forming R&D alliances with partners correspond to 41 different SIC codes. The backgrounds of the partners vary from similar fields, such as medicinal chemicals and diagnostic substances, to disparate fields, such as crude petroleum, cosmetics and semiconductors. In other words, due to the composition of such alliance portfolios, the present dissertation deals with firms from a number of different industries and, compared to simply testing alliance network within a single industry, increases the generalizability of the findings.

Moreover, the dissertation also includes some operationalization and measurement issues in each chapter that I expect future research to overcome, adding further robustness to the claims of the present thesis.

Relating to Chapter 3, the dependent variable, focal firms' innovation performance, is based on patent applications and does not consider whether the patent would be actually granted or the significance of the underlying knowledge and technology. Chapter 3 focused on the amount of technological outputs which the firms themselves consider innovative at the time of their invention and follows previous literature (e.g. Brouwer and Kleinknecht, 1999; Cheung and Lin, 2004) in using patent applications as a proxy for innovation performance. In addition, Chapter 3 focused on the amount of innovation output and counted the number of patent applications following the way widely used in previous literature (e.g., Ahuja, 2000a; Baum et al., 2000; Shan et al., 1994). However, it

does not consider the significance of the underlying knowledge and technology of each invention. Thus, I expect future research to consider this significance and introduce a better way for measuring innovation performance.

Additionally, in Chapter 3, the size of the alliance portfolio is operationalized by counting the number of alliance partners. This simple but intuitive measure for alliance portfolio size reflects the amount of network resources the focal firm possesses and has been adopted by a number of prior studies (e.g. Ahuja, 2000a; Baum et al., 2000; Deeds & Hill, 1996). However, following a stream of research which highlights detailed characteristics of network resources such as the breadth and efficiency of alliance portfolios and partner quality (e.g. Stuart, 2000; Stuart et al., 1999), this measure per se also needs improvement to allow it to precisely capture the amount of network resources and provide more insights relating to the size – performance link. Hence, I expect future research to develop a more detailed measure for alliance portfolio size, for example, an approach including the relative importance or the level of involvement of each alliance.

Finally, I expect further research on the influence of embeddedness in alliance portfolios. Previous literature deals with structural variables of the firm network and studies the influence of structural embeddedness. On top of the existing research, Chapter 3 applies the structural embeddedness concept, together with competitive embeddedness, to firms' egocentric networks. In case of competitive embeddedness, recent studies including Gimeno (2004) and Trapido (2007) initiate the discussion and much of this field is still unexplored. Though not explicit, competitive relationships are ubiquitous

among firms and affect their actions and outcomes. I hope for future research to study the influence of competitive embeddedness on alliance portfolios and focal firms in multifaceted ways. Moreover, I expect future research on other types of embeddedness, i.e. relational embeddedness and sectoral embeddedness, and their influence on alliance portfolios. This will lead to deeper understanding on how to configure alliance portfolios in terms of social network perspective.

Chapter 4, to operationalize the innovation performance, used data on patent applications and related patent citations and measured weighted patent counts. However, to measure the diversity of alliance portfolios and the proximity to alliance portfolios, Chapter 4 used the SIC codes instead of patent data. Using the SIC codes binds firms' knowledge base to their primary business fields and does not specifically distinguish the differences between firms in the same industry. To analyze the detailed knowledge configuration of an alliance portfolio, more specific data that captures specific knowledge variations among firms is required. Thus, I considered using firms' patent data to measure the diversity and proximity, however, still adhered to the SIC codes because of some disadvantages of patent data relating to the purpose of Chapter 4 as follows:

First, due to a great number of patent classes among the patents possessed by partner firms, it was difficult to distinguish the differences in alliance portfolio diversity among the sample firms. Through a pilot test based on some of the sample firms' patent data, a commonly high level of alliance portfolio diversity was identified. It did not seem to be relevant to examine the effect of alliance portfolio diversity and related moderating

effects which change the adoption level of diversity. Thus, in line with some prior studies (e.g. Cui & O'Connor, 2012; Jiang et al., 2010) which focus on the fact that firms in different industries possess different sets of knowledge, I adopted the SIC codes, which correspond to different industry fields, to measure both the diversity and proximity. Fortunately, the sample firms in the dataset were forming alliances across various industry fields, as many as 41 different SIC codes were identified, and allowed me to draw relevant conclusions based on the empirical results.

Second, considering the fact that firms' decision making relating to the management of their alliance portfolios is mainly about adding or withdrawing a certain alliance partner, with implications based on the patent configuration within alliance portfolios, firms would find it difficult to elaborately adjust the level of alliance portfolio diversity and proximity to their alliance portfolios. Thus, such implications would be of little practical help and thus would only provide a limited significance to firms. To provide more practical implications and ready-to-use strategic options to alliance managers, I focused on the firm level knowledge configurations of alliance portfolios, i.e. the SIC codes of each firm, in measuring the diversity of alliance portfolios and the proximity to alliance portfolios.

Nevertheless, I still acknowledge the limitation of the current measure and expect an alternative in future studies which sufficiently reflects the diversity and proximity of alliance portfolios while at the same time being able to provide a practical implication to firms.

As a result of the used data set and necessary assumptions and definitions, Chapter 5 also has some limitations which I hope can be overcome by future research. Due to the use of KIS data, which is generated by a survey, my data is mostly based on managers' perceptions, i.e. the contribution of each type of alliance and firms' innovation intent stated are the perception of managers of the respective firms. While this subjective measurement can be criticized, it offers a unique advantage by providing an insight into the organizational landscape from the top managers' point of view. Similar survey data has been used in previous literature (Beers & Zand, 2014; Faems et al., 2005; Mouri et al., 2012; etc.) to study the relationship between alliance behaviors and innovation performance. As the general recognition of the importance of alliance and innovation might be chance in different industries, I introduced industry dummy variables related to the 21 different industries of my data set to account for possible between-industry differences. To complement and further verify the findings of this study on innovation effectiveness, I recommend future research to use a different set of data which captures firm behaviors and intents in a more systematic way.

Another limitation of Chapter 5 arises from the necessary definition of exploratory or exploitative alliances. Previous literature attempts to discern exploratory and exploitative alliances in various domains (e.g. Lavie & Rosenkopf, 2006; Li, Vanhaverbeke, & Schoenmakers) In Chapter 5, alliances which complement existing business are treated as exploitative (Brown & Eisenhardt, 1995; Faems et al., 2005; Schoonhoven & Jelinek, 1997) and, on the contrary, alliances which aim at creating new

technology and developing totally new products are regarded to be exploratory (George et al., 2002; Peters et al., 1998). Previous literature has shown several other possible domains for distinguishing exploratory and exploitative alliances such as function, structure, attribute (Lavie & Rosenkopf, 2006). Because of these various domains for exploration and exploitation alliances, a verified link between alliance activity and firm performance in one domain might be less effective in another domain. Considering this, I recommend future research to extensively investigate the relationship between alliance activities and innovation effectiveness across various domains to strengthen the findings of Chapter 5.

Finally, I would like future research to sufficiently take care of possible negative aspects of alliance strategy. For example, despite a number of advantages of technology alliances, alliance experience sometimes leads to indiscriminate alliance formations and may deteriorate firms' internal R&D capabilities (Park & Kang, 2013), hence, exhibits a diminishing return on R&D product success (Hoang & Rothaermel, 2005). Future research should investigate other possible risks of alliance strategy, systemize them and contribute to a more balanced approach toward managing alliance portfolios.

Bibliography

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

Ahuja, G. (2000b). The duality of collaboration: Inducements and opportunities in the formation of interfirm linkages. *Strategic Management Journal, 21*(3), 317-343.

Alexander, P. A., Schallert, D. L., & Hare, V. C. (1991). Coming to terms: How researchers in learning and literacy talk about knowledge.*Review of Educational Research*, *61*(3), 315-343.

Allison, P. D. (2012). When can you safely ignore multicollinearity? http://www.statisticalhorizons.com/multicollinearity. [Accessed May. 28, 2014].

Alter, C., & Hage, J. (1993). *Organizations Working Together*. Newbury Park, CA: Sage Publications.

Anand, B. N., & Khanna, T. (2000). Do firms learn to create value? The case of alliances. *Strategic Management Journal, 21*, 295-315.

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.

Bae, J., & Gargiulo, M. (2004). Partner substitutability, alliance network structure, and firm profitability in the telecommunications industry. *Academy of Management Journal, 47*, 843-859.

Bahemia, H., & Squire, B. (2010). A contingent perspective of open innovation in new product development projects. *International Journal of Innovation Management*, *14*(04), 603-627.

Bamford, J. D., & Ernst, D. (2002). Managing an alliance portfolio. *The McKinsey Quarterly, 3*, 29-39.

Barnett, W. P. (1991). Strategic deterrence among multipoint competitors. In L. R. Jauch & J. L. Wall (Eds.), *Best Paper Proceedings: 7-10*. Miami, FL: Academy of Management.

Barney, J. (1991). Firm resources and sustained competitive advantage. *Journal of Management*, *17*(1), 99-120.

Barron, D. (1992). The analysis of count data: Over-dispersion and autocorrelation. *Sociological Methodology, 22*, 179-220.

Baron, R. M., & Kenny, D. A. (1986). The moderator–mediator variable distinction in social psychological research: Conceptual, strategic, and statistical considerations. *Journal of Personality and Social Psychology, 51*, 1173.

Bapuji, H., Loree, D., & Crossan, M. (2011). Connecting external knowledge usage and firm performance: An empirical analysis. *Journal of Engineering and Technology*

Management, *28*(4), 215-231.

Baum, J. A. C., & Dutton, J. E. (1996). Introduction: The embeddedness of strategy. *Advances in Strategic Management, 13*, 1-15.

Baum, J. A. C., & Mezias, S. J. (1992). Localized competition and organizational failure in the Manhattan hotel industry, 1898-1990. *Administrative Science Quarterly, 37*(4), 580–604.

Baum, J. A. C., Calabrese, T., & Silverman, B. S. (2000). Don't go it alone: Alliance network composition and startups' performance in Canadian biotechnology. *Strategic Management Journal*, *21*(3) 267-294.

Beers, C., & Zand, F. (2014). R&D cooperation, partner diversity, and innovation performance: An empirical analysis. *Journal of Product Innovation Management, 31*, 292-312.

Belderbos, R., Carree, M., Diederen, B., Lokshin, B., & Veugelers, R. (2004). Heterogeneity in R&D cooperation strategies. *International Journal of Industrial Organization*, *22*(8), 1237-1263.

Belderbos, R., Carree, M., & Lokshin, B. (2006). Complementarity in R&D cooperation strategies. *Review of Industrial Organization*, *28*(4), 401-426.

Berg, S. V., Duncan, J. & Friedman, P. (1982). *Joint Venture Strategies and Corporate Innovation*. Cambridge, MA: Oelgeschlager, Gunn & Hain.

Bettis, R. A., & Prahalad, C. K. (1995). The dominant logic: Retrospective and extension. *Strategic Management Journal*, *16*(1), 5-14.

Blau, P. M. (1977). *Inequality and Heterogeneity.* New York, NY: Free Press.

Bogers, M., & West, J. (2012). Managing distributed innovation: Strategic utilization of open and user innovation. *Creativity and Innovation Management, 21*, 61-75.

Bonacich, P. (1987). Power and centrality: A family of measures. *American Journal of Sociology, 92*(5), 1170-1182.

Borgatti, S. P. (1997). Structural holes: Unpacking Burt's redundancy measure. *Connections 20*, 35-38.

Bower, J. L., & Christensen, C. M. (1997). Disruptive technologies: Catching the wave. In J. S. Brown (Ed.) *Seeing Differently: Insights on Innovation*. Cambridge, MA: Harvard Business Review.

Brambor, T., Clark, W. R., & Golder, M. (2006). Understanding interaction models: Improving empirical analyses. *Political analysis, 14*(1), 63-82.

Brandenburger, A. M., & Nalebuff, B. J. (1996). *Co-opetition*. New York, NY: Doubleday.

Brouthers, K. D., & Hennart, J. F. (2007). Boundaries of the firm: Insights from international entry mode research. *Journal of Management, 33*(3), 395-425.

Brouwer, E., & Kleinknecht, A. (1999). Innovative output, and a firm's propensity to patent: An exploration of CIS micro data. *Research Policy, 28*(6), 615-624.

Brown, S. L., & Eisenhardt, K. M. (1995). Product development: Past research, present findings, and future directions. *Academy of Management Review, 20*, 343-378.

Brown, S. L., & Eisenhardt, K. M. (1997). The art of continuous change: Linking complexity theory and time-paced evolution in relentlessly shifting

organizations. *Administrative Science Quarterly, 42*(Mar.), 1-34.

Bruyaka, O., & Durand, R. (2012). Sell-off or shut-down? Alliance portfolio diversity and two types of high tech firms' exit. *Strategic Organization, 10*(1), 7-30.

Buchko, A. A. (1994). Barriers to strategic transformation: Interorganizational networks and institutional forces. *Advances in Strategic Management, 10*(B), 81-106.

Burt, R. S. (1980). Autonomy in a social topology. *American Journal of Sociology*, 892-925.

Burt, R. S. (1987). Social contagion and innovation: Cohesion versus structural equivalence. *American Journal of Sociology, 92*(6), 1287-1335.

Burt, R. S. (1992). *Structural Holes*. Cambridge, MA: Cambridge University Press.

Burt, R. S. (2000). The network structure of social capital. *Research in Organizational Behavior, 22*, 345-423.

Cameron, A. C., & Trivedi, P. K. (1986). Econometric models based on count data: Comparisons and applications of some estimators and tests. *Journal of Applied Econometrics, 1*(1), 29-53.

Canals, J. (2001). How to think about corporate growth? *European Management Journal, 19*, 587-598.

Cantwell, J., & Colombo, M. G. (2000). Technological and output complementarities, and inter-firm cooperation in information technology ventures. *Journal of Management and Governance, 4*(1-2), 117-147.

Chen, M. J. (1996). Competitor analysis and interfirm rivalry: Toward a theoretical

integration. *Academy of Management Review, 21*(1), 100-134.

Chen, J., Chen, Y., & Vanhaverbeke, W. (2011). The influence of scope, depth, and orientation of external technology sources on the innovative performance of Chinese firms. *Technovation, 31*(8), 362-373.

Cheung, K. Y., & Lin, P. (2004). Spillover effects of FDI on innovation in China: Evidence from the provincial data. *China Economic Review, 15*(1), 25-44.

Chung, S. A., Singh, H., & Lee, K. (2000). Complementarity, status similarity and social capital as drivers of alliance formation. *Strategic Management Journal, 21*(1), 1-22.

Coase, R. H. (1937). The nature of the firm. *Economica, 4*(16), 386-405.

Cohen, W. M., & Levinthal, D. A. (1990). Absorptive capacity: A new perspective on learning and innovation. *Administrative Science Quarterly, 35*(1), 128-152.

Coleman, J. S. (1988). Social capital in the creation of human capital. *American Journal of Sociology, 94*, S95-S120.

Colombo, M. G., Doganova, L., Piva, E., D'Adda, D., & Mustar, P. (2014). Hybrid alliances and radical innovation: The performance implications of integrating exploration and exploitation. *The Journal of Technology Transfer*, 1-27.

Cronbach, L. J. (1987). Statistical tests for moderator variables: Flaws in analyses recently proposed. *Psychological Bulletin, 102*, 414-417.

Cui, A. S., & O'Connor, G. (2012). Alliance portfolio resource diversity and firm innovation. *Journal of Marketing, 76*(4), 24-43.

Dacin, M. T., Ventresca, M. J., & Beal, B. D. (1999). The embeddedness of organizations: Dialogue & directions. *Journal of Management, 25*(3), 317-356.

Das, T. K., & Teng, B. S. (2000). A resource-based theory of strategic alliances. *Journal of Management, 26*(1), 31-61.

Deeds, D. L., & Hill, C. W. L. (1996). Strategic alliances and the rate of new product development: An empirical study of entrepreneurial biotechnology firms. *Journal of Business Venturing, 11*(1), 41-55.

De Leeuw, T., Lokshin, B., & Duysters, G. (2014). Returns to alliance portfolio diversity: The relative effects of partner diversity on firm's innovative performance and productivity. *Journal of Business Research, 67*(9), 1839-1849.

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.

Dervitsiotis, K. N. (2010). Developing full-spectrum innovation capability for survival and success in the global economy. *Total Quality Management, 21*, 159-170.

Dickson, P. H., & Weaver, K. M. (1997). Environmental determinants and individual-level moderators of alliance use. *Academy of Management Journal, 40*, 404-425.

Doz, Y. L., & Hamel, G. (1995). The use of alliances in implementing technology strategies. In M. L. Tushman & P. Anderson (Eds.), *Managing Strategic Innovation and Change: A Collection of Readings* (pp. 556-580). New York, NY: Oxford University Press.

Dutta, S., & Weiss, A. M. (1997). The relationship between a firm's level of technological innovativeness and its pattern of partnership agreements. *Management Science*, *43*(3), 343-356.

Duysters, G., De Man, A. P., & Wildeman, L. (1999). A network approach to alliance management. *European Management Journal, 17*(2), 182-187.

Duysters, G., Hagedoorn, J., & Lemmens, C. (2003). The effect of alliance block membership on innovative performance. *Revue d'Economie Industrielle, 103*, 59–70.

Duysters, G., Heimeriks, K. H., Lokshin, B., Meijer, E., & Sabidussi, A. (2012). Do firms learn to manage alliance portfolio diversity? The diversity-performance relationship and the moderating effects of experience and capability. *European Management Review*, *9*(3), 139-152.

Duysters, G., & Lemmens, C. (2003). Alliance group formation: Enabling and constraining effects of embeddedness and social capital in strategic technology alliance networks. *International Studies of Management and Organization*, *33*(2), 49-68.

Duysters, G., & Lokshin, B. (2011). Determinants of alliance portfolio complexity and its effect on innovative performance of companies. *Journal of Product Innovation Management*, *28*(4), 570-585.

Dyer, J. H., & Hatch, N. W. (2004). Using supplier networks to learn faster. *MIT Sloan Management Review, 45*(3), 57-63.

Dyer, J. H., & Hatch, N. W. (2006). Relation-specific capabilities and barriers to knowledge transfers: Creating advantage through network relationships. *Strategic Management Journal, 27*(8), 701-719.

Dyer, J. H., & Singh, H. (1998). The relational view: Cooperative strategy and sources of interorganizational competitive advantage. *Academy of Management Review, 23*(4), 660-679.

Echols, A., & Tsai, W. (2005). Niche and performance: The moderating role of network embeddedness. *Strategic Management Journal, 26*(3), 219-238.

Eisenhardt, K. M., & Schoonhoven, C. B. (1996). Resource-based view of strategic alliance formation: Strategic and social effects in entrepreneurial firms. *Organization Science, 7*(2), 136-150.

Faems, D., Van Looy, B., & Debackere, K. (2005). Interorganizational collaboration and innovation: Toward a portfolio approach. *Journal of Product Innovation Management, 22*, 238-250.

Faems, D., Janssens, M., & Neyens, I. (2012). Alliance portfolios and innovation performance connecting structural and managerial perspectives. *Group & Organization Management, 37*(2), 241-268.

Ferrary, M. (2011). Specialized organizations and ambidextrous clusters in the open innovation paradigm. *European Management Journal, 29*(3), 181-192.

Flavell, J. H. (1987). Speculation about the nature and development of metacognition. In F. E. Weinert & R. H. Kluwe (Eds.), *Metacognition, Motivation, and*

Understanding (pp. 21-29). Hillsdale, NJ: Erlbaum.

Freeman, L. C. (1979). Centrality in social networks conceptual clarification. *Social Networks, 1*(3), 215-239.

Fricke, S. E., & Shenbar, A. J. (2000). Managing multiple engineering projects in a manufacturing support environment. *IEEE Transactions on Engineering Management, 47*(2), 258-268.

Gassmann, O., Reepmeyer, G., & Von Zedtwitz, M. (2008). *Leading Pharmaceutical Innovation: Trends and Drivers for Growth in the Pharmaceutical Industry*. New York, NY: Springer Science & Business Media.

Garcia-Pont, C., & Nohria, N. (2002). Local versus global mimetism: Dynamics of alliance formation in the automobile industry. *Strategic Management Journal, 23*, 307–321.

Gatignon, H., & Xuereb, J. M. (1997). Strategic orientation of the firm and new product performance. *Journal of Marketing Research*, 77-90.

George, G., Zahra, S. A., Wheatley, K. K., & Khan, R. (2001). The effects of alliance portfolio characteristics and absorptive capacity on performance: A study of biotechnology firms. *Journal of High Technology Management Research, 12*: 205-226.

George, G., Zahra, S. A., & Wood Jr, D. R. (2002). The effects of business–university alliances on innovative output and financial performance: A study of publicly traded biotechnology companies. *Journal of Business Venturing, 17*, 577-609.

Gilsing, V., & Nooteboom, B. (2005). Density and strength of ties in innovation networks: An analysis of multimedia and biotechnology. *European Management Review, 2*(3), 179-197.

Gilsing, V., & Nooteboom, B. (2006). Exploration and exploitation in innovation systems: The case of pharmaceutical biotechnology. *Research Policy, 35*, 1-23.

Gilsing, V. A., & Nooteboom, B., Vanhaverbeke, W., Duysters, G. M., & Van den Oord, A. (2008). Network embeddedness and the exploration of novel technologies: Technological distance, betweenness centrality and density. *Research Policy, 37*, 1717-1731.

Gimeno, J. (2004). Competition within and between networks: The contingent effect of competitive embeddedness on alliance formation. *Academy of Management Journal, 47*(6), 820-842.

Gnyawali, D. R., & Madhavan, R. (2001). Cooperative networks and competitive dynamics: A structural embeddedness perspective. *Academy of Management Review, 26*(3), 431-445.

Granovetter, M. (1983). The strength of weak ties: A network theory revisited. *Sociological Theory, 1*(1), 201-233.

Granovetter, M. (1985). Economic action and social structure: The problem of embeddedness. *American Journal of Sociology, 91*(3), 481-510.

Goerzen, A. (2005). Managing alliance networks: Emerging practices of multinational corporations. *Academy of Management Executive, 19*(2), 94-107.

Goerzen, A. (2007). Alliance networks and firm performance: The impact of repeated partnerships. *Strategic Management Journal, 28*(5), 487-509.

Goerzen, A., & Beamish, P. W. (2005). The effect of alliance network diversity on multinational enterprise performance. *Strategic Management Journal, 26*(4), 333-354.

Gomes-Casseres, B. (2006). How alliances reshape competition. In O. Shenkar & J. J. Reuer (Eds.), *Handbook of Strategic Alliances* (pp. 39-53). Thousand Oaks, CA: SAGE Publications.

Grant, R. M. (1996). Toward a knowledge-based theory of the firm. *Strategic Management Journal, 17*(S2), 109-122.

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

Sims, N., Harrison, R., & Gueth, A. (2001). Managing alliances at Lilly. *Windhover's In Vivo: The Business & Medicine Report, 19*(6), 1-9.

Gulati, R. (1995a). Does familiarity breed trust? The implications of repeated ties for contractual choice in alliances. *Academy of Management Journal, 38*(1), 85-112.

Gulati, R. (1995b). Social structure and alliance formation patterns: A longitudinal analysis. *Administrative Science Quarterly, 40*(4), 619-652.

Gulati, R. (1998). Alliances and networks. *Strategic Management Journal, 19*(4), 293-317.

Gulati, R. & Singh, H. (1998). The architecture of cooperation: Managing coordination costs and appropriation concerns in strategic alliances. *Administrative Science*

Quarterly, 43, 781-814.

Gulati, R (1999). Network location and learning: The influence of network resources and firm capabilities on alliance formation. *Strategic Management Journal, 20*, 397–420.

Gulati, R. & Gargiulo, M. (1999). Where do interorganizational networks come from? *American Journal of Sociology, 104*(5), 1439-1493.

Gulati, R., Nohria, N., & Zaheer, A. (2000). Guest editors' introduction to the special issue: Strategic networks. *Strategic Management Journal, 21*(3), 199-201.

Gulati, R. (2007). *Managing Network Resources: Alliances, Affiliations and Other Relational Assets*. Oxford, UK: Oxford University Press.

Hagedoorn, J. (1993). Understanding the rationale of strategic technology partnering: Interorganizational modes of cooperation and sectoral differences. *Strategic Management Journal, 14*(5), 371–385.

Hagedoorn, J. (2002). Inter-firm R&D partnerships: An overview of major trends and patterns since 1960. *Research Policy, 31*(4), 477-492.

Hagedoorn, J. & Duysters, G. (2002). Learning in dynamic inter-firm networks: The efficacy of multiple contacts. *Organization studies, 23*(4), 525-548.

Hagedoorn, J., Letterie, W., & Palm, F. (2007). On the information value of (un)embedded network ties. *METEOR Research Memorandum 2007-004*, Maastricht University, The Netherlands.

Hair, J. F., Anderson, R. E., Tatham, R. L., & Black, W. C. (1995). *Multivariate Data*

Analysis with Readings. Upper Saddle River, NJ: Prentice Hall.

Hannan, M. T., & Freeman, J. (1977). The population ecology of organizations. *American Journal of Sociology, 82*(5), 929–964.

Hannan, M. T., & Freeman, J. (1989). *Organizational Ecology.* Cambridge, MA: Harvard University Press.

Hargadon, A., & Sutton, R. I. (1997). Technology brokering and innovation in a product development firm. *Administrative Science Quarterly, 42*(4), 716-749.

Hargrave, T. J., & Van de Ven, A. H. (2006). A collective action model of institutional innovation. *Academy of Management Review, 31*(4), 864-888.

Harrigan, K. R. (1988). Joint ventures and competitive strategy. *Strategic Management Journal*, *9*(2), 141-158.

Hausman, J., Hall, B. H., & Griliches, Z. (1984). Econometric models for count data with an application to the patents-R & D relationship. *Econometrica, 52*, 909-938.

Heimeriks, K. H., & Duysters, G. (2007). Alliance capability as a mediator between experience and alliance performance: An empirical investigation into the alliance capability development process. *Journal of Management Studies*, *44*(1), 25-49.

Heimeriks, K. H., Duysters, G., & Vanhaverbeke, W. (2007). Learning mechanisms and differential performance in alliance portfolios. *Strategic Organization*, *5*(4), 373-408.

Helfat, C. E. (2000). Guest editor's introduction to the special issue: The evolution of firm capabilities. *Strategic Management Journal, 21*(10-11), 955-959.

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

Hill, C. W. (1988). Differentiation versus low cost or differentiation and low cost: A contingency framework. *Academy of Management Review*, *13*, 401-412.

Hitt, M. A., Hoskisson, R. E., & Ireland, R. D. (1994). A mid-range theory of the interactive effects of international and product diversification on innovation and performance. *Journal of Management*, *20*(2), 297-326.

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*, 332-345.

Hoang, H., & Rothaermel, F. T. (2010). Leveraging Internal and External Experience: Exploration, Exploitation, and R&D Project Performance. *Strategic Management Journal*, *31*, 734-758.

Hoffmann, W. H. (2005). How to manage a portfolio of alliances. *Long Range Planning*, 38(2), 121-143.

Hoffmann, W. H. (2007). Strategies for managing a portfolio of alliances. *Strategic Management Journal*, 28(8), 827-856.

Holmqvist, M. (2003). A dynamic model of intra-and interorganizational learning. *Organization Studies*, *24*(1), 95-123.

Ibarra, H (1993). Personal networks of women and minorities in management: A conceptual framework. *Academy of Management Review*, *18*(1), 56-87.

Ingram, P., & Baum, J. A. (1997). Opportunity and constraint: Organizations' learning from the operating and competitive experience of industries. *Strategic Management Journal*, *18*(s1), 75-98.

Inkpen, A. C. (2000). Learning through joint ventures: A framework of knowledge acquisition. *Journal of Management Studies*, *37*(7), 1019-1044.

Jassawalla, A. R., & Sashittal, H. C. (2002). Cultures that support product-innovation processes. *Academy of Management Executive*, *16*, 42-54.

Jiang, R. J., Tao, Q. T., & Santoro, M. D. (2010). Alliance portfolio diversity and firm performance. *Strategic Management Journal*, *31*(10), 1136-1144.

Kale, P., Dyer, J. H., & Singh, H. (2002). Alliance capability, stock market response, and long-term alliance success: The role of the alliance function. *Strategic Management Journal*, *23*(8), 317-343.

Kale, P., & Singh, H. (1999, August). Alliance capability & success: A knowledge-based approach. In *Academy of Management Proceedings* (Vol. 1999, No. 1, pp. 1-6). Academy of Management.

Kam, C., & Franzese, R. (2003). Modeling and interpreting interactive hypotheses in regression analysis: A brief refresher and some practical advice. Unpublished manuscript, University of Michigan, Ann Arbor.

Keil, T., Maula, M., Schildt, H., & Zahra, S. A. (2008). The effect of governance modes and relatedness of external business development activities on innovative performance. *Strategic Management Journal*, *29*(8), 895-907.

Khanna, T., Gulati, R., & Nohria, N. (1998). The dynamics of learning alliances: Competition, cooperation, and relative scope. *Strategic Management Journal, 19*(3), 193-210.

Kim, Y. (2013). Some recent empirical developments regarding the bio-industry: Using the Granger-causality test with Indonesia's palm oil data. *International Journal of Bio-Science and Bio-Technology, 5*(5), 13-24.

King, A. A., & Tucci, C. L. (2002). Incumbent entry into new market niches: The role of experience and managerial choice in the creation of dynamic capabilities. *Management Science, 48*(2), 171-186.

Klein, K. J., & Sorra, J. S. (1996). The challenge of innovation implementation. *Academy of Management Review, 21*, 1055-1080.

Kogut, B. (1988). Joint ventures: Theoretical and empirical perspectives. *Strategic Management Journal, 9*(4), 319-332.

Kogut, B. (1991). Joint ventures and the option to expand and acquire. *Management Science, 37*(1), 19-33.

Kogut, B., Walker, G., & Kim, D.J. (1995). Cooperation and entry induction as an extension of technological rivalry. *Research Policy, 24*(1), 77-95.

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

Koka, B. R., & Prescott, J. E. (2008). Designing alliance networks: The influence of network position, environmental change, and strategy on firm

performance. *Strategic Management Journal*, *29*(6), 639-661.

Koput, K. W. (1997). A chaotic model of innovative search: Some answers, many questions. *Organization Science*, *8*(5), 528-542.

Koza, M. P., & Lewin, A. Y. (1998). The co-evolution of strategic alliances. *Organization Science*, *9*, 255-264.

Kraatz, M. S. (1998). Learning by association? Interorganizational networks and adaptation to environmental change. *Academy of Management Journal*, *41*(6), 621-643.

Kratzer, J., Gemuenden, H. G., & Lettl, C. (2008). Revealing dynamics and consequences of fit and misfit between formal and informal networks in multi-institutional product development collaborations. *Research Policy*, *37*, 1356-1370.

Kulatilaka, N., & Kogut, B. (1994). Options thinking and platform investments: Investing in opportunity. *California Management Review*, *36*(2), 52-71.

Lai, J. H., Chang, S. C., & Chen, S. S. (2010). Is experience valuable in international strategic alliances?. *Journal of International Management*, *16*(3), 247-261.

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

Lanjouw, J. O., & Schankerman, M. (1999). *The Quality of Ideas: Measuring Innovation with Multiple Indicators*. NBER working papers no. 7345. National Bureau of Economic Research, Cambridge, MA.

Lavie, D (2006). The competitive advantage of interconnected firms: An extension of the

resource-based view. *Academy of Management Review, 31*(3), 638-658.

Lavie, D (2007). Alliance portfolios and firm performance: A study of value creation and appropriation in the U.S. software industry. *Strategic Management Journal, 28*(12), 1187-1212.

Lavie, D., Kang, J., & Rosenkopf, L. (2011). Balance within and across Domains: The performance implications of exploration and exploitation in alliances. *Organization Science, 22*, 1517-1538.

Lavie, D., & Miller, S. R. (2008). Alliance portfolio internationalization and firm performance. *Organization Science, 19*(4), 623-646.

Lavie, D., & Rosenkopf, L. (2006). Balancing exploration and exploitation in alliance formation. *Academy of Management Journal, 49*, 797-818.

Lee, H., & Kelley, D. (2008). Building dynamic capabilities for innovation: An exploratory study of key management practices. *R&D Management, 38*, 155-168.

Lee, C., Lee, K., & Pennings, J. M. (2001). Internal capabilities, external networks, and performance: a study on technology-based ventures. *Strategic Management Journal*, *22*(6-7), 615-640.

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

Levitt, B., & March, J. G. (1988). Organizational learning. *Annual Review of Sociology, 14*, 319-340.

Li, Y., Vanhaverbeke, W., & Schoenmakers, W. (2008). Exploration and exploitation in

innovation: Reframing the interpretation. *Creativity and Innovation Management*, *17*, 107-126.

Lichtenthaler, U., & Lichtenthaler, E. (2004). Alliance functions: Implications of the international multi-R&D-alliance perspective. *Technovation*, *24*(7), 541-552.

Lin, N., Ensel, W. M., & Vaughn, J. C. (1981). Social resources and strength of ties: Structural factors in occupational status attainment. *American Sociological Review*, 393-405.

Lin, C., Wu, Y. J., Chang, C., Wang, W., & Lee, C. Y. (2012). The alliance innovation performance of R&D alliances—the absorptive capacity perspective. *Technovation*, *32*(5), 282-292.

Lin, Z., Yang, H., & Arya, B. (2009). Alliance partners and firm performance: Resource complementarity and status association. *Strategic Management Journal*, *30*, 921-940.

Loewe, P., & Dominiquini, J. (2006). Overcoming the barriers to effective innovation. *Strategy & Leadership*, *34*, 24-31.

Lorenzoni, G., & Lipparini, A. (1999). The leveraging of interfirm relationships as a distinctive organizational capability: A longitudinal study. *Strategic Management Journal*, *20*(4), 317-338.

Luo, X., & Deng, L. (2009). Do birds of a feather flock higher? The effects of partner similarity on innovation in strategic alliances in knowledge-intensive industries. *Journal of Management Studies*, *46*(6), 1005-1030.

Malik, T. (2012). Disparate association between alliance social capital and the global pharmaceutical firm's performance. *International Business Review, 21*(6), 1017-1028.

March, J. G. (1991). Exploration and exploitation in organizational learning. *Organization Science, 2*, 71-87.

Marino, L., Strandholm, K. & Steensma, H. K., & Weaver, K. M. (2002). The moderating effect of national culture on the relationship between entrepreneurial orientation and strategic alliance portfolio extensiveness. *Entrepreneurship Theory and Practice, 26*, 145-160.

McEvily, B., & Zaheer, A. (1999). Bridging ties: A source of firm heterogeneity in competitive capabilities. *Strategic Management Journal, 20*(12), 1133-1156.

McGrath, R. G. (2001). Exploratory learning, innovative capacity, and managerial oversight. *Academy of Management Journal, 44*(1), 118-131.

Mc Namara, P., & Baden-Fuller, C. (2007). Shareholder returns and the exploration–exploitation dilemma: R&D announcements by biotechnology firms. *Research Policy, 36*, 548-565.

McPherson, M. (1983). An ecology of affiliation. *American Sociological Review, 48*, 519-532.

Miller, D. (1983). The correlates of entrepreneurship in three types of firms. *Management Science, 29*, 770-791.

Mitchell, W., & Singh, K. (1996). Survival of businesses using collaborative relationships

to commercialize complex goods. *Strategic Management Journal*, *17*(3), 169-195.

Mody, A. (1993). Learning through alliances. *Journal of Economic Behavior & Organization*, *20*(2), 151-170.

Morrison, E. W. (2002). Newcomers' relationships: The role of social network ties during socialization. *The Academy of Management Journal*, *45*(6), 1149-1160.

Mouri, N., Sarkar, M. B., & Frye, M. (2012). Alliance portfolios and shareholder value in post-IPO firms: The moderating roles of portfolio structure and firm-level uncertainty. *Journal of Business Venturing*, *27*, 355-371.

Mohr, J., & Spekman, R. (1994). Characteristics of partnership success: Partnership attributes, communication behavior, and conflict resolution techniques. *Strategic Management Journal*, *15*(2), 135-152.

Mowery, D. C., Oxley, J. E., & Silverman, B. S. (2002). The two faces of partner-specific absorptive capacity: Learning and cospecializing in strategic alliances. In F. J. Contractor & P. Lorange (Eds.), *Cooperative Strategies and Alliances* (pp. 292-319). Oxford, UK: Elsevier Science.

Nahapiet, J., & Ghoshal, S. (1998). Social capital, intellectual capital, and the organizational advantage. *Academy of Management Review*, *23*, 242–266.

Narin, F., Noma, E., & Perry, R. (1987). Patents as indicators of corporate technological strength. *Research Policy*, *16*(2-4), 143-155.

Nelson, R., & Winter, S. (1982). *An Evolutionary Theory of Economic Change.* Cambridge, MA: Harvard University Press.

Nieto, M. J., & Santamaría, L. (2007). The importance of diverse collaborative networks for the novelty of product innovation. *Technovation, 27*(6), 367-377.

Nonaka, I. (1994). A dynamic theory of organizational knowledge creation. *Organization Science, 5*(1), 14-37.

Nooteboom, B. (1999). *Inter-firm Alliances: Analysis and Design*. London, UK: Routledge.

Nooteboom, B. (2002). *Trust: Forms, Foundations, Functions, Failures and Figures*. Cheltenham, UK: Edward Elgar Publishing.

Oerlemans, L. A., Knoben, J., & Pretorius, M. W. (2013). Alliance portfolio diversity, radical and incremental innovation: The moderating role of technology management. *Technovation, 33*(6), 234-246.

O'Hara, R. B., & Kotze, J. (2010). Do not log-transform count data. *Methods in Ecology and Evolution, 1*, 118-122.

Oliver, C. (1990). Determinants of interorganizational relationships: Integration and future directions. *Academy of Management Review, 15*(2), 241-265.

Ozcan, P., & Eisenhardt, K. (2009). Origin of alliance portfolios: Entrepreneurs, network strategies, and firm performance. *Academy of Management Journal, 52*(2), 246-279.

Park, S. H., Chen, R. R., & Gallagher, S. (2002). Firm resources as moderators of the relationship between market growth and strategic alliances in semiconductor start-ups. *Academy of Management Journal, 45*(3), 527-545.

Park, G., & Kang, J. (2010). Entry conditions, firm strategies, and their relationship on the innovaiton performance of emerging green industry. *Asian Journal of Technology Innovation, 18*(2), 22-42.

Park, G., & Kang, J. (2013). Alliance addiction: Do alliances create real benefits?. *Creativity and Innovation Management, 22*(1), 53-66.

Park, G., Kim, M. J., & Kang, J. (2015). Competitive embeddedness: The impact of competitive relations among a firm's current alliance partners on its new alliance formations. *International Business Review, 24*(2), 196-208.

Parise, S., & Casher, A. (2003). Alliance portfolios: Designing and managing your network of business-partner relationships. *Academy of Management Executive, 17*(4), 25-39.

Peteraf, M. A. (1993). The cornerstones of competitive advantage: A resource-based view. *Strategic Management Journal, 14*(3), 179-191.

Peters, L., Groenewegen, P., & Fiebelkorn, N. (1998). A comparison of networks between industry and public sector research in materials technology and biotechnology. *Research Policy, 27*, 255-271.

Podolny, J. M. (1993). A status-based model of market competition. *American Journal of Sociology, 98*(4), 829-872.

Podolny, J. M., & Baron, J. N. (1997). Resources and relationships: Social networks and mobility in the workplace. *American Sociological Review, 62*(5), 673-693.

Porter, M. E. (1980). *Competitive Strategy: Techniques for Analyzing Industries and*

Competitors. New York, NY: The Free Press

Porter, M. (1996). What is strategy? *Harvard Business Review, 74*, 61–79.

Powell, W. W., Koput, K. W., & Smith-Doerr, L. (1996). Interorganizational collaboration and the locus of innovation: Networks of learning in biotechnology. *Administrative Science Quarterly, 41*(1), 116-145.

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

Raisch, S., Birkinshaw, J., Probst, G., & Tushman, M. L. (2009). Organizational ambidexterity: Balancing exploitation and exploration for sustained performance. *Organization Science, 20*, 685-695.

Rangan, S. (2000). Search and deliberation in international exchange: Microfoundations to some macro patterns. *Journal of International Business Studies*, 205-222.

Ranger-Moore, J., Banaszak-Holl, J., & Hannan, M. T. (1991). Density-dependent dynamics in regulated industries: Founding rates of banks and life insurance companies. *Administrative Science Quarterly, 36*(1), 36-65.

Riccaboni, M., & Moliterni, R. (2009). Managing technological transitions through R&D alliances. *R&D Management*, *39*(2), 124-135.

Richardson, G. B. (1972). The organization of industry. *Economic Journal*, *82*, 883-896.

Reuer, J. J., & Ragozzino, R. (2006). Agency hazards and alliance portfolios. *Strategic Management Journal*, *27*(1), 27-43.

Reuer, J. J., Park, K. M., & Zollo, M. (2002). Experimental learning in international joint

ventures: The role of experience heterogeneity and venture novelty. In F. J. Contractor & P. Lorange (Eds.), *Cooperative Strategies and Alliances* (pp. 321-344). Oxford, UK: Pergamon.

Rosenkopf, L., & Nerkar, A. (2001). Beyond local search: Boundary-spanning, exploration, and impact in the optical disk industry. *Strategic Management Journal*, *22*(4), 287-306.

Rothaermel, F. T. (2001). Incumbent's advantage through exploiting complementary assets via interfirm cooperation. *Strategic Management Journal*, *22*, 687-699.

Rothaermel, F. T., & Boeker, W. (2008). Old technology meets new technology: Complementarities, similarities, and alliance formation. *Strategic Management Journal*, *29*(1), 47-77.

Rothaermel, F. T., & Deeds, D. L. (2004). Exploration and exploitation alliances in biotechnology: A system of new product development. *Strategic Management Journal*, *25*, 201-221.

Rowley, T., Behrens, D., & Krackhardt, D. (2000). Redundant governance structures: An analysis of relational embeddedness in the steel and semiconductor industries. *Strategic Management Journal*, *21*(Special Issue), 369-386.

Russo, A., & Vurro, C. (2010). Cross-boundary ambidexterity: Balancing exploration and exploitation in the fuel cell industry. *European Management Review*, *7*(1), 30-45.

Sampson, R. C. (2004). Organizational choice in R&D alliances: Knowledge-based and transaction cost perspectives. *Managerial and Decision Economics*, *25*(6-7), 421-

436.

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.

Schilke, O., & Goerzen, A. (2010). Alliance management capability: An investigation of the construct and its measurement. *Journal of Management*, *36*(5), 1192-1219.

Schilling, M. A., & Phelps, C. C. (2007). Interfirm collaboration networks: The impact of large-scale network structure on firm innovation. *Management Science*, *53*(7), 1113-1126.

Schoonhoven, C. B., & Jelinek, M. (1997). Dynamic tension in innovative, high technological firms: Managing rapid technological change through organizational structure. In M. L. Tushman & P. Anderson (Eds.), *Managing Strategic Innovation and Change: A Collection of Readings* (pp. 233-254). New York, NY: Oxford University Press.

Scott, J. (1991). *Social Network Analysis: A Handbook*. Thousand Oaks, CA: Sage.

Shan, W., Walker, G., & Kogut, B. (1994). Interfirm cooperation and startup innovation in the biotechnology industry. *Strategic Management Journal*, *15*(5), 387-394.

Shipilov, A. (2013, September, 26). Samsung beats Blackberry in the global alliance game. *Forbes*. Retrieved from http://www.forbes.com.

Silverman, B. S. (1999). Technological resources and the direction of corporate diversification: Toward an integration of the resource-based view and transaction

cost economics. *Management Science, 45*(8), 1109-1124.

Silverman, B. S., & Baum, J. A. C. (2002). Alliance-based competitive dynamics. *Academy of Management Journal, 45*(4), 791-806.

Simonin, B. L. (1997). The importance of collaborative know-how: An empirical test of the learning organization. *Academy of Management Journal, 40*(5), 1150-1174.

Sinkula, J. M., Baker, W. E., & Noordewier, T. (1997). A framework for market-based organizational learning: Linking values, knowledge, and behavior. *Journal of the Academy of Marketing Science, 25*, 305-318.

Smith, K. W., & Sasaki, M. S. (1979). Decreasing multicollinearity: A method for models with multiplicative Functions. *Sociological Methods & Research, 8*(1), 35-56.

Srivastava, M. K., & Gnyawali, D. R. (2011). When do relational resources matter? Leveraging portfolio technological resources for breakthrough innovation. *Academy of Management Journal, 54*(4), 797-810.

Stuart, T. E. (2000). Interorganizational alliances and the performance of firms: A study of growth and innovation rates in a high-technology industry. *Strategic Management Journal, 21*(8), 791-811.

Stuart, T. E., Hoang, H., & Hybels, R. C. (1999). Interorganizational endorsements and the performance of entrepreneurial ventures. *Administrative Science Quarterly, 44*(2), 315-349.

Stuart, T. E., Ozdemir, S. Z., & Ding, W. W. (2007). Vertical alliance networks: The case of university–biotechnology–pharmaceutical alliance chains. *Research*

Policy, *36*(4), 477-498.

Tanriverdi, H. (2006). Performance effects of information technology synergies in multibusiness firms. *MIS Quarterly*, *30*(1), 57-77.

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

Teece, D. J., Pisano, G., & Shuen, A. (1997). Dynamic capabilities and strategic management. *Strategic Management Journal*, *18*(7), 509-533.

The Bank of Korea. (2014). Economic Statistical System. URL http://ecos.bok.or.kr/. [accessed on 28 May 2014]

Thrasher, E. H., Craighead, C. W., & Byrd, T. A. (2010). An empirical investigation of integration in healthcare alliance networks. *Decision Support Systems*, *50*, 116-127.

Trajtenberg, M. (1990). A penny for your quotes. *Rand Journal of Economics*, *21*(1), 172-187.

Trapido, D. (2007). Competitive embeddedness and the emergence of interfirm cooperation. *Social Forces*, *86*(1), 165-191.

Tushman, M. L., & Anderson, P. (1986). Technological discontinuities and organizational environments. *Administrative Science Quarterly*, *31*(3), 439-465.

Uzzi, B. (1997). Social structure and competition in interfirm networks: The paradox of embeddedness. *Administrative Science Quarterly*, *42*(1), 35-67.

Van de Vrande, V. (2013). Balancing your technology-sourcing portfolio: How sourcing

mode diversity enhances innovative performance. *Strategic Management Journal*, *34*(5), 610-621.

Vassolo, R. S., Anand, J., & Folta, T. B. (2004). Non-additivity in portfolios of exploration activities: A real options-based analysis of equity alliances in biotechnology. *Strategic Management Journal*, *25*(11), 1045-1061.

Vasudeva, G., & Anand, J. (2011). Unpacking absorptive capacity: A study of knowledge utilization from alliance portfolios. *Academy of Management Journal*, *54*(3), 611-623.

Verona, G. (1999). A resource-based view of product development. *Academy of Management Review*, *24*, 132-142.

Walker, G., Kogut, B., & Shan, W. (1997). Social capital, structural holes and the formation of an industry network. *Organization Science*, *8*(2), 109-125.

Walker, M. E., Wasserman, S., & Wellman, B. (1993). Statistical models for social support networks. *Sociological Methods & Research*, *22*(1), 71-98.

Wang, L., & Zajac, E. J. (2007). Alliance or acquisition? A dyadic perspective on interfirm resource combinations. *Strategic Management Journal*, *28*(13), 1291-1317.

Wassmer, U (2010). Alliance portfolios: A review and research agenda. *Journal of Management*, *36*(1), 141-171.

Wick, C. W., & Leon, L. S. (1993). *The Learning Edge: How Smart Managers and Smart Companies Stay Ahead*. New York, NY: McGraw-Hill.

Williamson, O. E. (1985). *The Economic Institutions of Capitalism*. New York, NY: Free Press.

Wuyts, S., & Dutta, S. (2014). Benefiting from alliance portfolio diversity the role of past internal knowledge creation strategy. *Journal of Management*, *40*(6), 1653-1674.

Yamakawa, Y., Yang, H., & Lin, Z. J. (2011). Exploration versus exploitation in alliance portfolio: Performance implications of organizational, strategic, and environmental fit. *Research Policy*, *40*, 287-296.

Yang, J. (2012). Innovation capability and corporate growth: An empirical investigation in China. *Journal of Engineering and Technology Management*, *29*, 34-46.

Yi, Y. (1989). On the evaluation of main effects in multiplicative regression models. *Journal of the Market Research Society*, *31*, 133-138.

Zollo, M., & Winter, S. G. (2002). Deliberate learning and the evolution of dynamic capabilities. *Organization Science*, *13*(3), 339-351.

Zukin, S., & DiMaggio, P. (1990). *Structures of Capital: The Social Organization of the Economy*. Cambridge, UK: Cambridge University Press.

국 문 초 록

혁신에 대한 중요성이 날로 커지는 가운데 기업 및 조직간의 제휴는 새로운 지식을 흡수하여 혁신을 실현하기 위한 중요한 전략적 수단으로 부상하였다. 이미 컴퓨터 소프트웨어, 하드웨어, 생명공학 및 통신장비 등 혁신이 중시되는 첨단 산업 내에서 제휴가 빈번하게 이루어지고 있으며 이들 산업의 지속적인 성장과 혁신 창출에 기여하고 있다. 그러한 가운데 현대의 기업은 개별적인 제휴를 관리하는 것을 넘어 다수의 제휴를 동시에 관리해야 하는 새로운 과업에 맞닥뜨리게 되었다. 제휴와 혁신 분야의 문헌 역시 개별 제휴를 관리하고 성과를 내는 데서 제휴 포트폴리오 - 한 기업이 맺고 있는 모든 제휴 - 를 관리하고 이를 통해 성과를 창출하는 쪽으로 그들의 관점을 확대시켰다.

기존 문헌 내용 그리고 제휴 포트폴리오와 관련된 중요한 이슈를 고려하여 본 논문은 '파트너 조율', '다양성 수용' 그리고 '목적 조화'의 세 가지 구성요소를 포함하고 있다. 이들은 독자적으로 그리고 더불어 혁신 성과 창출에 기여한다. 그러나 성과를 극대화시키기 위해 각 요소에 적합한 상이한 관리 전략이 요구된다. 첫째, 파트너 조율 측면에서 더 나은 혁신 성과를 위해 제휴 포트폴리오의 크기를 키우는 동시에 중심 기업과 제휴를 맺고 있는 파트너들 사이의 관계 역시 고려해야 한다. 둘째, 제휴 포트폴리오 내에 산재하는 다양한 지식을 받아들이기 위해 기업의 제휴 경험을 증진시키는 것이 필요하다. 마지막으로 목적 조화의 측면에서 기업은 양손잡이 성격의 제휴 포트폴리오를

구축하고 동시에 적합한 혁신 의지를 통해 그들의 제휴 전략을 뒷받침해야 한다. 본 논문은 제휴 포트폴리오 관리의 각 요소들이 혁신 성과에 미치는 영향을 계량적으로 검증함으로써 제대로 된 제휴 포트폴리오 관리가 혁신을 실재화하는데 기여함을 밝힌다.

제휴 포트폴리오 구축 시 중심기업은 단순히 포트폴리오 내에 다수의 파트너를 포진시키는 것뿐만 아니라 그들간의 관계를 조율해야 한다. 파트너들 협력 혹은 경쟁 관계가 일차적으로 제휴 포트폴리오 내 지식 이전에 영향을 줄 뿐만 아니라 궁극적으로 중심 기업이 그들의 제휴 자원으로부터 얻게 될 이득에까지 영향을 미친다. 3장에서는 자원기반관점과 사회연결망 이론을 바탕으로 제휴 포트폴리오 내의 네트워크 자원이 중심 기업의 혁신 성과에 미치는 영향과 제휴 포트폴리오의 구조적 및 경쟁적 배태성이 이러한 영향을 어떻게 조절하는지 확인한다. 분석 결과에 의하면 제휴 포트폴리오의 크기가 클수록 중심기업에 혁신 성과를 증진시키는 데는 분명히 도움이 되지만 동시에 파트너 기업들간의 관계 역시 중심 기업 성과에 영향을 미치는 것으로 나타났다. 구체적으로 구조적 배태성의 관점에서 중심 기업의 파트너들이 촘촘히 상호 제휴 관계를 맺고 있을 때 제휴 포트폴리오 크기가 중심 기업의 혁신 성과에 미치는 긍정적인 영향을 더 강화하는 것으로 나타났다. 반면에 경쟁적 배태성의 관점에서 중심 기업의 파트너들이 서로 경쟁 관계에 있다면 포트폴리오 크기가 중심 기업의 혁신 성과에 미치는 긍정적인 영향을 약화시키는 것으로 나타났다. 이러한 결과는 기업들이 제휴 포트폴리오를 확장하는 과정에서 포트폴리오 내 파트너들이 형성하고 있는 양면적인 네트워크 관계 - 협력 네

트워크 및 경쟁 네트워크 - 에도 관심을 기울이라는 제언을 하고 있다.

기업들이 제휴 포트폴리오를 형성한 후에는 그들의 포트폴리오에 산재하는 다양한 지식을 수용할 수 있어야 한다. 다양성을 지닌 제휴 포트폴리오는 분명히 중심 기업에게 득이 되지만 중심 기업이 수용할 수 있는 다양성의 최대 수준은 그들의 제휴 경험 그리고 파트너와의 지식 인접성을 통해 확보되는 그들의 포괄적인 흡수 역량에 의해 영향을 받을 수 있다. 4장에서는 제휴 포트폴리오의 다양성과 혁신 성과 사이의 관계를 확인하며 뿐만 아니라 중심 기업의 제휴 경험과 중심 기업과 파트너 사이의 인접성이 이 관계를 어떻게 조절하는지 확인하다. 계량적 분석을 통해 제휴 포트폴리오의 다양성과 중심 기업의 혁신 성과 사이의 역 U자형 관계가 있음을 확인했다. 하지만 중심 기업이 제휴 경험을 축적할수록 제휴포트폴리오가 더 높은 수준의 다양성을 수용하고 그에 따라 더 증진된 혁신 성과를 누릴 수 있었다. 중심 기업과 포트폴리오 사이의 인접성은 다양한 지식을 흡수하는데 직접적인 기여를 하지는 않는 것으로 나타났다. 이러한 결과는 중심 기업이 누릴 수 있는 최대 수준의 제휴 포트폴리오 다양성은 제한되어 있지만 제휴 경험을 축적함으로써 높은 다양성이 제공하는 이점을 어떻게 누릴 수 있는지 배울 수 있음을 시사한다.

마지막으로 기업은 제휴 포트폴리오와 관련된 목적을 조화시킴으로써 더욱 효과적인 혁신 성과를 거둘 수 있어야 한다. 제휴를 통한 다자간의 의사결정은 시장 수요에 대한 이해와 시장 적응력을 높이는데 기여한다. 뿐만 아니라 제휴 결과물에 대해 서로 다른 배경을 지닌 파트너들이 내리는 엄밀한 평가는 혁신의 현실성과 시장성을 배가시킨다. 그리하여 제휴 포트폴리오는

즉각적인 혁신의 결과물을 산출하는 데뿐 아니라 혁신의 유효성을 높이는데 기여한다. 5장에서는 새로운 지식 습득을 목표로 하는 탐험적인 제휴가 혁신의 유효성에도 영향을 미침을 밝힌다. 더불어 제휴가 혁신 유효성에 미치는 영향을 강화하는데 기여하는 조직 외부 및 내부의 조건이 무엇인지 확인한다. 계량 분석을 통해 기업이 탐험적 제휴에 집중하는 것이 신 제품의 매출로 측정되는 혁신의 유효성에 기여함을 확인했다. 뿐만 아니라 제휴 포트폴리오 내에 탐험적 제휴와 더불어 활용적 제휴를 병행할 때와 조직 내부의 혁신 의지를 탐험적인 제휴의 목적과 일치시킬 때 신 제품의 혁신 유효성이 더 커짐을 확인했다. 이러한 결과는 제휴 포트폴리오를 조직 외부적으로 그리고 내부적으로 적절히 조화시킴으로써 효과적인 혁신 창출에 기여할 수 있음을 시사한다. 외부적으로 기업은 양손잡이 성격의 제휴 포트폴리오를 구축해야 하고, 내부적으로 적합한 혁신 의지를 갖춤으로써 제휴의 목적을 뒷받침해야 한다.

결론적으로 본 논문은 제휴 포트폴리오 관리를 구성하는 주요 요소를 다루고 있으며 이들이 중심 기업의 혁신 성과에 기여하고 있음을 밝힌다. 포트폴리오 관리의 각 요소에 해당하는 본 논문의 주요 결과와 의의는 다음과 같다. 첫째, 본 논문은 제휴 포트폴리오 내 파트너간 관계가 혁신 성과에 미치는 조절 효과를 확인함으로써 포트폴리오 구축 단계에서 한 편으로 파트너의 입장을 고려할 것을 권고한다. 다음으로 본 논문은 포트폴리오가 지닌 다양성을 흡수하는 단계에서 기업의 제휴 경험 그리고 포트폴리오와 기업간 인접성이 미치는 영향을 확인했다. 이러한 통합적인 접근은 기업이 제휴 포트폴리오 내의 지식을 받아들일 때 어떻게 하면 포트폴리오가 제공하는 다양성을 충분

히 누릴 수 있는지를 보여준다. 마지막으로 본 논문은 양손잡이 성격의 제휴 포트폴리오와 조직 내의 혁신 의지가 더 효과적인 혁신 성과를 내도록 제휴 포트폴리오를 조화시키고 있음을 확인했다. 이러한 결과는 더 나은 혁신 성과를 위해 탐험적 제휴와 활용적 제휴간 균형을 유지할 것을 기업들에게 권고하고 있으며 제휴 전략을 제휴의 영역에서 한정시킬 것이 아니라 전사적인 범위에서 지원할 것을 제안한다. 정리하면 본 논문은 적절한 제휴 포트폴리오 관리라는 이슈를 제시함으로써 기업의 제휴 포트폴리오가 외부 지식을 습득하고 궁극적으로 혁신을 실현하는데 중요한 전략적 수단임을 보이고 있다.

주요어 : 제휴 포트폴리오 관리, 혁신 성과, 제휴 파트너, 배태성, 제휴 포트폴리오 다양성, 양손잡이 전략
학 번 : 2009-21083

Ph. D. Dissertation in Engineering

Increasing Innovation through Alliance Portfolio Management

: Coordinating Partners, Accommodating Diversity, and Aligning Objectives

제휴 포트폴리오 관리를 통한 혁신 성과 증진

: 파트너간 조화, 다양성의 흡수, 목적 조율

February 2016

Marco JinHwan Kim

Technology Management, Economics, and Policy Program

Seoul National University

Abstract

Increasing Innovation through Alliance Portfolio Management

: Coordinating Partners, Accommodating Diversity, and Aligning Objectives

Marco JinHwan Kim
Technology Management, Economics, and Policy Program
College of Engineering
Seoul National University

With the increasing importance of innovation outcomes, alliances have become important strategic instruments allowing firms to take advantage of new knowledge for realizing innovation. For example, in some high-tech industries such as computer software and hardware, biotechnology, and telecommunications, forming alliances to support growth and innovativeness is a ubiquitous phenomenon. Firms becoming engaged in multiple simultaneous alliances face new management tasks beyond simply managing the individual alliances. Alliance and innovation literature has expanded the point of view from individual alliances and their resulting performance to also consider the alliance portfolio – all the alliances conducted by a firm – and how to manage and use it to

generate performance.

Considering the interests in the extant literature and the significance of tasks relating to alliance portfolios, this dissertation includes three different components of alliance portfolio management, namely, ‘coordinating partners’, ‘accommodating diversity’, and ‘aligning objectives’. It is important to realize that these components both individually and collectively contribute to the firm’s innovation outcome. Each component, however, requires a different portfolio management strategy to obtain the best outcome: In terms of coordinating partners, as firms increase the size of their alliance portfolios, the innovation outcome is largely depending on partners’ relationships. In terms of accommodating diversity, firms need to increase their alliance experience and proximity to their partners to accommodate diverse knowledge from their alliance portfolios. In terms of aligning objectives, for more effective innovation, firms should embrace the ambidexterity in their alliance portfolios and support their alliances with an appropriate innovation intent. This dissertation empirically examines the effects of the constituents of each component on innovation outcome to research the influence of alliance portfolio management on realizing innovation.

When firms build up their alliance portfolios, they have to coordinate the relationships among their partners as well as the size of their alliance portfolios. The relationships, which include cooperative as well as competitive ties among the focal firm’s partners, affect the flow of knowledge within the focal firm’s alliance portfolio and thus influence the amount of benefits the focal firm gains from its alliance resources.

Employing the resource-based view and a social network perspective, Chapter 3 examines the impact of network resources in alliance portfolios on the focal firms' innovation performance and how structural and competitive embeddedness in alliance portfolios positively or negatively moderates this impact. Results verify that a larger alliance portfolio leads to an improved innovation performance of the focal firm, but, at the same time, relationships among the focal firm's partners are found to affect the link between alliance portfolio size and focal firm performance. Specifically, in terms of structural embeddedness, a cooperative and densely tied portfolio strengthens the positive impact of alliance portfolio size on the focal firm's innovation performance. In terms of competitive embeddedness, a portfolio with severe competition among the partners weakens the positive impact and leads to a reduced innovation performance. These findings suggest firms to increase their alliance portfolio size and, at the same time, to keep an eye on their portfolios' two-sided network characteristics, i.e., the connectivity and competition among their partners.

Firms also need to be able to accommodate the diverse knowledge within their alliance portfolios. While an alliance portfolio which consists of diverse partners is usually beneficial to the focal firm, the maximum level of diversity that a firm can handle is determined by its extensive absorptive capacity. Chapter 4 examines the relationship between alliance portfolio diversity and innovation performance and how the absorptive capacity, developed by the focal firm's alliance experience and the proximity of knowledge between the focal firm and its alliance portfolio, moderates this relationship.

Empirical results verify an inverted u-shape relation between alliance portfolio diversity and focal firms' innovation performance. However, with accumulated alliance experience and higher proximity to partners, focal firms can accommodate more diversity in their alliance portfolios, which contributes to an improved innovation performance. These findings suggest that the maximum level of alliance portfolio diversity which contributes to innovation performance is limited, however, firms can learn to take advantage of higher diversity by building up their alliance experience and placing relatively proximate partners in their alliance portfolios.

Finally, firms should align the goals of their alliance portfolios so that they can enhance the effectiveness of their innovation outcomes. Collaborative decision making through alliances contributes to a profound understanding toward market needs and market adaptation. The evaluation of the collaborative output by collaborators with different backgrounds also increases the practicality and marketability of the resulting innovations. Thus, alliance portfolios do not only contribute to immediate innovation outcomes but can also serve to increase innovation effectiveness as well. Chapter 5 investigates the influence of alliances which aim to obtain new knowledge, i.e. exploratory alliances, on firms' innovation effectiveness. Moreover, this chapter examines some external and internal conditions which strengthen the influence of such alliances on innovation effectiveness. The results of the empirical study verify a positive relationship between the commitment to exploratory alliances and innovation effectiveness as measured by the percentage of revenue from new products. It is also confirmed that

exploitative alliances and internal innovation intent positively moderate this relationship. These findings suggest that firms' alliance portfolios can be aligned for more effective innovation outcomes through external and internal efforts. Externally, firms should organize ambidextrous alliance portfolios, and, internally, firms need to support their alliance objectives with relevant innovation intents.

In conclusion, this dissertation highlights major building blocks of alliance portfolio management that contribute to the focal firm's innovation outcome. This dissertation provides a number of important findings and implications corresponding to each component of alliance portfolio management: First, this dissertation confirms the moderation effect of partners' relationships on the link between alliance portfolio size and innovation performance and thus suggests firms to pay attention to coordinating their partners. Next, this dissertation investigates the role of alliance experience and proximity in accommodating diversity. This integrative approach to accommodating diversity shows how firms can learn to benefit from diversity in their alliance portfolios. Finally, this dissertation confirms the role of ambidextrous alliances and internal innovation intent in aligning alliance portfolios. This finding suggests firms to balance different types of alliances, i.e., exploratory and exploitative alliances, and to support alliances by integrating them into the companywide strategy. Overall, this dissertation shows that with proper alliance portfolio management, a firm's alliance portfolio is an important strategic element which contributes to the sourcing of external knowledge and realizing innovation.

Keywords: alliance portfolio management, innovation performance, alliance partner, embeddedness, alliance portfolio diversity, ambidexterity

Student Number: 2009-21083

Contents

List of Tables

List of Figures

Chapter 1. Introduction

1.1. Backgrounds

Alliances have become significant strategic instruments allowing firms to take advantage of new knowledge for realizing innovation. As shown in the example of alliances in the micro-electronics industry in Figure 1, in some high-tech industries such as computer software and hardware, biotechnology, and telecommunications, forming alliances to support growth and innovativeness is a ubiquitous phenomenon. Firms simultaneously engaging in multiple alliances face new management tasks beyond simply

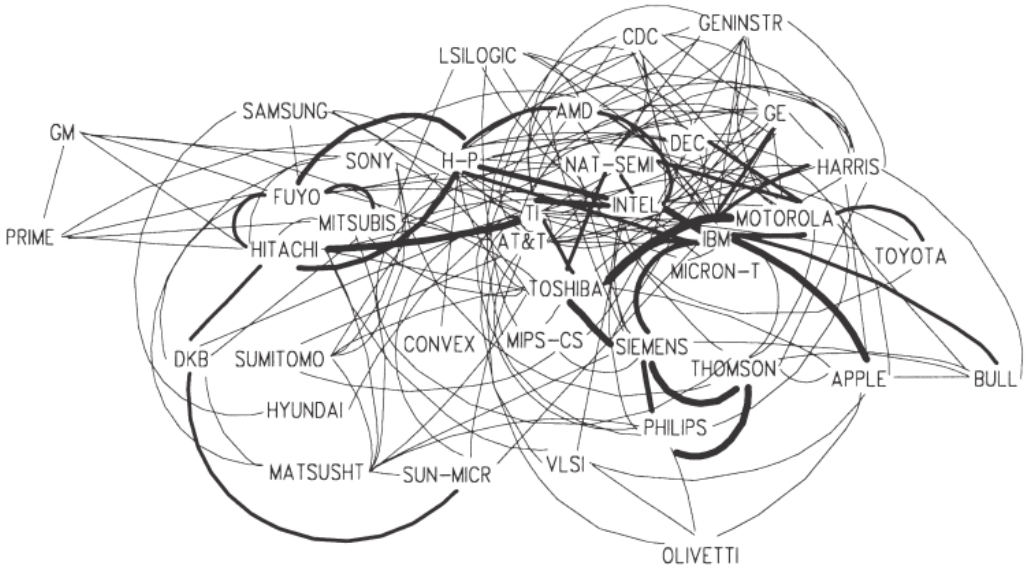
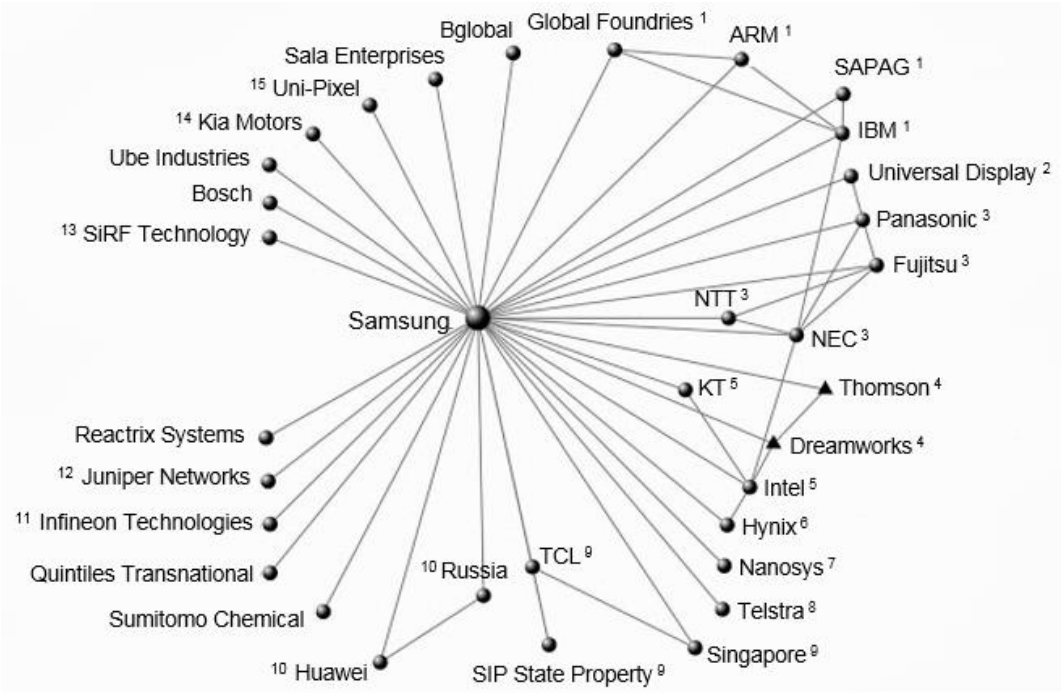


Figure 1. Alliances in the micro-electronics industry. Source: MERIT-CATI Database (as cited in Duysters, De Man, & Wildeman, 1999).

managing the individual alliances. For managing individual alliances, firms' strategy is focused on selecting partners based on individual fit and exchanging bilateral knowledge (Duysters et al., 1999). However, for managing multiple alliances, firms should pay more attention to the interdependency between the individual alliances and their potential positive or negative synergies (Lichtenthaler & Lichtenthaler, 2004).

In order to address the issues stemming from managing multiple alliances at the same time, alliance and innovation literature has expanded the point of view from individual alliances and their resulting performance to considering the "alliance portfolio" and how to manage and use it to generate performance. Previous literature has achieved an adequate consensus on the definition of an alliance portfolio – all the alliances conducted by a firm –, however, exhibits different perspectives on its definition. According to the perspectives and aims of the extant studies, an alliance portfolio is understood as a list of all ongoing alliances of a focal firm (Bae & Gargiulo, 2004; Hoffmann, 2005, 2007), an egocentric social network of a focal firm (Baum et al., 2000; Rowley et al., 2000) or the accumulated alliance experience of a focal firm (Reuer et al., 2002; Reuer & Ragozzino, 2006). For example, Figure 2 shows the alliance portfolio of Samsung Electronics during the 2008-2011 period. Based on the social network perspective, this figure also contains the ties between Samsung Electronics' partners.

Adopting theses different perspectives and definitions, a broad range of theoretical lenses has been used to study alliance portfolios in previous literature. They are social network theory (e.g. Ahuja, 2000a, 2000b; Baum et al., 2000; Gulati, 1999; Stuart, 2000),



1	Semiconductors	6	Semiconductor R&D	11	Mobiles chips in Germany
2	LED	7	Nanotech screens/batteries	12	Mobile security
3	Chips for mobiles	8	Real time IPTV	13	GPS
4	3D movies	9	LCD	14	Tablets in cars
5	3D over air	10	4G	15	LCD

Figure 2. Alliances of Samsung Electronics during the 2008-2011 period. Source: Shipilov (2013, Sep 26).

resource-based view (e.g. Chung et al., 2000; Lavie, 2006) and resource dependency theory (e.g. Bae & Ggargiulo, 2004; Ozcan & Eisenhardt, 2009), organizational learning (e.g. Anand & Khanna, 2000; George et al., 2001; Kale et al., 2002) including exploration and exploitation perspectives (e.g. Lavie & Rosenkopf, 2006; Rothaermel, 2001), transaction cost economics (e.g. Goerzen, 2007; Goerzen & Beamish, 2005), etc. For an

increased understanding of alliance portfolios from diverse perspectives, most prior studies integrate two or more theoretical lenses and examine the cause and effect relationships relating to alliance portfolios.

Recently alliance managers and scholars' interests are centered on the systematic management approach required for operating an effective alliance portfolio. This approach is not only constrained to the holistic approach toward an alliance portfolio (e.g. Bamford & Ernst, 2002; Duysters et al., 1999; Hoffmann, 2005; Parise & Casher, 2003), which pursues a positive synergy between partners and the global optimum within the portfolio, but also includes an extensive process for building and managing an alliance portfolio which helps to effectively acquire external knowledge, turn it into an increased performance and thus contribute to the sustainability of the focal firm. In a similar vein, some seminal studies in alliance portfolio literature suggest ideas for managing an alliance portfolio as a whole. For example, Parise and Casher (2003) suggest an alliance portfolio model which starts from the designing of the alliance portfolio and ultimately embraces individual alliance factors and portfolio management factors. Hoffmann (2005) suggests an alliance management system that involves the co-ordination and monitoring of the portfolio as well as the whole portfolio strategy. In a later work, Hoffmann (2007) also suggests a typology of alliance strategies which includes shaping, adapting, and stabilizing an alliance portfolio. In a review paper of Wassmer (2010), this trend in alliance portfolio literature is reflected and the extant studies are classified as focusing on the emergence, configuration, or management of alliance portfolios. One can clearly state

that the emphasis on a systematic and strategic approach toward managing alliance portfolios has been greatly increased during recent years.

1.2. Research purpose

With an increasing significance of and need for technology management, this dissertation is focused on technology alliances and firms' technology alliance portfolios. Technology alliances are a major tool for acquiring valuable external knowledge or creating new knowledge. Depending more on external resources in the open innovation era (Bae & Gargiulo, 2004; Ozcan & Eisenhardt, 2009), firms acknowledge the significance of technology alliances more than ever before. The aim of this dissertation is to systemize the management of technology alliance portfolios that contributes to increasing innovation outcomes in diverse ways. Through investigating diverse aspects of the portfolio management, the present dissertation expects that firms are better able to understand the integrative way of how to manage their alliance portfolios and in turn become better at realizing innovation.

Integrating the approaches found in the extant literature and tasks relating to managing technology alliance portfolios, this dissertation classifies alliance portfolio management into three different components, namely, coordinating partners, accommodating diversity, and aligning objectives. It is important to realize that these

components both individually and collectively contribute to the innovation outcome. Each component, however, requires a different portfolio management strategy to obtain the best outcome: In terms of coordinating partners, firms should not only increase the size of their alliance portfolios, but also, to utilize them as an innovation tool, coordinate the relationships between their partners. In terms of accommodating diversity, firms need to increase their alliance experience and pay attention to the knowledge gap between them and their alliance partners to accommodate diverse knowledge from their alliance portfolios. In terms of aligning objectives, for more effective innovation, firms should embrace the ambidexterity in their alliance portfolios and support their alliances with an appropriate innovation intent. This dissertation empirically examines the effects of the constituents of each component on innovation outcome to research the influence of alliance portfolio management on realizing innovation.

1.3. Research outline

The main body of this dissertation consists of three different parts: the literature review, three different empirical studies corresponding to each component of alliance portfolio management, and the overall conclusions.

Chapter 2 covers the literature review. Specifically, this chapter introduces the extant approach toward alliance portfolio management and how it relates to the approach

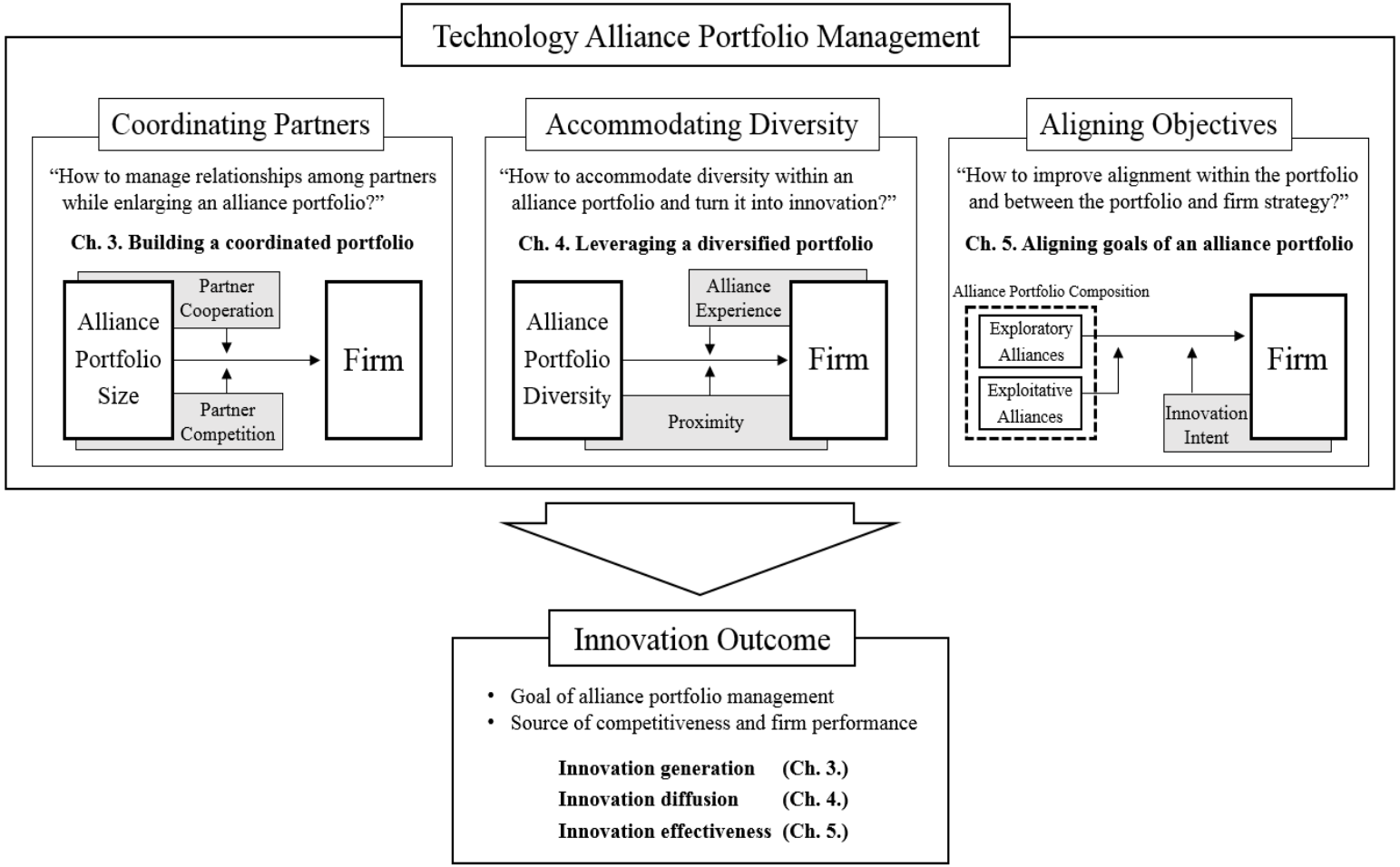


Figure 3. The key components of alliance portfolio management for increasing innovation.

of this dissertation. Moreover, Chapter 2 introduces the theoretical backgrounds of the subsequent empirical studies of this dissertation and connects the arguments of this thesis with the realm of the extant literature.

Three different empirical studies are covered in Chapters 3, 4, and 5. Figure 3 provides an overview of the three components of alliance portfolio management that correspond to the different empirical studies of this dissertation.

Focusing on the relationships between alliance partners, Chapter 3 discusses the coordination of alliance partners and provides implications on how to form and grow alliance portfolios. When firms build up their alliance portfolios, they have to take care of the relationships among their partners as well as the size of their alliance portfolios. The relationships, which include cooperative as well as competitive ties among the focal firm's partners, affect the flow of knowledge within the focal firm's alliance portfolio and thus influence the amount of benefits the focal firm gains from its alliance resources. Employing the resource-based view and a social network perspective, Chapter 3 examines the impact of network resources in alliance portfolios on the focal firms' innovation performance and how structural and competitive embeddedness in alliance portfolios positively or negatively moderate this impact. Results verify that a larger alliance portfolio leads to an improved innovation performance of the focal firm, but, at the same time, relationships among the focal firm's partners are found to affect the link between alliance portfolio size and focal firm performance. Specifically, in terms of structural embeddedness, a cooperative and densely tied portfolio strengthens the positive

impact of alliance portfolio size on the focal firm's innovation performance. In terms of competitive embeddedness, a portfolio with severe competition among the partners weakens the positive impact and leads to a reduced innovation performance. These findings suggest firms to increase their alliance portfolio size and, at the same time, to keep an eye on their portfolios' two-sided network characteristics, i.e. the connectivity and competition among their partners.

Chapter 4 discusses how to fully leverage diversified alliance portfolios and turn them into innovation. While an alliance portfolio which consists of diverse partners is usually beneficial to the focal firm, the maximum level of diversity that a firm can handle is determined by its extensive absorptive capacity. To improve their absorptive capacity, firms need to build up alliance experience and manage the knowledge distance between them and their alliance partners. Chapter 4 examines the influence of alliance portfolio diversity on innovation performance and how the focal firm's alliance experience and the proximity of knowledge between the focal firm and its alliance portfolio moderate this influence. Empirical results verify an inverted u-shape relation between alliance portfolio diversity and focal firms' innovation performance. However, with accumulated alliance experience and higher proximity to partners, focal firms can accommodate more diversity in their alliance portfolios, which contributes to an improved innovation performance. These findings suggest that the maximum level of alliance portfolio diversity which contributes to innovation performance is limited. However, firms can learn to take advantage of higher diversity through accumulated alliance experience and proximate

partners.

Focusing on the innovation effectiveness achieved by ambidextrous alliance strategy and internal innovation intent, Chapter 5 discusses the alignment of alliance portfolios. Collaborative decision making through alliances contributes to a profound understanding toward market needs and market adaptation. The evaluation of the collaborative output by collaborators with different backgrounds also increases the practicality and marketability of the resulting innovations. Thus, alliance portfolios do not only contribute to immediate innovation outcomes but can also serve to increase innovation effectiveness as well. Chapter 5 investigates the influence of alliances which aim to obtain new knowledge on firms' innovation effectiveness. Moreover, by aligning their alliance portfolios in diverse ways, firms can enhance the effectiveness of their innovation outcomes. Thus, this chapter examines some internal and external organizational factors which strengthen the influence of alliances on innovation effectiveness. The results of the empirical study verify a positive relationship between the commitment to exploratory alliances and innovation effectiveness as measured by the percentage of revenue from new products. It is also confirmed that exploitative alliances and internal innovation intent positively moderate this relationship. These findings suggest the importance of ambidexterity within the alliance portfolios and the need for an alignment of firms' strategic intents with their alliance objectives.

Finally, Chapter 6 provides a summary of the results of this dissertation and concludes with a discussion of implications, limitations, and directions of future research.

Chapter 2. Literature review

2.1. Alliance portfolio management

2.1.1. The definition of alliance portfolios

Initial studies relating to multiple alliance phenomenon, mainly conducted by social network theorists, focused on the alliance network per se as a unit of analysis. This approach is useful for understanding the process of how the whole network grows and develops (e.g. Gulati & Gargiulo, 1999), but lacks implications for individual performance within the network. Later studies, which still choose a whole alliance network as a unit of analysis (e.g. Schilling & Phelps, 2007), made further efforts to provide implications on the individuals' performance within the network. However, they have not sufficiently reflected idiosyncratic characteristics of the constituent individuals and the associated performance (Barney, 1991; Peteraf, 1993). Moreover, the whole network approach cannot fully incorporate diverse alliance partners of individual firms from different industrial backgrounds because an alliance network has been usually considered within a single industry. As exemplified in the figures in Chapter 1, by solely identifying the alliance network in the micro-electronics industry (Figure 1), Samsung electronics' entire alliance partners from a wide array of industries (Figure 2) and their influences cannot be captured. Thus, to overcome such limitations of the whole network

approach and to provide firm-specific implications, scholars in management and strategy literature (e.g. Baum et al., 2000; Rowley et al., 2000) have paid more attention to a focal firm's direct ties with different partners, i.e., its alliance portfolio (Wassmer, 2010). Such an individual level of analysis contributes to understanding how a firm's unique web of contacts (its egocentric "universe") affects its power, advancement, perceptions and attitudes as well as the social support toward it (Morrison, 2002; Walker, Wasserman, & Wellman, 1993).

For the specific definition of an alliance portfolio, previous studies have achieved an adequate consensus – all the alliances conducted by the focal firm –, however, according to the fields they are stemming from, also exhibit different perspectives on what exactly constitutes an alliance portfolio. The most common approach to define an alliance portfolio is viewing it as the aggregate of all strategic alliances of a focal firm (Bae and Gargiulo, 2004; George et al., 2001; Hoffmann, 2005, 2007; Lavie, 2007; Lavie and Miller, 2008; Marino et al., 2002). Studies in network literature define an alliance portfolio as the focal firm's egocentric alliance network which includes all direct ties with the partner firms and ties between the focal firm's direct partners (Baum et al., 2000; Rowley et al., 2000; Ozcan and Eisenhardt, 2009). Organizational learning literature focuses on alliance experience and defines an alliance portfolio as a focal firm's accumulated alliance experience which includes past as well as ongoing alliances (Anand and Khanna, 2000; Kale et al. 2002; Reuer et al. 2002; Hoang and Rothaermel, 2005; Park and Kang, 2010).

This dissertation adopts these different points of view on the definition of an alliance portfolio and uses them according to the purpose of each chapter. In Chapter 3, to focus on the structural and competitive embeddedness in alliance portfolios, the egocentric network approach is used to define each focal firm's alliance portfolio. Chapter 4 highlights learning through alliances and, though it does not exhaustively include past alliances, adopts the organizational learning perspective in order to define the alliance portfolio. In Chapter 5, the information of all alliance partners including alliance type, e.g. technology or other type of alliances, is collected in order to examine the influence of exploratory and exploitative alliances.

2.1.2. A holistic approach toward alliance portfolios

Firms simultaneously engaging in multiple alliances face new management tasks beyond simply managing the individual alliances. In a multi-alliance situation, on top of individual alliance outcomes, alliance managers have to pay more attention to the overall success of alliances (Fricke & Shenhar, 2000). Table 1 compares different managerial perspectives relating to an individual alliance and an alliance portfolio. While individual alliances pursue a local optimum at the alliance level, the alliance portfolio approach pursues the global optimum at the portfolio level. This difference is mainly attributable to the fact that the local rationality can lead to the positive or negative influence on other

alliances (Lichtenthaler & Lichtenthaler, 2004). Due to this interdependency, managing an alliance portfolio involves a higher complexity than managing a single alliance and, hence, requires a holistic approach across all alliance partners. Firms should continuously monitor the influence of individual alliances on each other and the overall performance of alliance portfolios and change the configuration of their portfolios in order to generate a positive synergy and avoid conflicts (Duysters et al., 1999; Hoffmann, 2005; Parise & Casher, 2003).

Table 1. Different perspectives on managing individual alliances and an alliance portfolio

	Individual Alliance	**Alliance Portfolio**
Objective	Local optimum	Overall optimum
Strategic focus	Individual partner fit Bilateral knowledge exchange Manage alliances as separate contracts	Portfolio fit Knowledge leverage across partners Manage alliances as a set of competences
Complexity	Relatively low	High due to the interdependency
Opportunities/ Threats	Limited to the individual alliances	Potential positive or negative synergies
Top management involvement	Top management initiates and evaluates	Top management moderates and prioritizes

Source: Duysters et al. (1999), Lichtenthaler & Lichtenthaler (2004), etc.

For a more systematic and holistic approach towards alliance portfolio management, it is required for firms to have a superior management perspective which

incorporates the individual alliance strategy and alliance portfolio strategy into the realm of corporate strategy (Duysters et al., 1999). In case of managing a single alliance, the top management of firms initiates the alliance and evaluates the outcomes of the alliance in the final stage of the alliance. However, with the superior perspective, the top management pays more attention to the interplay of individual alliance strategy, alliance portfolio strategy, and corporate strategy. Hence, at a corporate level, they prioritize the alliance portfolio strategy and continuously moderate their alliance portfolios.

2.1.3. Theoretical lenses used in alliance portfolio research

A broad range of theoretical lenses from the strategy literature has been used to study alliance portfolios in previous literature. Table 2 introduces these theoretical lenses and related prior studies. Major theoretical pillars in alliance portfolio literature are social network theory (e.g. Ahuja, 2000a, 2000b; Baum et al., 2000; Gulati, 1999; Stuart, 2000), resource-based view (e.g. Lavie, 2006; Vassolo et al., 2004) and organizational learning (e.g. Anand & Khanna, 2000; George et al., 2001; Kale et al., 2002) including the exploration and exploitation perspectives (e.g. Lavie & Rosenkopf, 2006; Rothaermel, 2001). As shown in Table 2, around these major pillars, a number of prior studies integrate two or more theoretical lenses and examine the cause and effect relationships relating to alliance portfolios (Wassmer, 2010).

Table 2. Theoretical backgrounds applied to alliance portfolio literature

Theoretical background	Related studies (selected)
Resource-based view	Ahuja (2000a, 2000b), Eisenhardt & Schoonhoven (1996); Lavie (2006), Park et al. (2002), Vassolo et al., (2004)
Knowledge-based view	Kale et al. (2002), Lorenzoni & Lipparini (1999)
Social network theory	Ahuja (2000a, 2000b), Baum et al. (2000), Goerzen (2007), Goerzen, & Beamish (2005), Gulati (1998, 1999), Koka & Prescott (2002), Powell et al. (1996), Stuart (2000), Walker et al. (1997)
Relational view	Dyer & Singh (1998), Gulati et al. (2000)
Organizational learning	Anand & Khanna (2000), Deeds & Hill (1996), George et al. (2001), Gulati (1999), Hoang & Rothaermel (2005), Kale et al. (2002), Powell et al. (1996), Stuart (2000)
Exploration/exploitation	Lavie & Rosenkopf (2006), Rothaermel (2001)
Contingency theory	Hoffmann (2007)
Dynamic capabilities	Kale et al. (2002), Lorenzoni & Lipparini (1999)
Agency theory	Reuer & Ragozzino (2006)
Real options	Vassolo et al. (2004)
Evolutionary economics	Kale et al. (2002)
Transaction cost economics	Goerzen (2007), Goerzen & Beamish (2005)
Coevolutionary perspective	Hoffmann (2007)

Source: Hoffmann (2007), Wassmer (2010), etc.

Consistent with the approach in previous literature, this dissertation also adopts diverse theoretical backgrounds at the same time and increases the understanding relating to the major issues in each chapter. Chapter 3, to study the effect of network resources and how the embeddedness affects the outcome of the alliance portfolio, adopted the resource-based view and social network theory. Based on resource-based view, transaction cost economics and related contingency theory, Chapter 4 presents the pros and cons of alliance portfolio diversity. Furthermore, Chapter 4 examines the role of alliance experience and knowledge proximity in leveraging diversified alliance portfolios, hence, theoretical lenses such as organizational learning and knowledge-based view are adopted. In Chapter 5, focusing on the alignment of alliance portfolios through an ambidextrous strategy, the exploration and exploitation perspectives are adopted. Across the Sections 2.2. to 2.4. of this dissertation, these theoretical backgrounds are directly related with the research questions of subsequent chapters.

2.1.4. Alliance portfolio management and its components

Beyond a holistic approach toward alliance portfolios, alliance managers and scholars' interests are focused on a specific process for configuring and managing an alliance portfolio which leads to a positive synergy between alliances, allow the focal firm to effectively acquire external knowledge, and ultimately turn it into an increased

performance of the focal firm. Some influential studies in alliance portfolio literature suggest such processes toward managing alliance portfolios as follow:

Parise and Casher (2003) propose an alliance portfolio model which consists of "alliance portfolio design", "individual alliance factors", and "alliance portfolio management". These different constituents of the alliance portfolio model interact with each other and ultimately affect the success of each alliance and the portfolio as a whole. They suggest that, in terms of alliance portfolio design, firms should examine the impact of each alliance on one another and continuously change the composition of their alliance portfolios. Relating to individual alliance factors, they focus on trust in alliance relationships and highlights learning opportunities in alliance relationships. For alliance portfolio management, they point out the alignment of strategic objectives between the alliance portfolio and the corporation and attempt to introduce a measure for the overall portfolio performance.

In case of Hoffmann (2005)'s conceptual study of "how to manage a portfolio of alliances", he proposes tasks of alliance portfolio management which include "portfolio co-ordination", "portfolio monitoring", and "portfolio strategy". The aim of portfolio co-ordination is to utilize synergies among different alliance partners and, at the same time, to avoid conflicts among these alliances. Portfolio monitoring allows the focal firms to investigate the reasons why the performance of their alliance portfolios falls short of expectations and systemize the processes of learning from the alliance portfolios through routinization and formalization. Portfolio strategy is focused on the balance between

exploration and exploitation alliances and aims for the alignment of alliance strategy, business strategy and corporate strategy.

Further, to cope with a complex and changing environment, Hoffmann (2007) classifies alliance strategies into “shaping strategy”, “adapting strategy”, and “stabilizing strategy”. Shaping strategy refers to expanding alliance portfolios centered on core exploration alliances which contribute to developing new opportunities in a certain field. Meanwhile, the goal of adapting strategy is broadening the resource base of alliance portfolios through “probing alliances” in diverse fields (Kogut & Kulatilaka, 1994) and increasing the strategic flexibility of alliance portfolios. Finally, stabilizing strategy highlights the role of exploitation alliances, which commercialize resources and capabilities gained through exploration (Koza & Lewin, 1998).

The aforementioned studies are based on different perspectives of managing alliance portfolios, however, they provide a similar approach on how to manage an alliance portfolio. Parise and Casher (2003) and Hoffmann (2005), throughout their approaches, suggest firms to scrutinize the interdependency among different alliances and learning mechanisms for absorbing knowledge in their alliance portfolios, and finally, to align their alliance portfolios per se and have them go along with their business or corporate level strategy. These approaches are fairly related to the main research topics of this thesis, i.e., how to coordinate individual alliances in terms of a portfolio, how to fully capture learning opportunities from a diversified alliance portfolio, and how to align the objectives of an alliance portfolio across a variety of organizational levels. On top of that,

as described above, Hoffmann (2007) emphasizes several alliance portfolio strategies - shaping, adapting and stabilizing - which are respectively similar to the coordination, diversity accommodation and object alignment of an alliance portfolio in the present dissertation.

Arranging the approaches of managing alliance portfolios found in the extant literature, this dissertation discusses three integrative components of technology alliance portfolio management. First, in terms of coordinating partners, while expanding alliance portfolios, firms should explore new technology opportunities and, at the same time, pay attention to the interdependency among their alliance partners. Second, in terms of accommodating diversity, firms should acquire external knowledge through their diversified alliance portfolios and monitor the smooth knowledge transfer from their portfolios. Third, in terms of aligning objectives, firms should stabilize their alliance portfolios through ambidexterity and have them align with the business or corporate level strategy. Table 3 compares these three components of alliance portfolio management with the approach in the extant studies. Although not the prior approach exactly coincides with each component in the present dissertation, a high level of affinity between them is identified and corroborates the claims of the present dissertation.

Additionally, Table 3 includes major streams of alliance portfolio literature, the emergence, configuration and management of alliance portfolios, identified in a review paper of Wassmer (2010) and also compares these streams with the components of alliance portfolio management of the present dissertation. The emergence of alliance

Table 3. Comparison of alliance portfolio management approaches between prior studies and the management components described in the present dissertation

Prior studies	Alliance Portfolio Management Components		
	Coordinating Partners	**Accommodating Diversity**	**Aligning Objectives**
Parise & Casher (2003): Alliance Portfolio Model	alliance portfolio design individual alliance factors	individual alliance factors	alliance portfolio management
Hoffmann (2005): Tasks of alliance portfolio management	portfolio co-ordination	portfolio monitoring	portfolio strategy
Hoffmann (2007): Typology of alliance strategies	shaping strategy	adapting strategy	stabilizing strategy
Wassmer (2010): Classification of alliance portfolio research	emergence configuration	configuration management	management

portfolios is about why and how firms build alliance portfolios. The configuration stream deals with multiple dimensions of alliance portfolios such as size, breadth, density, partner characteristics, etc. The management of alliance portfolios mainly focuses on firms' alliance capability and how to simultaneously manage multiple alliances.

2.2. Enlarging and coordinating alliance portfolios

2.2.1. The size effect of alliance portfolios

Based on a broad range of theoretical backgrounds, resource-based view, social network theory and basic economic theory, previous literature discusses how alliance portfolio size affects the focal firms' performance (Wassmer, 2010). An initial stream of research suggests that alliance portfolio size contributes to explaining the performance differential among firms (Wassmer, 2010) and confirms a positive relationship between the number of alliance partners and firms' innovation outcomes such as patenting rates (Shan et al., 1994) or new product development (Deeds & Hill, 1996). Larger alliance portfolios allow firms to access more network resources and thus contribute to an increased innovation performance. However, alliance portfolio size alone might not be a sufficient predictor for performance (Wassmer, 2010). A later stream of research raises the possibility of diminishing returns from alliance portfolio size. Studies in this stream suggest that, in addition to size, alliance portfolio breadth (Ahuja, 2000a, Gulati, 1999), efficiency (Baum

et al., 2000) and alliance partner quality (Stuart, 2000; Stuart et al., 1999) can serve as suitable predictors for firm performance. Therefore, for firms, having access to diverse and quality partners and an efficient portfolio configuration are as or even more important for the performance than alliance portfolio size alone (Wassmer, 2010).

2.2.2. Embeddedness in alliance portfolios

In chapter 3, in the formation stage, this dissertation focuses on the social network characteristics of alliance portfolios. A number of social network studies, for the theoretical background, have adopted an embeddedness lens. The key argument of embeddedness is that actors' actions and outcomes are influenced by the relationships that surround them (Baum and Dutton, 1996; Dacin et al., 1999; Granovetter, 1985). Specifically, network embeddedness describes a firm's social structure, the extent to which it is connected to others and how those other firms are interconnected to each other (Granovetter, 1992; Nahapiet & Ghoshal, 1998). Some researchers describe the influence of embeddedness as follows. Granovetter (1985) suggests that an actor's social surroundings facilitate or constrain his or her economic actions. Strategic actions of a firm are determined not only by its internal context but also by its social context (Echols & Tsai, 2005; Gulati & Gargiulo, 1999). In line with this stream, researchers focus on holistic characteristics (i.e. structural embeddedness, sectoral embeddedness, etc.) of

alliance portfolios and how they affect a firm's new alliance formations. For example, Garcia-Pont and Nohria (2002) suggest that structural embeddedness in an alliance network affects the likelihood of alliance formation between firms in the network, and Hagedoorn (1993) suggests that firms' sectoral embeddedness affects their propensity to engage in new alliances. Contrary to the somewhat positive view of the role of embeddedness in alliance formations, some researchers suggest possibilities of decreasing opportunities for new alliances under conditions of increasing social embeddedness (Burt, 1992; Duysters, Hagedoorn, & Lemmens, 2003; Hagedoorn, Letterie, & Palm, 2007; Uzzi, 1997).

Moreover, the embeddedness perspective suggests that the interfirm network influences the flow of knowledge and resources among them (Chen, 1996; Gnyawali and Madhavan, 2001). Within its alliance portfolio, the focal firm has a structural advantage which provides it with simultaneous access to its network resources and this advantage increases with the portfolio size (Zukin and DiMaggio, 1990; Gulati, 1998). At the same time, relationships among the focal firm's partners also affect the flow of resources within the portfolio. Specifically, the flow of knowledge within the alliance portfolio is influenced by the extent to which partners are interconnected with each other (structural embeddedness) and how partners compete with each other (competitive embeddedness).

In conclusion, relationships among a firm's partners determine the flow of knowledge within its alliance portfolio and affect its innovation performance. Therefore, firms should not only focus on increasing their portfolios but, at the same time, consider

the relationships among their partners as an important configurational factor of their portfolios.

2.2.3. The influence of structural embeddedness

The structural embeddedness perspective suggests that a superior position in a cooperative network translates into resource advantages (Gnyawali and Madhavan, 2001). Previous literature exemplifies variables related to structural embeddedness such as structural holes (Burt, 1992), centrality (Freeman, 1979; Bonacich, 1987; Ibarra, 1993; Podolny, 1993), structural equivalence (Burt, 1987), and density (Coleman, 1988). Gnyawali and Madhavan (2001) classify them into the structural properties of firm-level, pair-level and network-level and point out the density as a network-level structural variable. Density in this context refers to the extent of interconnectedness among the actors in a network. In Chapter 3, this dissertation investigates how the extent of interconnections among partners affect the flow of resources within an alliance portfolio and, therefore, among the variables related to structural embeddedness, focuses on the density.

The existing views toward the effects of network density are divergent. A dense network is advantageous in building up absorptive capacity of actors within the network but at the same time limits novelty creation within the network (Gilsing et al., 2008).

Specifically, a dense alliance portfolio provides the following advantages to the focal firm. First, in the case of a large technological distance between the focal firm and one of its partners, another partner, tied to the first one, complements the focal firm's absorptive capacity and helps to narrow down the technological gap (Gilsing & Nooteboom, 2005). Connections among the focal firm's partners increase the similarity of their knowledge base and allow the focal firm to easily absorb and understand its partners' knowledge (Gilsing et al., 2008). Second, the focal firm may easily judge the reliability of information from its partners through its dense alliance portfolio (Gilsing and Nooteboom, 2005). Triangulations which consists of the focal firm and its partners allow the focal firm to objectively evaluate the acquired novelty from each partner (Rowley et al., 2000). Third, a dense alliance portfolio facilitates the build-up of trust based on a reputation mechanism and coalitions to constrain opportunism (Gulati, 1995a, b; Hagedoorn & Duysters, 2002). These advantages are also suggested by Coleman (1999)'s network closure theory and become more effective in the case of high uncertainty of technology development (Nooteboom, 1999, 2002).

However, the dense portfolio may lead to a number of disadvantages to the focal firm. First, it inhibits the inflow of novel and diverse knowledge. In a dense network, due to knowledge spread, 'everyone knows what everyone knows' (Gilsing et al., 2008). Therefore the novelty of knowledge accessed by the focal firm declines and this in turn decreases the innovation performance (Gilsing et al., 2008). Second, there is a risk of undesirable spillovers which makes the focal firm reluctant to share valuable knowledge

with other partners in the portfolio. This restricts the focal firm's ability to appropriate novelty in its alliance portfolio (Gilsing and Nooteboom, 2005). Third, a dense network may create a strong behavioral pressure which forces the actors to conform rather than to be radically different (Kraatz, 1998). Therefore, a dense alliance portfolio may force the focal firm into coalitions with existing partners and to show loyalty toward them and, therefore, imposes restrictions on entering relationships with new and more innovative partners (Buchko, 1994; Nooteboom, 1999; Duysters and Lemmens, 2003; Gulati et al., 2000).

2.2.4. The influence of competitive embeddedness

Competitive embeddedness is a theoretical concept which accounts for how competitive relations affect alliance formations. Competitive relations refer to firms competing for limited resources or targeting the same market and include direct rivalry and indirect rivalry (McPherson, 1983). In previous literature in the field of competitive embeddedness, Trapido (2007) builds on the co-opetition concept (Brandenburger & Nalebuff, 1996) and explores how the likelihood of cooperation between two firms is influenced by their direct rivalry. Gimeno (2004) emphasizes that various network perspectives such as indirect ties have not been fully adopted to account for the relationship between competitive relations and alliance formations in existing literature.

Accordingly, Gimeno (2004) explores the likelihood of cooperation between two firms in case of their indirect rivalry. When two firms with high niche overlap have a common partner, they are considered to be substitutes in the common partner's point of view and cannot appropriate rents from the partner.

Competitive embeddedness in this dissertation differs from existing competitive embeddedness literature in two perspectives. First, existing literature highlights the impact of a focal firm's rivalry (direct or indirect) on its alliance formations. Trapido (2007) pays attention to the alliance link formation between a focal firm and its direct rival (Figure 4) while Gimeno (2004) pays attention to the alliance link formation between a focal firm and its rival's partner (Figure 5). In the meantime, this dissertation, in Chapter 3, pays attention to the impact of rivalry between a focal firm's partners on the focal firm's alliance formations (Figure 6). This dissertation is interested in competitive relations among partners of a focal firm and how these competitive relations affect the focal firm's alliance formations with existing or new partners. Second, the aforementioned differences between existing literature and this dissertation lead to going beyond analyzing dyadic relationships of a focal firm and instead to focus on the focal firm's alliance portfolio as the unit of analysis. As depicted in Figure 6, within the portfolio, rivalries can take place across many partners of a focal firm and potentially affect all the alliance links of the focal firm.

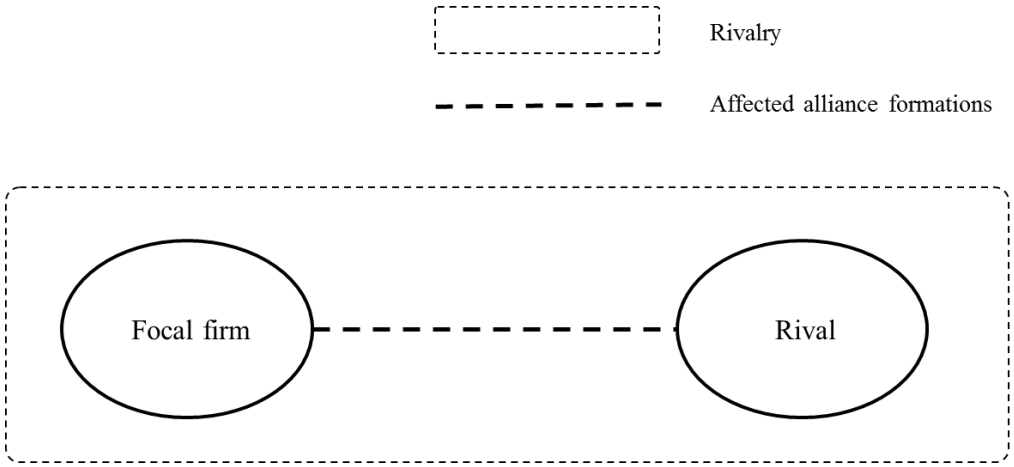


Figure 4. The influence of competitive embeddedness in Trapido (2007).

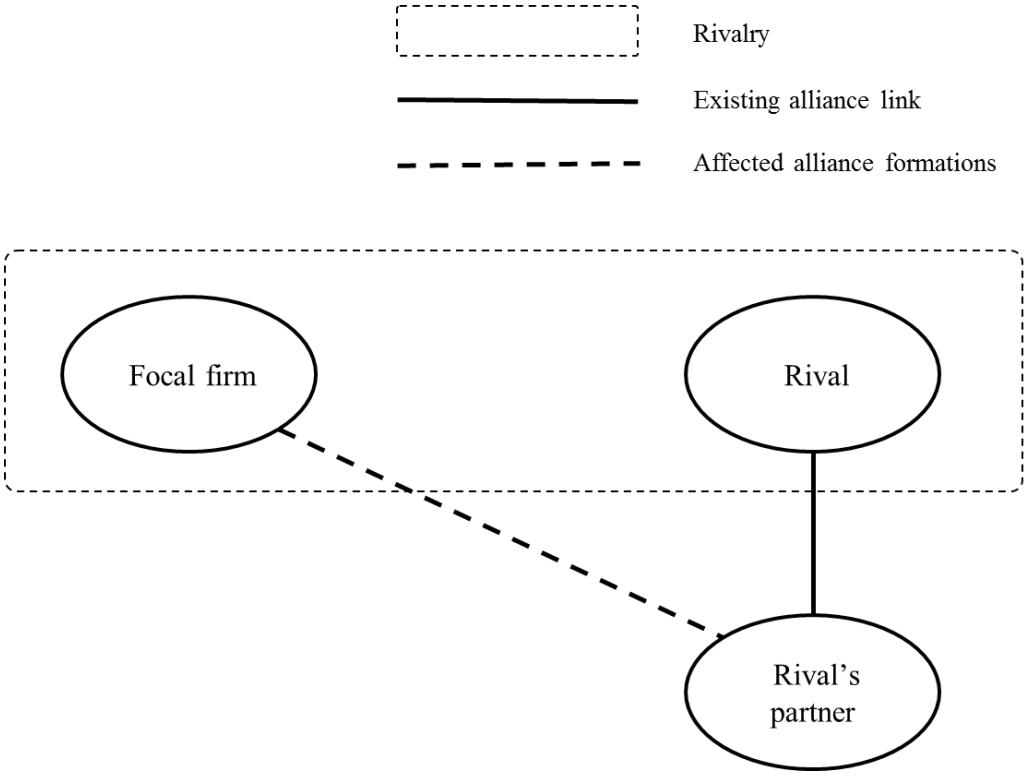


Figure 5. The influence of competitive embeddedness in Gimeno (2004).

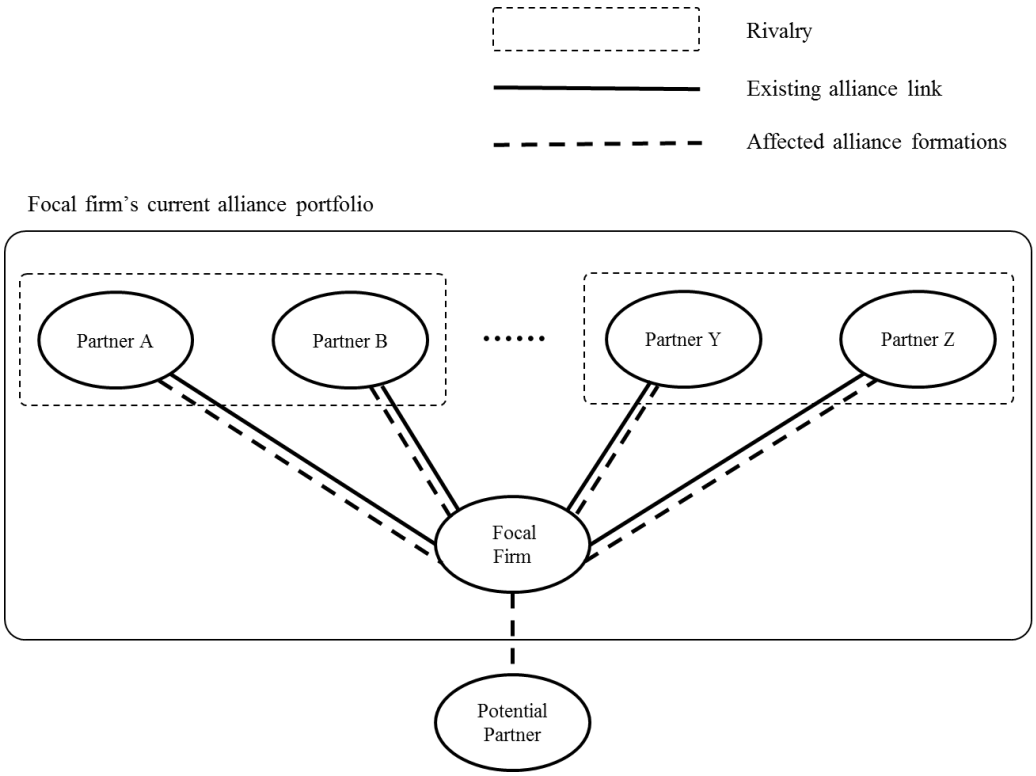


Figure 6. The influence of competitive embeddedness in the present dissertation.

2.3. Accommodating diversity of alliance portfolios

2.3.1. Alliance portfolio diversity and its influences on firm performance

Alliance portfolio diversity is defined as the level or the distribution of differences among types of a firm's alliance partners, for example, the industry the partners are involved in, their governance or organizational forms, their functions in a value chain and technologies they are possessing (Bruyaka & Durand, 2012; Oerlemans et al., 2013). The

extant studies have introduced these various dimensions of alliance portfolio diversity and examined their influences on firm performance. For example, Yamakawa et al. (2011), focusing on the functional diversity, find a negative relationship between a high proportion of exploitative ties and firms' return on assets. Jiang et al. (2010) show that greater organizational and functional diversity and lower governance diversity in alliance portfolios lead to a higher net profit of the focal firms, while partner diversity exhibits a non-linear relationship with net profit. Lavie and Miller (2008) suggest a sigmoid influence of international and geographical diversity on firms' financial performance.

Relating to the partner diversity, as shown in Jiang et al. (2010), a number of prior studies confirm a non-linear or a curvilinear relation between the diversity and firm performance, especially the innovation outcome. This relationship can be explained by the extended resource-based view (Lavie, 2006) and organizational economics (Belderbos et al., 2006). At a low level of portfolio diversity, firms become surrounded by partners that possess similar resources and capabilities and have limited opportunities to acquire complementary and novel knowledge (Faems et al., 2005). As a result, the outcomes of alliance portfolio would exhibit a relatively low level of innovativeness. In the meantime, at an intermediate level of portfolio diversity, firms can avoid the overlap of knowledge among alliance partners and have an increased access to complementary and novel knowledge (Oerlemans et al., 2013). Moreover, a moderate level of alliance diversity diminishes intra-portfolio competition costs (Belderbos et al., 2006) and does not give rise to extremely complex managerial issues (Bruyaka and Durand, 2012). Thus firms are

most able to take advantage of the benefits from their alliance portfolios. As the level of portfolio diversity further increases, managerial costs (e.g. the costs of coordination, monitoring and communication, and the probability of opportunism) derived from the higher level of diversity surpass the benefits of a diversified alliance portfolio (Bapuji et al., 2011; Chen et al., 2011). Too much diversity of the knowledge inflow takes up firms' attention and prevents them from capturing the appropriate knowledge at the right time (Koput, 1997).

Network theory and transaction cost economics are also able to account for the pros and cons relating to alliance portfolio diversity. Diverse alliance ties allow firms to have access to a variety of ideas and perspective which would not available to firms with similar and redundant ties (Goerzen & Beamish, 2005). Moreover, surrounded by diverse alliance ties from different backgrounds, the focal firm would act as an information channel and take advantage of the centralized information flow in the middle of its portfolio (Burt, 1980; 1992). Other network theorists shed light on the value of ties outside a network of strong relationships and recommend actors to continuously seek for new partners based on their empirical findings (Granovetter, 1973; Lin, 1981). However, Burt (1992) suggests a 'budget equation' which determines optimal network redundancy and advises on a trade-off between the network benefit generated by new ties and the time and energy called for to maintain such valuable relationships. Transaction cost theory (Coase, 1937; Williamson, 1985), according to the level of diversity, sequentially explains how the cost of managing alliance portfolio diversity develops. Increasing the diversity

requires an initial search cost because valuable partners would generally reside outside of the focal firm's neighborhood or known circle of contacts (Rangan, 2000). Once a new partnership is established, due to the lack of trust and unfamiliarity of processes and routines between the parties, additional costs of monitoring the new partner arise (Hitt, Hoskisson, & Ireland, 1994). Finally, as the focal firm's alliance portfolio becomes more diverse, a 'dominant logic' of senior management, which only figured out the surface of its diverse partners, can act as a liability in managing the increased diversity and result in irrelevant management decisions (Prahalad & Bettis, 1986). Consequentially, the marginal benefits of alliance portfolio diversity become overwhelmed by the marginal costs of diversity (Goerzen & Beamish, 2005). Moreover, the cost of arranging an additional transaction (alliance) equals or surpasses the cost of acquiring relevant resources and capabilities via internal development or open market exchange (Williamson, 1985).

2.3.2. From alliance experience to building alliance capabilities

Experience is regarded to be a key concept in capability development and shapes future firm capabilities since they are not easily acquirable through the spot market (Heimeriks & Duysters, 2007; Helfat, 2000; Teece et al., 1997; Zollo & Winter, 2002). Iterative experience in an activity fosters organizational learning and creates inferences for future

engagements in the activity (Levitt & March, 1988). The stored experience might be encoded in routines and is retrieved and activated when certain stimuli are commenced (Nelson & Winter, 1982). Via simplification and specialization, routines that result from experience are likely to improve performance in future similar activities (Barney, 1991; Levinthal & March, 1993). Hence, a number of prior studies (e.g. Ingram & Baum, 1997; King & Tucci, 2002; Simonin, 1997) confirms the positive association between experience and firm performance in various empirical settings.

Concerning the role of alliance experience, as firms build up their alliance experience, they formulate standardized solutions of implementing alliances and become more effective at managing alliances than less experienced firms (Das & Teng, 2002; Heimeriks & Duysters, 2007). The specific mechanism which harnesses alliance experience and turns it into alliance capability initiates from individuals in an organization (Anand & Khanna, 2000). The build-up of experience makes the individuals to be accustomed to implementing alliances. Hence, the firm exploits the individuals' experiences and synthesizes them into an alliance capability at the organization level through a formalized process (Cohen & Levinthal, 1990).

2.4. Innovation effectiveness and aligning alliance portfolios

2.4.1. The significance of innovation effectiveness

While most innovation literature pays attention to an organization's innovation outcomes, recent literature has begun to approach the whole innovation process which spans key activities ranging from creating novel knowledge to its commercialization (Bogers and West, 2012; Dervitsiotis, 2010, Lee & Kelly, 2008; Loewe & Dominiquini, 2006). Especially, Dervitsiotis (2010) suggests that the innovation process is not complete until new ideas turn into valuable products and generate cash flow. In line with this new stream of research, the concept of innovation effectiveness became more important. Klein and Sorra (1996) describe innovation effectiveness as "the benefits an organization receives as a result of its implementation of a given innovation" and suggest that organizations might even fail in obtaining the benefits of innovation in the course of implementing it. Thus, innovation effectiveness is a concept which highlights the actual influence of a given innovation and its practical performance. Dervitsiotis (2010) proposes a number of measures for innovation effectiveness such as speed to market, percentage of current revenue from innovations of the last two to three years, or level of innovation project risk. This dissertation focuses on how much a given innovation contributes to the actual firm sales and, in chapter 5, adopts "percentage of revenue from innovation" as the measure of innovation effectiveness.

2.4.2. From alliances to innovation effectiveness

This dissertation acknowledges the significance of innovation effectiveness and complements the extant alliance literature which deals with the effects of alliances on innovation performance. Most previous literature highlights the effects of strategic alliances on immediate innovation outcomes such as the number of patent applications, whereas some literature pays attention to the financial performance of alliance strategies such as market value (Lavie, Kang, & Rosenkopf, 2011; Mouri, Sarkar, & Frye, 2012) and return on assets (Yamakawa et al., 2011). A few recent studies (e.g. Beers & Zand, 2014; Faems et al., 2005) introduce "turnover from new products" as a dependent variable which reflects the performance of strategic alliances but are still lacking in their understanding of why strategic alliances affect innovation effectiveness and how to strengthen this relationship.

This dissertation focuses on exploratory alliances and examines their influence on innovation effectiveness. Following March (1991)'s approach of exploration and exploitation, exploration aims to develop more innovative outputs compared to firms' existing business or products but introduces a great deal of uncertainty because it challenges the status quo. Exploratory alliances, which are an extension of the concept of exploration to the realm of strategic alliances, represent strategic alliances for new technology learning such as collaborative basic R&D (Lane & Lubatkin, 1998; Rothaermel, 2001). What matters for the performance of exploratory alliances is not only how innovative the outcome is, but also whether the firm is able to overcome the uncertainty and turn the innovation into actual firm performance, i.e. revenue. Given their

linkage with firm performance and innovation, examining the influence of exploratory alliances, rather than exploitative alliances, on innovation effectiveness provides a range of academic and practical contributions.

2.4.3. Exploratory and exploitative alliances and innovation

Exploration is a concept related to capturing or creating new knowledge (Lavie & Rosenkopf, 2006; March, 1991; Rothaermel & Deeds, 2004) and focuses on absorbing external knowledge that firms do not possess (Rosenkopf & Nerkar, 2001). Thus, sufficient absorptive capacity and responsiveness to uncertainty are required to help absorb and integrate the new knowledge (Cohen & Levinthal, 1990; Lavie & Rosenkopf, 2006; McGrath, 2001). Considering these characteristics, successful exploration generally results in more radical innovation than exploitation.

On the other hand, exploitation, another type of learning firms are engaged in, focuses on improving firms' existing knowledge bases or technologies (Hoang & Rothaermel, 2010; March, 1991; Rothaermel & Deeds, 2004). Exploitation is often coupled with the expectation of short-term results and pursues the improvement of existing products or services instead of a radical change.

Extending the concept of exploration and exploitation from the realm of intraorganizational learning to that of interorganizational learning (e.g. Grant & Baden-

Fuller, 2004; Holmqvist, 2003; Lane & Lubatkin, 1998), previous literature has introduced new domains relating to the characteristics of the knowledge source. For example, Lavie and Rosenkopf (2006) suggest three different domains for exploration and exploitation at the level of alliances, namely, function, structure, and attribute. In case of the function domain, upstream alliances in a business value chain (e.g. R&D alliances which generate new knowledge) are regarded to be exploratory, and, on the other hand, downstream alliances in the value chain (e.g. marketing or production alliances which leverage existing knowledge) are regarded to be exploitative. The structure domain examines inter-firm networks and distinguishes forming new ties between firms (exploration) from repeating prior ties (exploitation). Finally, forming alliances with a new type of partners, in terms of organizational attributes (e.g. size, industry focus, etc.), is regarded to be exploratory and, in the same vein, forming alliances with similar partners is regarded to be exploitative.

Exploratory alliances allow firms access to new knowledge and opportunities, hence contributing to radical innovation unprecedented in the firms or market (Faems et al., 2005; Lavie & Rosenkopf, 2006; Rothaermel, 2001). On the contrary, exploitative alliances focus on increasing efficiency and adapting to market needs, hence, contributing to incremental innovation that improves existing processes or the quality of existing products (Rothaermel & Deeds, 2004; Levinthal & March 1993).

Chapter 3. Building a coordinated portfolio[1]

3.1. Introduction

There are a number of motivations for interfirm alliances such as reducing transaction costs (Kogut, 1988) and uncertainty (Kogut, 1991) or improving the competitive positioning (Gimeno, 2004; Kogut, 1988; Silverman and Baum, 2002). Moreover, alliances allow firms to access their partners' resources (Chung *et al*., 2000; Das and Teng, 2000; Eisenhardt and Schoonhoven, 1996; Lavie, 2006), to learn from their partners (Inkpen, 2000; Kogut, 1988) and to create value and innovation. As firms build up their own alliance portfolio, a collection of alliance partners, they gain access to a larger resource stock and earn greater benefits (George *et al*., 2001; Gulati, 2007; Hoffmann, 2007, Lavie, 2006). Previous literature has empirically verified that a larger alliance portfolio leads to a better innovation performance (Ahuja, 2000a; Baum *et al*., 2000).

Alliance portfolio research differs from previous alliance research in that it can be understood from a social network perspective. Therefore, a number of previous literature (e.g., Baum et al., 2000; Ozcan and Eisenhardt, 2009; Rowley et al., 2000) define an alliance portfolio as a firm's egocentric alliance network. Previous alliance portfolio literature with a social network perspective has several characteristics. First, it focuses mainly on the structural characteristics of alliance portfolios and examines structural

[1]An earlier version of this chapter has been accepted for publication in International Journal of Innovation Management, and is scheduled to be published in August 2015.

variables which bring positive outcomes to the focal firms of the portfolios (Gnyawali and Madhavan, 2001; Walker et al., 1997). Second, it pays attention to the influence of the existing alliance network on firms' further alliance formations (Goerzen, 2007; Gulati, 1995a; Gulati and Gargiulo, 1999; Walker et al., 1997). Third, so far, while adopting a common social network perspective, the existing literature does not provide a consistent theoretical background.

The present study also focuses on the social network perspective of alliance portfolios and complements the existing research. In doing so, this study adopts an embeddedness lens, a basic premise in social network literature, and aims to suggest a balanced view toward the influence of alliance portfolios on their focal firms. Specifically, this chapter examines the impact of network resources in alliance portfolios on focal firms' innovation performance and how structural and competitive embeddedness in alliance portfolios positively or negatively moderate this impact. As a result, this chapter is able to verify that a larger alliance portfolio leads to an improved innovation performance of the focal firm, but, at the same time, relationships among the focal firm's partners were found to affect the relationship between alliance portfolio size and focal firm performance. In terms of structural embeddedness, a cooperative and densely tied portfolio strengthens the positive impact of network resources on the focal firm's innovation performance. In terms of competitive embeddedness, a portfolio with severe competition among the partners weakens the positive impact and leads to a reduced innovation performance.

This chapter makes several contributions to alliance portfolio literature and provides implications for alliance managers. First, the present study highlights the usefulness of embeddedness as a tool for understanding the relationships among partners in an alliance portfolio and suggest researchers and managers to care about two-sided embeddedness in configuring alliance portfolios. Second, this chapter clarifies the context in which the network density outweighs structural holes in line with the debate originating from the different views of Coleman (1988)'s social capital theory and Burt (1992)'s structural hole theory. Third, the present study compares the impact of the breadth and depth of competitive relations among partners in alliance portfolios and provide specific advice on how to expand and configure alliance portfolios to improve the firm's performance. These contributions allow deeper insights into the social network perspective and management of alliance portfolios.

The remainder of Chapter 3 is organized as follows: First, based on the theoretical background of structural and competitive embeddedness, this study develops hypotheses which link alliance portfolio size, firms' innovation performance and moderating variables related to structural and competitive embeddedness. Second, employing negative binomial regression, this study tests the hypotheses using data on 1863 technology alliance cases in the biopharmaceutical industry. Finally, this study presents the empirical results and conclude with a discussion of implications, limitations, and directions of future research.

3.2. Research hypotheses

3.2.1. The relationship between network resources and innovation performance

Firms ally with diverse partners and build up their alliance portfolios because it allows them to gain access to their partners' resources, expand their learning and grow their businesses (Lavie, 2007). This explains why previous literature considers expanding alliance portfolios a significant issue in terms of alliance portfolio configuration and suggests the positive impact of alliance portfolio size on focal firms' innovation performance (Ahuja, 2000a; Baum et al., 2000; Shan et al., 1994).

Specifically, the benefits of larger alliance portfolios are as follows. First, multiple partners increase knowledge sharing (Berg et al., 1982). When firms collaborate for technology development, the outcome is available to all partners (Ahuja, 2000a). Thus, the collaboration provides firms a greater amount of knowledge and technology than independent R&D activities, and the effect of collaboration increases with the number of partners.

Second, collaborations with multiple partners allow the focal firm to access complementary skills (Richardson, 1972; Arora and Gambardella, 1990). Technology development often requires the simultaneous use of different sets of skills and knowledge in the innovation process (Arora and Gambardella 1990; Powell et al., 1996). However,

developing and maintaining diverse sets of competencies in an environment of rapid technological change is difficult for an individual firm (Mitchell and Singh, 1996). Under such circumstances, collaborations allow firms to have an access to their partners' knowledge to complement their existing knowledge base and thereby enhance their innovation performance (Ahuja, 2000a).

Third, multiple collaborations enable firms to take advantage of scale economies (Ahuja, 2000a). Technology development demands various resources such as research manpower, knowledge base and capital. In the case of collaborations, firms combine their resources and share an increased output. Especially, if the technology output is characterized by increasing returns, the impact of the collaborations improves significantly (Ahuja, 2000a). As firms collaborate with an increasing number of partners, they take advantage of a great deal of resources and improve their innovation performance.

Therefore, other things being equal, the present study suggests:

Hypothesis 3-1. A firm's innovation performance increases with the size of its alliance portfolio.

3.2.2. The role of structural embeddedness in alliance portfolios

A dense alliance portfolio can be seen to have both advantages and disadvantages. Previous literature is inconclusive on whether a dense or a sparse network is most advantageous for the actors' innovation performance (Bae and Gargiulo, 2004). For example, McEvily and Zaheer (1999) confirm the positive relationship between alliance networks with many structural holes and firms' capabilities. On the contrary, Ahuja (2000a) confirms the positive relationship between network closure and the likelihood of the firm's innovation. Based on this literature, some scholars account for the contradictory predictions with a contingency approach and examine the context in which a certain form of network prevails (e.g., Rowley et al., 2000). The present study is not biased toward a specific form of network and aims to examine how the network structure of alliance portfolios interacts with the amount of network resources through an opposite set of hypotheses. Therefore, other things being equal, the present study suggests:

Hypothesis 3-2a. An increase in network density within a firm's alliance portfolio will strengthen the positive relationship between alliance portfolio size and innovation performance.

Hypothesis 3-2b. An increase in network density within a firm's alliance portfolio will weaken the positive relationship between alliance portfolio size and innovation performance.

3.2.3. The role of competitive embeddedness in alliance portfolios

Gimeno (2004) argues for an application of the network perspective not only to alliance relations but also to competitive relations. This is due to the fact that just like within alliance relations, where there are direct and indirect partners, also competitive relations consist of direct and indirect relations (such as rivals' rivals, or rivals' partners). Thus, competitive embeddedness, which is derived from the competitive relations surrounding the actors, also affects the actors' actions and outcomes like other types of embeddedness. Competitive relations are defined as the niche overlap in which firms seek the same resources or target the same markets or customers (Gimeno, 2004; McPherson, 1983). Previous literature suggests that the overlap of firms' resource requirements translates into their competitive relations (Baum and Mezias, 1992; Hannan and Freeman, 1977, 1989). Thus, within a focal firm's alliance portfolio, partners' alliances with the focal firm in the same business field can be viewed as an overlap of resource requirements and imply competitive relations.

The reasons why competitive relations among partners within an alliance portfolio negatively influence the focal firm's innovation performance are as follows: First, the competitive relations prevent active knowledge sharing within an alliance portfolio and deteriorate the competitiveness of the portfolio. Dyer and Hatch (2004, 2006) suggest that the competitive advantage of an alliance portfolio originates from the smooth transfer of explicit and tacit knowledge among the focal firm and partners. According to this view,

the alliance portfolio functions as a knowledge sharing network which contributes to the focal firm's innovation performance. However, in case of competitive relations among the partners, they are wary of knowledge spillovers via the focal firm and sharing collaborative outputs with other partners of the focal firm and do not actively participate in the alliances with the focal firm. Second, competitive relations among partners deteriorate trust within an alliance portfolio and increase concerns about the cooperation. Within a network with low trust, alliances are considered to offer a number of opportunities for cheating such as 'stealing partners' technology', 'providing poorer quality investments on joint projects', and 'not fulfilling ex ante commitments' and, thus, successful resource sharing is not possible (Ahuja, 2000a). Moreover, the focal firm faces difficulties in coordinating its relationships with its partners who are wary of the opportunistic behavior of the focal firm and its partners (Gulati and Singh, 1998). Finally, the competitive relations might also affect the successful resource sharing by inhibiting fine-grained information transfer and joint problem solving activities (Uzzi, 1997).

In conclusion, focal firms of alliance portfolios are not able to fully utilize the advantage of their network resources in case of competitive relations among their partners. Therefore, other things being equal, the present study suggests:

Hypothesis 3-3. An increase in competitive relations among a firm's alliance partners will weaken the positive relationship between alliance portfolio size and innovation performance.

To describe the outline of this study more clearly, Figure 7 shows a diagram that summarizes the research model and hypotheses of Chapter 3.

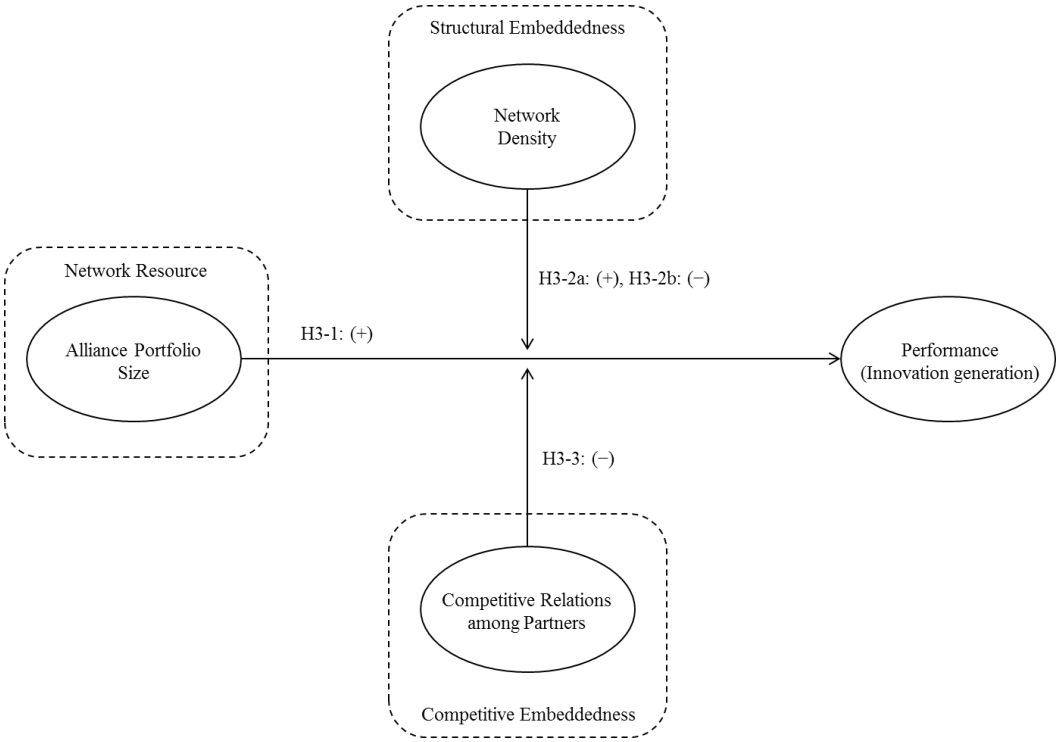


Figure 7. The conceptual model for Chapter 3.

3.3. Methods

3.3.1. Data and sample

To test the hypotheses, I compiled data on the alliance portfolios of US biotechnology firms. The collection of the data was performed as follows: First, I collected information on technology alliances formed between US biotechnology firms and multinational pharmaceutical companies from 2002 to 2004 through the Bioscan database. A three-year window for defining an alliance portfolio was adopted in line with the extant alliance literature (e.g. Stuart et al., 2007) that focused on the biopharmaceutical industry. To select technology alliances, I referred to the qualitative section of the Bioscan database, which describes each alliance in detail, and confirmed the technology focus of the alliances in my sample while excluding those that have a purpose other than technology development (e.g. manufacturing and equity investment) from my dataset. In the next step, I added firm statistics such as R&D expenditure from the Datastream database. Finally, I added patent information provided by the US Patent and Trademark Office. I counted the number of patents filed by each focal firm to measure their technological capabilities and ex post innovation performance. In total, excluding cases with missing information, I collected 1,863 technology alliance cases of 125 focal firms.

High-tech industries are characterized by frequent alliances and growth from innovation (Hagedoorn, 2002). The biopharmaceutical industry shows high alliance tendencies and accounts for about 20 percent of alliances formed in high-tech industries

(Hagedoorn, 1993). Therefore, the biopharmaceutical industry is an ideal setting to study alliance networks and the consequent innovation performance and a number of researchers have chosen this industry when doing research on related issues (Baum et al., 2000; Deeds and Hill, 1996; Powell et al., 1996; Shan et al., 1994; Vassolo et al., 2004). In addition, the highly competitive environment of the biopharmaceutical industry, where rents accrue to the first-mover firm that makes a discovery (Malik, 2012; Vassolo et al., 2004), makes it an appropriate setting to study competitive embeddedness. Especially during 2005-2006, the period I selected for capturing innovation performance, the biopharmaceutical industry exhibited a record growth, nearly 20 percent or more year over year growth for the sales of biologic drugs. Finally, empirical tests within a single industry do not need to control for industry effects and thus raise the reliability of the results (Brouthers and Hennart, 2007).

3.3.2. Dependent variable

The dependent variable, *innovation performance*, is the number of US patent applications filed by each focal firm of my dataset from 2005 to 2006. I focused on the amount of technological outputs, i.e. the generation of innovation, which firms consider innovative at the time of their inventions and counted the number of patents filed as implemented in previous literature (e.g. Brouwer and Kleinknecht, 1999; Cheung and Lin; 2003). As patents are likely to correspond to activity immediately preceding the patent application, I

used a one-year lead with respect to influences of the independent and control variables as used in previous literature (e.g., Ahuja, 2000a; Cheung and Lin, 2004). By measuring the application count over a two year period, I allowed sufficient time to capture the outcome of the technology alliances and at the same time can reduce the effects of unexpected annual variations which might affect a firm's patenting activities.

3.3.3. Independent variables

Network relationships have been described as network resources (Gulati, 1999). Accordingly, a number of previous studies count the number of partners in alliance portfolio to measure the overall level of network resources (e.g., Ahuja, 2000a; Baum *et al*., 2000; Deeds and Hill, 1996; Shan *et al*. 1994). Likewise in the present research, *portfolio size*, the variable to represent the level of network resources, is defined as the number of technology alliance partners of a firm during the 2002-2004 period.

To measure network density, I followed an approach used in previous literature (e.g. Rowley et al., 2000) and excluded the focal firm and its relationships and solely considered the interconnections among a focal firm's partners. Scott (1991: 75) also suggests that '[i]n an egocentric network it is usual to disregard the focal agent and his or her direct contacts, concentrating only on the links which exist among these contacts'. Therefore, I defined network density as the number of existing ties in each alliance

portfolio (other than those involving the focal firm), divided by the total possible number of ties among its partners (Rowley et al., 2000).

$$\textit{Network density} = t / n(n-1) / 2 \qquad \text{[Equation 3-1]}$$

t: the number of ties in an alliance portfolio (excluding all ties to the focal firm)

n: the number of firms in the portfolio (excluding the focal firm)

Because network density shows the presence or absence of ties among alliance partners, it is an appropriate measure of both the absence of structural holes in an alliance network and of its closure (Bae and Gargiulo, 2004; Borgatti, 1997; Burt, 2000; Podolny and Baron, 1997). Besides, in the present case, the measure for structural holes is regarded to be less relevant in that it figures out the number of hole position nodes rather than the whole connectivity of a network, hence, exhibits a high correlation with alliance portfolio size, which causes a multicollinearity problem in a statistical model (Bae & Gargiulo, 2004). Thus, network density was analyzed using alliance ties among the focal firm's partners in each alliance portfolio between 2002 and 2004.

To measure the level of competitive relations in detail and to test its influence empirically, I introduced the concept of breadth and depth. The concept is necessary to account for single-point competition in one market field and multipoint competition in more than one market field (Barnett, 1991). Competitive relations within an alliance

portfolio also can intensify broadly across a variety of fields (breadth) and deeply in certain fields (depth). Thus I introduced the breadth and depth concept to measure how competitive relations build up in each alliance portfolio and to analyze their influence in more detail. Diverse sub-sectors in the biopharmaceutical industry related to the field of products (e.g. cancer, cell therapy, vaccines, etc.) are appropriate to measure the breadth and depth of competition. I investigated the purpose of each alliance between the focal firms and their partners. The Bioscan database relates each alliance with its purpose which corresponds to at least one or, sometimes, multiple business fields. Therefore I could measure the breadth and depth of competitive relations in the level of business fields. Specifically, the breadth of competitive relations is the scope of rivalry in an alliance portfolio. When target business fields of each alliance between a focal firm and its partners overlap across many different fields, the competitive relations in an alliance portfolio become broader. Therefore, the breadth is measured by counting the number of business fields in an alliance portfolio in which at least two partner firms are in competitive relations. The depth of competitive relations is the extent of rivalry within the business fields covered by the alliance portfolio. When target business fields of each alliance between a focal firm and its partners overlap in the same business, the competitive relations in an alliance portfolio become deeper. Therefore, the depth is measured by dividing the total competitive relations (the number of entire dyadic competitive relations) in an alliance portfolio by the number of competing business fields (breadth). In the present study breadth and depth were analyzed for the alliance portfolios

consisting of alliances formed between the focal firms and their partners between 2002 and 2004.

Figure 8 shows an example of how breadth and depth are defined and measured in this study. The focal firm's alliance portfolio in this example consists of partner firms A, B, and C. The target business fields of each alliance are described next to the tie between the focal firm and each partner. For example, partner A seeks the focal firm's technology in the cell therapy, cancer and vaccines field. The dotted boxes describe competitive relations between partners within this portfolio. For example, Partner A and B compete with each other in this alliance portfolio because their target business fields through the alliances with the focal firm coincide with each other in the field of vaccine development. The breadth of competitive relations in this portfolio is simply the number of competing fields. Since partners are competing in the vaccines and cancer fields, the breadth in this example is 2. There are a total of two dyadic competitive relations in this portfolio. As mentioned earlier, Partner A and B compete with each other in the vaccine field. Also, Partner A and C compete with each other in the cancer field. To measure the depth, I should divide these two dyadic competitive relations by the breadth of this portfolio. Consequently, the depth of competitive relations in this portfolio is 2 over 2, simply 1.

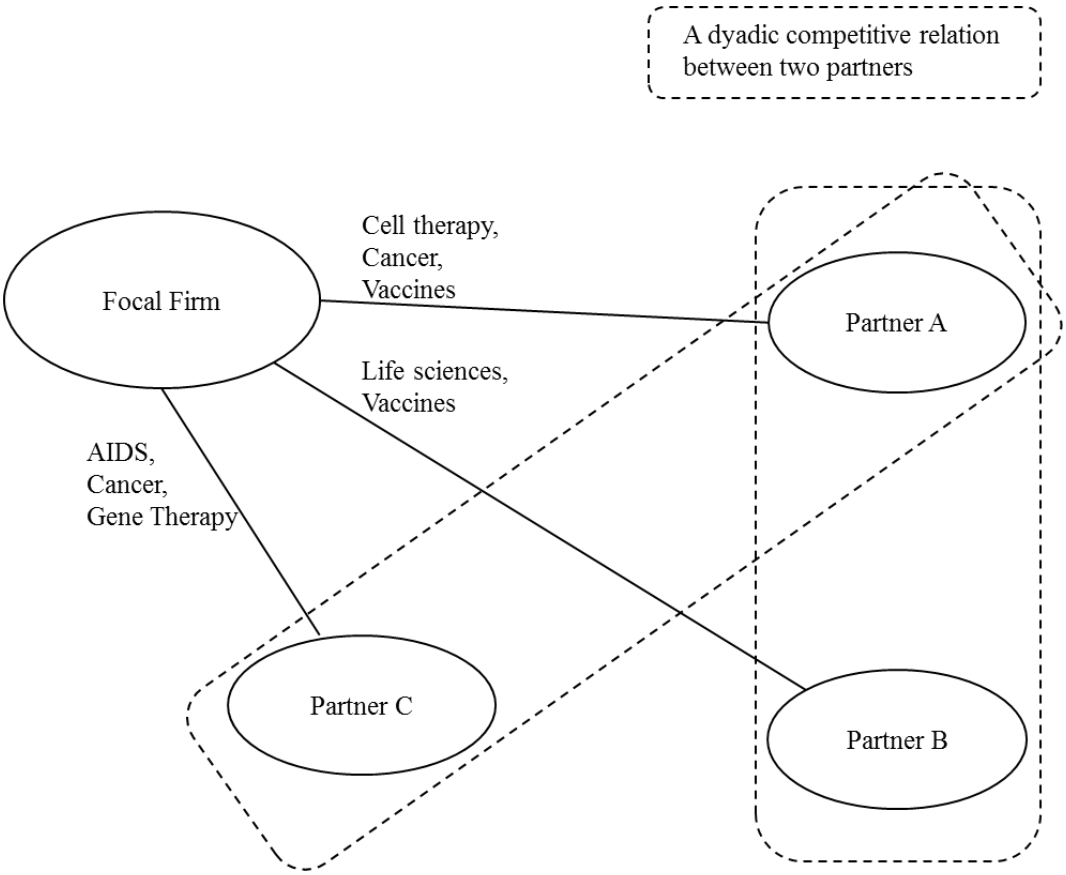


Figure 8. An example of competitive relations among a focal firm's partners.

3.3.4. Control variables

I added six control variables which describe some characteristics of the focal firms and may directly affect the dependent variable. First, technological capability is measured by counting the total number of US patent applications filed by each focal firm until 2004.

Previous literature suggests that the patenting record can be understood as a firm's technological stature (Narin et al., 1987; Trajtenberg, 1990), and counts the number of cumulative patents field by a firm to measure its technological capability (Park and Kang, 2013; Silverman, 1999). Second, R&D expenditure is the logarithm of a focal firm's averaged annual expenditure for R&D during the period of 2002-2004. Third, prior M&A experience is a dummy variable coded as 1 (previous experience) or 0 (no experience). Fourth, prior manufacturing alliance experience is coded as 1 (previous experience) or 0 (no experience). M&A experience and manufacturing alliance experience of focal firms might lead to opportunities for accessing external knowledge outside their existing network and thus might affect the dependent variable. Fifth, firm age measures the number of years between the year a focal firm's recorded its first sales and 2004. Finally, the IPO (Initial Public Offering) distinguishes public companies (coded as 1) from private companies (coded as 0). Compared to private companies, the ownership of public companies is decentralized and public companies have to publicize their information and performance. Therefore their strategy and decision making would be different from those of private companies. In summary, I controlled for a few variables to increase the reliability of the test results and examine the direct effects of network resource and embeddedness on the focal firms' innovation performance.

3.3.5. Empirical model specification

In the current study, the dependent variable is innovation performance which is proxied by the number of patent applications. Therefore, the dependent variable is for discrete events and has a positive integer value. Besides, the dependent variable shows an over-dispersion distribution. The standard deviation, 210.20, is greater than the mean value, 59.43, as indicated in Table 4. In the case of a dependent variable with over-dispersed count data, negative binomial regression is appropriate to analyze the model (Barron, 1992; Cameron and Trivedi, 1986; Ranger-Moore et al., 1991).

Table 4 presents a summary of descriptive statistics and correlations among the variables. Some variables show relatively high correlations (higher than 0.6) with other variables. Thus, I conducted an additional variance inflation factor (VIF) analysis to examine whether a multicollinearity problem exists. I excluded moderating variables (products of main effect variables) from the analysis because multicollinearity can be ignored when the high variance inflation factors are caused by the inclusion of products or powers of main effect variables in the model (Allison, 2012). Table 5 presents the result of the VIF analysis and it can be seen that portfolio size exhibits the highest value (3.84). There is no multicollinearity problem when the VIF value is less than 10 (Hair et al., 1995). Therefore, I concluded that the correlations among variables in the present study do not lead to a multicollinearity problem.

Table 4. Descriptive statistics and correlations matrix for Chapter 3.

Variables	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Mean	SD
Technological capability	1.00														98.096	329.28
R&D expenditure	0.50	1.00													1.55	0.75
M&A experience	0.22	0.05	1.00												0.07	0.26
Manufacturing alliance	0.25	0.19	0.07	1.00											0.22	0.42
Firm age	0.32	0.42	0.14	0.18	1.00										9.18	4.83
IPO	0.11	0.10	-0.00	0.14	0.20	1.00									0.78	0.41
Portfolio size	0.12	0.30	0.16	0.36	0.23	0.12	1.00								5.26	3.15
Network density	-0.11	-0.22	-0.12	-0.31	-0.23	-0.07	-0.71	1.00							0.50	0.23
Breadth	0.12	0.18	0.22	0.33	0.06	0.08	0.61	-0.37	1.00						1.45	1.27
Depth	-0.00	-0.01	-0.01	-0.00	-0.04	0.08	0.42	-0.24	0.09	1.00					2.73	9.58
Portfolio size × Network density	0.17	0.07	0.20	0.07	0.05	0.07	0.06	0.41	0.23	0.03	1.00				2.11	0.28
Portfolio size × Breadth	0.09	0.25	0.10	0.30	0.16	0.09	0.81	-0.42	0.78	0.12	0.10	1.00			10.06	19.58
Portfolio size × Depth	-0.01	-0.00	-0.02	-0.01	-0.03	0.07	0.41	-0.22	0.06	0.99	-0.00	0.13	1.00		27.01	151.16
Innovation performance	0.98	0.48	0.25	0.25	0.33	0.11	0.13	-0.12	0.14	-0.00	0.18	0.10	-0.01	1.00	59.43	210.20

Table 5. VIF test results of Chapter 3

Variables	VIF
Technological capability	1.51
R&D expenditure	1.63
M&A experience	1.13
Manufacturing alliance	1.28
Firm age	1.36
IPO	1.07
Portfolio size	3.84
Network density	2.08
Breadth	1.84
Depth	1.41
Average	1.72

3.4. Results

Table 6 presents the results from the negative binomial regression. The following analysis of the results is based on Model 3 of Table 6 which includes all variables and shows greater likelihood compared to the other models.

The portfolio size is positively related with the focal firms' future innovation performance and this relationship is significant ($p<0.1$). Therefore Hypothesis 3-1 of the

Table 6. Negative binomial regression results of Chapter 3.

Depend variable:	Model 1		Model 2		Model 3	
Innovation performance	Coefficient	S.E	Coefficient	S.E	Coefficient	S.E
Control variables						
R&D expenditure	1.0284***	0.1915	0.9992***	0.1866	0.9132***	0.1813
Technological capability	0.0024***	0.0007	0.0024***	0.0007	0.0026***	0.0006
M&A experience	0.2654	0.3831	0.0882	0.3940	-0.4086	0.4010
Manufacturing alliance	-0.2256	0.2496	-0.3947	0.2659	-0.6421**	0.2630
Firm age	-0.0253	0.0219	-0.0304	0.0214	-0.0500**	0.0219
IPO	0.3568	0.2476	0.3646	0.2474	0.4843**	0.2415
Independent variables						
Portfolio size			0.0769*	0.0455	0.2355*	0.1433
Network density					-1.4651	1.2871
Breadth					0.1172	0.1633
Depth					-0.2044*	0.1126
Portfolio size × Network density					1.3510*	0.7807
Portfolio size × Breadth					-0.0461**	0.0181
Portfolio size × Depth					0.0104	0.0071
N	125		125		125	
Log likelihood	-495.013		-493.477		-484.802	
Pseudo *R*^2	0.1263		0.1291		0.1444	
LR Chi^2	143.18		146.25		163.60	
Regression *p*-value	0.0000***		0.0000***		0.0000***	

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

present study is supported. This result implies that a focal firms' innovation performance increases when they have more partners in their alliance portfolios.

Furthermore, interaction terms (products of the main effect variable and moderating variables) are introduced to examine whether structural embeddedness and competitive embeddedness strengthen or weaken the positive influence of alliance portfolio size on the focal firms' innovation performance. They are Portfolio size × Network density, related to structural embeddedness, and Portfolio size × Breadth as well as Portfolio size × Depth, related to competitive embeddedness.

First, the coefficient of Portfolio size × Network density is positive and significant ($p<0.1$). Therefore Hypothesis 3-2a is supported and Hypothesis 3-2b is not supported. This result implies that dense alliance portfolios contribute more to the focal firm's innovation performance than sparse ones. When focal firms increase their alliance portfolio size, they should also aim to have their partners increase the collaboration with one another for better innovation performance.

Second, among the variables relating to competitive relations among the partners, only Portfolio size × Breadth exhibits a significant coefficient. The coefficient of Portfolio size × Breadth is negative and significant ($p<0.05$). Therefore Hypothesis 3-3 is supported. This result implies that competitive relations among partners within an alliance portfolio lessen the positive effect of alliance portfolio size on innovation performance. Especially, when target business fields of each alliance between a focal firm and its partners overlap across many different fields, the resulting competition

significantly weakens the contribution of alliance portfolio size to innovation performance.

The coefficients of some control variable also show significant values. Expectedly, the influence of R&D expenditure and technological capability on innovation performance is positive and highly significant ($p<0.01$). Firms with manufacturing alliance experience and older firms (firm age) show less innovation performance. Public companies (IPO) show better innovation performance than private firms.

3.5. Discussion

This chapter empirically confirms the positive influence of alliance portfolio size on innovation performance that has been suggested in previous literature (Ahuja, 2000a; Baum et al., 2000; Shan et al., 1994). The positive relationship between alliance portfolio size and innovation performance originates from knowledge sharing, complementarity and scale economies within alliance portfolios (Ahuja, 2000a; Arora and Gambardella, 1990; Berg et al., 1982; Richardson, 1972). In addition to this empirical test, the present study conveys three key findings and related theoretical implications.

First, this study finds a positive moderating effect of structural embeddedness and a negative moderating effect of competitive embeddedness. Specifically, increasing network density within an alliance portfolio strengthens the relationship between the

portfolio size and innovation performance, and broad competitive relations among a focal firm's partners weaken this relationship. These findings clarify how synergies and conflicts occur within an alliance portfolio and how they affect the focal firm. The synergies and conflicts within an alliance portfolio arise from the independencies of the focal firm' partners and make the overall value of the portfolio greater or smaller than the sum of the value of each alliance in the portfolio (Parise and Casher, 2003; Vassolo et al., 2004). Despite their significance, previous literature on the synergies and conflicts has not sufficiently examined the process of how they arise and has not empirically verified their effects (Wassmer, 2010). With an embeddedness lens, the present study suggests that dense cooperative relationships among partners lead to synergies in an alliance portfolio and broad competitive relationships among partners lead to conflicts in the portfolio, and that these cooperative and competitive relationships, respectively, positively and negatively affect the focal firm's innovation performance. Through investigating cooperative and competitive ties of partners, these relationships were operationalized and their effects were empirically verified. Furthermore, this study suggests the relationships among partners as another configurational factor of alliance portfolios which affects the focal firm's innovation performance together with factors suggested in previous literature such as portfolio size (Ahuja, 2000a; Baum et al., 2000; Shan et al., 1994), portfolio breadth (Ahuja, 2000a, Gulati, 1999), efficiency (Baum et al., 2000) and alliance partner quality (Stuart, 2000; Stuart et al., 1999).

Second, it is more beneficial for focal firms to form dense alliance portfolios

compared to sparse ones. What constitutes a social structure for enabling one type of action may be disabling others (Podolny and Baron, 1997). Therefore, the more advantageous network structure, a dense network or a network with many structural holes, is likely to be contingent on what actors aspire to enable through it (Ahuja, 2000a). The present study, in the case of technology alliances in the biopharmaceutical industry, suggests that dense alliance portfolios contribute more to the focal firms' innovation performance compared to portfolios with many structural holes. This is in agreement with previous literature which specifies the context in which a dense network outweighs structural holes. Ahuja (2000a) suggests that, in the case of interorganizational collaborations, benefits of trust building, sharing collaboration routines, and blocking opportunism that result from a group of cohesive interconnected partners outweigh the disadvantages of not having the diverse information that is yielded from many structural holes within a firm's alliance portfolio. Further, many interlocking ties facilitate the cooperation and contribute to standard setting in high-tech industries (Kogut et al., 1995; Oliver, 1990). The biopharmaceutical industry is also characterized by the significance of strategic preoccupancy of technology (Kim, 2013). Thus, the cooperation through cohesive alliance portfolios leads to better technology performance in the industry. On the contrary, structural holes matter when firms have diverse partners from different industries and provide brokering among them (Ahuja, 2000a). Therefore, the samples of previous literature, which support the significance of structural holes, tend to include portfolios composed of firms from various industries. For example, Hargadon and Sutton

(1997) investigate the role of product-development consulting firms that bridge structural holes between clients in different industries. The present study investigates technology collaborations within the biopharmaceutical industry and, therefore, does not correspond to a context in which structural holes prevail.

Third, competitive relations among a focal firm's partners across many different business fields deteriorate the innovation performance of the focal firm. Previous literature suggests that alliance portfolio breadth is one of the significant factors which explain the benefits firms achieve from their alliance portfolios (Ahuja, 2000a; Gulati, 1999). However, although a focal firm has a number of partners in a broad range of fields, it cannot fully take advantage of its alliance portfolio in case of competition among the partners across those fields. It is because they are not willing to actively participate in alliances with the focal firm when they are put in competitive relationships with each other and seek the same resource of the focal firm (Khanna et al, 1998). Thus, the present study suggests that competition among a focal firm's partners across a broad range of fields deteriorates the advantage the focal could enjoy from their diverse alliances. Moreover, this also reduces the efficiency of an alliance portfolio, another significant factor which accounts for alliance portfolio performance (Baum et al., 2000), due to the high costs of coordinating the portfolio (Bamford and Ernst, 2002; Gulati and Singh, 1998). In a similar vein, Lavie (2007) investigated the influence of 'multilateral competition', the extent to which the partners in an alliance portfolio are considered competitors of each other. He suggests that multilateral competition among partners

increases the focal firm's relative bargaining power over its partners, and eventually positively affects firm performance. The multilateral competition concept is similar to the depth of competitive relations in the present study because both consider competition among the focal firm's partners in an alliance portfolio and their concentrating competition in a single field. The result of the present study finds no negative influence of the depth on focal firms' performance and does not deviate much from Lavie (2007)'s finding. Additionally, the present study focuses on the competitive relations among the focal firm's partners across diverse fields (breadth) and, due to the high costs of coordination and the depletion of management resources, finds their negative influence on the focal firm's performance. This result complements the findings of previous literature and sheds a light on different perspectives relating to intra-portfolio competition and its consequences on firm performance.

Fourth, despite the possibility of a curvilinear or inverted-u shape relationship between alliance portfolio size and firm performance (e.g. Deeds & Hill, 1996), the present study is focused on a positive relationship between the portfolio size and performance. More specifically, the focus of the present study is the relationships among a firm's alliance partners and how they can strengthen or deteriorate the positive side of alliance portfolio size. This study still acknowledges the diminishing return of alliance portfolio size on firm performance and suggests that one of the present findings, the negative moderating effect of the breadth of partner competition, can also contribute to the curvilinear relationship.

Chapter 4. Leveraging a diversified portfolio

4.1. Introduction

The advantages of collaborative R&D and the exchange of technological resources lead to an increasing number of technological alliances among firms. Technological alliances allow firms to combine their own knowledge with that of their partners and contribute to solving more complex problems, reducing the cost of R&D and more rapidly adapting to changing markets (De Man & Duyster, 2005). To obtain more advantages from alliances, a firm is usually involved in multiple alliances with different partners at the same time (Gulati & Singh, 1993) and creates what is referred to as an alliance portfolio. Recognizing the importance of the access to the diverse knowledge and resources of different alliance parters, scholars and practitioners have increasingly paid attention to "alliance portfolio diversity", one of the major characteristics of alliance portfolios (Goerzen & Beamish, 2005; Hoffmann, 2007; Koka & Prescott, 2008). A diverse alliance portfolio generates various growth options (Powell et al., 1996; Vassolo et al., 2004), provides enterepreneurial opportunites (Ozcan & Eisenhardt, 2009) and expertise, and, hence, contributes to improving the focal firm's innovation performance (Belderbos et al., 2004; Faems et al., 2005).

However, to fully realize the opportunities provided by their alliance portfolios, managerial attention by the focal firms is required in order to effectively absorb the

diverse knowledge. Alliance portfolio diversity, on one hand, encourages the focal firms' innovativeness and allows them to prepare for technologically turbulent environments (Baum et al., 2000; Dutta & Weiss, 1997; Lee et al., 2001), but, on the other hand, incurs additional costs related to the management of diverse relationships and prevents the smooth transfer of knowledge (Goerzen & Beamish, 2005; Koka & Prescott, 2008). Moreover, among the diverse knowledge in alliance portfolios, firms might find it difficult to identify which is valuable knowledge, i.e. knowledge with the highest innovation potential (Koput, 1997). Considering these advantages and potential drawbacks of diversified portfolios, managers and scholars need to understand the mechanisms of effective alliance portfolio management to sufficiently absorb the benefits of diversity.

Existing literature investigating the relationship between alliance portfolio diversity and firm performance has either shown inconclusive results or an inverted u-shape (e.g. Duysters et al. 2012; Vasudeva & Anand, 2011) and also highlighted the significance of alliance portfolio management. Previous literature has, however, not directly focused on capturing the value of diversity or conveyed a thorough understanding of how to absorb it. A stream of literature relating to alliance portfolio diversity focuses on the purpose of diversity and examines the differential effects of alliance portfolio diversity on different types of firm performance (De Leeuw et al., 2014; Oerlemans et al., 2013). Another stream of literature investigates the impact of alliance portfolio diversity relating to the firms' internal knowledge creation (Srivastava & Gnyawali, 2011; Wuyts & Dutta, 2012).

This literature suggests that a firm's internal knowledge creation pattern, e.g., patent citation pattern, might "indirectly" affect how it utilizes the diverse knowledge in its alliance portfolios. However, it does not place its attention on more proactive ways of absorbing the diverse knowledge in alliance portfolios, for example, by suggesting how firms should manage their alliance portfolios or by explaining how firms could directly link their internal knowledge with the external knowledge.

This study emphasizes a more explicit and comprehensive approach to alliance portfolio management and aims to understand how to better absorb diverse knowledge from alliance portfolios for an increased innovation performance. This study especially focuses on the firms' alliance experience to deal with different alliance tasks and the firms' ability to recognize valuable knowledge residing in multiple alliances. Previous literature also acknowledges the significance of both alliance experience and the ability to recognize relevant knowledge in alliances (Goerzen & Beamish, 2005; Koka & Prescott, 2008; Wuyts & Dutta, 2012). Recent literature (e.g. Duysters et al., 2012; Van de Vrande, 2013) has started to introduce these concepts to dealing with alliance portfolio diversity, however, it falls short of reaching an integrative understanding on managing alliance portfolio diversity. The present study, focusing on the value of an integrative approach, examines the relationship between the level of alliance portfolio diversity and the focal firms' innovation performance. This study also examines whether the firms' alliance experience and the proximity of knowledge between the focal firms and their alliance portfolios contribute to improving the performance. These two different concepts

respectively correspond to “task knowledge” and “content knowledge”, terms used to designate a different set of knowledge constructs (Alexander et al., 1991), of forming alliances and help firms to accommodate more diversity in their alliance portfolios. As a result, this study verifies an inverted-u shape relation, consistent with a number of previous literature, between alliance portfolio diversity and the focal firms’ innovation performance. Moreover, positive moderating effects of alliance experience and proximity on the relationship between alliance portfolio diversity and innovation performance are verified.

This chapter makes several contributions to alliance portfolio literature and provides implications for alliance managers. First, this study corroborates the arguments found in previous literature and suggest an inverted u-shape relation between firms’ alliance portfolio diversity and their innovation performance. Especially, this study operationalizes innovation performance using the weighted patent counts of focal firms and highlights the impact and diffusion aspects of innovation driven by alliance portfolio diversity. Second, this study suggests that the ability to successfully leverage the diversity of alliance portfolios is determined by the firms’ alliance experience and proximity to their partners. Firms can learn to take advantage of higher diversity through accumulated alliance experience and proximate partners. Third, following a contingency perspective on the influence of alliance portfolio diversity (e.g. Schilke & Goerzen, 2010; Schilling & Phelps, 2007; Wassmer, 2010; Wuyts & Dutta, 2012), this study suggests that focal firms’ alliance experience and proximity to their partners play a critical role in explaining

performance variation across firms.

The remainder of chapter 4 is organized as follows: First, based on the theoretical background, this study develops hypotheses which link alliance portfolio diversity, alliance experience, knowledge proximity of alliance portfolios, and innovation performance. Second, employing negative binomial regression, this study tests the hypotheses using data on 396 R&D alliance cases in the biopharmaceutical industry. Finally, this study presents the empirical results and conclude with a discussion of the implications of this chapter.

4.2. Research hypotheses

4.2.1. The impact of alliance portfolio diversity on firm performance

Alliance portfolio diversity serves the focal firms' innovation in several ways. First, alliance portfolio diversity provides the focal firm diverse knowledge and experience which contribute to their thinking "out of the box" (Levinthal & March, 1993; Levitt & March, 1988, Vasudeva & Anand, 2011). Thus previous literature empirically confirms that firms with diverse alliances lead to their successful performance (Baum, et al., 2000; Powell, et al., 1996). Accumulated knowledge and experience through technological cooperation with partners from different backgrounds directly affects the focal firms' knowledge, a major source of innovation, and consequentially their innovation outcomes

(Hargrave & Van de Ven, 2006; Tushman & Anderson, 1986). Second, combinations of diversity from alliance portfolios generates valuable innovation opportunities. Combining a different set of resources and capabilities of different alliance partners produces a number of different outcomes. Attempting various combinations, focal firms detect complementarities and synergies among them which lead to superior innovation performance (Belderbos et al., 2006; Nieto & Santamaria, 2007). Third, alliance portfolio diversity enables the focal firms to address technological and environmental diversity. Hoffmann (2007) highlights the role of high levels of dispersion in alliance portfolios and suggests that they contribute to strategic flexibility and ability of focal firms to handle a high level of technological uncertainty. Thus, with timely and appropriate technological solutions, they sustain their innovativeness and survive in a volatile environment (Ozcan & Eisenhardt, 2009). Fourth, alliance portfolio diversity prevents the overlap of partner capabilities, ideas and knowledge which might lead to a subadditive alliance portfolio (Anand et al., 2007; Vassolo et al., 2004). The addition of redundant knowledge to the portfolio makes no unique contribution to the focal firm's knowledge base and does not improve the quality of innovation outcomes (Duysters et al., 2012).

At the same time, alliance portfolio diversity has several drawbacks. First, complicated tasks due to alliance portfolio diversity leads to managerial challenges (Duysters & Lokshin, 2011). Dealing with different types of partners requires a great deal of focal firms' internal resources and prevents them from generating performance from the knowledge they have earned through their partners. Second, in case of low

compatibility among diverse partners, the diversity takes up focal firms' learning resources and reduces their overall knowledge utilization (Vassolo et al., 2004). Thus, firms cannot fully utilize the advantage of alliance portfolio diversity. Third, alliance portfolio diversity detracts focal firms' attention to identify valuable knowledge. According to attention based view, alliance portfolio diversity generates information overflow. Koput (1997) suggests that information overflow leads firms to consider only few ideas and, even more, has them choose irrelevant ones among those ideas at a wrong time or place. Finally, in case of higher diversity in alliance portfolios, focal firms have difficulty in knowledge management varying from partners to partners and fail to block knowledge spillover to their different partners (Jiang et al., 2010).

Considering the pros and cons of alliance portfolio diversity, firms need to carefully control the diversity level of their alliance portfolios. Vasudeva and Anand (2011) suggest that, beyond a certain point, the advantages of diversity such as learning opportunities are not effective any longer or even decrease. Even more, in case of higher diversity, focal firms have difficulty in strategically aligning the goals of diverse alliances and monitoring the whole portfolio (Hoffmann, 2005). Too little diversity is also less beneficial as is too much diversity because of the reduced exposure to alternative decisions, greater redundancy of knowledge and underutilization of latitudinal absorptive capacity (Duysters et al., 2012). In sum, at both extremes, alliance portfolio diversity impedes sufficient learning opportunities of focal firms and leads them to a decreased innovation outcomes.

Hence, this study suggests firms to avoid too low or high levels of alliance portfolio diversity and to adopt a medium level of portfolio diversity for an increased innovation performance. The present study therefore hypothesizes:

Hypothesis 4-1. A firm's innovation performance exhibits an inverted U-shape relation with its alliance portfolio diversity.

4.2.2. The role of alliance experience on absorbing the diversity

Alliance experience is defined as lessons and know-how obtained by a firms' prior alliances (e.g. Gulati, 1995b; Kale & Singh, 1999; Kale et al., 2002; Reuer et al., 2002). The obtained lessons and know-how are pervaded into the organization and work as a routine which deals with similar tasks in the future (Heimeriks & Duysters, 2007; Nelson & Winter, 1982). The accumulated experience develops into firms' capabilities because they are not easily attainable through the spot market (Teece et al., 1997). Thus, with an increased alliance experience, firms become more able to process alliance tasks and learn how to generate performance from them. The positive relationship between experience and firm performance is also verified by a number of empirical studies (e.g. Ingram & Baum, 1997; King & Tucci, 2002; Simonin, 1997).

Specifically, firms' alliance experience enable them to understand "critical

processes and issues in alliance management" (Heimeriks & Duysters, 2007). Prior alliance experience includes a series of alliance tasks from selecting partners, exchanging knowledge, and to generating performance. Firms learn from the experience and become more able to manage each step of alliance tasks. This learning effect would especially increase in case of R&D alliances due to the ambiguity and uncertainty of the high-technology context (Harrigan, 1988; Mody, 1993).

Moreover, there are several more advantages of alliance experience which ultimately contributes to firm performance. Alliance experience enables firms to develop their "common perspectives" and, hence, to understand and absorb knowledge from new alliances more effectively (Grant, 1996; Nonaka, 1994). Thus useful knowledge builds up inside of the firms and become the source of innovation performance. Various alliance experience also provides lessons of how to structure and manage their alliance portfolios as a whole. Simultaneously forming alliances with different partners, focal firms would face conflict situations between their partners (Vassolo et al., 2004) and learn how to ease and manage the conflicts as they are more exposed to such situations (Mohr & Spekman, 1994). In other words, alliance experience is not simply constrained to the management of individual alliances but also linked with managing the entire alliance partners which leads to the synergy between them and ultimately contributes to generating an increased performance. Few prior studies (e.g. Hoang & Rothaermel, 2005) suggest a curvilinear relationship between alliance experience and firm performance. However, this study suggests the role of alliance experience is still valid and critical in case of complex

alliance portfolios as Lai et al. (2010) have shown in their study.

As firms have more alliance experience, they are likely to establish a dedicated alliance function within the organization (Kale et al., 2002). This function contributes not only to coordinating activities and allocating responsibilities but also to gathering and dispersing lessons from alliance experience (Heimeriks et al., 2007). Moreover, it nurtures common practices in the process of alliances (Goerzen, 2005; Kale et al., 2002). Eli Lilly, one of the sample firms in this study, established an Office of Alliance Management in late 1999, during the focal period of this study, and was paid off by its role of "integrator, intermediary and catalyst for best practice performance" (Sims et al., 2001). Previous empirical studies (e.g. Kale et al., 2002) also support the relationship between the cumulative number of alliances and establishing a dedicated alliance function. This function leads to a more coordinated approach of firms to managing their alliance portfolios and an increased benefit from the portfolios.

Thus alliance experience mitigates aforementioned drawbacks of diverse pools of alliance partners and help firms to adopt more diversity. It is difficult for firms to grasp the know-how of successful alliances and apply this to new alliances with little experience. However, as firms build up a great deal of alliance experience, they recognize inherent differences of each alliance which appear similar and become more able to learn from them (Duysters et al., 2012; Reuer et al., 2002). Higher levels of alliance experience facilitate firms to perceive causes and effects of specific actions, recognize the patterns (Duysters et al., 2012) and ultimately contribute to absorb knowledge from their diverse

alliance portfolios.

Hence, this study suggests firms to increase the level of alliance experience to adopt more diversity in their alliance portfolios that turns into the source of innovation. The present study therefore hypothesizes:

Hypothesis 4-2. A firm's alliance experience positively moderates the relationship between innovation performance and alliance portfolio diversity such that higher levels of alliance experience will increase the portfolio diversity that maximizes innovation performance.

4.2.3. The role of knowledge proximity on absorbing the diversity

While alliance experience enables firms to have a better understanding of diverse alliance "tasks", proximity between a focal firm and its partners facilitates the absorption of diverse "contents" of alliances.

Previous literature suggests the significance of proximity in multifaceted ways. From an innovation perspective, major characteristics of technology alliance portfolios are technological competences of alliance partners and how much they are in line with those of the focal firm (e.g. Cantwell & Colombo, 2000; Rothaermel and Boeker, 2008). Lane and Lubatkin (1998) and further research in line with them (e.g. Mowery et al.,

2002) suggest that relative or partner-specific absorptive capacity is dependent on the similarity of the partners' knowledge bases. Especially, in the biopharmaceutical industry, it is demonstrated that firms that have the same knowledge base are more likely to partner with each other and exhibit better performance (Lane & Lubatkin, 1998). Ahuja (2000b) also finds that greater technological similarity between alliance partners improves their patenting performance.

In case of high levels of proximity between firms and their alliance portfolios, firms are better able to use their learning resources to adopt a wide array of knowledge in the portfolios (Vasudeva & Anand, 2011). Vasudeva and Anand (2011) subdivide firms' absorptive capacity into latitudinal (relating to processing and using diverse knowledge) and longitudinal (relating to processing and using distant knowledge) absorptive capacity which share the learning resources of firms. They, hence, confirm a trade-off relation between latitudinal absorptive capacity and longitudinal absorptive capacity in terms of knowledge utilization. At a lower level of technological distance (a higher level of proximity), firms are allowed to concentrate more learning resources on latitudinal absorptive capacity that maximizes utilizing knowledge of alliance portfolios which consists of diverse partners.

Hence, this study suggests firms to increase the level of proximity to their alliance portfolio. This enables firms to adopt more diversity in their alliance portfolios that turns into the source of innovation. The present study therefore hypothesizes:

Hypothesis 4-3. A firm's proximity to its alliance portfolio positively moderates the relationship between innovation performance and alliance portfolio diversity such that a higher proximity will increase the portfolio diversity that maximizes innovation performance.

The outline of this study is shown in Figure 9, which summarizes the research model and hypotheses of Chapter 4.

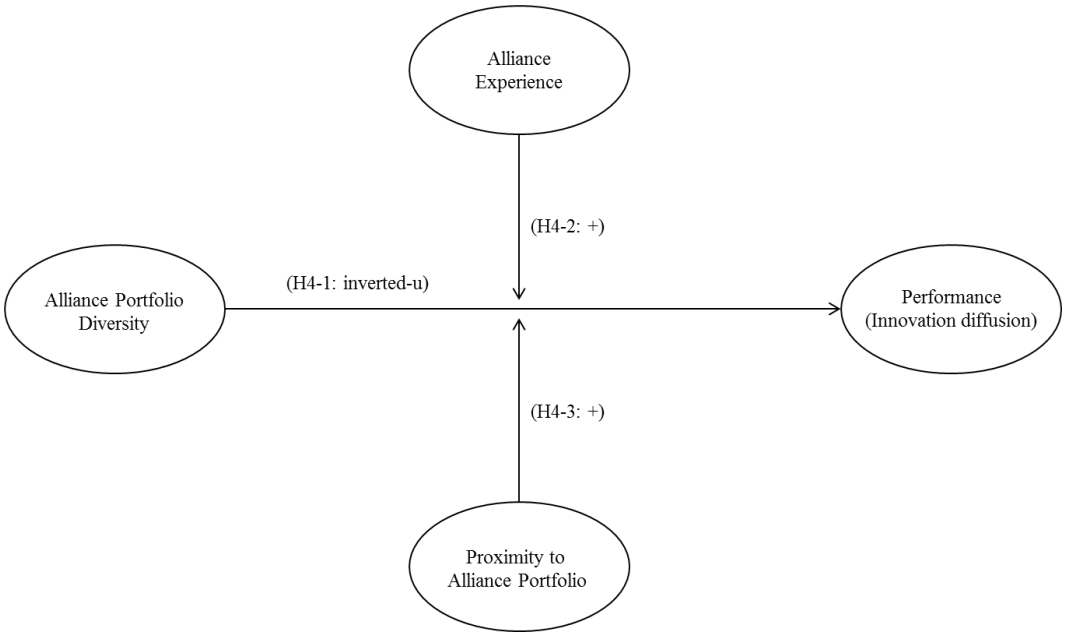


Figure 9. The conceptual model for Chapter 4.

4.3. Method

4.3.1. Data and sample

To test the hypotheses, I collected R&D alliance records of US biopharmaceutical firms during the 1998-2002 period. The biopharmaceutical industry is characterized by a strong tendency to form alliances and accounts for about 20 percent of all alliances formed in high-tech industries (Hagedoorn, 1993) as firms in this industry see within- and cross-industry alliances as a suitable way to address high development cost and rapidly changing technology (Luo & Deng, 2009; Powell et al., 1996). Therefore, the biopharmaceutical industry is an ideal setting to study R&D alliances and their impacts on the firms, e.g. on innovation performance (Lin et al., 2012). A number of prior studies have chosen this industry when doing research on alliance portfolios (Baum et al., 2000; Deeds & Hill, 1996; Powell et al., 1996; Shan et al., 1994; Vassolo et al., 2004).

There are several reasons why, studying the alliance portfolio diversity of firms operating in the biopharmaceutical industry, it is appropriate to focus on the period of 1998-2002.

First, the number of R&D collaborations during this period had unprecedentedly increased due to the advent of general purpose technologies (GPTs) such as genomics and post-genomic techniques, bio-informatics, high-throughput screening and combinatorial chemistry (Riccaboni & Moliterni, 2009). Since the early 1990s, the number of R&D collaborative agreements started to sharply increase to the point where the number of

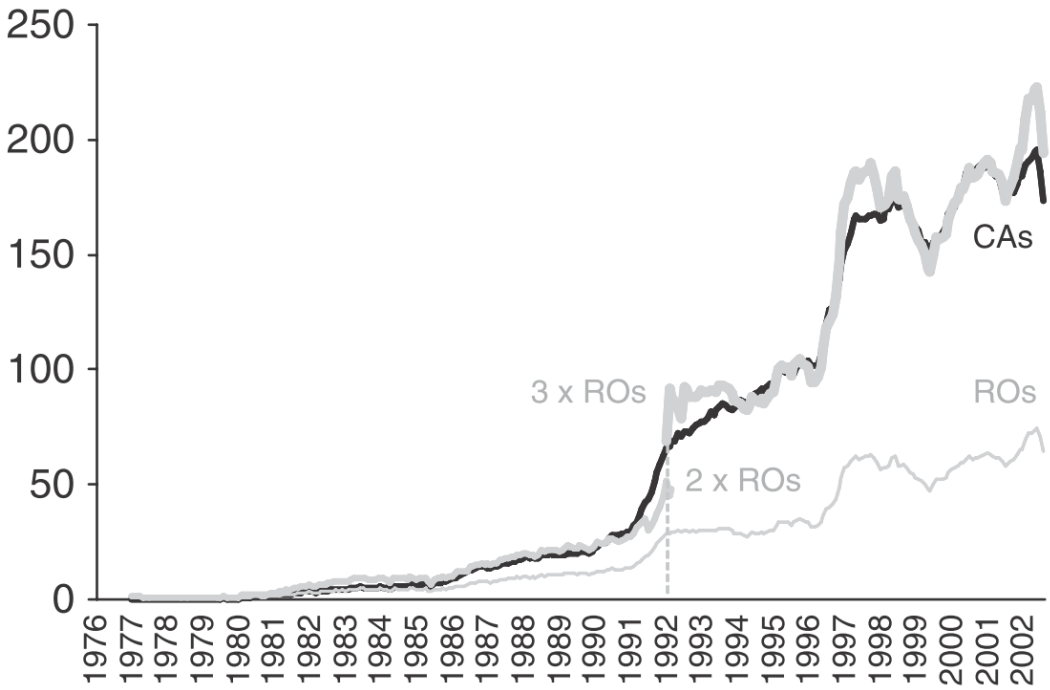


Figure 10. Number of new R&D collaborative agreements (CAs) and research organizations (ROs) entering the network each month, 1976-2002. Source: Riccaboni & Moliterni (2009).

newly entered alliances exceeded the number of new entrants in the biopharmaceutical industry by a factor of three as can be seen in Figure 10. The peaking collaboration rate during the late 1990s and the early 2000s provides a sufficient number of data points to investigate the effect of alliance portfolio characteristics.

Second, as Figure 11 shows, during this period, a substantial portion of the R&D alliances in the biopharmaceutical industry were exploration-focused. Dedicated biotechnology firms applied their general purpose technologies to multiple drug development areas through their horizontal business models (Riccaboni & Moliterni,

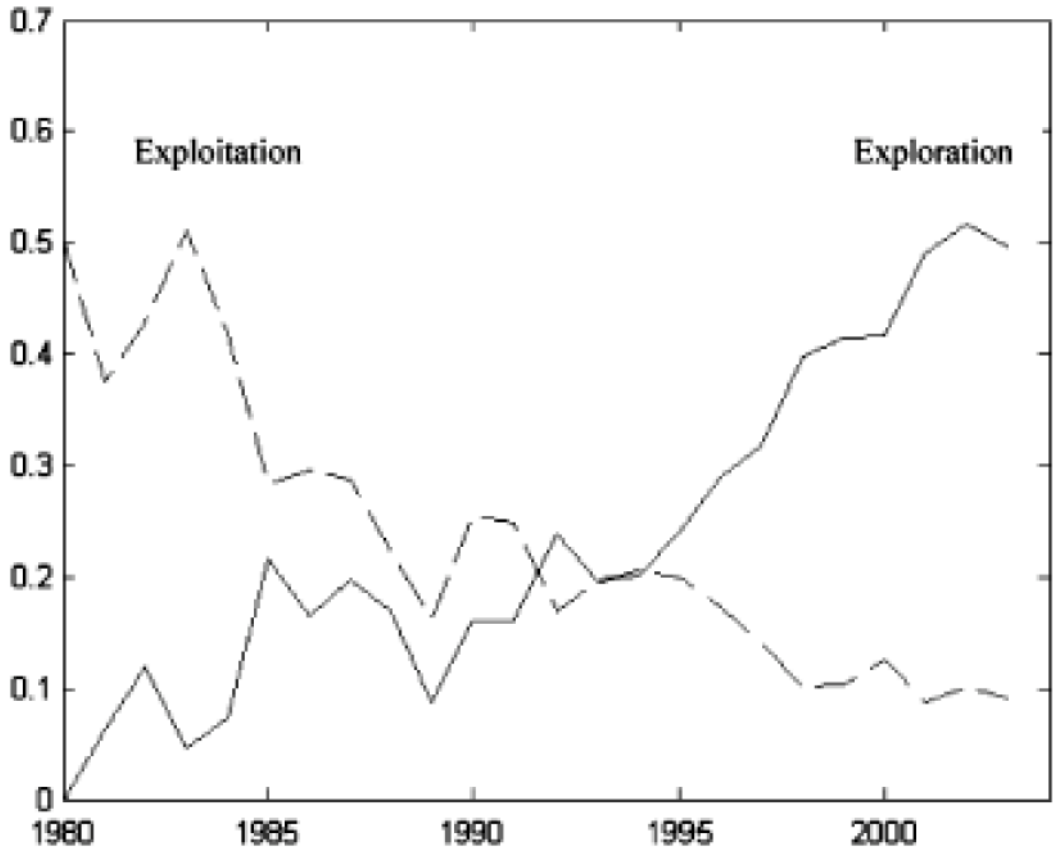


Figure 11. Proportion of R&D alliances by type: exploration versus exploitation. Source: Riccaboni & Moliterni (2009).

2009). This fact indicates that during this period, firms were exposed to more diversity in their alliance portfolios, hence increasing the suitability of the data for the research on alliance portfolio diversity.

Third, the previously experienced double-digit industry growth rate (on average 11.1 percent annually from 1970 to 2002) of the biopharmaceutical industry began to stagnate during the mid 2000s (Gassmann et al., 2008). For example, for the first time in

the firm's recent history, Pfizer posted negative revenue growth for 2005 and 2006. Many pharmaceutical giants made the implementation of cost cutting programs a top priority during this period. This pressure to reduce costs had impacts on the firms' ability to maintain and increase the previously seen levels of diversity in their alliance portfolio.

The collection of the data was performed as follows: First, I compiled alliance portfolios of US biopharmaceutical firms, i.e. firms in SIC class 283, from the Securities Database Corporation (SDC) Database on Joint Ventures and Alliances. This database includes all types of alliances records collected from SEC filings, industry and trade journals, and news reports since 1988 and allows large-scale empirical studies on alliances (Anand & Khanna, 2000; Sampson, 2004). To identify R&D alliances, I refered to the Activity Code and Activity Description section of each alliance case which describe the purpose of the alliance. Most cases included multiple alliance purposes such as research and development, licensing, manufacturing and distribution, at the same time. I excluded alliance cases which do not include the purpose of research and development and with the remaining alliances built the R&D alliance portfolios of each firm in the dataset. Second, I added financial information of each focal firm such as sales and R&D expenditure collected from the COMPUSTAT database. This database provides financial and market information on over 90,000 securities which include active and inactive firms throughout the world (Lin et al., 2012). Finally, I added patent information of each focal firm provided by the US Patent and Trademark Office (USPTO), which issues over 150,000 patents annually to organizations and individuals worldwide and maintains a

publicly available database of all US patents. I collected the information on patents filed by each focal firm to approximate their knowledge stock and ex post innovation performance. The patenting activities of firms in the biopharmaceutical industry also provides the reason for focusing only on US firms. A preliminary analysis of the patent data showed that non-US firms tend to file for patents in other countries as much as, or sometimes even more than, in the US. Therefore, I decided to exclude non-US firms from the dataset in order to avoid dealing with different country-depending patenting patterns, which might affect the analysis, and, at the same time, to remove other unobserved heterogeneity among firms from different countries.

Throughout the aforementioned data collection process, I focused on larger firms and refined the dataset due to several reasons. First, due to the frequent M&A activities during the observation period, for some, mostly smaller, target firms, complete financial or patent information was not available. Second, activities such as the establishment of alliances and the filing of patent applications were sometimes accomplished by subsidiaries of large pharmaceutical corporations. Each corporation exhibits a different level of this pattern, thus, to capture the entire activities of large corporations, the alliance and patent related information were consolidated on the parent company level as it was already done in some previous studies (e.g. Van de Vrande, 2013). Third, some information of small or privately owned firms were missing in my dataset and could not be retrieved from other sources. For that reason, previous studies on alliances often focused on the larger companies in an industry (e.g. Ahuja, 2000b; Gulati, 1995b; Keil et

al., 2008). The final dataset for the empirical analysis consists of 396 R&D alliance cases of 69 focal firms.

4.3.2. Dependent variable

The dependent variable, *innovation performance*, focusing on the diffusion effect of innovation, was measured by employing the concept of weighted patent count which incorporates both the number of each focal firm's granted patent applications as well as their forward citations. Patents are closely related to the firms' technological competitive advantage which drives innovation and results in profitability (Henderson & Cockburn, 1994). By counting forward citations as well as the number of the firms' own patent applications allows the study to reflect the value and quality of innovation (Trajtenberg, 1990). Empirical evidence also shows a strong association between the "ex post citations" of a patent and the value of the invention (Trajtenberg, 1990) and it is generally assumed that more important patents have more forward citations and vice versa (Van de Vrande, 2013).

I operationalized the weighted patent counts (*WPC*) as follows: Each patent i is weighted according to its forward citations C_i, The weighted patent count of each focal firm j can be calculated using Equation 4-1 below, which is based on the formula of Trajtenberg (1990) but has been adopted to fit the characteristics of the dataset used in

this study:

$$WPC_j = \sum_{i=1}^{nj}(1 + C_i) \qquad \text{[Equation 4-1]}$$

Adopting the four-year post-alliance window found in Sampson (2007), who also employed weighted patent counts to measure innovation performance, focal firms' patents were collected during the 2003-2006 period. This lagged measure also contributes to reducing the likelihood of embellishing performance from one unusual year (Tanriverdi, 2006). Considering a contemporaneous relationship between a firm's R&D efforts and patent applications (e.g. Hausman et al., 1984), I decided to additionally include the focal firms' patent applications in 2002 and their associated forward citations. Patents applied for by the focal firms prior to 2002 might have been the outcome of previous R&D efforts and alliances not investigated by this study and thus I have regarded them as knowledge stock and controlled their impact on the focal firms' innovation performance.

Forward citations were collected until the year 2010. Thus, forward citations are necessarily truncated for patents applied in later years. During the observation period, patents applied for in 2006, for example, will have received less forward citations than patents applied for in 2002. However, Lanjouw and Schankerman (1999) suggest that, considering the initial expectations about the quality of a patented innovation, it is not necessary or even helpful to consider citations received over very long time spans.

4.3.3. Independent variables

Alliance portfolio diversity. To measure the diversity in a firm's alliance portfolio, I used the primary Standard Industrial Classification (SIC) codes, the 4-digit industry code assigned to each partner firm in the SDC database. Firms from the same industry tend to have similar resources, routines, and tacit knowledge relating to markets, operation processes, and managerial expertise (Wang & Zajac, 2007). Thus, the SIC code provides a reasonable indication of similarities and differences in partners' resources and knowledge and has been widely used in strategy literature to classify firms according to their resources and knowledge (e.g. Cui & O'Connor, 2012; Wang & Zajac, 2007). To create an alliance portfolio diversity measure based on the firms' SIC codes, I employed the Blau Index of Variability (Blau, 1977). The Blau Index has been extensively used in previous literature (e.g. Vasudeva & Anand, 2011; Van de Vrande, 2013) to measure the level of heterogeneity of constituents, identified by categorical variables, within a group (Jiang et al., 2010). The diversity of each alliance portfolio can be calculated using Equation 4-2 below:

$$\text{Alliance Portfolio Diversity} = 1 - \sum\left(\frac{n_i}{N}\right)^2 \qquad \text{[Equation 4-2]}$$

, where n_i represents the cumulative number of partners belonging to SIC code i and N represents the cumulative number of all partners of a focal firm during the 1998-2002 period. This variable ranges from 0 (a perfectly homogeneous alliance portfolio) to 1 (a perfectly heterogeneous alliance portfolio with partners spread evenly among the different SIC codes). Focal firms' alliance portfolios in the final dataset included 41 different SIC codes, representing diverse fields including medicinal chemicals, diagnostic substances, testing laboratories, etc.

Alliance experience. I counted the number of alliances formed by each focal firm during the 1998-2002 period to measure the level of their alliance experience. Considering the sharp increase in the number of alliances during the 1998-2002 period and their exploration-biased characteristics compared to the prior period, I followed the procedure of a number of recent studies (e.g. Duysters et al., 2012; Heimeriks, 2010) which measured the level of R&D alliance experience in the same period as the alliance portfolio diversity. Contemporaneous experience is better suited to help a firm process tasks which are similar to the ones it is currently working on, and this is in line with one of the aims of this study, the examination of the role of task knowledge.

Proximity. To measure proximity between each focal firm and their alliance portfolios, in line with the measure for the alliance portfolio diversity, I focused on the primary SIC codes of these firms. By measuring alliance portfolio diversity based on the SIC codes, the absolute level of knowledge distribution in each alliance portfolio, regardless of the focal firm, can be captured. On top of that, by measuring the proximity

based on the SIC codes as well, the relative level of knowledge distance between a focal firm and its alliance portfolio can be operationalized. Adopting the method of Jiang et al. (2010), I assigned a score of zero to four points to each alliance relationship within a portfolio during the 1998-2002 period according to the following conventions: ‘4’ for an alliance formed with a partner having the same four-digit SIC code; ‘3’ for the same three-digit SIC code; ‘2’ for the same two-digit SIC code; ‘1’ for the same one-digit SIC code, and ‘0’ if the two companies share no common first digit in their respective SIC codes. The proximity level of a whole alliance portfolio relative to the focal firm is the average of the score for each alliance in its portfolio.

4.3.4. Control variables

R&D expenditure. As the focal firms’ innovation efforts concurrent with its alliance activities might affect the innovation output, I controlled the focal firms’ R&D expenditure. Specifically, each focal firm’s annual R&D expenditure during the 1998-2002 period was averaged and the variable was log-transformed due to its spread of values.

Firm size. I also controlled the size of the focal firms as it is correlated to the amount of resources firms can utilize. Specifically, each focal firm’s annual sales during the 1998-2002 period was averaged and the variable was log-transformed.

Prior patents. I counted the number of granted US patents applied for by each focal firm during the 1998-2001 period. Patents are one of the best means for representing firms' technological capabilities (Sampson, 2007; Silverman, 1999) and, thus, a firm's recent patent stock might affect the subsequent patenting output in terms of both quantity and quality. Moreover, simple patent counts have shown to be a good measure of innovative inputs and are strongly associated with R&D spending (Sampson, 2007; Trajtenberg, 1990).

Ongoing alliances. I also took into account alliances to capture their concurrent effects in the period during which the patenting performance is measured. Thus, I counted the number of alliances each focal firm implemented during the 2003-2006 period. Some extant studies (e.g. Sampson, 2007) also capture this effect of later alliances on patent applications in the same period.

4.3.5. Empirical model specification

The dependent variable of this study is weighted patent counts and thus has a non-negative integer value. Poisson regression is appropriate to test such data, but in my case, the dependent variable exhibits over-dispersion and violates the underlying assumption of the Poisson model, i.e. the equality of the mean and variance of the event count (Luo & Deng, 2009; Lin et al., 2012). In the case of a dependent variable with over-dispersed

count data, negative binomial regression is an appropriate method to analyze the model (Barron, 1992; Cameron & Trivedi, 1986; Ranger-Moore et al., 1991). The negative binomial regression can also handle the dependent variable with a large number of zeros (Lin et al., 2012), a natural outcome among the count data, however, some prior studies (e.g. Park et al., 2015), in case of a large number of zeros, tested such models through zero-inflated negative binomial regression. In the case of my dataset, there were few zero values for the dependent variable, thus, I did not have to consider employing zero-inflated negative binomial regression.

4.4. Results

Table 7 presents a summary of the descriptive statistics and the correlations among the variables including the interaction terms, the products of different independent variables. Some variables exhibit relatively high correlations (higher than 0.6) with other variables. Thus, I conducted an additional variance inflation factor (VIF) analysis to examine whether a multicollinearity problem exists. I excluded the interaction terms from the analysis because multicollinearity can be ignored when the high variance inflation factors are caused by the inclusion of products or powers of main effect variables in the model (Allison, 2012). Table 8 presents the result of the VIF analysis and it can be seen that *R&D expenditure* exhibits the highest value (5.76). There is no multicollinearity problem

Table 7. Descriptive statistics and correlations matrix for Chapter 4.

Variables	1	2	3	4	5	6	7	8	9	10	11	Mean	SD
R&D expenditure	1.00											4.62	2.04
Firm size	0.88	1.00										5.31	3.17
Prior patents	0.68	0.63	1.00									153.32	227.36
Ongoing alliances	0.54	0.50	0.52	1.00								4.63	7.65
Alliance portfolio diversity (Diversity)	0.41	0.36	0.35	0.35	1.00							0.48	0.25
Alliance experience (Experience)	0.61	0.50	0.70	0.59	0.50	1.00						4.64	3.85
Proximity	0.11	0.03	0.04	0.07	-0.42	0.08	1.00					2.36	1.02
Diversity_Sqaured	0.44	0.38	0.38	0.42	0.96	0.57	-0.40	1.00				0.29	0.18
Diversity × Experience	0.59	0.50	0.67	0.61	0.62	0.98	-0.02	0.70	1.00			2.67	2.98
Diversity × Proximity	0.50	0.41	0.39	0.40	0.72	0.59	0.20	0.66	0.63	1.00		1.02	0.68
Innovation performance	0.67	0.64	0.70	0.54	0.34	0.72	0.09	0.38	0.72	0.45	1.00	792.92	1229.11

Table 8. VIF test results of Chapter 4.

Variables	VIF
R&D expenditure	5.76
Firm size	4.59
Prior patents	2.58
Ongoing alliances	1.71
Alliance portfolio diversity	2.02
Alliance experience	2.80
Proximity	1.52
Average	3.00

when the VIF value is less than 10 (Hair *et al*., 1995). Therefore, I concluded that the correlations among variables in this study do not lead to a multicollinearity problem.

Table 9 presents the results from the negative binomial regression. In each model I have included the control variables. Model 1 contains only the control variables.

In Model 2, *Alliance portfolio diversity (Diversity)* alone does not show any significant influence on the focal firms' innovation performance. However, in Model 3, *Alliance portfolio diversity (Diversity)* is positively associated with the focal firms' innovation performance and this relationship is significant ($p<0.01$). In the meantime, *Diversity_Squared* is negatively related to the focal firms' innovation performance and this relationship is also significant ($p<0.01$). This result implies an inverted u-shape relationship between *Diversity* and innovation performance. As firms pursue diversity in their alliance portfolios, their innovation performance increases up to a certain level of

diversity and then decreases afterward with even higher diversity. Thus, Hypothesis 4-1 of this study is supported.

Across Models 4 to 7, I added the moderating variables, *Alliance experience (Experience)* and *Proximity*, and their interactions with the main effect variable, *Diversity*, to examine how *Experience* and *Proximity* moderate the relationship between *Diversity* and innovation performance. The moderating variables by themselves exhibit no significant effects on the focal firms' innovation performance or mixed results. However, the interaction term, *Diversity* × *Experience*, exhibits a positive and significant ($p<0.1$) coefficient. This result implies that higher levels of alliance experience facilitate firms to accommodate more diversity in their alliance portfolio, which maximizes innovation performance and supports Hypothesis 4-2 of this study. The interaction term, *Proximity* × *Experience*, also exhibits a positive and significant ($p<0.05$) coefficient. This result implies that higher levels of proximity between a firm and its partners facilitate the firm to accommodate more diversity in its alliance portfolio, which maximizes innovation performance and supports Hypothesis 4-3 of this study.

The coefficients of some control variable also show significant values. Expectedly, the influence of *R&D expenditure*, *Firm size*, and *Prior patents* on innovation performance is positive and significant throughout all models.

Table 9. Negative binomial regression results of Chapter 4.

Depend variable:	Model 1		Model 2		Model 3	
Innovation performance	Coefficient	S.E.	Coefficient	S.E.	Coefficient	S.E.
Control variables						
R&D expenditure	0.2436*	0.1331	0.2265*	0.1350	0.2387*	0.1290
Firm size	0.1521**	0.0763	0.1581**	0.0766	0.1439*	0.0744
Prior patents	0.0022**	0.0009	0.0021**	0.0009	0.0024***	0.0009
Ongoing alliances	-0.0033	0.0205	-0.0057	0.0209	0.0139	0.0221
Independent variables						
Alliance portfolio diversity (Diversity)			0.3900	0.6178	4.2189***	1.5275
Diversity_Squared					-5.8999***	2.2037
Alliance experience (Experience)						
Proximity						
Diversity × Experience						
Diversity × Proximity						
N	72		72		72	
Log likelihood	-498.013		-497.819		-494.451	
Pseudo *R*^2[a]	0.0705		0.0709		0.0772	
LR Chi^2	75.59		75.98		82.72	
Regression *p*-value	0.000***		0.000***		0.000***	

[a] The pseudo-R squared value in table 9 is McFadden's pseudo R-squared. According to Long and Freese (2006), the pseudo R-squared of negative binomial regression does not carry the same meaning as the R-squared in OLS regression (the proportion of variance for the response variable explained by the predictors). But when comparing two models using the same data, McFadden's pseudo R-squared would be higher for the model with the greater likelihood.

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

Table 9 (Continued). Negative Binomial Regression Results of Chapter 4.

Depend variable:	Model 4		Model 5		Model 6		Model 7	
Innovation performance	Coefficient	S.E.	Coefficient	S.E.	Coefficient	S.E.	Coefficient	S.E.
Control variables								
R&D expenditure	0.2426*	0.1361	0.3038**	0.1376	0.26119**	0.1229	0.3341***	0.1264
Firm size	0.1456*	0.0765	0.1394*	0.0764	0.1358*	0.0715	0.1254*	0.0713
Prior patents	0.0021**	0.0010	0.0017**	0.0009	0.0021**	0.0009	0.0017**	0.0008
Ongoing alliances	0.0008	0.0244	-0.0054	0.0216	0.0090	0.0232	0.0021	0.0208
Independent variables								
Alliance portfolio diversity (Diversity)	4.4984***	1.5260	5.3891***	1.5623	0.2389	2.5042	1.4807	2.3743
Diversity_Squared	-6.6537***	2.2865	-10.1712***	2.8785	-4.6865*	2.3998	-8.1994***	2.9140
Alliance experience (Experience)	0.0523	0.0487	-0.3494*	0.2068	0.0091	0.0480	-0.3705*	0.1943
Proximity	-0.0278	0.1292	-0.0340	0.1248	-0.4627*	0.2481	-0.4258*	0.2232
Diversity × Experience			1.0467*	0.5394			0.9863**	0.5028
Diversity × Proximity					1.2163**	0.5045	1.1343**	0.4616
N	72		72		72		72	
Log likelihood	-493.879		-491.956		-490.518		-488.572	
Pseudo *R*^2[a]	0.0783		0.0818		0.0845		0.0882	
LR Chi^2	83.86		87.71		90.58		94.47	
Regression *p*-value	0.000***		0.000***		0.000***		0.000***	

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

The moderating role of alliance experience is depicted in Figure 12. In this three-dimensional diagram, it is shown that how firms' alliance experience affects the relationship between the firms' alliance portfolio diversity and their innovation performance. Basically, regardless of alliance experience, the relationship between alliance portfolio diversity and innovation performance is inverted-u shaped, i.e. the innovation performance peaks at a medium level of alliance portfolio diversity. However, with an increased alliance experience, firms' innovation performance peaks at a higher level of alliance portfolio diversity that indicates the positive moderating role of alliance experience in absorbing diversity within alliance portfolios. Besides, the peak point of innovation performance becomes higher in case of higher alliance experience and corresponding maximum alliance portfolio diversity tolerable.

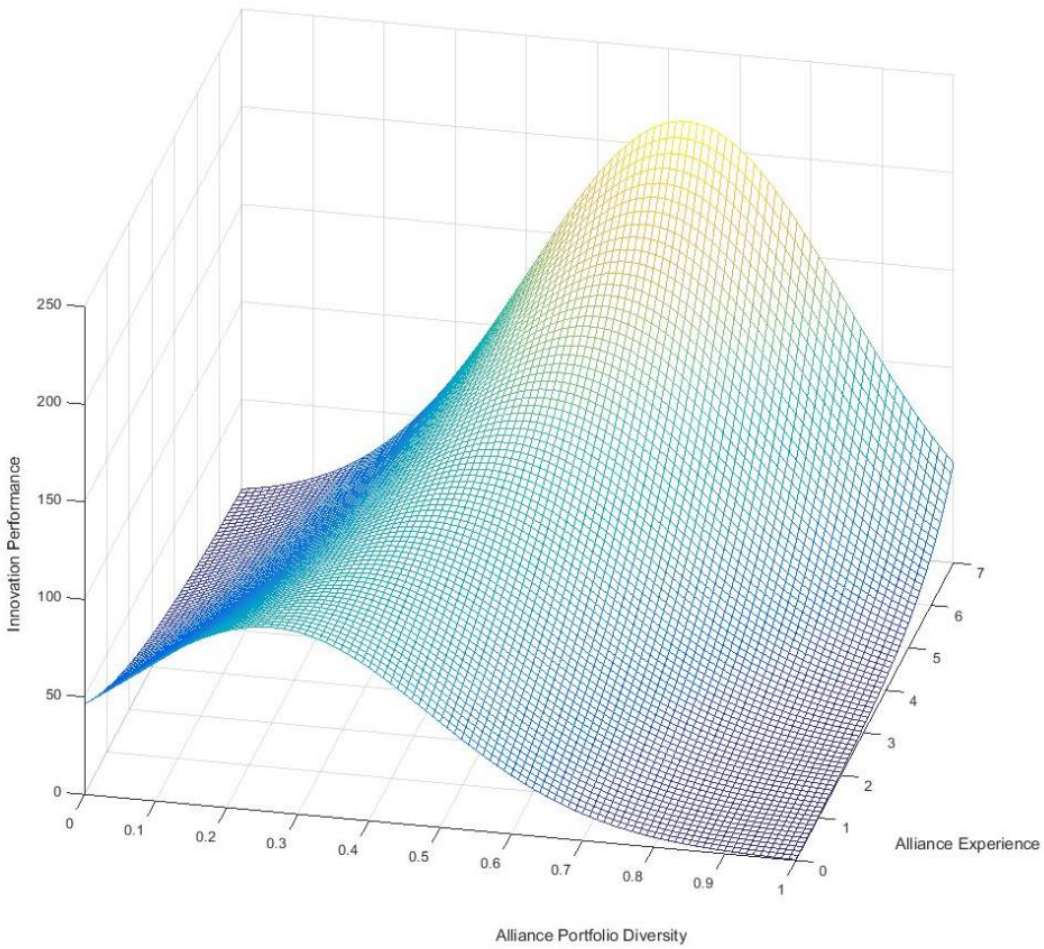


Figure 12. The moderating role of alliance experience between alliance portfolio diversity and innovation performance

4.5. Discussion

This chapter contributes to alliance portfolio and organizational learning literature by highlighting the significant role of alliance experience and proximity on handling alliance portfolio diversity and improving innovation performance. The findings of this chapter

are closely associated with the issues in the extant literature as follows:

First, this study introduces a concept of task knowledge and content knowledge, thus, specifying the constituents of knowledge relating to implementing alliances. Across diverse fields of social science, scholars have attempted to reveal the configuration of knowledge. Alexander et al. (1991) is one of the seminal studies relating to this endeavor and points out two major planes of knowledge interacting with each other, i.e. conceptual knowledge and metacognitive knowledge. The conceptual knowledge represents "an individual's knowledge of ideas, or concepts" while metacognitive knowledge refers to "the part of one's acquired world knowledge that has to do with cognitive matters" (Alexander et al., 1991; Flavell, 1987). In short, conceptual knowledge refers to an object per se while metacognitive knowledge refers to the context surrounding the object. One of the major blocks of conceptual knowledge is content knowledge while task knowledge is one of the major blocks of metacognitive knowledge (Alexander et al., 1991). This study uses these concepts for an integrative understanding of knowledge relating to implementing alliances. For a successful alliance strategy, both content knowledge, which facilitates the understanding of knowledge transferred or created through alliances, and task knowledge, which facilitates conducting repeated alliance tasks, are critical. The moderating effects of both content knowledge, i.e. knowledge proximity to partners, and task knowledge, i.e. alliance experience, on dealing with a diversified alliance portfolio are empirically verified in the present study.

Second, the findings of this chapters advocates a contingency perspective relating

to alliance portfolios. According to the contingency perspective, the benefits from alliance portfolio diversity are not equal to all firms, and previous literature (e.g. Schilke & Goerzen, 2010; Schilling & Phelps, 2007; Wassmer, 2010) observed the varying effects of alliance portfolio diversity on firms. However, the extant literature does not come to a conclusion regarding the origin of this contingency (Wuyts & Dutta, 2012). To account for this contingency, the main approach in this chapter is based on a comprehensive organizational learning perspective relating to processing alliances. A stream of previous literature (Bettis & Prahalad, 1995; Kogut & Zander, 1992; Levinthal & March, 1993; Wuyts & Dutta, 2012) suggests an interesting argument that extends internal knowledge creation pattern to leveraging extramural knowledge, but, does not exactly point out what kind of knowledge or capabilities firms should possess to absorb diversity from alliance portfolios. Thus, this study separates the alliance related knowledge into task knowledge and content knowledge, respectively attainable through repeated alliance experience and narrowing down the gap between firms and their partners, and examine how they moderate the relationship between alliance portfolio diversity and the firm's innovation performance. To absorb a higher level of diversity and turn it into an increased innovation performance, the result of this chapter suggest firms to increase their alliance experience and proximity to their partners. This result provides a reasonable explanation for the contingency relating to the effects of alliance portfolio diversity and complements the extant alliance portfolio and organizational learning literature.

Third, the present study confirms an inverted u-shape relationship between alliance

portfolio diversity and firm performance, suggested in previous literature, in a different empirical setting and corroborates the extant argument. In prior studies, the u-shape relation has been empirically verified by using different sets of dependent variables including new product development (De Leeuw et al., 2014; Oerlemans et al., 2013), drug approval (Wuyts & Dutta, 2012), an exhaustive alliance portfolio performance (Duysters et al., 2012), and knowledge utilization (Vasudeva & Anand, 2011). In this chapter, for the dependent variable, this study focuses on the quantity and quality of the innovation outcomes, measured by weighted patent counts, and show that the u-shape relation is still valid in a different setting. Moreover, the period in which this study tested the hypotheses is worthy of attention. To measure alliance portfolio diversity, this study collected alliance records in the biopharmaceutical industry around the year 2000, in which the number of alliances had sharply increased compared to the prior period and the purpose of alliances was mainly exploration. Thus, this period is appropriate to study the effects of alliance portfolio diversity and the results of the present study contribute to generalizing the inverted u-shape relation between alliance portfolio diversity and firm performance.

On top of the findings and contributions of the present study, relating to the influence of alliance portfolio diversity, further discussion on the source of the diversity or configuration of alliance portfolios is required. Specifically, firms' alliance strategy can affect the diversity of their alliance portfolios. If firms aim to explore new development opportunities and actively shape their environment (shaping strategy), to acquire new technologies and lead the market, they place core exploration alliances in their alliance

portfolios (Hoffmann, 2007). Conversely, if they aim to reactively adapt to their current environment (adapting strategy), they place several low-cost probing alliances in their portfolios and make careful follow-up investments depending on the environmental development (Brown & Eisenhardt, 1997; Hoffmann, 2007). As a result, firms' alliance portfolio diversity tends to become lower in case of a shaping strategy and tends to become higher in case of an adapting strategy. Hence, interpreting firms' innovation performance without understanding their alliance strategy may lead to an erroneous conclusion. For example, pursuing an adapting strategy, a firm might intend an extra level of diversity in its alliance portfolio and would take a temporarily low level of innovation outcome for granted. I expect future research to operationalize these alliance strategies and include them in investigating the influence of alliance portfolio diversity. This would allow for an unbiased approach to interpreting innovation performance driven by the diversity.

Chapter 5. Aligning goals of an alliance portfolio

5.1. Introduction

Strategic alliances are essential tools for firms in that they facilitate absorbing new knowledge and encourage innovation (Hagedoorn, 1993; Park & Kang, 2013). The extant literature highlights a variety of causal relations between strategic alliances and innovation performance. For example, previous research has shown the positive influence of the number of alliance partners on the innovation output such as patent applications and new product developments (Ahuja, 2000a; Deeds & Hill, 1996). On top of that, Stuart (2000) suggests that the collective characteristics of alliance partners affect a focal firm's patenting performance. Another stream of research classifies alliances according to their objectives (i.e. exploration and exploitation) and suggests that they have an effect on different domains of new product development (Rothaermel, 2001; Rothaermel & Deeds, 2004; Hoang & Rothaermel, 2010). Likewise, many researchers focused on immediate innovation outcomes such as patenting performance and new product development and confirmed the effect of strategic alliances on such outcomes. Existing literature, however, has not sufficiently examined the effects of strategic alliances on the effectiveness or the practicality of innovation such as its contribution to firm sales. To understand innovation performance in a more profound way, it is required to focus not only on the immediate output of innovation activities but also on the entire process from knowledge creation to

how it generates cash flow (Dervitsiotis, 2010; Lee & Kelly, 2008; Loewe & Dominiquini, 2006). Klein and Sorra (1996) suggest the significance of innovation effectiveness which indicates the organizational benefit achieved from implementing innovation.

Strategic alliances can also contribute to innovation effectiveness as well as immediate innovation outcomes. Diverse knowledge of different parties increases the innovativeness of the collaborative output. Moreover, the evaluation of the collaborative output by collaborators with different backgrounds also increases the practicality and marketability of the resulting innovations. Especially exploration focused alliances are advantageous not only to novel creations but also to innovation effectiveness because they contribute to sourcing new knowledge, verifying internal knowledge and checking the general prospect toward emerging technology. Previous literature (e.g. Alter & Hage, 1993; Thrasher, Craighead, & Byrd, 2010) also suggests that collaborative decision making contributes to a profound understanding toward market needs and market adaptation. Likewise, despite the big role of strategic alliances for successful innovations, except for some initial steps (e.g. Beers & Zand, 2014; Faems, Looy, & Debackere, 2005), the extant literature has not yet sufficiently examined the influence of alliances on innovation effectiveness.

The objective of this study is to investigate the influence of alliances which aim to obtain new knowledge and technology on firms' innovation effectiveness. Moreover, this study examines some internal and external organizational characteristics which strengthen the influence of alliances on innovation effectiveness. Specifically, this study focuses on

entirely new innovation (new to the focal firms or new to the market) and, thus, the influence of exploratory alliances that are known to influence radical innovation (Koza & Lewin, 1998; Faems et al., 2005). The results of the present empirical study finds a positive effect of the commitment to exploratory alliances on innovation effectiveness measured by percentage of revenue from new products (Dervitsiotis, 2010). This study also confirms that firms' another external behaviors (exploitative alliances) and internal innovation intent positively moderate this relationship.

This chapter makes several contributions to innovation and alliance literature: First, the results of the present study suggest the influence of exploratory alliances not only on the number of new technology and products developed but also, more importantly, on the firms' innovation effectiveness. Second, this study adopts the criticism of recent literature (e.g. Kratzer, Gemuenden, & Lettle, 2008; Yamakawa, Yang, & Lin, 2011) that boundary conditions or interactions with organizational characteristics has not been sufficiently covered by existing alliance literature and investigate some internal and external driving factors which increase alliance performance. Finally, this study investigates the Korean manufacturing sector during its peak growth rate (2002-2004) after the 1997 Asian Financial Crisis and provides a case of successful collaboration and innovation strategy to other countries' manufacturing sectors.

The remainder of Chapter 5 is organized as follows: First, this study explains the significance of innovation effectiveness and how it is affected by strategic alliances. This study develops hypotheses which link innovation effectiveness with exploratory alliance

activity as well as moderating factors related to the firms' alliance propensity and strategic intent. Second, employing ordinary least square regression, this study tests the hypotheses using Korea Innovation Survey (KIS) data on 364 Korean manufacturing firms. Finally, the study presents the empirical results and conclude with a discussion of implications, limitations, and directions for future research.

5.2. Research hypotheses

5.2.1. Exploratory alliances and innovation effectiveness

Exploratory alliances contribute to innovation effectiveness in a number of ways:

First, multilateral participation in a given innovation project results in an increased innovativeness and marketability. By participating in exploratory alliances, firms are able to access knowledge of diverse partners and to rigorously evaluate the ongoing innovation project relating to its practicality from diverse standpoints. Thus, innovation projects created through alliances are likely to be more influential and marketable. Compared to within-firm exploration, exploratory alliances provide firms with a number of advantages such as sourcing external knowledge, verifying internal knowledge and examining the market outlook for specific technologies. Previous literature (e.g. Alter & Hage, 1993; Thrasher et al., 2010) also suggests that decision making through collaborations enhances the understanding of customer needs and market adaptability.

Second, exploratory alliances provide complementary assets which can turn innovation projects into a commercial success (Faems et al., 2005; Hagedoorn, 1993; Teece, 1986). For example, in the biopharmaceutical industry, biotechnology firms or pharmaceutical companies form exploratory alliances with hospitals and research institutes in order to develop technology applicable to new drugs. During the collaboration, the firms are able to take advantage of their partners' technicians and research manpower, clinical tests and test equipment. As a result, the firms are able to estimate the effectiveness of their innovation outcomes as well as to improve their technology.

Third, collaborations facilitate the transfer of codified and tacit knowledge (Ahuja, 2000a; Doz & Hamel, 1997; Eisenhardt & Schoonhoven 1996). Compared to an indirect access to a certain technology through patent citations or informal sources, forming an alliance with the inventor or the provider of a certain technology would allow the transfer of the tacit side, as well as the codified side, of the knowledge. Thus, firms would be able to appreciate the true value of the technology and successfully commercialize it.

Therefore, the present study suggests:

Hypothesis 5-1. A higher importance of exploratory alliances for a firm's innovation activities leads to an increased innovation effectiveness.

This study predicts not only a positive effect of exploratory alliances on innovation

effectiveness, but also examines the influence of firms' other alliance activities and internal intent which can positively moderate this relationship: First, from the viewpoint of ambidexterity (March, 1991; Levinthal & March, 1993), this study examines the moderating effect of exploitative alliances on the relationship between exploratory alliances and innovation effectiveness. Next, in line with the stream of research (e.g. Dickson & Weaver, 1997; Kratzer et al., 2008; Yamakawa et al., 2011) which points out the scarcity of interactions between alliance strategy and organizational characteristics in the extant literature, this study examines the moderating effect of firms' innovation intent on the relationship between exploratory alliances and innovation effectiveness.

5.2.2. The role of ambidexterity on innovation effectiveness

Unlike exploration, exploitation focuses on efficiency and aims to improve the performance of processes and products (Levinthal & March, 1993; March, 1991). Similarly, exploitative alliances, e.g. alliances with customers, business service providers, and suppliers, improve the productivity of businesses (Koza & Lewin, 1998; Rothaermel, 2001; Rothaermel & Deeds, 2004). In exploitative alliances firms have access to complementary assets for commercialization and can expect faster and more predictable outcomes compared to exploratory alliances (March, 1991). March (1991) emphasizes the significance of ambidexterity in implementing exploration and exploitation and suggests

that they complement each other and increase each other's effectiveness in contributing to firm performance. Ambidextrous organizations can expect a synergy between exploration, which contributes to innovativeness in capabilities and outputs, and exploitation, which focuses on prompt sales and commercialization (March, 1991; Levinthal & March, 1993). By employing an ambidextrous alliance strategy, firms are able to develop new capabilities and radically new technology through exploratory alliances and, at the same time, use exploitative alliances to make the resulting innovation more effective in the market (Faems et al., 2005; Koza & Lewin, 1998; Rothaermel, 2001). Thus, exploitative alliances increase the market adaptiveness and productivity of the innovation process and contribute to strengthening the influence of exploratory alliances on the firms' innovation effectiveness. Therefore, the present study suggests:

Hypothesis 5-2. A higher importance of exploitative alliances for a firm's innovation activities will positively moderate the relationship between its focus on exploratory alliances and innovation effectiveness.

5.2.3. The role of strategic fit on innovation effectiveness

Previous literature considers internal support and managers' support for the firm's activities as an important factor in the innovation process (Lee & Kelly, 2008; Loewe &

Dominiquini, 2006). When a beneficial firm behavior or strategy, e.g. a strategy to use exploratory alliances for innovation, is identified, the top management team needs to allocate the firm's resources accordingly. Positive outcomes will be stronger when the firm's actions and strategic intent are aligned. This not only supports firm's behavior (Yamakawa et al., 2011), but also sustains competitive advantage (Porter, 1996). Porter (1980) suggests that a firm's internal strategic orientation decides how to allocate its resources and categorizes strategic orientation into cost leadership and differentiation. A differentiation strategy aims at creating new capabilities to differentiate the firm's services or products in order to obtain a competitive advantage (Hill, 1988). Firms which adopts such a differentiation strategy show strong intent to continuously search for new technologies which help them respond to changing markets and launch new products (Koza & Lewin, 1998; Yamakawa et al., 2011). Exploratory alliances focus on such a search for new technologies, which is why they have been linked with the firm's intent toward innovation described above (Gilsing & Nooteboom, 2006; Yamakawa et al., 2011).

In previous literature, innovation intent has been linked to commitment to learning and risk-taking propensity (Gatignon & Xuereb, 1997; Sinkula, Baker, & Noordewier, 1997; Verona, 1999; Yang, 2012). As these two factors grow, innovation capability will increase and the firm will grow (Yang, 2012). A firm which is strongly committed to learning is more likely to possess state-of-the-art technology that further increases its innovation capabilities (Gatignon & Xuereb, 1997). Therefore, the more the firm's culture is committed to learning, the higher will be its productivity and profitability (Wick &

Leon, 1993). Risk-taking propensity indicates how much risk top managers are willing to accept to gain a competitive advantage (Miller, 1983). Because firm growth always entails risk (Canals, 2001), it is important for managers to foster a culture of risk-taking in order to achieve innovation (Jassawalla & Sarshittal, 2002). In summary, firms with a higher innovation intent are less risk-averse and in a better position to obtain higher innovation outcomes from their exploratory alliance activities.

Therefore, the present study suggests:

Hypothesis 5-3. The firm's innovation intent will positively moderate the relationship between its focus on exploratory alliances and innovation effectiveness.

To describe the outline of this study more clearly, Figure 12 shows a diagram that summarizes the research model and hypotheses of Chapter 5.

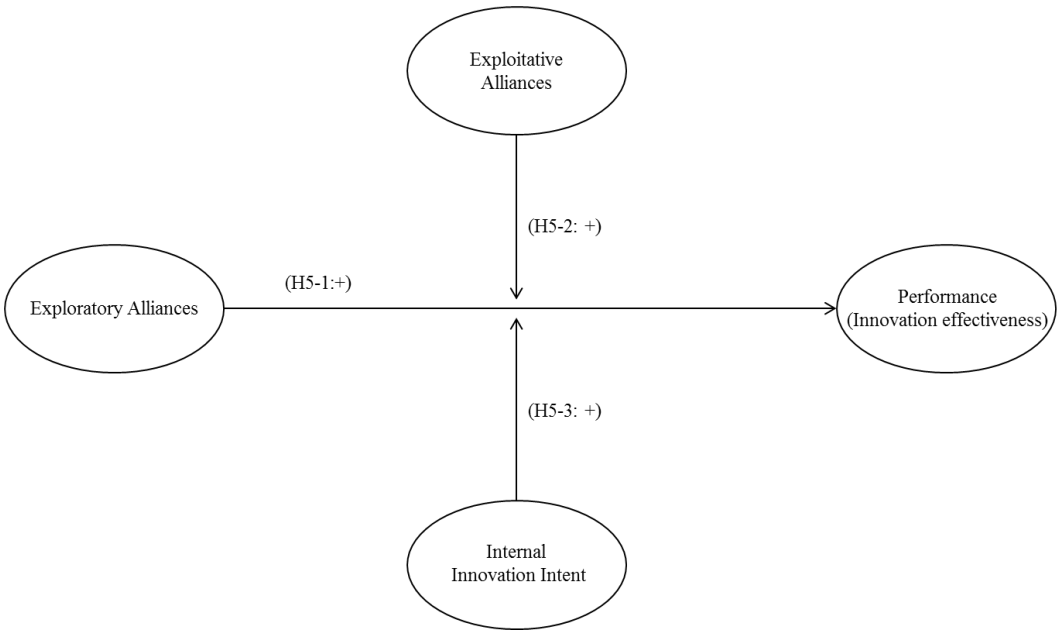


Figure 13. The conceptual model for Chapter 5.

5.3. Method

5.3.1. Data and sample

The empirical analysis is based on data from the "Korean Innovation Survey 2005: Manufacturing Sector (KIS)", which is a survey undertaken by the Korean Science & Technology Policy Institute (STEPI). The employed questionnaire and methods of the survey follow the standards set forth in the third edition of the Oslo Manual published by the Organisation for Economic Cooperation and Development (OECD). KIS contains a

multitude of questions related to the firms' use of external knowledge sources, R&D collaborations and the firms' innovation outcomes.

Table 10. Sample composition by industry.

Industry	Frequency	Percent
Food products and beverages	24	6.59
Textiles	14	3.85
Wearing apparel and fur	2	0.55
Leather products and footwear	2	0.55
Wood and cork (not furniture)	2	0.55
Pulp, paper and paper products	6	1.65
Printing (except publishing and reproduction of recorded media)	4	1.10
Coke, refined petroleum products and nuclear fuel	5	1.37
Chemicals and chemical products	54	14.84
Rubber and plastic products	18	4.95
Non-metallic mineral products	10	2.75
Basic metals	15	4.12
Fabricated metal products (except machinery and equipment)	27	7.42
Machinery and equipment	54	14.84
Office, accounting and computing machinery	3	0.82
Electronic components (including semiconductors)	21	5.77
Television, radio and communication equipment	40	10.99
Medical, precision and optical instruments, watches, clocks (instruments)	15	4.12
Motor vehicles	30	8.24
Other transport equipment	10	2.75
Furniture, other manufacturing n.e.c.	8	2.20
Total	364	100

STEPI collected 2738 filled out questionnaires from 4507 firms which were selected as the targets for the survey based on a population of Korean firms identified by a prior survey of the Korean National Statistical Office. In the present study, a sub sample of 364 firms is used due to the need to exclude samples which were missing information on the variables selected for the empirical analysis. The firms in my sample are operating in a number of different industries as shown in Table 10.

In the present study I used innovation effectiveness, the percentage of a firm's revenue stemming from innovative products to measure the performance of firms. The continuous variable in my dataset had an almost normal distribution and thus, unlike other studies based on innovation survey data such as Faems et al. (2005), I did not need to censor the data and was able to use OLS regression for the analysis.

5.3.2. Dependent variable

The dependent variable in the present study is the firm's *Innovation effectiveness*. Among the measures of innovation effectiveness suggested by Dervitsiotis (2010), I decided on using the percentage of current revenue from recent innovations as the measurement for innovation effectiveness in the present study. I defined the percentage of revenue stemming from recent innovation activities as the revenue in 2004 from both innovations which were new to the market and innovations which were not new to the market, but

new to the firm in the 2002-2004 timeframe. My approach is similar to the one used by Faems et al. (2005) who used the proportion of turnover attributed to both new and improved products as a measurement for firms' innovation effectiveness.

5.3.3. Independent variables

The independent variables *Exploratory alliance* and *Exploitative alliance* are based on the evaluation of different external entities with respect to their contribution to the firm's innovation in the 2002-2004 time period. In the KIS survey I used the responses in the "Collaboration" part of the KIS questionnaire. The relevant question is "Please evaluate the contribution of your partner for innovation activity for the past three years", and firms responded on a 5-point Likert scale according to the contribution of the respective partners. They marked 5 points if the collaboration partners' contribution was very useful, and 1 point if their contribution was not useful. To measure the contributions from exploratory alliances, I calculated the average value of the evaluation from three categories: private research institutes, universities and institutes of advanced studies, and government-funded research centers. Previous literature discusses the role of such institutions in the creation of new technologies which can be used by firms in the development of innovative products (Peters, Groenewegen, & Fiebelkorn, 1998; George, Zahra, & Wood, 2002) and my approach is in line with that of previous studies using

innovation survey data such as the one by Faems et al. (2005). Following the approach I used in evaluating the contributions from exploratory alliances, for exploitative alliances I calculated the average value of the evaluation from the following three categories: customers, business service providers (technology, legal, accounting or consulting), and suppliers (raw materials, components, software, and services). The classification of these kinds of collaborations as exploitative rather than exploratory follows the approach found in Faems et al. (2005) and is in line with previous literature which also deals with firms' collaboration with customers and suppliers (Brown & Eisenhardt, 1995; Schoonhoven & Jelinek, 1997). My variable *Innovation intent* was also derived from the KIS data. In the survey, firms were asked to rate the objectives for the innovation related activities they performed between 2002 and 2004. Individual objectives were rated on a five-point scale, my measurement is the average of the importance of product diversification and the opening up of new markets as objectives of the firms' activities.

5.3.4. Control variables

The empirical analysis includes four control variables: *R&D intensity*, *Firm size*, *Firm age*, and *Geomarket*. A firm's technological innovation outcome is affected by its absorptive capacity, which can be measured by the firm's R&D intensity (Cohen & Levinthal, 1990). I defined *R&D intensity* as the total expenditures on internal and

external R&D in 2004 divided by the firm's total sales in 2004. Another variable that might have an effect on the firm's innovation is its size. I defined *Firm size* as the logarithm of the total number of employees at the end of 2004. As startups are often shown to be more active in pursuing innovation than incumbent firms, I controlled for the age of the firms by introducing the *Firm age* control variable. It is a dummy variable that is coded as 1 if the age of the firm was less than five years at the time of the survey and 0 if it was established more than five years before. A further dummy variable, *Geomarket*, was introduced to control for an international orientation of the firm. It was coded as 1 if the firm had customers from abroad and 0 if the firm was only serving customers in Korea in the 2002-2004 time period. Additionally I included industry dummy variables to account for the fact, that although all the firms in my sample are classified as manufacturing firms, they are operating in a range of different industries.

5.4. Results

Table 11 shows a summary of the descriptive statistics and the correlations among the variables used in the present study. The correlations are relatively low, however I performed an additional variance inflation factor test (VIF test). The results of this calculation are summarized in Table 12 and the low values (average of 1.22) show that this study does not have any problems with multicollinearity.

Table 11. Descriptive statistics and correlations matrix for Chapter 5.

Variables	1	2	3	4	5	6	7	8	9	10	Mean	SD
R&D intensity	1.00										0.08	0.54
Firm size	-0.15	1.00									5.12	1.31
Firm age	0.26	-0.15	1.00								0.07	0.44
Geomarket	0.04	0.30	-0.08	1.00							0.73	0.44
Exploratory alliance	0.08	0.14	0.01	0.11	1.00						1.39	1.23
Exploitative alliance	-0.01	0.18	0.01	0.06	0.33	1.00					1.42	1.35
Innovation intent	0.02	0.12	-0.01	0.04	0.23	0.23	1.00				3.61	1.38
Exploratory alliance x Exploitative alliance	0.01	0.20	-0.01	0.10	0.75	0.75	0.22	1.00			2.52	4.11
Exploratory alliance x Innovation intent	0.09	0.16	0.02	0.12	0.93	0.36	0.44	0.74	1.00		5.12	5.29
Innovation effectiveness	0.18	-0.03	0.10	0.05	0.30	0.19	0.16	0.32	0.34	1.00	43.40	26.85

Table 12. VIF test results of Chapter 5.

Variables	VIF
Firm size	1.32
Firm age	1.18
Geomarket	1.25
R&D intensity	1.12
Exploratory alliance	1.27
Exploitative alliance	1.23
Innovation intent	1.15
Average	1.22

Table 13 shows the results of the OLS regression models. In each model I have included the control variables as well as industry dummies. Model 1 contains only the control variables and it can be seen that, just as expected, a firm's R&D intensity has an influence on the innovation effectiveness. The other control variables did not show any significant effects. Model 2 analyzes the baseline hypothesis, which predicts positive effects of exploratory alliances on innovation effectiveness. The results show the parameter to be significant and positive, confirming Hypothesis 5-1.

Model 3 includes exploratory and exploitative alliances as well as the interaction between the two of them. Exploitative alliances by themselves do not show a significant

Table 13. Ordinary least square regression results of Chapter. 5.

Depend variable:	Model 1		Model 2		Model 3		Model 4		Model 5	
Innovation effectiveness	Coefficient	S.E	Coefficient	S.E	Coefficient	S.E	Coefficient	S.E	Coefficient	S.E
Control variables										
R&D intensity	7.44***	2.66	6.10**	2.55	6.53*	2.51	5.66**	2.52	6.12**	2.49
Firm size	0.45	1.17	-0.33	1.13	-0.77	1.11	-0.64	1.11	-0.99	1.11
Firm age	7.98	5.53	8.29	5.29	7.65	5.20	8.14	5.21	7.75	5.15
Geomarket	3.70	3.42	2.84	3.27	2.95	3.21	2.86	3.22	2.98	3.18
Independent variables										
Exploratory alliance			6.45***	1.12	1.25	1.92	-2.87	3.50	-5.70	3.58
Exploitative alliance					-0.99	1.69			-1.28	1.72
Exploratory alliance x Exploitative alliance					2.19***	0.79			2.07**	0.81
Innovation intent							0.10	1.27	0.48	1.29
Exploratory alliance x Innovation intent							2.32***	0.87	1.81**	0.88
Industry Dummies	Included		Included		Included		Included		Included	
N	364		364		364		364		364	
R^2	0.13		0.21		0.24		0.24		0.26	
F-Statistic	2.10***		3.53***		3.92***		3.83***		4.05***	

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

result, however the interaction between them, i.e. a firm following the concept of ambidexterity, has a significant positive effect on innovation effectiveness. Of interest is that in Model 3, as well as in Model 4, the effect of exploratory alliances, the baseline hypothesis, is insignificant while the moderation effects are confirmed. However, as Baron and Kenny (1986) point out, whether the main effects for predictor (in the present case exploratory alliance) and moderator (exploitative alliance or innovation intent) are significant or not, is not directly relevant for testing the moderator hypothesis.

Model 4 confirms Hypothesis 5-3 which stated that the firm's innovation intent positively moderates the relationship between exploratory alliances and innovation effectiveness. Both Hypotheses 5-2 and 5-3 are also confirmed in Model 5 which contains all the variables used in the present study.

5.5. Discussion

This chapter empirically verifies the positive influence of a firm's exploratory alliance activity on its innovation effectiveness. Levinthal and March (1993) characterize exploration as "the pursuit of knowledge, of things that might come to be known". It is commonly seen as a difficult and future oriented task, whose payoffs for a firm will not be immediate. Exploitation, on the other hand, "the use and development of things already known" (Levinthal & March 1993), is commonly understood to lead to an

immediate noticeable impact on the firm's performance. Following that thought, previous literature has found evidence for the positive impact of exploitative alliances on the innovation output of firms as measured e.g. by the number of new products developed or the approval rate of new pharmaceutical drugs (Rothaermel, 2001; Hoang & Rothaermel, 2010). Unlike these prior studies, this study focuses on innovation effectiveness, which captures the contribution of new to the firm and new to the market products to the firm's actual sales. Using this approach allowed me to show that exploratory alliances increase the firms' innovation effectiveness. Exploitative alliances, on the other hand, did by themselves not show any effect on the innovation effectiveness and were significant only in combination with exploratory alliances. This result contributes to the research on the effects of ambidexterity in alliances on the firms' performance (e.g. Lavie et al., 2011; Raisch, Birkinshaw, Probst, & Tushman, 2009).

Relating to pursuing ambidexterity in the realm of alliances, the extant literature suggests diverse ways of ambidextrous strategy which contribute to maximizing firm performance and the debate for a predominant one is still going on. The strategy appears in a variety of forms such as pursuing ambidexterity within an individual alliance (Colombo, Doganova, Piva, D'Adda, & Mustar, 2014), pursuing an ambidextrous alliance portfolio, i.e. different partners serve different roles, exploration or exploitation (Bahemia & Squire, 2010; Faems et al., 2012; Lavie et al., 2011), pursuing ambidexterity across an organizational boundary, e.g. internal exploitation and external exploration, (Ferrary, 2011; Hoang & Rothaermel, 2010; Russo & Vurro, 2010) and the fit or alignment rather

than balance across an organizational boundary (Yamakawa et al., 2011). Among these streams of research, the findings of the present study offer further support for certain perspectives. First, the present result shows the effectiveness of pursuing an ambidextrous alliance portfolio by confirming an increasingly positive effect of exploratory alliances on innovation effectiveness in case of implementing exploitative alliances together. Furthermore, the present result also suggests the importance of aligning the objectives of alliances with relevant internal intents. For an increased innovation effectiveness, internal innovation intent toward developing new markets and product diversification, regarded as consequences of exploration, should accompany exploratory alliances which aim to acquire new technology.

The findings of the present study further contribute to existing alliance literature by verifying the positive interaction between alliance behaviors and relevant boundary conditions. Lin, Yang and Arya (2009) state that considering relevant boundary conditions is important in understanding the performance of strategic alliances. They are especially important as different boundary conditions can lead to a different optimal mix of exploitative and exploratory alliance activities (Mc Namara & Baden-Fuller, 2007). The present study empirically verifies the relationship between exploratory alliances and a firm's innovation effectiveness and looks at how this relationship is moderated by the firm's exploitative alliances and the innovation intent of the organization. Previous literature falls short of explaining the effects of the interaction of alliance activities with the firm's behavior and strategic orientation (Yamakawa et al., 2011). Consequently, the

present work contributes to prior literature which has neglected the role of internal and external constraints and helps to embrace a more holistic understanding of which firm behaviors contribute to innovation performance.

By testing the hypotheses on a sample of Korean manufacturing firms during the 2002-2004 period, this study sheds light on the successful innovation strategy of firms during the recovery from an economic crisis. South Korean firms suffered heavily from the 1997 Asian financial crisis but after a bailout from the International Monetary Fund (IMF), the Korean economy experienced a fast recovery. During the 2002-2004 time period, the Korean manufacturing sector grew at an average annual rate of eight percent (The Bank of Korea, 2014). The present study investigates the collaborative behavior of Korean manufacturing firms and its impact on the firms' innovation performance which contributed to their fast growth and the rapid recovery from the crisis. The findings of the present study might contribute to the understanding of suitable innovation strategies in manufacturing sectors of other emerging countries which undergo a period of rapid economic growth or are undergoing a turnaround after experiencing a period of economic hardship.

Chapter 6. Conclusive remarks

6.1. Summary and contributions

In conclusion, the present dissertation highlights major building blocks of alliance portfolio management that sequentially contribute to the focal firm's innovation performance. Firms build their alliance portfolios, absorb knowledge from their portfolios, and finally optimize their portfolios to obtain a more effective innovation outcome. The dissertation provides following a number of significant findings and implications corresponding to each stage of alliance portfolio management. First, the dissertation confirms the moderation effect of partners' relationships on the link between alliance portfolio size and innovation performance and thus suggests firms to pay attention to their partners' perspectives in the stage of forming alliance portfolios. Second, the dissertation confirms the role of alliance experience and proximity in the absorption of knowledge stage. This integrative approach to absorbing knowledge shows how firms can learn to benefit from diversity in their alliance portfolios. Third, the dissertation confirms the role of ambidextrous alliance portfolios and internal innovation intent in optimizing innovation outcomes. This finding suggests firms to balance different types of alliance, i.e. exploratory and exploitative alliances, and to support alliance activities by integrating it into the companywide strategy. Overall, the dissertation shows that with proper alliance portfolio management, a firm's alliance portfolio is an important strategic element which

contributes to the sourcing of external knowledge and consequently realizing innovation.

In addition to the aforementioned overall contributions, each chapter of the present thesis provides managerial implications corresponding to their findings.

Based on the findings of Chapter 3, this thesis suggests firms to increase their alliance portfolio size and, at the same time, to keep an eye on the two-sided characteristic of their portfolios, which is the connectivity and competition among their partners. As firms obtain more alliance partners, they might experience positive effects on their innovation performance as a result of increasing connectivity, but might also be confronted with the negative influence of competition within their portfolio. Therefore, firms should foster collaborations among their partners and, at the same time, avoid the overlap of partners around the same business fields.

Specifically, this thesis suggests alliance managers to increase the network density within their alliance portfolios. If firms ally with their indirect partners (partners' partners), they can increase both the size and network density of their alliance portfolios and, consequentially, their innovation performance. Another way of fostering interconnections within an alliance portfolio is to develop joint projects which involve the focal firm and multiple partners from within the portfolio. These joint projects are likely to result in more ties among the focal firm's partners (higher network density) and can lead to an increased innovation performance of the focal firm by fostering active knowledge sharing between the multiple parties.

This thesis also suggests alliance managers to restrict competitive relations across

broad fields in their alliance portfolios. Chapter 3 subdivides the measure of competitive relations into breadth and depth and verifies the negative influence of competitive relations across broad fields on the innovation performance of focal firms. Focal firms face difficulties in absorbing knowledge throughout portfolios that include competitive relations across a number of (broad) fields. In such case, alliance portfolios turns into a conflict pool rather than a resource pool and do not significantly contribute to the focal firms' innovation performance. Accordingly, when firms increase their alliance portfolios, they should form alliances with the most suitable partner in each field rather than with many partners in the same field.

The findings of Chapter 4 suggest that firms examine their status which allows them to effectively embrace the diverse knowledge obtained through alliances without incurring large cost to handle it. Pursuing a medium level of diversity in alliance portfolios is generally beneficial for firms and results in an increased innovation performance. However, pursuing too much diversity in alliance relationships, without a sufficient level of alliance experience or proximity to alliance partners, is likely to lead to a decreased innovation performance. Thus, this thesis recommends firms to gradually increase the level of diversity in their alliance portfolio as they build up alliance experience and monitor their proximity to alliance partners. This approach of building alliance portfolios will increase the level of diversity firms can accommodate and allow them to utilize the inflow of diverse knowledge for generating new innovation. In line with this approach, establishing a dedicated alliance management function is an efficient

way of improving learning from alliances. This function, throughout the organization, gathers and disperses lessons from prior and ongoing alliances in a systematic way, and nurtures common practices in the process of forming and managing alliances. This allows firms to employ their accumulated know-how, stay focused on a systemized procedure of alliance management, and successfully absorb knowledge from their alliance portfolios.

In sum, the lessons from Chapter 4 highlight the importance of management resources and capabilities relating to alliance portfolios. Building up alliance experience and configuring a proximate alliance portfolio would enrich these resources and capabilities. The increased management resources and capabilities essentially provide room for firms to handle the drawbacks of too much alliance diversity and ultimately contribute to an increased innovation performance by allowing the firms to fully leverage the advantages of alliance portfolio diversity.

Chapter 5 provides two key recommendations for managers who are concerned with planning and coordinating a firm's alliance strategy: The importance of ambidexterity, i.e. the balancing of both exploratory and exploitative alliances, and the need for an alignment of the alliance objectives with the firm's organizational intent.

The results of Chapter 5 suggest that simultaneous exploration and exploitation in alliances are necessary to achieve innovative effectiveness. Even in case of radical innovation (products which are either new to the firm or new to the market), exploitative alliance activity contributes to increasing the firm's innovation efficiency, i.e. increase the percentage of total sales stemming from such innovative products. Despite the difficulties

in simultaneously using a firm's limited resources for both exploration and exploitation, due to their conflicting requirements for resources and capabilities, ambidexterity matters for an effective innovation and should be considered when deciding on an alliance strategy which can foster innovation and enable the firm to benefit from its outcomes.

Chapter 5 has further shown the importance of aligning organizational intent and the alliance objective. Following an open innovation paradigm, the business environment fosters strategic alliances. These alliances can be classified by their objectives as either exploratory or exploitative ones. To achieve a better performance from their alliance activities, firms need to align their organizational intent with their alliance objective. The results show that firms which have a clear organizational intent of pursuing innovation for the purpose of product diversification or the opening up of new markets experienced a higher effectiveness of their exploratory alliances. This thesis thus suggests for managers to align the firm's intent and to put strong organizational support in accordance to the alliance objectives to maximize the returns from the alliances activities.

6.2. Limitations and future research

Despite the contributions and implications the present thesis provides, it still involves some limitations.

Chapter 3 and 4 focus on the biopharmaceutical industry and provide implications

on effectively managing technology alliance portfolios. The findings obtained from a single industry may have difficulty in applying to another industry. Furthermore, frequent M&As among pharmaceutical firms provide only a limited number of final data points during a long span of time (e.g. 72 firms are tested in Chapter 4), a problem also faced by prior studies of alliance portfolios in the biopharmaceutical industry (e.g. Hoang & Rothaermel, 2005). Thus, I acknowledge limited generalizability of the results of the present dissertation. Nonetheless, the biopharmaceutical industry is one of the best possible choices for testing the hypotheses of this dissertation due to following reasons:

First, in terms of knowledge flow, the biopharmaceutical industry is more dynamic than other technology-oriented industries (Arora & Gambardella, 1994; Malik, 2012; Stuart, Ozdemir, & Ding, 2007). Thus, this industry shows high alliance tendencies and accounts for about 20 percent of alliances formed in high-tech industries (Hagedoorn, 1993). Therefore, the biopharmaceutical industry is an ideal setting to study alliance formations and their antecedents (Rothaermel & Boeker, 2008), as if Bower and Christensen (1995), inspired by fruit flies studies in biology, did research on product life span through the hard-disk-drive industry.

Second, the highly competitive environment of the biopharmaceutical industry, where rents accrue to the first-mover firm that makes a discovery (Malik, 2012; Vassolo et al., 2004), is appropriate to study competitive relations among partners. Moreover, diverse sub-sectors in the biopharmaceutical industry related to the field of products (e.g. cancer, cell therapy, vaccines, etc.) are appropriate to measure the breadth and depth of

competition.

Third, as described in Chapter 4, biopharmaceutical firms in my dataset try to obtain cutting edge knowledge in a variety of industries and are forming R&D alliances with partners correspond to 41 different SIC codes. The backgrounds of the partners vary from similar fields, such as medicinal chemicals and diagnostic substances, to disparate fields, such as crude petroleum, cosmetics and semiconductors. In other words, due to the composition of such alliance portfolios, the present dissertation deals with firms from a number of different industries and, compared to simply testing alliance network within a single industry, increases the generalizability of the findings.

Moreover, the dissertation also includes some operationalization and measurement issues in each chapter that I expect future research to overcome, adding further robustness to the claims of the present thesis.

Relating to Chapter 3, the dependent variable, focal firms' innovation performance, is based on patent applications and does not consider whether the patent would be actually granted or the significance of the underlying knowledge and technology. Chapter 3 focused on the amount of technological outputs which the firms themselves consider innovative at the time of their invention and follows previous literature (e.g. Brouwer and Kleinknecht, 1999; Cheung and Lin, 2004) in using patent applications as a proxy for innovation performance. In addition, Chapter 3 focused on the amount of innovation output and counted the number of patent applications following the way widely used in previous literature (e.g., Ahuja, 2000a; Baum et al., 2000; Shan et al., 1994). However, it

does not consider the significance of the underlying knowledge and technology of each invention. Thus, I expect future research to consider this significance and introduce a better way for measuring innovation performance.

Additionally, in Chapter 3, the size of the alliance portfolio is operationalized by counting the number of alliance partners. This simple but intuitive measure for alliance portfolio size reflects the amount of network resources the focal firm possesses and has been adopted by a number of prior studies (e.g. Ahuja, 2000a; Baum et al., 2000; Deeds & Hill, 1996). However, following a stream of research which highlights detailed characteristics of network resources such as the breadth and efficiency of alliance portfolios and partner quality (e.g. Stuart, 2000; Stuart et al., 1999), this measure per se also needs improvement to allow it to precisely capture the amount of network resources and provide more insights relating to the size – performance link. Hence, I expect future research to develop a more detailed measure for alliance portfolio size, for example, an approach including the relative importance or the level of involvement of each alliance.

Finally, I expect further research on the influence of embeddedness in alliance portfolios. Previous literature deals with structural variables of the firm network and studies the influence of structural embeddedness. On top of the existing research, Chapter 3 applies the structural embeddedness concept, together with competitive embeddedness, to firms' egocentric networks. In case of competitive embeddedness, recent studies including Gimeno (2004) and Trapido (2007) initiate the discussion and much of this field is still unexplored. Though not explicit, competitive relationships are ubiquitous

among firms and affect their actions and outcomes. I hope for future research to study the influence of competitive embeddedness on alliance portfolios and focal firms in multifaceted ways. Moreover, I expect future research on other types of embeddedness, i.e. relational embeddedness and sectoral embeddedness, and their influence on alliance portfolios. This will lead to deeper understanding on how to configure alliance portfolios in terms of social network perspective.

Chapter 4, to operationalize the innovation performance, used data on patent applications and related patent citations and measured weighted patent counts. However, to measure the diversity of alliance portfolios and the proximity to alliance portfolios, Chapter 4 used the SIC codes instead of patent data. Using the SIC codes binds firms' knowledge base to their primary business fields and does not specifically distinguish the differences between firms in the same industry. To analyze the detailed knowledge configuration of an alliance portfolio, more specific data that captures specific knowledge variations among firms is required. Thus, I considered using firms' patent data to measure the diversity and proximity, however, still adhered to the SIC codes because of some disadvantages of patent data relating to the purpose of Chapter 4 as follows:

First, due to a great number of patent classes among the patents possessed by partner firms, it was difficult to distinguish the differences in alliance portfolio diversity among the sample firms. Through a pilot test based on some of the sample firms' patent data, a commonly high level of alliance portfolio diversity was identified. It did not seem to be relevant to examine the effect of alliance portfolio diversity and related moderating

effects which change the adoption level of diversity. Thus, in line with some prior studies (e.g. Cui & O'Connor, 2012; Jiang et al., 2010) which focus on the fact that firms in different industries possess different sets of knowledge, I adopted the SIC codes, which correspond to different industry fields, to measure both the diversity and proximity. Fortunately, the sample firms in the dataset were forming alliances across various industry fields, as many as 41 different SIC codes were identified, and allowed me to draw relevant conclusions based on the empirical results.

Second, considering the fact that firms' decision making relating to the management of their alliance portfolios is mainly about adding or withdrawing a certain alliance partner, with implications based on the patent configuration within alliance portfolios, firms would find it difficult to elaborately adjust the level of alliance portfolio diversity and proximity to their alliance portfolios. Thus, such implications would be of little practical help and thus would only provide a limited significance to firms. To provide more practical implications and ready-to-use strategic options to alliance managers, I focused on the firm level knowledge configurations of alliance portfolios, i.e. the SIC codes of each firm, in measuring the diversity of alliance portfolios and the proximity to alliance portfolios.

Nevertheless, I still acknowledge the limitation of the current measure and expect an alternative in future studies which sufficiently reflects the diversity and proximity of alliance portfolios while at the same time being able to provide a practical implication to firms.

As a result of the used data set and necessary assumptions and definitions, Chapter 5 also has some limitations which I hope can be overcome by future research. Due to the use of KIS data, which is generated by a survey, my data is mostly based on managers' perceptions, i.e. the contribution of each type of alliance and firms' innovation intent stated are the perception of managers of the respective firms. While this subjective measurement can be criticized, it offers a unique advantage by providing an insight into the organizational landscape from the top managers' point of view. Similar survey data has been used in previous literature (Beers & Zand, 2014; Faems et al., 2005; Mouri et al., 2012; etc.) to study the relationship between alliance behaviors and innovation performance. As the general recognition of the importance of alliance and innovation might be chance in different industries, I introduced industry dummy variables related to the 21 different industries of my data set to account for possible between-industry differences. To complement and further verify the findings of this study on innovation effectiveness, I recommend future research to use a different set of data which captures firm behaviors and intents in a more systematic way.

Another limitation of Chapter 5 arises from the necessary definition of exploratory or exploitative alliances. Previous literature attempts to discern exploratory and exploitative alliances in various domains (e.g. Lavie & Rosenkopf, 2006; Li, Vanhaverbeke, & Schoenmakers) In Chapter 5, alliances which complement existing business are treated as exploitative (Brown & Eisenhardt, 1995; Faems et al., 2005; Schoonhoven & Jelinek, 1997) and, on the contrary, alliances which aim at creating new

technology and developing totally new products are regarded to be exploratory (George et al., 2002; Peters et al., 1998). Previous literature has shown several other possible domains for distinguishing exploratory and exploitative alliances such as function, structure, attribute (Lavie & Rosenkopf, 2006). Because of these various domains for exploration and exploitation alliances, a verified link between alliance activity and firm performance in one domain might be less effective in another domain. Considering this, I recommend future research to extensively investigate the relationship between alliance activities and innovation effectiveness across various domains to strengthen the findings of Chapter 5.

Finally, I would like future research to sufficiently take care of possible negative aspects of alliance strategy. For example, despite a number of advantages of technology alliances, alliance experience sometimes leads to indiscriminate alliance formations and may deteriorate firms' internal R&D capabilities (Park & Kang, 2013), hence, exhibits a diminishing return on R&D product success (Hoang & Rothaermel, 2005). Future research should investigate other possible risks of alliance strategy, systemize them and contribute to a more balanced approach toward managing alliance portfolios.

Bibliography

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

Ahuja, G. (2000b). The duality of collaboration: Inducements and opportunities in the formation of interfirm linkages. *Strategic Management Journal, 21*(3), 317-343.

Alexander, P. A., Schallert, D. L., & Hare, V. C. (1991). Coming to terms: How researchers in learning and literacy talk about knowledge.*Review of Educational Research*, *61*(3), 315-343.

Allison, P. D. (2012). When can you safely ignore multicollinearity? http://www.statisticalhorizons.com/multicollinearity. [Accessed May. 28, 2014].

Alter, C., & Hage, J. (1993). *Organizations Working Together*. Newbury Park, CA: Sage Publications.

Anand, B. N., & Khanna, T. (2000). Do firms learn to create value? The case of alliances. *Strategic Management Journal, 21*, 295-315.

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.

Bae, J., & Gargiulo, M. (2004). Partner substitutability, alliance network structure, and firm profitability in the telecommunications industry. *Academy of Management Journal, 47*, 843-859.

Bahemia, H., & Squire, B. (2010). A contingent perspective of open innovation in new product development projects. *International Journal of Innovation Management*, *14*(04), 603-627.

Bamford, J. D., & Ernst, D. (2002). Managing an alliance portfolio. *The McKinsey Quarterly, 3*, 29-39.

Barnett, W. P. (1991). Strategic deterrence among multipoint competitors. In L. R. Jauch & J. L. Wall (Eds.), *Best Paper Proceedings: 7-10*. Miami, FL: Academy of Management.

Barney, J. (1991). Firm resources and sustained competitive advantage. *Journal of Management*, *17*(1), 99-120.

Barron, D. (1992). The analysis of count data: Over-dispersion and autocorrelation. *Sociological Methodology, 22*, 179-220.

Baron, R. M., & Kenny, D. A. (1986). The moderator–mediator variable distinction in social psychological research: Conceptual, strategic, and statistical considerations. *Journal of Personality and Social Psychology, 51*, 1173.

Bapuji, H., Loree, D., & Crossan, M. (2011). Connecting external knowledge usage and firm performance: An empirical analysis. *Journal of Engineering and Technology*

Management, *28*(4), 215-231.

Baum, J. A. C., & Dutton, J. E. (1996). Introduction: The embeddedness of strategy. *Advances in Strategic Management, 13*, 1-15.

Baum, J. A. C., & Mezias, S. J. (1992). Localized competition and organizational failure in the Manhattan hotel industry, 1898-1990. *Administrative Science Quarterly, 37*(4), 580–604.

Baum, J. A. C., Calabrese, T., & Silverman, B. S. (2000). Don't go it alone: Alliance network composition and startups' performance in Canadian biotechnology. *Strategic Management Journal*, *21*(3) 267-294.

Beers, C., & Zand, F. (2014). R&D cooperation, partner diversity, and innovation performance: An empirical analysis. *Journal of Product Innovation Management, 31*, 292-312.

Belderbos, R., Carree, M., Diederen, B., Lokshin, B., & Veugelers, R. (2004). Heterogeneity in R&D cooperation strategies. *International Journal of Industrial Organization*, *22*(8), 1237-1263.

Belderbos, R., Carree, M., & Lokshin, B. (2006). Complementarity in R&D cooperation strategies. *Review of Industrial Organization*, *28*(4), 401-426.

Berg, S. V., Duncan, J. & Friedman, P. (1982). *Joint Venture Strategies and Corporate Innovation*. Cambridge, MA: Oelgeschlager, Gunn & Hain.

Bettis, R. A., & Prahalad, C. K. (1995). The dominant logic: Retrospective and extension. *Strategic Management Journal*, *16*(1), 5-14.

Blau, P. M. (1977). *Inequality and Heterogeneity.* New York, NY: Free Press.

Bogers, M., & West, J. (2012). Managing distributed innovation: Strategic utilization of open and user innovation. *Creativity and Innovation Management, 21*, 61-75.

Bonacich, P. (1987). Power and centrality: A family of measures. *American Journal of Sociology, 92*(5), 1170-1182.

Borgatti, S. P. (1997). Structural holes: Unpacking Burt's redundancy measure. *Connections 20*, 35-38.

Bower, J. L., & Christensen, C. M. (1997). Disruptive technologies: Catching the wave. In J. S. Brown (Ed.) *Seeing Differently: Insights on Innovation*. Cambridge, MA: Harvard Business Review.

Brambor, T., Clark, W. R., & Golder, M. (2006). Understanding interaction models: Improving empirical analyses. *Political analysis, 14*(1), 63-82.

Brandenburger, A. M., & Nalebuff, B. J. (1996). *Co-opetition*. New York, NY: Doubleday.

Brouthers, K. D., & Hennart, J. F. (2007). Boundaries of the firm: Insights from international entry mode research. *Journal of Management, 33*(3), 395-425.

Brouwer, E., & Kleinknecht, A. (1999). Innovative output, and a firm's propensity to patent: An exploration of CIS micro data. *Research Policy, 28*(6), 615-624.

Brown, S. L., & Eisenhardt, K. M. (1995). Product development: Past research, present findings, and future directions. *Academy of Management Review, 20*, 343-378.

Brown, S. L., & Eisenhardt, K. M. (1997). The art of continuous change: Linking complexity theory and time-paced evolution in relentlessly shifting

organizations. *Administrative Science Quarterly, 42*(Mar.), 1-34.

Bruyaka, O., & Durand, R. (2012). Sell-off or shut-down? Alliance portfolio diversity and two types of high tech firms' exit. *Strategic Organization, 10*(1), 7-30.

Buchko, A. A. (1994). Barriers to strategic transformation: Interorganizational networks and institutional forces. *Advances in Strategic Management, 10*(B), 81-106.

Burt, R. S. (1980). Autonomy in a social topology. *American Journal of Sociology*, 892-925.

Burt, R. S. (1987). Social contagion and innovation: Cohesion versus structural equivalence. *American Journal of Sociology, 92*(6), 1287-1335.

Burt, R. S. (1992). *Structural Holes*. Cambridge, MA: Cambridge University Press.

Burt, R. S. (2000). The network structure of social capital. *Research in Organizational Behavior, 22*, 345-423.

Cameron, A. C., & Trivedi, P. K. (1986). Econometric models based on count data: Comparisons and applications of some estimators and tests. *Journal of Applied Econometrics, 1*(1), 29-53.

Canals, J. (2001). How to think about corporate growth? *European Management Journal, 19*, 587-598.

Cantwell, J., & Colombo, M. G. (2000). Technological and output complementarities, and inter-firm cooperation in information technology ventures. *Journal of Management and Governance, 4*(1-2), 117-147.

Chen, M. J. (1996). Competitor analysis and interfirm rivalry: Toward a theoretical

integration. *Academy of Management Review, 21*(1), 100-134.

Chen, J., Chen, Y., & Vanhaverbeke, W. (2011). The influence of scope, depth, and orientation of external technology sources on the innovative performance of Chinese firms. *Technovation, 31*(8), 362-373.

Cheung, K. Y., & Lin, P. (2004). Spillover effects of FDI on innovation in China: Evidence from the provincial data. *China Economic Review, 15*(1), 25-44.

Chung, S. A., Singh, H., & Lee, K. (2000). Complementarity, status similarity and social capital as drivers of alliance formation. *Strategic Management Journal, 21*(1), 1-22.

Coase, R. H. (1937). The nature of the firm. *Economica, 4*(16), 386-405.

Cohen, W. M., & Levinthal, D. A. (1990). Absorptive capacity: A new perspective on learning and innovation. *Administrative Science Quarterly, 35*(1), 128-152.

Coleman, J. S. (1988). Social capital in the creation of human capital. *American Journal of Sociology, 94*, S95-S120.

Colombo, M. G., Doganova, L., Piva, E., D'Adda, D., & Mustar, P. (2014). Hybrid alliances and radical innovation: The performance implications of integrating exploration and exploitation. *The Journal of Technology Transfer*, 1-27.

Cronbach, L. J. (1987). Statistical tests for moderator variables: Flaws in analyses recently proposed. *Psychological Bulletin, 102*, 414-417.

Cui, A. S., & O'Connor, G. (2012). Alliance portfolio resource diversity and firm innovation. *Journal of Marketing, 76*(4), 24-43.

Dacin, M. T., Ventresca, M. J., & Beal, B. D. (1999). The embeddedness of organizations: Dialogue & directions. *Journal of Management, 25*(3), 317-356.

Das, T. K., & Teng, B. S. (2000). A resource-based theory of strategic alliances. *Journal of Management, 26*(1), 31-61.

Deeds, D. L., & Hill, C. W. L. (1996). Strategic alliances and the rate of new product development: An empirical study of entrepreneurial biotechnology firms. *Journal of Business Venturing, 11*(1), 41-55.

De Leeuw, T., Lokshin, B., & Duysters, G. (2014). Returns to alliance portfolio diversity: The relative effects of partner diversity on firm's innovative performance and productivity. *Journal of Business Research, 67*(9), 1839-1849.

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.

Dervitsiotis, K. N. (2010). Developing full-spectrum innovation capability for survival and success in the global economy. *Total Quality Management, 21*, 159-170.

Dickson, P. H., & Weaver, K. M. (1997). Environmental determinants and individual-level moderators of alliance use. *Academy of Management Journal, 40*, 404-425.

Doz, Y. L., & Hamel, G. (1995). The use of alliances in implementing technology strategies. In M. L. Tushman & P. Anderson (Eds.), *Managing Strategic Innovation and Change: A Collection of Readings* (pp. 556-580). New York, NY: Oxford University Press.

Dutta, S., & Weiss, A. M. (1997). The relationship between a firm's level of technological innovativeness and its pattern of partnership agreements. *Management Science*, *43*(3), 343-356.

Duysters, G., De Man, A. P., & Wildeman, L. (1999). A network approach to alliance management. *European Management Journal, 17*(2), 182-187.

Duysters, G., Hagedoorn, J., & Lemmens, C. (2003). The effect of alliance block membership on innovative performance. *Revue d'Economie Industrielle, 103*, 59–70.

Duysters, G., Heimeriks, K. H., Lokshin, B., Meijer, E., & Sabidussi, A. (2012). Do firms learn to manage alliance portfolio diversity? The diversity-performance relationship and the moderating effects of experience and capability. *European Management Review*, *9*(3), 139-152.

Duysters, G., & Lemmens, C. (2003). Alliance group formation: Enabling and constraining effects of embeddedness and social capital in strategic technology alliance networks. *International Studies of Management and Organization*, *33*(2), 49-68.

Duysters, G., & Lokshin, B. (2011). Determinants of alliance portfolio complexity and its effect on innovative performance of companies. *Journal of Product Innovation Management*, *28*(4), 570-585.

Dyer, J. H., & Hatch, N. W. (2004). Using supplier networks to learn faster. *MIT Sloan Management Review, 45*(3), 57-63.

Dyer, J. H., & Hatch, N. W. (2006). Relation-specific capabilities and barriers to knowledge transfers: Creating advantage through network relationships. *Strategic Management Journal, 27*(8), 701-719.

Dyer, J. H., & Singh, H. (1998). The relational view: Cooperative strategy and sources of interorganizational competitive advantage. *Academy of Management Review, 23*(4), 660-679.

Echols, A., & Tsai, W. (2005). Niche and performance: The moderating role of network embeddedness. *Strategic Management Journal, 26*(3), 219-238.

Eisenhardt, K. M., & Schoonhoven, C. B. (1996). Resource-based view of strategic alliance formation: Strategic and social effects in entrepreneurial firms. *Organization Science, 7*(2), 136-150.

Faems, D., Van Looy, B., & Debackere, K. (2005). Interorganizational collaboration and innovation: Toward a portfolio approach. *Journal of Product Innovation Management, 22*, 238-250.

Faems, D., Janssens, M., & Neyens, I. (2012). Alliance portfolios and innovation performance connecting structural and managerial perspectives. *Group & Organization Management, 37*(2), 241-268.

Ferrary, M. (2011). Specialized organizations and ambidextrous clusters in the open innovation paradigm. *European Management Journal, 29*(3), 181-192.

Flavell, J. H. (1987). Speculation about the nature and development of metacognition. In F. E. Weinert & R. H. Kluwe (Eds.), *Metacognition, Motivation, and*

Understanding (pp. 21-29). Hillsdale, NJ: Erlbaum.

Freeman, L. C. (1979). Centrality in social networks conceptual clarification. *Social Networks, 1*(3), 215-239.

Fricke, S. E., & Shenbar, A. J. (2000). Managing multiple engineering projects in a manufacturing support environment. *IEEE Transactions on Engineering Management, 47*(2), 258-268.

Gassmann, O., Reepmeyer, G., & Von Zedtwitz, M. (2008). *Leading Pharmaceutical Innovation: Trends and Drivers for Growth in the Pharmaceutical Industry*. New York, NY: Springer Science & Business Media.

Garcia-Pont, C., & Nohria, N. (2002). Local versus global mimetism: Dynamics of alliance formation in the automobile industry. *Strategic Management Journal, 23*, 307–321.

Gatignon, H., & Xuereb, J. M. (1997). Strategic orientation of the firm and new product performance. *Journal of Marketing Research*, 77-90.

George, G., Zahra, S. A., Wheatley, K. K., & Khan, R. (2001). The effects of alliance portfolio characteristics and absorptive capacity on performance: A study of biotechnology firms. *Journal of High Technology Management Research, 12*: 205-226.

George, G., Zahra, S. A., & Wood Jr, D. R. (2002). The effects of business–university alliances on innovative output and financial performance: A study of publicly traded biotechnology companies. *Journal of Business Venturing, 17*, 577-609.

Gilsing, V., & Nooteboom, B. (2005). Density and strength of ties in innovation networks: An analysis of multimedia and biotechnology. *European Management Review, 2*(3), 179-197.

Gilsing, V., & Nooteboom, B. (2006). Exploration and exploitation in innovation systems: The case of pharmaceutical biotechnology. *Research Policy, 35*, 1-23.

Gilsing, V. A., & Nooteboom, B., Vanhaverbeke, W., Duysters, G. M., & Van den Oord, A. (2008). Network embeddedness and the exploration of novel technologies: Technological distance, betweenness centrality and density. *Research Policy, 37*, 1717-1731.

Gimeno, J. (2004). Competition within and between networks: The contingent effect of competitive embeddedness on alliance formation. *Academy of Management Journal, 47*(6), 820-842.

Gnyawali, D. R., & Madhavan, R. (2001). Cooperative networks and competitive dynamics: A structural embeddedness perspective. *Academy of Management Review, 26*(3), 431-445.

Granovetter, M. (1983). The strength of weak ties: A network theory revisited. *Sociological Theory, 1*(1), 201-233.

Granovetter, M. (1985). Economic action and social structure: The problem of embeddedness. *American Journal of Sociology, 91*(3), 481-510.

Goerzen, A. (2005). Managing alliance networks: Emerging practices of multinational corporations. *Academy of Management Executive, 19*(2), 94-107.

Goerzen, A. (2007). Alliance networks and firm performance: The impact of repeated partnerships. *Strategic Management Journal, 28*(5), 487-509.

Goerzen, A., & Beamish, P. W. (2005). The effect of alliance network diversity on multinational enterprise performance. *Strategic Management Journal, 26*(4), 333-354.

Gomes-Casseres, B. (2006). How alliances reshape competition. In O. Shenkar & J. J. Reuer (Eds.), *Handbook of Strategic Alliances* (pp. 39-53). Thousand Oaks, CA: SAGE Publications.

Grant, R. M. (1996). Toward a knowledge-based theory of the firm. *Strategic Management Journal, 17*(S2), 109-122.

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

Sims, N., Harrison, R., & Gueth, A. (2001). Managing alliances at Lilly. *Windhover's In Vivo: The Business & Medicine Report, 19*(6), 1-9.

Gulati, R. (1995a). Does familiarity breed trust? The implications of repeated ties for contractual choice in alliances. *Academy of Management Journal, 38*(1), 85-112.

Gulati, R. (1995b). Social structure and alliance formation patterns: A longitudinal analysis. *Administrative Science Quarterly, 40*(4), 619-652.

Gulati, R. (1998). Alliances and networks. *Strategic Management Journal, 19*(4), 293-317.

Gulati, R. & Singh, H. (1998). The architecture of cooperation: Managing coordination costs and appropriation concerns in strategic alliances. *Administrative Science*

Quarterly, 43, 781-814.

Gulati, R (1999). Network location and learning: The influence of network resources and firm capabilities on alliance formation. *Strategic Management Journal, 20*, 397–420.

Gulati, R. & Gargiulo, M. (1999). Where do interorganizational networks come from? *American Journal of Sociology, 104*(5), 1439-1493.

Gulati, R., Nohria, N., & Zaheer, A. (2000). Guest editors' introduction to the special issue: Strategic networks. *Strategic Management Journal, 21*(3), 199-201.

Gulati, R. (2007). *Managing Network Resources: Alliances, Affiliations and Other Relational Assets*. Oxford, UK: Oxford University Press.

Hagedoorn, J. (1993). Understanding the rationale of strategic technology partnering: Interorganizational modes of cooperation and sectoral differences. *Strategic Management Journal, 14*(5), 371–385.

Hagedoorn, J. (2002). Inter-firm R&D partnerships: An overview of major trends and patterns since 1960. *Research Policy, 31*(4), 477-492.

Hagedoorn, J. & Duysters, G. (2002). Learning in dynamic inter-firm networks: The efficacy of multiple contacts. *Organization studies, 23*(4), 525-548.

Hagedoorn, J., Letterie, W., & Palm, F. (2007). On the information value of (un)embedded network ties. *METEOR Research Memorandum 2007-004*, Maastricht University, The Netherlands.

Hair, J. F., Anderson, R. E., Tatham, R. L., & Black, W. C. (1995). *Multivariate Data*

Analysis with Readings. Upper Saddle River, NJ: Prentice Hall.

Hannan, M. T., & Freeman, J. (1977). The population ecology of organizations. *American Journal of Sociology, 82*(5), 929–964.

Hannan, M. T., & Freeman, J. (1989). *Organizational Ecology.* Cambridge, MA: Harvard University Press.

Hargadon, A., & Sutton, R. I. (1997). Technology brokering and innovation in a product development firm. *Administrative Science Quarterly, 42*(4), 716-749.

Hargrave, T. J., & Van de Ven, A. H. (2006). A collective action model of institutional innovation. *Academy of Management Review, 31*(4), 864-888.

Harrigan, K. R. (1988). Joint ventures and competitive strategy. *Strategic Management Journal*, *9*(2), 141-158.

Hausman, J., Hall, B. H., & Griliches, Z. (1984). Econometric models for count data with an application to the patents-R & D relationship. *Econometrica, 52*, 909-938.

Heimeriks, K. H., & Duysters, G. (2007). Alliance capability as a mediator between experience and alliance performance: An empirical investigation into the alliance capability development process. *Journal of Management Studies*, *44*(1), 25-49.

Heimeriks, K. H., Duysters, G., & Vanhaverbeke, W. (2007). Learning mechanisms and differential performance in alliance portfolios. *Strategic Organization*, *5*(4), 373-408.

Helfat, C. E. (2000). Guest editor's introduction to the special issue: The evolution of firm capabilities. *Strategic Management Journal, 21*(10-11), 955-959.

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

Hill, C. W. (1988). Differentiation versus low cost or differentiation and low cost: A contingency framework. *Academy of Management Review*, *13*, 401-412.

Hitt, M. A., Hoskisson, R. E., & Ireland, R. D. (1994). A mid-range theory of the interactive effects of international and product diversification on innovation and performance. *Journal of Management*, *20*(2), 297-326.

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*, 332-345.

Hoang, H., & Rothaermel, F. T. (2010). Leveraging Internal and External Experience: Exploration, Exploitation, and R&D Project Performance. *Strategic Management Journal*, *31*, 734-758.

Hoffmann, W. H. (2005). How to manage a portfolio of alliances. *Long Range Planning*, 38(2), 121-143.

Hoffmann, W. H. (2007). Strategies for managing a portfolio of alliances. *Strategic Management Journal*, 28(8), 827-856.

Holmqvist, M. (2003). A dynamic model of intra-and interorganizational learning. *Organization Studies*, *24*(1), 95-123.

Ibarra, H (1993). Personal networks of women and minorities in management: A conceptual framework. *Academy of Management Review*, *18*(1), 56-87.

Ingram, P., & Baum, J. A. (1997). Opportunity and constraint: Organizations' learning from the operating and competitive experience of industries. *Strategic Management Journal*, *18*(s1), 75-98.

Inkpen, A. C. (2000). Learning through joint ventures: A framework of knowledge acquisition. *Journal of Management Studies*, *37*(7), 1019-1044.

Jassawalla, A. R., & Sashittal, H. C. (2002). Cultures that support product-innovation processes. *Academy of Management Executive*, *16*, 42-54.

Jiang, R. J., Tao, Q. T., & Santoro, M. D. (2010). Alliance portfolio diversity and firm performance. *Strategic Management Journal*, *31*(10), 1136-1144.

Kale, P., Dyer, J. H., & Singh, H. (2002). Alliance capability, stock market response, and long-term alliance success: The role of the alliance function. *Strategic Management Journal*, *23*(8), 317-343.

Kale, P., & Singh, H. (1999, August). Alliance capability & success: A knowledge-based approach. In *Academy of Management Proceedings* (Vol. 1999, No. 1, pp. 1-6). Academy of Management.

Kam, C., & Franzese, R. (2003). Modeling and interpreting interactive hypotheses in regression analysis: A brief refresher and some practical advice. Unpublished manuscript, University of Michigan, Ann Arbor.

Keil, T., Maula, M., Schildt, H., & Zahra, S. A. (2008). The effect of governance modes and relatedness of external business development activities on innovative performance. *Strategic Management Journal*, *29*(8), 895-907.

Khanna, T., Gulati, R., & Nohria, N. (1998). The dynamics of learning alliances: Competition, cooperation, and relative scope. *Strategic Management Journal, 19*(3), 193-210.

Kim, Y. (2013). Some recent empirical developments regarding the bio-industry: Using the Granger-causality test with Indonesia's palm oil data. *International Journal of Bio-Science and Bio-Technology, 5*(5), 13-24.

King, A. A., & Tucci, C. L. (2002). Incumbent entry into new market niches: The role of experience and managerial choice in the creation of dynamic capabilities. *Management Science, 48*(2), 171-186.

Klein, K. J., & Sorra, J. S. (1996). The challenge of innovation implementation. *Academy of Management Review, 21*, 1055-1080.

Kogut, B. (1988). Joint ventures: Theoretical and empirical perspectives. *Strategic Management Journal, 9*(4), 319-332.

Kogut, B. (1991). Joint ventures and the option to expand and acquire. *Management Science, 37*(1), 19-33.

Kogut, B., Walker, G., & Kim, D.J. (1995). Cooperation and entry induction as an extension of technological rivalry. *Research Policy, 24*(1), 77-95.

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

Koka, B. R., & Prescott, J. E. (2008). Designing alliance networks: The influence of network position, environmental change, and strategy on firm

performance. *Strategic Management Journal*, *29*(6), 639-661.

Koput, K. W. (1997). A chaotic model of innovative search: Some answers, many questions. *Organization Science*, *8*(5), 528-542.

Koza, M. P., & Lewin, A. Y. (1998). The co-evolution of strategic alliances. *Organization Science*, *9*, 255-264.

Kraatz, M. S. (1998). Learning by association? Interorganizational networks and adaptation to environmental change. *Academy of Management Journal*, *41*(6), 621-643.

Kratzer, J., Gemuenden, H. G., & Lettl, C. (2008). Revealing dynamics and consequences of fit and misfit between formal and informal networks in multi-institutional product development collaborations. *Research Policy*, *37*, 1356-1370.

Kulatilaka, N., & Kogut, B. (1994). Options thinking and platform investments: Investing in opportunity. *California Management Review*, *36*(2), 52-71.

Lai, J. H., Chang, S. C., & Chen, S. S. (2010). Is experience valuable in international strategic alliances?. *Journal of International Management*, *16*(3), 247-261.

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

Lanjouw, J. O., & Schankerman, M. (1999). *The Quality of Ideas: Measuring Innovation with Multiple Indicators*. NBER working papers no. 7345. National Bureau of Economic Research, Cambridge, MA.

Lavie, D (2006). The competitive advantage of interconnected firms: An extension of the

resource-based view. *Academy of Management Review, 31*(3), 638-658.

Lavie, D (2007). Alliance portfolios and firm performance: A study of value creation and appropriation in the U.S. software industry. *Strategic Management Journal, 28*(12), 1187-1212.

Lavie, D., Kang, J., & Rosenkopf, L. (2011). Balance within and across Domains: The performance implications of exploration and exploitation in alliances. *Organization Science, 22*, 1517-1538.

Lavie, D., & Miller, S. R. (2008). Alliance portfolio internationalization and firm performance. *Organization Science, 19*(4), 623-646.

Lavie, D., & Rosenkopf, L. (2006). Balancing exploration and exploitation in alliance formation. *Academy of Management Journal, 49*, 797-818.

Lee, H., & Kelley, D. (2008). Building dynamic capabilities for innovation: An exploratory study of key management practices. *R&D Management, 38*, 155-168.

Lee, C., Lee, K., & Pennings, J. M. (2001). Internal capabilities, external networks, and performance: a study on technology-based ventures. *Strategic Management Journal*, *22*(6-7), 615-640.

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

Levitt, B., & March, J. G. (1988). Organizational learning. *Annual Review of Sociology, 14*, 319-340.

Li, Y., Vanhaverbeke, W., & Schoenmakers, W. (2008). Exploration and exploitation in

innovation: Reframing the interpretation. *Creativity and Innovation Management*, *17*, 107-126.

Lichtenthaler, U., & Lichtenthaler, E. (2004). Alliance functions: Implications of the international multi-R&D-alliance perspective. *Technovation*, *24*(7), 541-552.

Lin, N., Ensel, W. M., & Vaughn, J. C. (1981). Social resources and strength of ties: Structural factors in occupational status attainment. *American Sociological Review*, 393-405.

Lin, C., Wu, Y. J., Chang, C., Wang, W., & Lee, C. Y. (2012). The alliance innovation performance of R&D alliances—the absorptive capacity perspective. *Technovation*, *32*(5), 282-292.

Lin, Z., Yang, H., & Arya, B. (2009). Alliance partners and firm performance: Resource complementarity and status association. *Strategic Management Journal*, *30*, 921-940.

Loewe, P., & Dominiquini, J. (2006). Overcoming the barriers to effective innovation. *Strategy & Leadership*, *34*, 24-31.

Lorenzoni, G., & Lipparini, A. (1999). The leveraging of interfirm relationships as a distinctive organizational capability: A longitudinal study. *Strategic Management Journal*, *20*(4), 317-338.

Luo, X., & Deng, L. (2009). Do birds of a feather flock higher? The effects of partner similarity on innovation in strategic alliances in knowledge-intensive industries. *Journal of Management Studies*, *46*(6), 1005-1030.

Malik, T. (2012). Disparate association between alliance social capital and the global pharmaceutical firm's performance. *International Business Review, 21*(6), 1017-1028.

March, J. G. (1991). Exploration and exploitation in organizational learning. *Organization Science, 2*, 71-87.

Marino, L., Strandholm, K. & Steensma, H. K., & Weaver, K. M. (2002). The moderating effect of national culture on the relationship between entrepreneurial orientation and strategic alliance portfolio extensiveness. *Entrepreneurship Theory and Practice, 26*, 145-160.

McEvily, B., & Zaheer, A. (1999). Bridging ties: A source of firm heterogeneity in competitive capabilities. *Strategic Management Journal, 20*(12), 1133-1156.

McGrath, R. G. (2001). Exploratory learning, innovative capacity, and managerial oversight. *Academy of Management Journal, 44*(1), 118-131.

Mc Namara, P., & Baden-Fuller, C. (2007). Shareholder returns and the exploration–exploitation dilemma: R&D announcements by biotechnology firms. *Research Policy, 36*, 548-565.

McPherson, M. (1983). An ecology of affiliation. *American Sociological Review, 48*, 519-532.

Miller, D. (1983). The correlates of entrepreneurship in three types of firms. *Management Science, 29*, 770-791.

Mitchell, W., & Singh, K. (1996). Survival of businesses using collaborative relationships

to commercialize complex goods. *Strategic Management Journal*, *17*(3), 169-195.

Mody, A. (1993). Learning through alliances. *Journal of Economic Behavior & Organization*, *20*(2), 151-170.

Morrison, E. W. (2002). Newcomers' relationships: The role of social network ties during socialization. *The Academy of Management Journal*, *45*(6), 1149-1160.

Mouri, N., Sarkar, M. B., & Frye, M. (2012). Alliance portfolios and shareholder value in post-IPO firms: The moderating roles of portfolio structure and firm-level uncertainty. *Journal of Business Venturing*, *27*, 355-371.

Mohr, J., & Spekman, R. (1994). Characteristics of partnership success: Partnership attributes, communication behavior, and conflict resolution techniques. *Strategic Management Journal*, *15*(2), 135-152.

Mowery, D. C., Oxley, J. E., & Silverman, B. S. (2002). The two faces of partner-specific absorptive capacity: Learning and cospecializing in strategic alliances. In F. J. Contractor & P. Lorange (Eds.), *Cooperative Strategies and Alliances* (pp. 292-319). Oxford, UK: Elsevier Science.

Nahapiet, J., & Ghoshal, S. (1998). Social capital, intellectual capital, and the organizational advantage. *Academy of Management Review*, *23*, 242–266.

Narin, F., Noma, E., & Perry, R. (1987). Patents as indicators of corporate technological strength. *Research Policy*, *16*(2-4), 143-155.

Nelson, R., & Winter, S. (1982). *An Evolutionary Theory of Economic Change.* Cambridge, MA: Harvard University Press.

Nieto, M. J., & Santamaría, L. (2007). The importance of diverse collaborative networks for the novelty of product innovation. *Technovation, 27*(6), 367-377.

Nonaka, I. (1994). A dynamic theory of organizational knowledge creation. *Organization Science, 5*(1), 14-37.

Nooteboom, B. (1999). *Inter-firm Alliances: Analysis and Design*. London, UK: Routledge.

Nooteboom, B. (2002). *Trust: Forms, Foundations, Functions, Failures and Figures*. Cheltenham, UK: Edward Elgar Publishing.

Oerlemans, L. A., Knoben, J., & Pretorius, M. W. (2013). Alliance portfolio diversity, radical and incremental innovation: The moderating role of technology management. *Technovation, 33*(6), 234-246.

O'Hara, R. B., & Kotze, J. (2010). Do not log-transform count data. *Methods in Ecology and Evolution, 1*, 118-122.

Oliver, C. (1990). Determinants of interorganizational relationships: Integration and future directions. *Academy of Management Review, 15*(2), 241-265.

Ozcan, P., & Eisenhardt, K. (2009). Origin of alliance portfolios: Entrepreneurs, network strategies, and firm performance. *Academy of Management Journal, 52*(2), 246-279.

Park, S. H., Chen, R. R., & Gallagher, S. (2002). Firm resources as moderators of the relationship between market growth and strategic alliances in semiconductor start-ups. *Academy of Management Journal, 45*(3), 527-545.

Park, G., & Kang, J. (2010). Entry conditions, firm strategies, and their relationship on the innovaiton performance of emerging green industry. *Asian Journal of Technology Innovation, 18*(2), 22-42.

Park, G., & Kang, J. (2013). Alliance addiction: Do alliances create real benefits?. *Creativity and Innovation Management, 22*(1), 53-66.

Park, G., Kim, M. J., & Kang, J. (2015). Competitive embeddedness: The impact of competitive relations among a firm's current alliance partners on its new alliance formations. *International Business Review, 24*(2), 196-208.

Parise, S., & Casher, A. (2003). Alliance portfolios: Designing and managing your network of business-partner relationships. *Academy of Management Executive, 17*(4), 25-39.

Peteraf, M. A. (1993). The cornerstones of competitive advantage: A resource-based view. *Strategic Management Journal, 14*(3), 179-191.

Peters, L., Groenewegen, P., & Fiebelkorn, N. (1998). A comparison of networks between industry and public sector research in materials technology and biotechnology. *Research Policy, 27*, 255-271.

Podolny, J. M. (1993). A status-based model of market competition. *American Journal of Sociology, 98*(4), 829-872.

Podolny, J. M., & Baron, J. N. (1997). Resources and relationships: Social networks and mobility in the workplace. *American Sociological Review, 62*(5), 673-693.

Porter, M. E. (1980). *Competitive Strategy: Techniques for Analyzing Industries and*

Competitors. New York, NY: The Free Press

Porter, M. (1996). What is strategy? *Harvard Business Review, 74*, 61–79.

Powell, W. W., Koput, K. W., & Smith-Doerr, L. (1996). Interorganizational collaboration and the locus of innovation: Networks of learning in biotechnology. *Administrative Science Quarterly, 41*(1), 116-145.

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

Raisch, S., Birkinshaw, J., Probst, G., & Tushman, M. L. (2009). Organizational ambidexterity: Balancing exploitation and exploration for sustained performance. *Organization Science, 20*, 685-695.

Rangan, S. (2000). Search and deliberation in international exchange: Microfoundations to some macro patterns. *Journal of International Business Studies*, 205-222.

Ranger-Moore, J., Banaszak-Holl, J., & Hannan, M. T. (1991). Density-dependent dynamics in regulated industries: Founding rates of banks and life insurance companies. *Administrative Science Quarterly, 36*(1), 36-65.

Riccaboni, M., & Moliterni, R. (2009). Managing technological transitions through R&D alliances. *R&D Management*, *39*(2), 124-135.

Richardson, G. B. (1972). The organization of industry. *Economic Journal*, *82*, 883-896.

Reuer, J. J., & Ragozzino, R. (2006). Agency hazards and alliance portfolios. *Strategic Management Journal*, *27*(1), 27-43.

Reuer, J. J., Park, K. M., & Zollo, M. (2002). Experimental learning in international joint

ventures: The role of experience heterogeneity and venture novelty. In F. J. Contractor & P. Lorange (Eds.), *Cooperative Strategies and Alliances* (pp. 321-344). Oxford, UK: Pergamon.

Rosenkopf, L., & Nerkar, A. (2001). Beyond local search: Boundary-spanning, exploration, and impact in the optical disk industry. *Strategic Management Journal*, *22*(4), 287-306.

Rothaermel, F. T. (2001). Incumbent's advantage through exploiting complementary assets via interfirm cooperation. *Strategic Management Journal*, *22*, 687-699.

Rothaermel, F. T., & Boeker, W. (2008). Old technology meets new technology: Complementarities, similarities, and alliance formation. *Strategic Management Journal*, *29*(1), 47-77.

Rothaermel, F. T., & Deeds, D. L. (2004). Exploration and exploitation alliances in biotechnology: A system of new product development. *Strategic Management Journal*, *25*, 201-221.

Rowley, T., Behrens, D., & Krackhardt, D. (2000). Redundant governance structures: An analysis of relational embeddedness in the steel and semiconductor industries. *Strategic Management Journal*, *21*(Special Issue), 369-386.

Russo, A., & Vurro, C. (2010). Cross-boundary ambidexterity: Balancing exploration and exploitation in the fuel cell industry. *European Management Review*, *7*(1), 30-45.

Sampson, R. C. (2004). Organizational choice in R&D alliances: Knowledge-based and transaction cost perspectives. *Managerial and Decision Economics*, *25*(6-7), 421-

436.

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.

Schilke, O., & Goerzen, A. (2010). Alliance management capability: An investigation of the construct and its measurement. *Journal of Management*, *36*(5), 1192-1219.

Schilling, M. A., & Phelps, C. C. (2007). Interfirm collaboration networks: The impact of large-scale network structure on firm innovation. *Management Science*, *53*(7), 1113-1126.

Schoonhoven, C. B., & Jelinek, M. (1997). Dynamic tension in innovative, high technological firms: Managing rapid technological change through organizational structure. In M. L. Tushman & P. Anderson (Eds.), *Managing Strategic Innovation and Change: A Collection of Readings* (pp. 233-254). New York, NY: Oxford University Press.

Scott, J. (1991). *Social Network Analysis: A Handbook*. Thousand Oaks, CA: Sage.

Shan, W., Walker, G., & Kogut, B. (1994). Interfirm cooperation and startup innovation in the biotechnology industry. *Strategic Management Journal*, *15*(5), 387-394.

Shipilov, A. (2013, September, 26). Samsung beats Blackberry in the global alliance game. *Forbes*. Retrieved from http://www.forbes.com.

Silverman, B. S. (1999). Technological resources and the direction of corporate diversification: Toward an integration of the resource-based view and transaction

cost economics. *Management Science, 45*(8), 1109-1124.

Silverman, B. S., & Baum, J. A. C. (2002). Alliance-based competitive dynamics. *Academy of Management Journal, 45*(4), 791-806.

Simonin, B. L. (1997). The importance of collaborative know-how: An empirical test of the learning organization. *Academy of Management Journal, 40*(5), 1150-1174.

Sinkula, J. M., Baker, W. E., & Noordewier, T. (1997). A framework for market-based organizational learning: Linking values, knowledge, and behavior. *Journal of the Academy of Marketing Science, 25*, 305-318.

Smith, K. W., & Sasaki, M. S. (1979). Decreasing multicollinearity: A method for models with multiplicative Functions. *Sociological Methods & Research, 8*(1), 35-56.

Srivastava, M. K., & Gnyawali, D. R. (2011). When do relational resources matter? Leveraging portfolio technological resources for breakthrough innovation. *Academy of Management Journal, 54*(4), 797-810.

Stuart, T. E. (2000). Interorganizational alliances and the performance of firms: A study of growth and innovation rates in a high-technology industry. *Strategic Management Journal, 21*(8), 791-811.

Stuart, T. E., Hoang, H., & Hybels, R. C. (1999). Interorganizational endorsements and the performance of entrepreneurial ventures. *Administrative Science Quarterly, 44*(2), 315-349.

Stuart, T. E., Ozdemir, S. Z., & Ding, W. W. (2007). Vertical alliance networks: The case of university–biotechnology–pharmaceutical alliance chains. *Research*

Policy, *36*(4), 477-498.

Tanriverdi, H. (2006). Performance effects of information technology synergies in multibusiness firms. *MIS Quarterly*, *30*(1), 57-77.

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

Teece, D. J., Pisano, G., & Shuen, A. (1997). Dynamic capabilities and strategic management. *Strategic Management Journal*, *18*(7), 509-533.

The Bank of Korea. (2014). Economic Statistical System. URL http://ecos.bok.or.kr/. [accessed on 28 May 2014]

Thrasher, E. H., Craighead, C. W., & Byrd, T. A. (2010). An empirical investigation of integration in healthcare alliance networks. *Decision Support Systems*, *50*, 116-127.

Trajtenberg, M. (1990). A penny for your quotes. *Rand Journal of Economics*, *21*(1), 172-187.

Trapido, D. (2007). Competitive embeddedness and the emergence of interfirm cooperation. *Social Forces*, *86*(1), 165-191.

Tushman, M. L., & Anderson, P. (1986). Technological discontinuities and organizational environments. *Administrative Science Quarterly*, *31*(3), 439-465.

Uzzi, B. (1997). Social structure and competition in interfirm networks: The paradox of embeddedness. *Administrative Science Quarterly*, *42*(1), 35-67.

Van de Vrande, V. (2013). Balancing your technology-sourcing portfolio: How sourcing

mode diversity enhances innovative performance. *Strategic Management Journal*, *34*(5), 610-621.

Vassolo, R. S., Anand, J., & Folta, T. B. (2004). Non-additivity in portfolios of exploration activities: A real options-based analysis of equity alliances in biotechnology. *Strategic Management Journal*, *25*(11), 1045-1061.

Vasudeva, G., & Anand, J. (2011). Unpacking absorptive capacity: A study of knowledge utilization from alliance portfolios. *Academy of Management Journal*, *54*(3), 611-623.

Verona, G. (1999). A resource-based view of product development. *Academy of Management Review*, *24*, 132-142.

Walker, G., Kogut, B., & Shan, W. (1997). Social capital, structural holes and the formation of an industry network. *Organization Science*, *8*(2), 109-125.

Walker, M. E., Wasserman, S., & Wellman, B. (1993). Statistical models for social support networks. *Sociological Methods & Research*, *22*(1), 71-98.

Wang, L., & Zajac, E. J. (2007). Alliance or acquisition? A dyadic perspective on interfirm resource combinations. *Strategic Management Journal*, *28*(13), 1291-1317.

Wassmer, U (2010). Alliance portfolios: A review and research agenda. *Journal of Management*, *36*(1), 141-171.

Wick, C. W., & Leon, L. S. (1993). *The Learning Edge: How Smart Managers and Smart Companies Stay Ahead*. New York, NY: McGraw-Hill.

Williamson, O. E. (1985). *The Economic Institutions of Capitalism*. New York, NY: Free Press.

Wuyts, S., & Dutta, S. (2014). Benefiting from alliance portfolio diversity the role of past internal knowledge creation strategy. *Journal of Management*, *40*(6), 1653-1674.

Yamakawa, Y., Yang, H., & Lin, Z. J. (2011). Exploration versus exploitation in alliance portfolio: Performance implications of organizational, strategic, and environmental fit. *Research Policy*, *40*, 287-296.

Yang, J. (2012). Innovation capability and corporate growth: An empirical investigation in China. *Journal of Engineering and Technology Management*, *29*, 34-46.

Yi, Y. (1989). On the evaluation of main effects in multiplicative regression models. *Journal of the Market Research Society*, *31*, 133-138.

Zollo, M., & Winter, S. G. (2002). Deliberate learning and the evolution of dynamic capabilities. *Organization Science*, *13*(3), 339-351.

Zukin, S., & DiMaggio, P. (1990). *Structures of Capital: The Social Organization of the Economy*. Cambridge, UK: Cambridge University Press.

국 문 초 록

혁신에 대한 중요성이 날로 커지는 가운데 기업 및 조직간의 제휴는 새로운 지식을 흡수하여 혁신을 실현하기 위한 중요한 전략적 수단으로 부상하였다. 이미 컴퓨터 소프트웨어, 하드웨어, 생명공학 및 통신장비 등 혁신이 중시되는 첨단 산업 내에서 제휴가 빈번하게 이루어지고 있으며 이들 산업의 지속적인 성장과 혁신 창출에 기여하고 있다. 그러한 가운데 현대의 기업은 개별적인 제휴를 관리하는 것을 넘어 다수의 제휴를 동시에 관리해야 하는 새로운 과업에 맞닥뜨리게 되었다. 제휴와 혁신 분야의 문헌 역시 개별 제휴를 관리하고 성과를 내는 데서 제휴 포트폴리오 - 한 기업이 맺고 있는 모든 제휴 - 를 관리하고 이를 통해 성과를 창출하는 쪽으로 그들의 관점을 확대시켰다.

기존 문헌 내용 그리고 제휴 포트폴리오와 관련된 중요한 이슈를 고려하여 본 논문은 '파트너 조율', '다양성 수용' 그리고 '목적 조화'의 세 가지 구성요소를 포함하고 있다. 이들은 독자적으로 그리고 더불어 혁신 성과 창출에 기여한다. 그러나 성과를 극대화시키기 위해 각 요소에 적합한 상이한 관리 전략이 요구된다. 첫째, 파트너 조율 측면에서 더 나은 혁신 성과를 위해 제휴 포트폴리오의 크기를 키우는 동시에 중심 기업과 제휴를 맺고 있는 파트너들 사이의 관계 역시 고려해야 한다. 둘째, 제휴 포트폴리오 내에 산재하는 다양한 지식을 받아들이기 위해 기업의 제휴 경험을 증진시키는 것이 필요하다. 마지막으로 목적 조화의 측면에서 기업은 양손잡이 성격의 제휴 포트폴리오를

구축하고 동시에 적합한 혁신 의지를 통해 그들의 제휴 전략을 뒷받침해야 한다. 본 논문은 제휴 포트폴리오 관리의 각 요소들이 혁신 성과에 미치는 영향을 계량적으로 검증함으로써 제대로 된 제휴 포트폴리오 관리가 혁신을 실재화하는데 기여함을 밝힌다.

제휴 포트폴리오 구축 시 중심기업은 단순히 포트폴리오 내에 다수의 파트너를 포진시키는 것뿐만 아니라 그들간의 관계를 조율해야 한다. 파트너들 협력 혹은 경쟁 관계가 일차적으로 제휴 포트폴리오 내 지식 이전에 영향을 줄 뿐만 아니라 궁극적으로 중심 기업이 그들의 제휴 자원으로부터 얻게 될 이득에까지 영향을 미친다. 3장에서는 자원기반관점과 사회연결망 이론을 바탕으로 제휴 포트폴리오 내의 네트워크 자원이 중심 기업의 혁신 성과에 미치는 영향과 제휴 포트폴리오의 구조적 및 경쟁적 배태성이 이러한 영향을 어떻게 조절하는지 확인한다. 분석 결과에 의하면 제휴 포트폴리오의 크기가 클수록 중심기업에 혁신 성과를 증진시키는 데는 분명히 도움이 되지만 동시에 파트너 기업들간의 관계 역시 중심 기업 성과에 영향을 미치는 것으로 나타났다. 구체적으로 구조적 배태성의 관점에서 중심 기업의 파트너들이 촘촘히 상호 제휴 관계를 맺고 있을 때 제휴 포트폴리오 크기가 중심 기업의 혁신 성과에 미치는 긍정적인 영향을 더 강화하는 것으로 나타났다. 반면에 경쟁적 배태성의 관점에서 중심 기업의 파트너들이 서로 경쟁 관계에 있다면 포트폴리오 크기가 중심 기업의 혁신 성과에 미치는 긍정적인 영향을 약화시키는 것으로 나타났다. 이러한 결과는 기업들이 제휴 포트폴리오를 확장하는 과정에서 포트폴리오 내 파트너들이 형성하고 있는 양면적인 네트워크 관계 - 협력 네

트워크 및 경쟁 네트워크 - 에도 관심을 기울이라는 제언을 하고 있다.

기업들이 제휴 포트폴리오를 형성한 후에는 그들의 포트폴리오에 산재하는 다양한 지식을 수용할 수 있어야 한다. 다양성을 지닌 제휴 포트폴리오는 분명히 중심 기업에게 득이 되지만 중심 기업이 수용할 수 있는 다양성의 최대 수준은 그들의 제휴 경험 그리고 파트너와의 지식 인접성을 통해 확보되는 그들의 포괄적인 흡수 역량에 의해 영향을 받을 수 있다. 4장에서는 제휴 포트폴리오의 다양성과 혁신 성과 사이의 관계를 확인하며 뿐만 아니라 중심 기업의 제휴 경험과 중심 기업과 파트너 사이의 인접성이 이 관계를 어떻게 조절하는지 확인하다. 계량적 분석을 통해 제휴 포트폴리오의 다양성과 중심 기업의 혁신 성과 사이의 역 U자형 관계가 있음을 확인했다. 하지만 중심 기업이 제휴 경험을 축적할수록 제휴포트폴리오가 더 높은 수준의 다양성을 수용하고 그에 따라 더 증진된 혁신 성과를 누릴 수 있었다. 중심 기업과 포트폴리오 사이의 인접성은 다양한 지식을 흡수하는데 직접적인 기여를 하지는 않는 것으로 나타났다. 이러한 결과는 중심 기업이 누릴 수 있는 최대 수준의 제휴 포트폴리오 다양성은 제한되어 있지만 제휴 경험을 축적함으로써 높은 다양성이 제공하는 이점을 어떻게 누릴 수 있는지 배울 수 있음을 시사한다.

마지막으로 기업은 제휴 포트폴리오와 관련된 목적을 조화시킴으로써 더욱 효과적인 혁신 성과를 거둘 수 있어야 한다. 제휴를 통한 다자간의 의사결정은 시장 수요에 대한 이해와 시장 적응력을 높이는데 기여한다. 뿐만 아니라 제휴 결과물에 대해 서로 다른 배경을 지닌 파트너들이 내리는 엄밀한 평가는 혁신의 현실성과 시장성을 배가시킨다. 그리하여 제휴 포트폴리오는

즉각적인 혁신의 결과물을 산출하는 데뿐 아니라 혁신의 유효성을 높이는데 기여한다. 5장에서는 새로운 지식 습득을 목표로 하는 탐험적인 제휴가 혁신의 유효성에도 영향을 미침을 밝힌다. 더불어 제휴가 혁신 유효성에 미치는 영향을 강화하는데 기여하는 조직 외부 및 내부의 조건이 무엇인지 확인한다. 계량 분석을 통해 기업이 탐험적 제휴에 집중하는 것이 신 제품의 매출로 측정되는 혁신의 유효성에 기여함을 확인했다. 뿐만 아니라 제휴 포트폴리오 내에 탐험적 제휴와 더불어 활용적 제휴를 병행할 때와 조직 내부의 혁신 의지를 탐험적인 제휴의 목적과 일치시킬 때 신 제품의 혁신 유효성이 더 커짐을 확인했다. 이러한 결과는 제휴 포트폴리오를 조직 외부적으로 그리고 내부적으로 적절히 조화시킴으로써 효과적인 혁신 창출에 기여할 수 있음을 시사한다. 외부적으로 기업은 양손잡이 성격의 제휴 포트폴리오를 구축해야 하고, 내부적으로 적합한 혁신 의지를 갖춤으로써 제휴의 목적을 뒷받침해야 한다.

결론적으로 본 논문은 제휴 포트폴리오 관리를 구성하는 주요 요소를 다루고 있으며 이들이 중심 기업의 혁신 성과에 기여하고 있음을 밝힌다. 포트폴리오 관리의 각 요소에 해당하는 본 논문의 주요 결과와 의의는 다음과 같다. 첫째, 본 논문은 제휴 포트폴리오 내 파트너간 관계가 혁신 성과에 미치는 조절 효과를 확인함으로써 포트폴리오 구축 단계에서 한 편으로 파트너의 입장을 고려할 것을 권고한다. 다음으로 본 논문은 포트폴리오가 지닌 다양성을 흡수하는 단계에서 기업의 제휴 경험 그리고 포트폴리오와 기업간 인접성이 미치는 영향을 확인했다. 이러한 통합적인 접근은 기업이 제휴 포트폴리오 내의 지식을 받아들일 때 어떻게 하면 포트폴리오가 제공하는 다양성을 충분

히 누릴 수 있는지를 보여준다. 마지막으로 본 논문은 양손잡이 성격의 제휴 포트폴리오와 조직 내의 혁신 의지가 더 효과적인 혁신 성과를 내도록 제휴 포트폴리오를 조화시키고 있음을 확인했다. 이러한 결과는 더 나은 혁신 성과를 위해 탐험적 제휴와 활용적 제휴간 균형을 유지할 것을 기업들에게 권고하고 있으며 제휴 전략을 제휴의 영역에서 한정시킬 것이 아니라 전사적인 범위에서 지원할 것을 제안한다. 정리하면 본 논문은 적절한 제휴 포트폴리오 관리라는 이슈를 제시함으로써 기업의 제휴 포트폴리오가 외부 지식을 습득하고 궁극적으로 혁신을 실현하는데 중요한 전략적 수단임을 보이고 있다.

주요어 : 제휴 포트폴리오 관리, 혁신 성과, 제휴 파트너, 배태성, 제휴 포트폴리오 다양성, 양손잡이 전략
학 번 : 2009-21083