Ph. D. Dissertation in Engineering

A Multi-dimensional Approach to Technological Alliance Portfolios and Firm Performance

- An Empirical Study of the Korean Defense Industry -

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Abstract

A Multi-dimensional Approach to Technological Alliance Portfolios and Firm Performance

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The alliance partners with which a focal firm allies itself can be classified into three layers (vertical up-stream, horizontal, and vertical down-stream alliances) depending on the partners' characteristics. In chapter 2, this thesis hypothesizes that alliance portfolios affecting the performance of the firm differ according to layers. It tests how alliance portfolio configuration variables affect the firm's performance at vertical up-stream, down-stream and comprehensive alliance network levels. Chapter 3 also deals with the effect of the alliance portfolio configuration on the firm's performance in the vertical down-stream alliance portfolio. It presents three questions. First, do the resources that are accessible to a focal firm affect its performance? Second, what are the relative capabilities between a focal firm and partners affecting the former's performance? Lastly, which alliance portfolio structure, that is, one spanning structural hole versus a densely

embedded network, is superior considering the relative capabilities? The 54 leading firms of Korean defense industry are analyzed with two–step generalized method of moments (GMM) estimates over the period 1995–2010. In chapter 2, the results show that the balance between vertical up-stream and down-stream partners is important and that the alliance portfolio should differ depending on the vertical up-stream and down-stream alliance portfolios. In chapter 3, in the vertical down-stream alliance portfolio, large amounts of resources could improve firm performance with improved accessible resource measurement. Also, when constituting an alliance portfolio, a focal firm should compare its capabilities with a candidate partner firm, and the alliance portfolio structure should different according to the relative capabilities of a focal firm and partners. These findings provide managers with good intuitions for the detailed analysis and specification of strategy for the composition of alliance portfolios.

Keywords: alliance portfolio, comprehensive alliance portfolio, vertical up-stream alliance portfolio, vertical down-stream alliance portfolio, two-step generalized method of moments (GMM), Specialization-Systematization Legislations

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Chapter 1. Introduction

1.1 Background

Firms entering strategic alliances have become a common phenomenon in today's business landscape (Contractor & Lorange, 2002; Gulati, 1998; Mani & Antia, 2006). For instance, Apple, the consumer electronics company, recently established a strategic alliance with Nuance, which has developed a cutting-edge voice recognition technology, to create a voice-based personal assistance application for Apple's iPhone OS (iOS). Similarly, Sony announced its strategic alliance with AU Optronics (AUO), the first manufacturer in Taiwan to mass produce TV panels, in developing the OLED TV, a television that uses new light-emitting diode (LED) technology. Meanwhile, Toyota is collaborating with BMW to develop a next-generation lithium-ion battery for an eco-friendly car. Firms pursue strategic alliances to gain a competitive advantage in markets with increasing competition. Hence, a strategic alliance could be considered an important asset (Hoffmann, 2007; Kanter, 1994).

In today's business environment, most firms no longer depend on a single alliance, but rather maintain entire networks of alliances with different partners in order to access a broad range of resources (Hoffmann, 2005, 2007; Lavie, 2007; Parise & Casher, 2003; Wassmer, 2010). Such networks of alliances are also called "alliance portfolios," which are referred to egocentric alliance networks with social network perspective in table 1.1.

Viewing networks of alliances in terms of portfolios is useful for analyzing the costs and benefits of such alliances, as an efficiently configured alliance portfolio can improve firm performance (Wassmer, 2010). Firms differ in the configuration of their alliance portfolios, and consequently differ in the external resources and capabilities they can access (Gulati & Gargiulo, 1999). A focal firm's network of alliances can be regarded as an inimitable and non-substitutable resource, as well as a means to access unique capabilities (Wassmer & Dussauge, 2011; Zaheer & Bell, 2005).

Table 1.1 Existing conceptualizations of alliance portfolio

Study	Alliance Portfolio Conceptualization
Baum et al. (2000), Rowley et al. (2000) and Ozcan et al. (2009)	A focal firm's egocentric alliance network (i.e., all direct ties with partner firms) (social network perspective)
Bae & Gargiulo (2004))	The set of alliances in which a firm is involved
Doz & Hamel (1998)	The set of bilateral alliances maintained by a focal firm
George et al. (2001)	A firm's portfolio of strategic agreements or relationships
Hoffmann (2005, 2007)	All alliances of a focal firm
Lavie (2007)	A firm's collection of direct alliances with partners
Lavie & Miller (2008)	A firm's collection of immediate alliance partners
Parise & Casher (2003)	A firm's network of business-partner relationships
Reuer et al. (2002)	A firm's accumulated international joint venture experience (learning perspective)
Reuer & Ragozzino (2006)	All international joint ventures of a focal firm

Source: Wassmer, U. (2010). Alliance portfolios: A review and research agenda. *Journal of Management*, 36(1), 143.

Several studies have indicated that a firm's network of alliances influences its behavior and outcomes (e.g., Ahuja, 2000; Powell et al., 1996; Walker, Kogut, & Shan, 1997). Gulati et al. (2000) suggested that the behaviors and performances of firms can be more fully understood by examining the network of relationships in which they are embedded. The reason why it should be understood that the alliance in terms of the overall portfolio is able to be expressed as the costs and benefits function, and also that efficiently configured alliance portfolio can improve firm performance (Wassmer, 2010). Each firm's alliance portfolio configuration is different, and so are the external resources or capabilities which they can access from the portfolio (Gulati & Gargiulo, 1999). As a result, research has begun to examine the influence of certain network characteristics on firms' abilities to realize potential benefits (Das & Teng, 2002) and has paid significant attention to the phenomenon of alliance networks from different perspectives (Goerzen, 2007). In spite of the growing consensus that networks matter, however, the specific effects of the different elements of network structure on organizational performance remain unclear (Ahuja, 2000). Thus, the effect of network of alliances on individual firm performance is still a critical question for both managers and scholars (Dyer & Singh, 1998; Goerzen & Beamish, 2005; Gulati et al., 2000; Koka & Prescott, 2002).

According to Wassmer (2010), alliance portfolios are a relatively new research area in the broader field of strategic alliances. Themes in this area cluster around three major issues, namely the emergence, configuration, and management of alliance portfolios.

Chapter 2 in this thesis examines the three issues, specifically, portfolio size (i.e., number of alliances, number of partners), the role of alliance partners (i.e., diversity of partners, capabilities of partners), and structural portfolio characteristics (i.e., spanning structural holes) with multi-dimensional views. The third chapter is about the role of the alliance partners and structural characteristics affecting firm performance in vertical down-stream alliance portfolio. These specific items are indicated by the shaded areas in figure 1.1. This new research perspective will help overcome the dyadic perspective, and help determine enduring relationship patterns among firms in strategic alliances (Lavie, 2007).

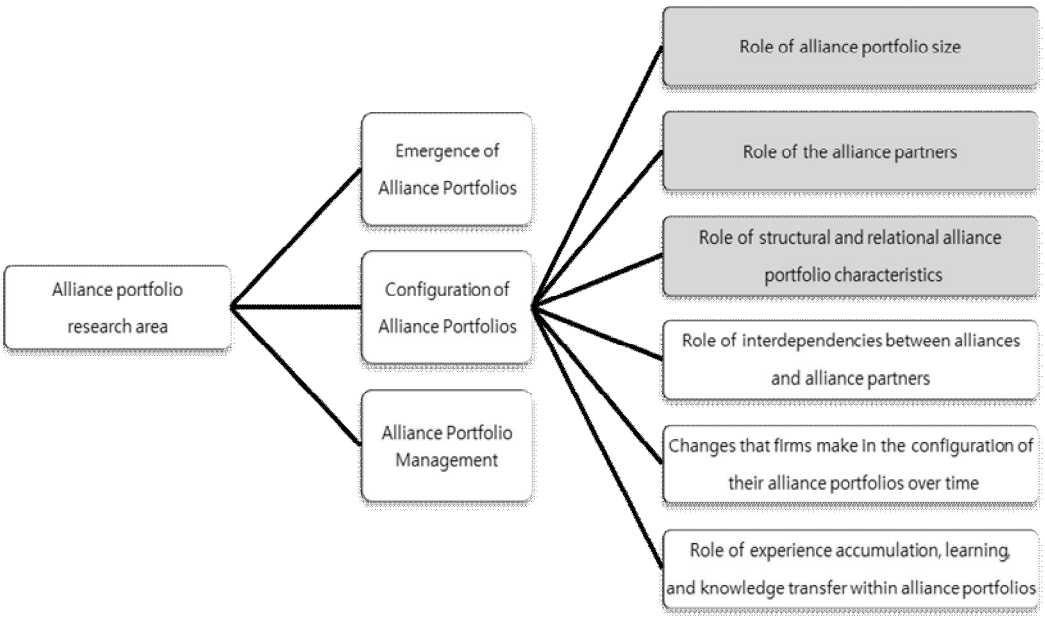

Figure 1.1. Research areas in alliance portfolio and the six prominent issues in alliance portfolio configuration

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

1.2 Research motivation

1.2.1 Previous research stream of Korean Defense industry

Recent scholarly interest in the Korean defense industry, designated by the government as a future growth sector, is the main reason for this study's focus on the defense industry in Korea. Previous studies on the defense industry can roughly be categorized into those at the national and industry levels (J. G. Kim, 2009). First, the studies at national level take a macroscopic approach. The main studies are as follows (S. H. Gu, 1998; S. G. Min, 1996): a study on the time-periodic characteristics of the development process in the defense industry prior to Park, Chung-hee's government (S. B. Hong, 1993), a study comparing the Korean defense industry's characteristics with those of the Taiwan defense industry, that is, focusing on foreign environments (Nolan, 1986); a study of the industry's overall characteristics focusing on its domestic environment, and so on. Second, the studies at industry level take a microscopic approach to the defense industry's development in line with government policies. The main studies are as follows: studies on strategies to overcome the downturn in the defense industry (W. S. Chae & B. O. Gil, 2009; S. P. Hong, 2007), which look at how to encourage the defense industry or encourage exports when the defense industry is experiencing a downturn; studies on the impact of specialization-systematization legislations, which were used to regulate the

defense industry, on the defense industry after the 1980s, and discussions of the follow-up measures taken after these legislations were abolished in 2009 (J. H. Kim, 2008; K. J. Kwon et al., 2007).

In summary, until now, studies on Korea's defense industry concentrated on the development strategies and the features of the industry at the national level, and on the institutional development plan at the industry level. In other words, Korea's defense industry has been viewed as an industry under the control of the country's institutions. This thesis looks at the defense industry at the firm level, and seeks to discover the effects of a strategic alliance portfolio. From this perspective, this study deviates from past studies, as well as presenting future growth strategies for the defense industry in the wake of the abolishment of the specialization-systematization legislations.

1.2.2 Specialization-Systematization Legislations

Meanwhile, the specialization-systematization legislations that supported government policies had a significant influence on the defense industry (K. Y. Kim, 2005). The background to these legislations is as follows: the development process of Korea's defense industry entered a new phase in the 1980s following successes over the 1970s. The defense industry, which the regime of President Park, Chung-hee did much to develop during the 1970s, faced a recession throughout the 1990s after going into decline during the 1980s (J. G. Kim, 2011). The defense industry's decline, on the whole, was due

to the government policy of importing foreign advanced weapons systems for short-term augmentation of the country's military power, rather than encouraging domestic R&D, as well as the government's dependence on U.S. military power. During this period, defense firms could no longer rely on government support and they saw the government reduce preferential measures for them. Hence, defense firms needed to explore new measures to ensure their survival by conducting their own R&D (J. G. Kim, 2011). The Minister of National Defense (MND) established the specialization-systematization legislations targeting existing defense products and firms to prevent overlapping investments and to promote technology development, as defense firms engaged in an intensely competitive struggle for survival. The specialization-systematization legislations classified specialization-systematization firms by areas, detailed areas, complete equipment, and components or parts of items depending on the required technologies and dedicated facilities, and gave priority to those firms participating in weapon systems acquisition programs through domestic R&D or technology acquisition. The government used the specialization-systematization legislations to promote its policy of fostering a technology-driven defense industry. Additionally, the legislations served not only to boost the competitiveness of defense firms, but also helped with rationalizing the management of independent weapons systems development and production capacities, which were necessary for self-reliant national defense (K. Y. Kim, 2005). The legislations were first introduced in 1983, and were developed through four rounds of revision as shown in table 1.2 below.

Table 1.2. Transition Process of the Specialization-Systematization Legislations

Revision	Period (Month of revision)	Operating System	Number of participating firms	Others
Introduction	Chun, Doo-Hwan administration (Jun. 1983)	Monopoly	Designation of main & sub-specialized firms	
1st revision	Roh, Tae-Woo administration (Dec. 1990)	Competition	Competition among 2–5 firms	Revision of product classification system
2nd revision	Kim, Young-Sam administration (Dec. 1993)	Restricted competition	2 specialized firms, 3 systematized firms	
3rd revision	Kim, Dae-Jung administration (Dec. 1998)	Strengthen dedicated system within restricted competition & Competition	Division into monopoly, oligopoly, depending on weapons system	The area of large-scale facilities: Strengthen dedicated system, Others: Competition
4th revision	Kim, Dae-Jung administration (Dec. 2001)	Monopoly & Oligopoly	Division into monopoly or oligopoly system, depending on weapons system	Restricted to core strategic weapons

Source: Kim, K. Y. (2005). Roh, Moo-hyun government's defense industrial policy: Focusing on the Specialization-Systematization Legislations. *The collection of treatises of Korean Political and Diplomatic History*, 27(1), 248. (In Korean)

At the core of the specialization-systematization legislations of the Chun, Doo-Hwan administration was the designating of main and sub-specialized firms. The Roh, Tae-Woo administration changed the focus of primary policy from one of a monopolistic production system to that of a competitive system in which several firms participated. However, the Kim, Young-Sam administration changed the legislations to enforce restricted competition due to the existing system's harmful effects of encouraging a scramble for survival among established firms. The Kim, Dae-Jung administration divided the defense industry into monopoly, oligopoly, and competition systems, depending on the weapons systems, in the third and fourth revisions. Further, most fields were converted to the competition system except that it is really needed to be maintained. In 2009, the Roh, Moo-hyun administration abolished these legislations in keeping with the principles of a market economy. In other words, defense firms were put into an infinite competition system. These institutional changes thus gave evidence of the strenuous efforts to decide on a policy for the defense industry, leading to a choice being made between a system of protection or competition.

The results of the study on the strategic alliance portfolio and firm performance during the period of government protection clearly indicate the importance of a strategic alliance portfolio with external partner firms. Therefore, this thesis can guide the future growth strategy of defense firms as it provides a reminder of the importance of external partners at the firm level.

1.3 Research scope

In many previous studies, scholars have tried to understand alliance portfolios as fragmentary layers. For example, horizontal alliance portfolios (Ahuja (2000), Stuart (2000), Zaheer & Bell (2005)) and comprehensive alliance portfolios (Baum (2000)) were investigated in this way. Although some studies were undertaken from the perspective of the concept of layers, they dealt with the relationship between firm performance and the number of alliances, not including other network properties (Haeussler & Patzelt, 2008; Rothaermel & Deeds, 2006; Silverman & Baum, 2002). In contrast, chapter 2 introduces four variables: the number of alliances, the number of partners, structural holes, and network diversity, within vertical up-stream, down-stream, and comprehensive alliance portfolios, in order to compare each with the other. It will discuss how the strategies differ at each of the layers represented in figure 1.2.

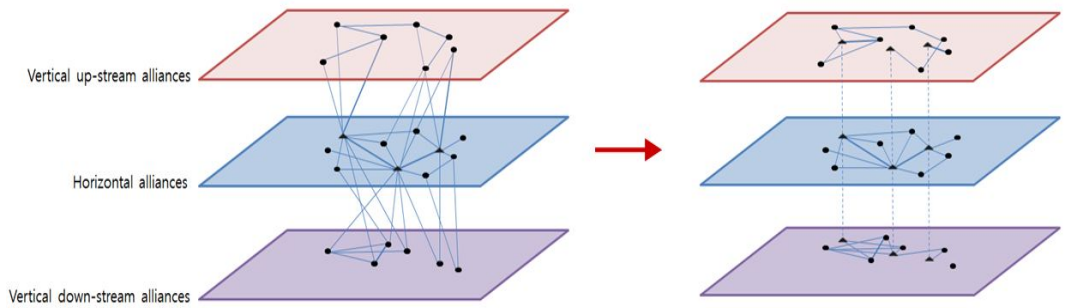

Figure 1.2. Hierarchical structure constituting the alliance portfolio of focal firms

Chapter 3 also concentrates on the technological vertical down-stream alliance

portfolio of Korean defense firms, with the aim of discussing the external resources, the characteristic differences between a focal firm and its partners, and structural hole spanning in vertical down-stream alliance portfolios. Alliance portfolios of two levels are excluded because it is hard to define the characteristics of partners in vertical up-stream alliance portfolios. Also, horizontal alliances of Korean defense firms are hard to find since the firms are segmented and specialized.

The scope of this thesis is summarized in below table 1.3.

Table 1.3. The scope of this thesis

Chapter	Issues	Vertical up-stream alliances	Horizontal alliances	Vertical down-stream alliances	Comprehensive alliances
2	The role of alliance portfolio size	○		○	○
2, 3	The role of structural portfolio characteristics	○		○	○
2	The role of diversity of partners	○		○	○
3	The role of the alliance partners			○	

1.4 Contributions

In chapter 2, the results show that the size variables of an alliance portfolio that are not significant in a comprehensive alliance network or in one layer can be significant in another layer. Also, the spanning of a structural hole may differ in up-stream and down-

stream alliance portfolios. In other words, the concept of layers provides a more specific grasp of the significant factors. Put differently, “ambidexterity in technological alliance portfolios” between these two layers can exist. Also, the balance between vertical up-stream and down-stream partners is important. In chapter 3, the role of the alliance partners in vertical down-stream alliance portfolio can be summarized in terms of three factors. First, large amounts of resources could improve firm performance with improved accessible resource measurement. Second, relative innovativeness, reputation, and bargaining power between a focal firm and its partners affect firm performance differently. This result gives a more fine-grained intuition than the argument of previous studies that simply innovative or reputational partners are better. This study aims to show not simply that good partners are better, but that superior performance lies in the capability relationship between a focal firm and partner firms. Lastly, the alliance portfolio structure should be different depending on the relative capability (innovativeness, reputation, and bargaining power) between a focal firm and a partner firm. In the debate about the linkage of social capital and communal social capital, the superior performance structures differ according to capability differences.

Chapter 2. Comparison of the alliance portfolio with respect to layers and firm performance

2.1 Introduction

The alliance partners of a focal firm can be classified into three levels (vertical up-stream alliances, horizontal alliances, vertical down-stream alliances) depending on the partner characteristics (Baum et al., 2000). These levels are expressible as layers, as shown in figure 2.1, in which an alliance portfolio of focal firms, represented by triangular nodes, in figure 2.1–①, means an egocentric network, and an alliance network means the whole picture of the relationships among nodes in the network in figure 2.1–②. The figure shows the relationships between the comprehensive alliance portfolio and the alliance portfolios that the three firms have in each layer: see figures 2.1–③, ④, ⑤. This representation makes clear why the benefits from each layer are different. A vertical up-stream alliance means entering partnerships with up-stream organizations in the value chain in order to obtain research knowledge from partners such as universities, research institutes, and government laboratories (Silverman & Baum, 2002). Vertical up-stream alliances provide opportunities to access essential, valuable, scientific, and advanced technical knowledge in developing new technologies (George et al., 2002; Powell et al., 1996; Rothaermel & Deeds, 2006). Horizontal alliances involve partnerships with firms on the same level in the value chain, and provide opportunities for joint development of

new products or services (Perry et al., 2004). The defense industry is classified in this layer. A down-stream alliance is a partnership with firms that lie down-stream in the value chain. Firms make these alliances not to obtain new knowledge, but to acquire complementary assets (Rothaermel & Deeds, 2006; Silverman & Baum, 2002). Sometimes, these assets are very valuable or ones those focal firms do not possess (Rothaermel & Deeds, 2006). The other industry firms are classified in this layer in technological alliances.

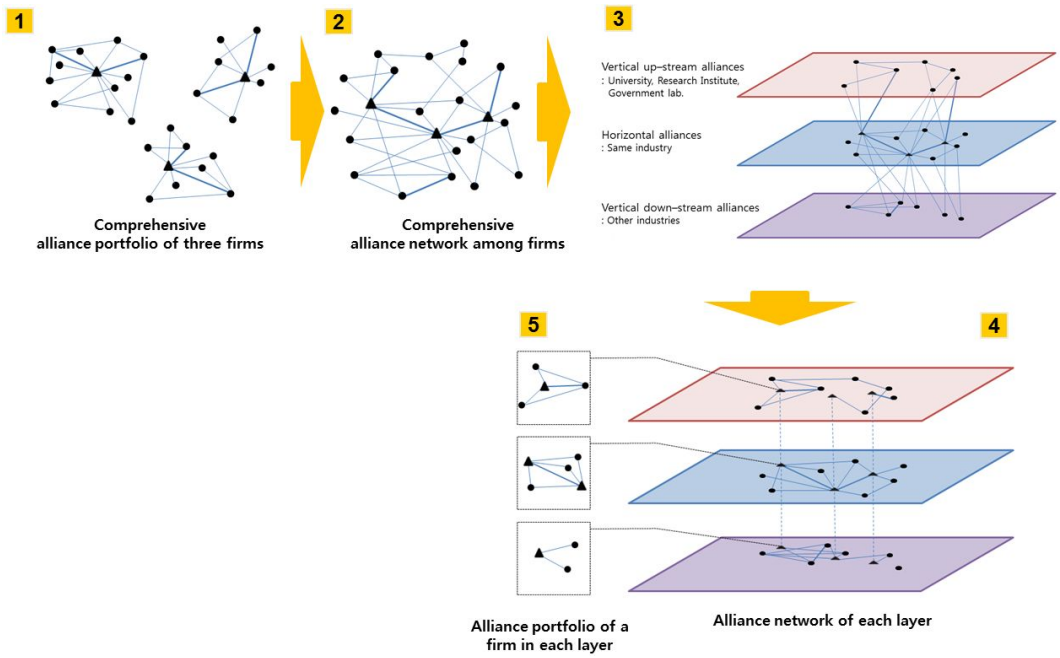

Figure 2.1. The relationship between comprehensive alliance portfolio and alliance portfolio in each layer

Figure 2.2 summarizes the scope of this chapter. The number of alliances and the

number of partners are included in the network size issue; structural holes are included amongst structural alliance portfolio characteristics, and network diversity is included in the role of the alliance partners among the six alliance portfolio configuration research area as introduced in chapter 1 (Wassmer, 2010). Horizontal alliance portfolios are omitted because relationships among defense industry firms are rarely easily identifiable, since defense industry technology is segmented and specialized. Two dependent variables (gross profit on sales and net income) are used.

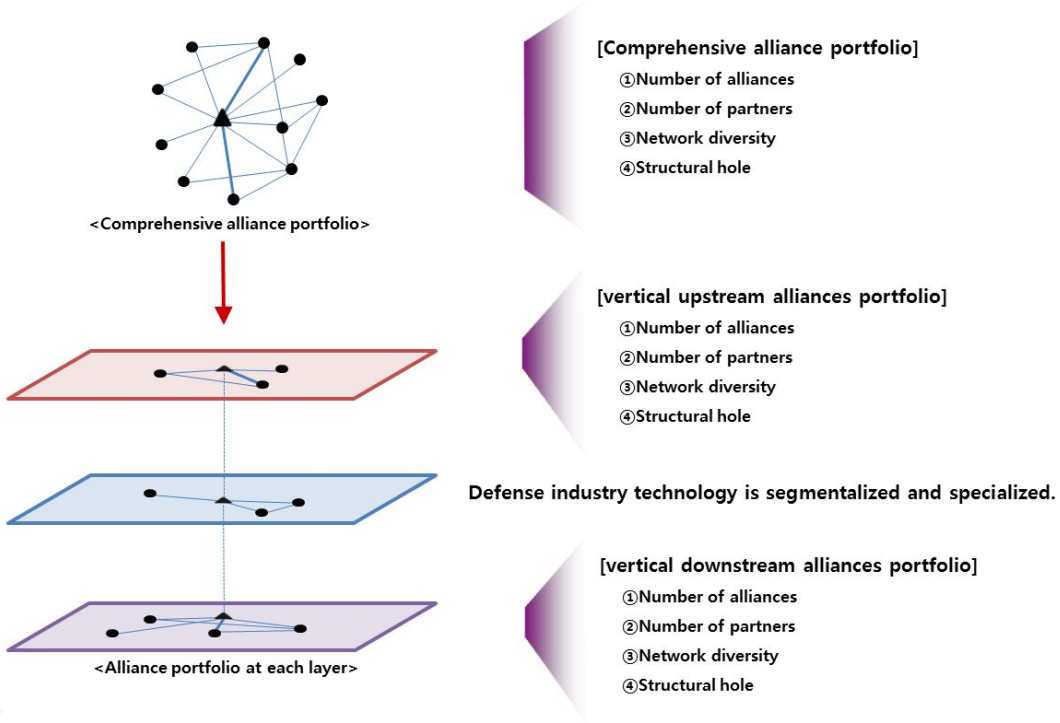

Figure 2.2. The scope of this chapter

Common hypotheses are formulated relating vertical up-stream, down-stream, and comprehensive alliance portfolios in terms of four variables derived from previous studies, and discuss the results from the perspective of the corresponding three analytic levels. This chapter shows that the alliance portfolio variables that are not significant at one analytic level can be significant at another. In other words, the concept of layers provides a more specific grasp of the significant factors: “ambidexterity in technological alliance portfolios” between two layers can exist. Further, the balance between vertical up-stream and down-stream partners is important. These results give managers sound intuitions for the detailed construction of alliance portfolios.

In the remainder of this paper, hypotheses are established, describe our methods, and outline our results. In the sections on theory and hypotheses, identical hypotheses are presented for the comprehensive, vertical up-stream, and down-stream alliance portfolios, and the findings are compared in the results sections. Our conclusions are discussed in light of the statistical results with implications for managers and scholars.

2.2 Theory and hypotheses

2.2.1 The number of alliances and number of partners

In previous research dealing with the size issue, the two variables, the number of alliances, and the number of partners, have not been strictly distinguished. In this article, these two variables are distinguished rigidly. A prerequisite for any precise distinction

between the two should be preceded by the identification of partners. The reason for this distinction is that the two variables can move very differently, as figure 2.3 shows. In (a) the focal firm has five alliances, but only one partner, whereas in (e) the two variables have the same value, 5.

	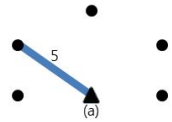	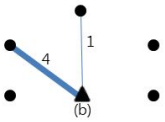	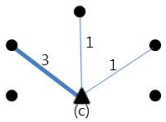	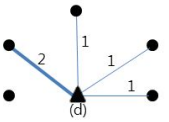	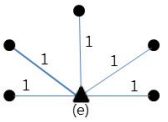
Number of alliances	5	5	5	5	5
Number of partners	1	2	3	4	5

Figure 2.3. The difference between the number of alliances and partners

There are countless studies on the number of alliances and corporate performance. Common to all these is the argument that increasing the number of alliances affects performance positively (e.g., Baum et al., 2000; Deeds & Hill, 1996; Oliver, 2001; Owen-Smith & Powell, 2004; Tsai, 2001).

The number of alliances was also used as a proxy for social capital (Chen & Ronowski, 2006) and for positional centrality in a network, which provides several benefits (Freeman, 1979). Through their central positioning, firms increase their abilities to access resources (Tsai, 2001), which can create new opportunities to enter new markets.

From a knowledge-based perspective, a central position favors better performance (Kogut & Zander, 1992; Tsai, 2000). In accordance with the received view highlighting the positive aspects of the number of alliances, the following hypothesis is proposed.

Hypothesis 1a: The more alliances a focal firm has, the better it performs.

In the study of alliance portfolios, fewer studies exist about the number of partners. Scholars may have thought the two concepts were too similar to be worth distinguishing. As mentioned before, however, these two concepts are distinct and different (Wassmer, 2010). The partner firms of a focal firm affect important decisions (Davis, 1996). A focal firm's information may be enriched by having many partners, and this information may affect the firm's practice (Davis & Greve, 1997; Galaskiewicz & Wasserman, 1989; Haunschild, 1993). In institutional theory, since a focal firm is affected by the culture and discipline of partner firms, it can follow its partners' advantages (Powell & DiMaggio, 1991). In addition, from a learning perspective, partner firms can affect a focal firm, since partner firms can be assume the role of teacher (Levitt and March 1988; Powell, 1990; Uzzi, 1996). Learning from several sources can lead to combinations of good or superior information (Powell et al., 1996; Stuart & Podolny, 2000), and affect the survival and growth of a focal firm (Podolny et al., 1996; Uzzi, 1996). In accordance with the received view highlighting the positive aspects of the number of partners, the following hypothesis is proposed.

Hypothesis 2a: The more partners a focal firm has, the better it performs.

On the other hand, increasing the number of alliances and the number of partners could affect the firm's performance negatively. From the resource-based view, accessing network resources through multiple simultaneous strategic alliances with different partners can express the alliance's benefits and costs function (Wassmer & Dussauge, 2011). An alliance portfolio maintaining the focal firm and its existing alliances and partners can increase the costs, and thus reduce the value. In other words, efficiency and inefficiency in the alliance portfolio could coexist. Therefore, increasing the number of the alliances and partners could produce a negative effect. Accordingly, the following hypotheses are proposed.

Hypothesis 1b: The more alliances a focal firm has, the worse it performs.

Hypothesis 2b: The more partners a focal firm has, the worse it performs.

2.2.2 Spanning structural holes

Information travels not only through proximate ties in networks but also through the structure of the network itself (Gulati, 1998). There are two main accounts of our understanding of social capital: one account sees social capital as linking and the other views social capital as communal (Wu & Wei, 2004). While the stream of linking social capital emphasizes the benefits of a focal firm in a brokering position in an open network,

the other stream of communal social capital stresses the benefits of embeddedness of a focal firm in a closed network (Coleman, 1988, 1990; Granovetter, 1985). Much previous research, based on the structural hole theory of Burt (1992), has underlined the importance of spanning structural holes (Bae & Gargiulo, 2004; Dyer et al., 2008; Zaheer & Bell, 2005).

Burt (1992) suggested that spanning a structural hole is favorable for gaining a control advantage over competitors and obtaining non-redundant information. Through spanning a structural hole, a focal firm enriches resources by achieving greater access to mutually unconnected partners. Bae & Gargiulo (2004) argued that a firm's structural hole spanning positively affects its return on assets (ROA) and return on equity (ROE). Zaheer & Bell (2005) showed that spanning a structural hole is positively related to a firm's market share. In particular, they emphasized that the benefits of spanning structural holes for the firm's performance derives from the availability of new information. In accordance with the received view highlighting the positive aspects of spanning structural holes, the following hypothesis is proposed.

Hypothesis 3a: Spanning a structural hole enhances a focal firm's performance.

According to the communal social capital view emphasizing densely embedded networks, there are completely contrary effects. The social structures, where a focal firm

has numerous interconnected partners, are called closed networks and are favorable for the firm (Coleman, 1988, 1990; Walker et al., 1997). Coleman (1988) stated that optimal social structure can be generated by building interconnections. In addition, a focal firm obtains benefits through the exchange of information, the reduction of opportunism, and the lowering of monitoring costs depending on trust within this dense network (Zaheer & Venkatraman, 1995). The connectivity among a firm's partners leads to more productive collaboration from the viewpoint of resource sharing and access to new information (Ahuja, 2000). In accordance with the received view highlighting the positive aspects of densely embedded networks, the following hypothesis is proposed.

Hypothesis 3b: A densely embedded network of a focal firm enhances the firm's performance.

2.2.3 Network diversity

Understanding the effect caused by network diversity is necessary a deeper comprehension of the effect of alliance portfolios (Wassmer, 2010). Since this duplication makes the alliance portfolio inefficient, purchasing diversity is important (Baum et al., 2000; Goerzen, 2007). Baum et al. (2000) stress the importance of the diverse partners, which may yield more diverse resources, information, and capabilities with less cost. Existing empirical studies have argued that heterogeneity relative to the alliance portfolio affects the firm's performance positively (Faems et al., 2010; Hargadon & Sutton, 1997;

Nieto & Santamaría, 2007; Pelled et al., 1999; Rodan & Galunic, 2004). This diversity makes a focal firm broaden the range of its viewpoint, enhance its resource diversification, and improve problem-solving skills (Hambrick et al., 1996). In the present study, diversity may arise from many perspectives. There are diversity of organizations (universities, research institutes, and government laboratories) in the vertical up-stream alliance portfolio, and diversity of industries in the vertical down-stream alliance portfolio. In addition, there are diversity of layers (vertical up/down-stream) and diversity of organizations and industries in the comprehensive alliance portfolio. In accordance with the received view highlighting the positive aspects of network diversity, the following several hypotheses are proposed.

Hypothesis 4a-1: The diversity of organizations in the vertical up-stream alliance portfolio of a focal firm enhances the firm's performance.

Hypothesis 4a-2: The diversity of industries in the vertical down-stream alliance portfolio of a focal firm enhances the firm's performance.

Hypothesis 4a-3: The diversity of layers in the comprehensive alliance portfolio of a focal firm enhances the firm's performance.

Hypothesis 4a-4: The diversity of organizations and industries in the comprehensive alliance portfolio of a focal firm enhances the firm's performance.

On the other hand, diversity could be the cause of disruptions for a focal firm (Hambrick et al., 1996; Miller et al., 1998). While diversity provides a focal firm with wide range of resources, obstacles or barriers could arise in exchanging information. For instance, heterogeneity, such as different cultures, or a firm's terminology, paradigms, and goals, might not foster trust and emotional consistency for the focal firm (Goerzen & Beamish, 2005). Combining two different companies might not feed into the performance and innovation, but become a liability (Hambrick et al., 1996). For these reasons, the following contrary hypotheses are proposed.

Hypothesis 4b-1: The diversity of organizations in the vertical up-stream alliance portfolio of a focal firm reduces the firm's performance.

Hypothesis 4b-2: The diversity of industries in the vertical down-stream alliance portfolio of a focal firm reduces the firm's performance.

Hypothesis 4b-3: The diversity of layers in the comprehensive alliance portfolio of a focal firm reduces the firm's performance.

Hypothesis 4b-4: The diversity of organizations and industries in the comprehensive alliance portfolio of a focal firm reduces the firm's performance.

2.3 Method

2.3.1 The effects of alliance

The effects of alliance have not been clearly defined (Wassmer, 2010). Most previous studies measured the alliance performance effects one year after their inception (Ahuja, 2000; Koka & Prescott, 2002, 2008; Padula, 2008; Powell et al., 1996; Zaheer & Bell, 2005). The network *decay effect* where the liability of new ties is evident from slower decay in older relationships is adopted (Burt, 2000). This concept was used by Stuart (2000), in which the effect of an alliance is assumed to weaken over time during a five-year period. For example, five years prior to an alliance, the effect's weight is 0.2; four years prior, it is 0.4; three years prior, it is 0.6, and so on, defining this the *decay effect*.

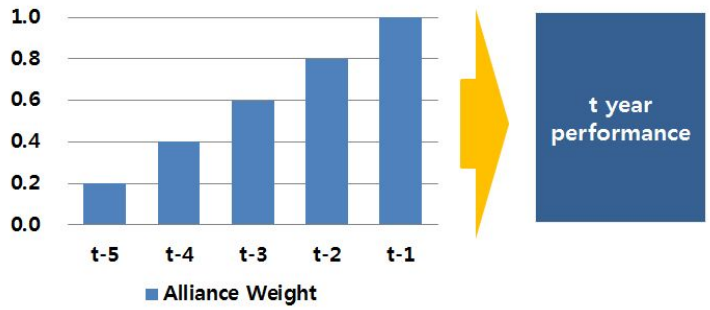

Figure 2.4. Measurement of the effect of alliance using the concept of network decay

2.3.2 Data

The technological alliances of 54 leading firms among 95 Korean defense firms, designated under the Korean government or Defense Acquisition Program Administration (DAPA), are investigated. Co-patenting is used as an indicator of technological alliance (Lecocq & Van Looy, 2009).

The defense firms can be divided according to two categories. First, it is divided along defense specialized sectors, that is maneuver, firepower, ammunition, battleship, air & guidance, communications electronics, chemical, biological, and radiological (CBR), and others. This division is based on battlefield functions. Second, the firms can be divided by main and general defense sectors. This division is based on how much the firms are concentrating on the defense products. Tables 2.1 and 2.2 show how many firms are participating in the alliance depending on the two categories. The firm's technological alliance ratio does not vary much in defense specialized sectors. However, when the firms are divided into main and general defense firms, the difference is larger. It seems to be related with the size of firms. Whereas the ratio of large firms in general defense firms is 15.8%, 6 among 38 firms, the ratio of large firms in main defense firms is 61.4%, 35 among 57 firms.

Table 2.1. The firm ratio of participants in technological alliances in defense specialized sectors

Specialized sector	Number of defense firms (A)	Number of participating firms in technological alliance (B)	Ratio (B/A)
Maneuver	14	8	57.1%
Firepower	13	7	53.8%
Ammunition	8	5	62.5%
Battleship	12	8	66.7%
Air & guidance	16	9	56.3%
Communications electronics	17	7	41.2%
Chemical, biological, and radiological (CBR)	3	1	33.3%
Others	12	9	75.0%

Table 2.2. The firm ratio of participants in technological alliance between main and general defense sectors

Division	Number of defense firms (A)	Number of participating firms in technological alliance (B)	Ratio (B/A)
Main defense firms	57	42	73.7%
General defense firms	38	12	31.6%

The year of technological alliance was assigned as the date of application, rather than the date of granting (Baum et al., 2000). The technological alliance data were obtained from the Korea Institute of Patent Information (KIPRIS) online patent search; from this,

492 alliances were found from 1995 to 2009, with each alliance involving two to six participants. Figure 2.5 shows cumulative comprehensive alliance network from 1995 to 2009. It shows how overall alliance portfolio configurations are consisted. In the comprehensive alliance network, 54 defense firms and 168 partner firms are identified. The red nodes indicate defense firms, and the blue ones do other industries' firms. If it is seen by the aspects of alliance portfolio, diverse alliance portfolio configurations are found in the figure 2.5.

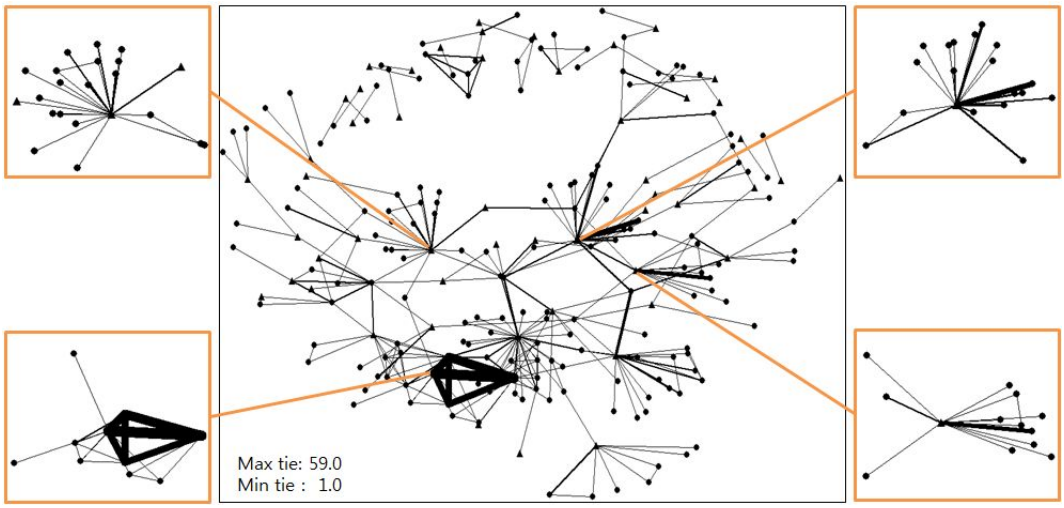

Figure 2.5. Alliance portfolios of several focal firms in cumulative comprehensive alliance network

This research represents the concept of layers according to the characteristics of partner firms. So, it is important to separate each layer, to show how overall alliance portfolio configurations are constituted. Furthermore, the separate figures will give

intuitions whether adopting the layer concept is proper. Figure 2.6 shows cumulative alliance networks with respect to vertical up-stream, horizontal, and down-stream alliances between defense firms and other firms. Just as above, the triangular nodes indicate defense firms, and the circle ones denote firms in other industries. Horizontal alliances of Korean defense firms are hard to find from figure 2.6–② since the firms are segmented and specialized. Through this figure, the scope of this study is limited to the comprehensive alliance portfolio, and the vertical up-stream and down-stream alliance portfolios.

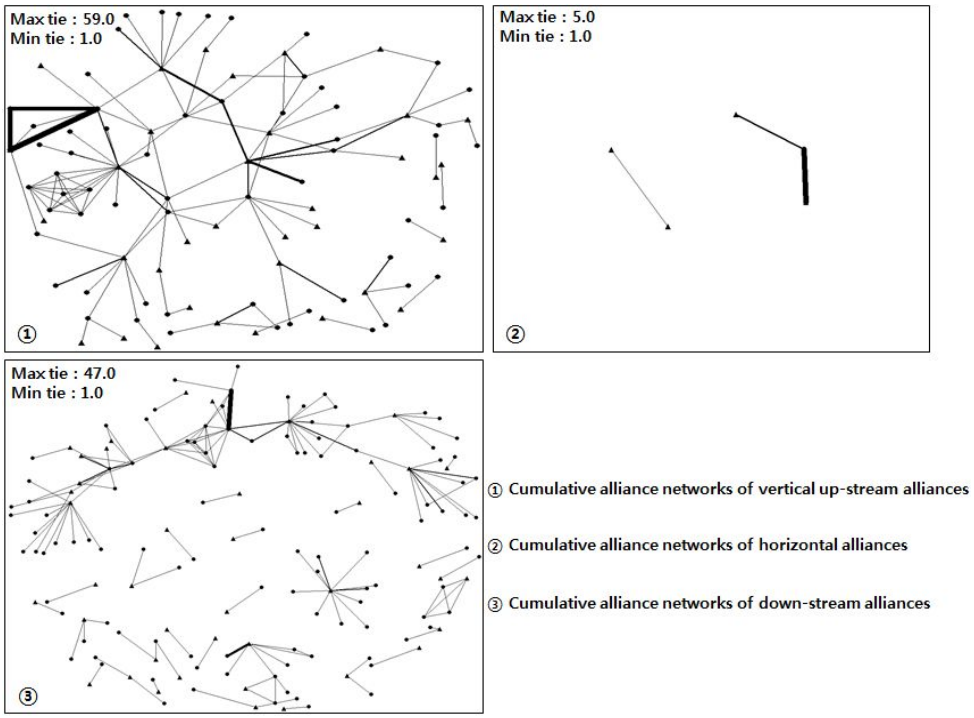

Figure 2.6. Cumulative vertical up-stream, horizontal, and down-stream alliance networks

To measure the *decay effect* of the alliances, their financial data was collected from the Korea Investors Service Value (KIS-Value) database for 2000–2010.

2.3.3 Dependent variables

To measure the performance of the 54 leading Korean defense firms, two variables are used: gross profit on sales[1], net income[2] of current year database for 2000–2010. The two variables indicate profitability of firm.

2.3.4 Explanatory variables

For the longitudinal analysis, 11 × 3 = 33 cumulative adjacency matrices for 1995–2009 with *decay effect* are set up to measure the financial and innovation effects for 2000–2010. For example, figure 2.7 represents 2004–2008 networks with *decay effect* affecting the performance in 2009 of comprehensive alliances, vertical up-stream alliance and vertical down-stream alliance networks. The maximum value of the alliances is 12.4, and the minimum value is 0.2. The red nodes represent defense firms. The explanatory variables, the number of alliances, the number of partners, structural holes, and network diversity, are measured in this setting each year.

[1] Gross profit on sales is the difference between revenue and the cost of making a product or providing a service.
[2] Net profit is equal to the gross profit on sales minus overhead expense minus interest.

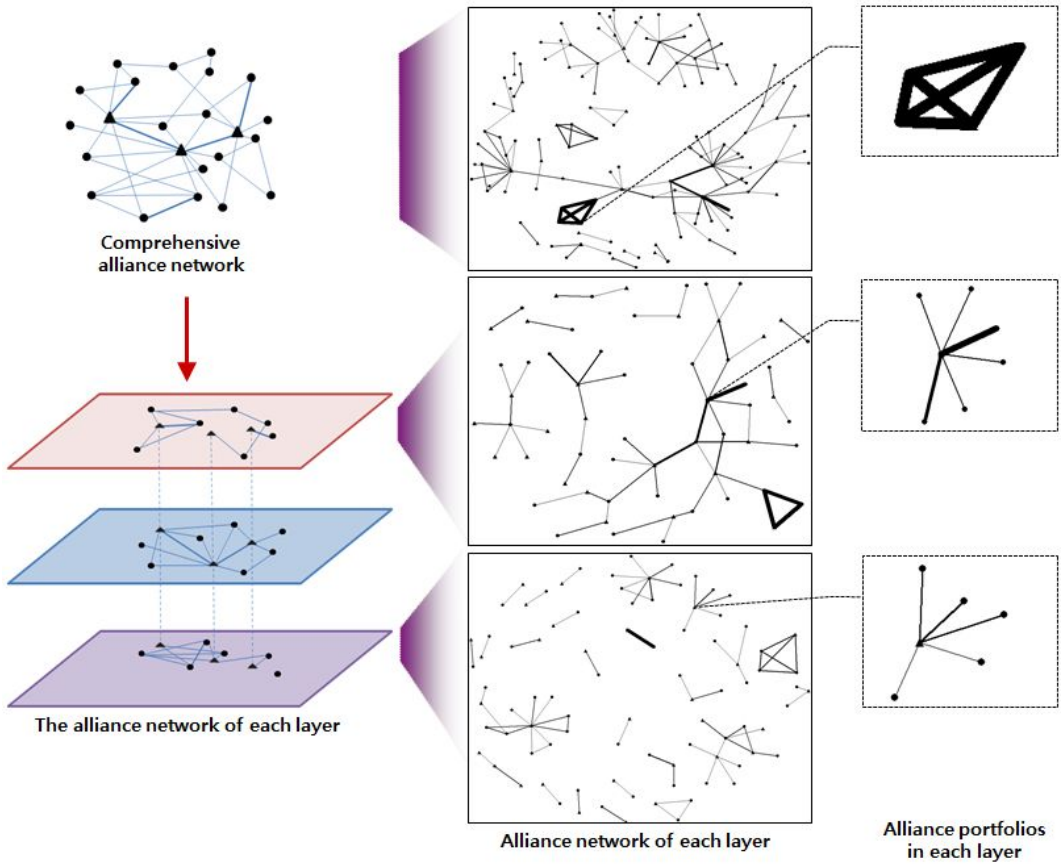

Figure 2.7. Alliance portfolios of each firm for the longitudinal analysis

2.3.4.1 The number of alliances

This variable is based on the degree centrality proposed by Freeman (1979), which measures the number of ties of a node. Ties can be defined as the weighted value between a set of two nodes that represent the firms. The single tie strength increases from 0.2 to 1.0 with the decay effect. The matrix A^t represents 33 adjacency matrices that affect the performance at *t*. Then, the number of alliances of firm *i* affecting performance in year *t*

can be calculated as follows: $w_{i1}^t + w_{i2}^t + \ldots + w_{iM}^t$

$$\mathrm{A}^t = \left(w_{ij}^t \right)_{i,j=1,\cdots,M} \quad \cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots \text{Eq. (1)}$$

Suppose the alliance portfolio configuration with the decreasing effect is composed as demonstrated in figure 2.8. The Figure shows that there are two alliances with thick ties and one alliance with a thin one. From this information, 9 alliances are found affecting the performance of focal firm (a) at *t*, and there are 5 alliances affecting the performance of focal firm (b) at the same periods.

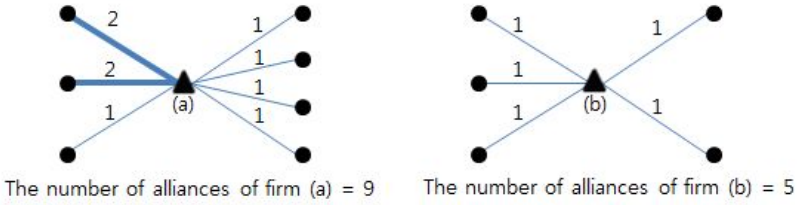

Figure 2.8. Examples of calculating the number of alliances

2.3.4.2 The number of partners

The number of partners of a focal firm is represented by the number of nodes to which a node is adjacent regardless of the strength of the ties. From the adjacency matrix A^t, the number of partners that a focal firm is connected can be calculated as the sum of the

indicator function I . It is the sum of the row in the matrix A^t counting only non-zero entries w_{ij}^t .

$$\sum_j (1 - I[w_{ij}^t = 0]) \quad where \quad \begin{matrix} I[x=c]=1 & if\ x=c \\ I[x=c]=0 & if\ x \neq c \end{matrix} \quad \text{for constant } c \qquad \cdots\cdots \text{Eq. (2)}$$

Suppose that the alliance portfolio configuration with the decreasing effect is composed as demonstrated in figure 2.9. As mentioned earlier, the number of alliances with thick and thin ties is 2 and 1, respectively. The number of partners of firm (a) is 7 and that of firm (b) is 5. It is important to note that the tie strength does not affect these two values.

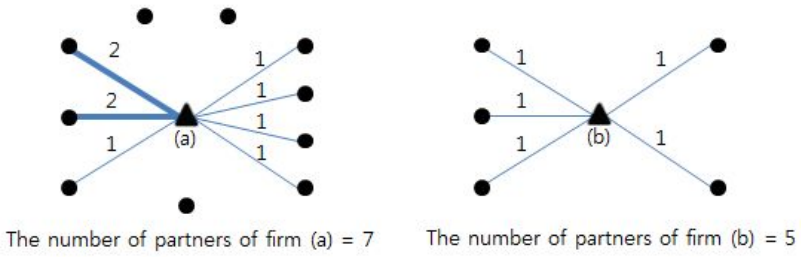

Figure 2.9. Examples of calculating the number of partners

2.3.4.3 Structural holes

The same equation as in Burt (1992) is used to calculate the structural hole score considering the *decay effect* (Borgatti et al., 2002; Zaheer & Bell, 2005). The more

unconnected partners a focal firm has, the higher its structural hole score. The equation is defined as follows:

$$(\text{Structural hole})_i^t = 1 - \sum_{\substack{j=1 \\ i \neq j}}^{n} C_{ij} = 1 - \sum_{\substack{j=1 \\ i \neq j}}^{n} (p_{ij} + \sum_{\substack{q=1 \\ q \neq i,\, j}}^{n} p_{iq} p_{qj})^2 \quad \cdots\cdots\cdots \text{Eq. (3)}$$

where

C_{ij} *is* constraint

p_{ij} equals the strength ratio of direct ties from i to j

$\sum_{\substack{q=1 \\ q \neq i,\, j}}^{n} p_{iq} p_{qj}$ is the sum of the indirect tie ratio

Figure 2.10 shows how a structural hole score changes. As the number of partners of a focal firm increases, so does its structural hole score. However, as the number of a firm's redundant partners increases, its structural hole score decreases.

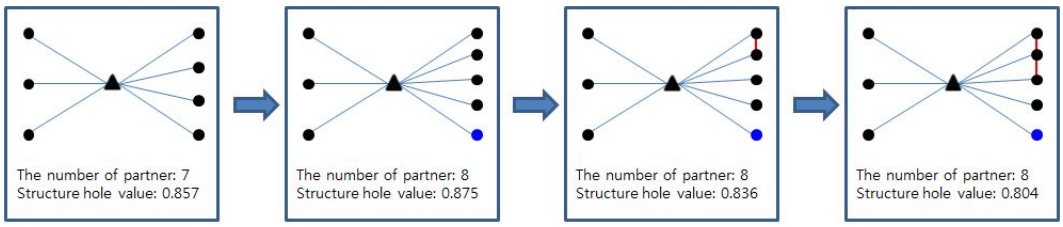

Figure 2.10. Example of how a structural hole score changes

2.3.4.4 Network diversity

The diversity has classified partner firms from several perspectives. In vertical up-

stream alliance portfolios, it is classified as three organizations, such as universities, research institutes, and government laboratories. In vertical down-stream alliance portfolios, it is classified as diverse industries based on 2-digit SIC codes. There are also diversity of layers (vertical up-stream and down-stream alliance partners) and diversity of organizations and industries in the comprehensive alliance portfolio.

The measure is a variation of the Blau's heterogeneity index with the *decay effect* (Koka & Prescott, 2008). If a focal firm forms an alliance network with several industrial partners, its network diversity increases. The equation is defined as:

$$(\text{Blau's heterogeneity index})_i^t = 1 - \sum_k (P_{ik}^t)^2 \quad \cdots\cdots\cdots\cdots\cdots \text{Eq. (4)}$$

where

P_{ik}^t is the proportion of partner firms in the *k* category of firm *i* at *t* year performance.

Suppose that the alliance portfolio configuration with the decreasing effect is composed as demonstrated in figure 2.11. The network diversity score of firm (a) is [1-$\{(2/6)^2 + (2/6)^2 + (2/6)^2\}$] = 0.67 where there are six partners with three industrial clusters. The network diversity score of firm (b) is [1 - $\{(3/7)^2 + (4/7)^2\}$] = 0.49 where there are seven partners with two industrial clusters. The less a focal firm is concentrated in the industrial clusters, the higher its diversity score.

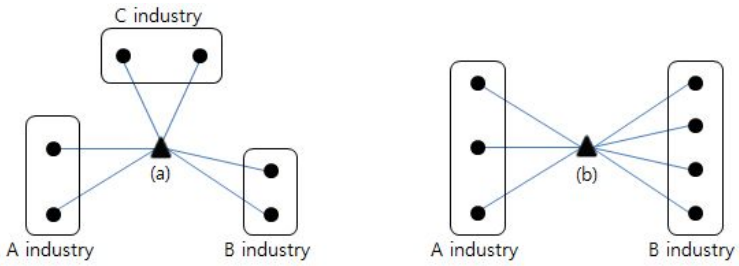

Figure 2.11. Examples of calculating network diversity

2.3.5 Controls

First, past performance is controlled. Firms that have been good performers in the past are likely also to do well in the future (Tsai, 2001). Thus, past performance measures are included for previous years (1999–2009). Second, debt-equity ratio is also controlled (Y. M. Kim, 2005). The debt-equity ratio is debt divided by equity. Third, firm age is also considered as a control (Goerzen, 2007; Zaheer & Bell, 2005). Firms that have been in existence longer are more likely to perform better because of numerous advantages, including an established reputation, brand value and recognition, and developed social networks (Zaheer & Bell, 2005). Firm age was calculated by counting the number of years since incorporation. Fourth, the internal capability of firms is also controlled (Lee et al., 2001; Oliva et al., 2011). This chapter concentrates on the impact of external effects, so the firms' own internal capability is controlled using the values of the cumulative number of patents of the previous five years to represent recent internal capability. Lastly, year dummies are controlled in the models for economy-wide shocks (Uotila et al., 2009).

2.4 Data analysis

The data are unbalanced longitudinal data sets. The models are estimated using the two-step generalized method of moments (GMM) as in Arellano and Bond (1991), which involves transforming the equation into first differences. It also uses lagged values of the endogenous variables as instruments. This procedure to obtain estimates is used for the dynamic longitudinal model, using STATA, version 11.0. This methodology should satisfy two tests: the Sargan test and the second-order serial correlation test. The Sargan test is used for over-identifying restrictions for the GMM estimators, while AR(2) tests for second-order serial correlation. The baseline model is introduced first, and then added four variables for the complete version.

$$
\begin{aligned}
&\text{Performance}_{it} \\
&= \alpha_0 + \beta_1 \text{Past performance}_{it-1} + \beta_2 \left(\frac{\text{Debt}}{\text{Equity}}\right)_{it} + \beta_3 \text{Internal capability}_{it} + \\
&\quad \beta_4 \text{Firm size}_{it} + \beta_5 \text{Firm age}_{it} + \\
&\quad \beta_6 \text{Number of alliances}_{id} + \beta_7 \text{Number of partners}_{id} + \\
&\quad \beta_8 \text{Network diversity}_{id} + \beta_9 \text{Structural hole}_{id} + \text{Dummy}_{year} + \varepsilon_{it}
\end{aligned}
\qquad \text{Eq. (5)}
$$

Where $d \in [t-5, t-1]$

The *decay effect* is applied to the variables with subscript "d".

2.5 Results

Tables 2.3, 2.4, and 2.5 present the correlation matrix and the descriptive statistics for the three datasets, while Tables 2.6, 2.7, and 2.8 show the standardized coefficients for the explanatory variables. No model encountered problems regarding over-identifying restrictions and second-order serial correlation. Therefore, all the models are suitable for two-step GMM.

Table 2.3. Means, standard deviations, and correlations for the comprehensive alliance portfolio

Variable	Mean	Std. Dev.	1	2	3	4	5	6	7	8	9
1.Gross profit on sales	1,956.07	4,554.46	1.00								
2.Net income	565.03	3,079.69	0.83***	1.00							
3.Debt- Equity ratio	57.45	18.69	0.18***	0.01	1.00						
4.Age	24.75	16.93	0.16***	0.13**	-0.07	1.00					
5.Internal capability	161.77	298.50	0.65***	0.41***	0.19***	-0.03	1.00				
6.Number of alliances	4.45	8.67	0.20***	0.16***	0.01	0.02	0.23***	1.00			
7.Number of partners	2.63	2.54	0.53***	0.36***	0.15**	0.29***	0.47***	0.55***	1.00		
8.Structural hole	0.21	0.33	0.46***	0.28***	0.10	0.21***	0.45***	0.28***	0.75***	1.00	
9.Diversity of layers	0.18	0.23	0.41***	0.26***	0.15	0.16***	0.29***	0.45***	0.68***	0.66***	1.00
10.Diversity of pub. institutes & industries	0.28	0.32	0.43***	0.26***	0.16***	0.29***	0.38***	0.43***	0.79***	0.78***	0.82***
11.Year 2000	0.05	0.21	0.00	-0.05	0.03	0.02	0.03	0.01	0.04	-0.03	0.03
12.Year 2001	0.06	0.23	-0.01	-0.05	0.01	0.06	0.00	-0.01	0.01	-0.05	-0.01
13.Year 2002	0.06	0.25	-0.03	-0.04	-0.02	0.07	-0.02	0.01	-0.03	-0.08	0.00
14.Year 2003	0.08	0.28	-0.04	-0.02	0.00	0.03	-0.04	0.01	-0.04	-0.06	-0.03
15.Year 2004	0.09	0.29	-0.06	-0.02	0.04	0.02	-0.03	-0.02	-0.06	-0.06	-0.03
16.Year 2005	0.10	0.29	-0.06	-0.03	0.00	0.00	-0.02	-0.02	-0.06	-0.03	-0.04
17.Year 2006	0.11	0.31	-0.05	-0.01	-0.02	-0.02	-0.02	-0.04	-0.06	-0.04	-0.07
18.Year 2007	0.10	0.31	0.00	0.04	0.03	-0.06	0.01	-0.02	-0.03	0.04	0.00
19.Year 2008	0.11	0.31	0.06	0.03	0.01	-0.06	0.02	0.01	0.03	0.08	0.05
20.Year 2009	0.11	0.32	0.04	0.00	-0.04	-0.03	0.03	0.02	0.08	0.11**	0.06

Variable	10	11	12	13	14	15	16	17	18	19	20
1.Gross profit on sales											
2.Net income											
3.Debt- Equity ratio											
4.Age											
5.Internal capability											
6.Number of alliances											
7.Number of partners											
8.Structural hole											
9.Diversity of layers											
10.Diversity of pub. institutes & industries	1.00										
11.Year 2000	0.04	1.00									
12.Year 2001	0.00	-0.05	1.00								
13.Year 2002	-0.03	-0.06	-0.06	1.00							
14.Year 2003	-0.04	-0.07	-0.07	-0.08	1.00						
15.Year 2004	-0.05	-0.07	-0.08	-0.08	-0.09*	1.00					
16.Year 2005	-0.05	-0.07	-0.08	-0.09	-0.10*	-0.10*	1.00				
17.Year 2006	-0.09	-0.08	-0.09	-0.09	-0.11*	-0.11*	-0.11**	1.00			
18.Year 2007	-0.01	-0.07	-0.08	-0.09	-0.10**	-0.11**	-0.11**	-0.12**	1.00		
19.Year 2008	0.06	-0.08	-0.08	-0.09	-0.10*	-0.11*	-0.11**	-0.12**	-0.12**	1.00	
20.Year 2009	0.08	-0.08	-0.09	-0.09**	-0.11**	-0.11*	-0.12*	-0.13*	-0.12*	-0.12*	1.00

Note: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table 2.4. Means, standard deviations, and correlations for the up-stream alliance portfolio

Variable	Mean	Std. Dev.	1	2	3	4	5	6	7	8	9
1.Gross profit on sales	2,512.83	5,335.52	1.00								
2.Net income	854.86	3,640.16	0.85***	1.00							
3.Debt- Equity ratio	59.61	16.69	0.17**	0.04	1.00						
4.Age	25.83	18.25	0.19**	0.13*	-0.08	1.00					
5.Internal capability	179.78	306.20	0.69***	0.51***	0.14**	0.01	1.00				
6.Number of alliances	3.69	7.01	0.16**	0.14**	-0.08	-0.07	0.25***	1.00			
7.Number of partners	1.85	1.29	0.45***	0.27***	0.11	0.13*	0.45***	0.49***	1.00		
8.Structural hole	0.19	0.27	0.47***	0.26***	0.15**	0.19***	0.43***	0.17**	0.81***	1.00	
9.Diversity of pub. Institutes	0.15	0.24	0.39***	0.26***	0.17**	0.23***	0.27***	0.14*	0.49***	0.64***	1.00
10.Year 2000	0.05	0.23	-0.02	-0.07	0.10	0.00	-0.06	-0.03	0.00	0.01	-0.06
11.Year 2001	0.06	0.24	-0.01	-0.06	0.07	0.05	-0.06	-0.05	-0.04	-0.04	-0.10
12.Year 2002	0.07	0.25	-0.02	-0.06	0.07	0.07	0.00	-0.02	-0.04	-0.08	-0.08
13.Year 2003	0.09	0.28	-0.04	-0.04	0.01	0.05	-0.03	0.00	-0.05	-0.04	-0.10
14.Year 2004	0.10	0.29	-0.08	-0.04	0.03	0.04	-0.04	-0.03	-0.08	-0.07	-0.11*
15.Year 2005	0.09	0.29	-0.07	-0.04	-0.03	-0.02	-0.01	-0.01	-0.07	-0.07	-0.03
16.Year 2006	0.10	0.31	-0.06	-0.02	-0.02	-0.05	0.00	-0.03	-0.05	-0.02	-0.02
17.Year 2007	0.11	0.31	-0.01	0.04	0.01	-0.05	0.02	-0.03	-0.04	0.02	0.03
18.Year 2008	0.10	0.30	0.09	0.06	0.02	-0.03	0.04	0.01	0.02	0.04	0.05
19.Year 2009	0.11	0.32	0.05	0.04	-0.10	-0.02	0.04	0.04	0.11	0.10	0.40***

Variable	10	11	12	13	14	15	16	17	18	19
1.Gross profit on sales										
2.Net income										
3.Debt- Equity ratio										
4.Age										
5.Internal capability										
6.Number of alliances										
7.Number of partners										
8.Structural hole										
9.Diversity of pub. Institutes										
10.Year 2000	1.00									
11.Year 2001	-0.06	1.00								
12.Year 2002	-0.06	-0.07	1.00							
13.Year 2003	-0.07	-0.08	-0.08	1.00						
14.Year 2004	-0.08	-0.08	-0.09	-0.10	1.00					
15.Year 2005	-0.08	-0.08	-0.09	-0.10	-0.10	1.00				
16.Year 2006	-0.08	-0.09	-0.09	-0.10	-0.11	-0.11	1.00			
17.Year 2007	-0.08	-0.09	-0.09	-0.11	-0.11*	-0.11	-0.12*	1.00		
18.Year 2008	-0.08	-0.08	-0.09	-0.10	-0.11	-0.10	-0.11*	-0.12*	1.00	
19.Year 2009	-0.09	-0.09	-0.10	-0.11	-0.12*	-0.11*	-0.12*	-0.12*	-0.12*	1.00

Note: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table 2.5. Means, standard deviations, and correlations for the down-stream alliance

Variable	Mean	Std. Dev.	1	2	3	4	5	6	7	8	9
1.Gross profit on sales	2,441.39	5,134.70	1.00								
2.Net income	746.28	3,572.26	0.84***	1.00							
3.Debt- Equity ratio	56.16	18.38	0.22***	0.03	1.00						
4.Age	25.72	17.32	0.17**	0.15**	0.05	1.00					
5.Internal capability	201.03	332.96	0.65***	0.40***	0.24***	-0.01	1.00				
6.Number of alliances	2.74	3.73	0.14**	0.09	0.11	0.09	0.13**	1.00			
7.Number of partners	1.99	1.56	0.53***	0.39***	0.20***	0.39***	0.46***	0.44***	1.00		
8.Structural hole	0.20	0.28	0.50***	0.35***	0.24***	0.42***	0.45***	0.27***	0.83***	1.00	
9.Diversity of industries	0.22	0.29	0.46***	0.29***	0.25***	0.50***	0.43***	0.36***	0.83***	0.80***	1.00
10.Year 2000	0.05	0.21	0.00	-0.05	-0.01	0.06	0.03	0.07	0.05	0.07	0.05
11.Year 2001	0.05	0.23	-0.02	-0.06	-0.03	0.07	0.00	0.05	0.05	0.05	0.06
12.Year 2002	0.06	0.24	-0.03	-0.05	-0.09	0.07	-0.03	0.05	-0.03	0.00	0.00
13.Year 2003	0.08	0.27	-0.05	-0.03	-0.04	0.06	-0.06	0.02	-0.05	0.01	0.01
14.Year 2004	0.08	0.27	-0.05	-0.02	0.01	0.03	-0.02	-0.01	-0.07	0.01	-0.01
15.Year 2005	0.09	0.29	-0.06	-0.03	-0.01	0.02	-0.02	-0.03	-0.03	-0.01	0.00
16.Year 2006	0.10	0.30	-0.04	-0.01	-0.03	0.03	-0.01	-0.04	-0.02	-0.01	-0.03
17.Year 2007	0.10	0.30	0.01	0.06	0.04	-0.04	0.01	-0.02	-0.02	0.03	0.00
18.Year 2008	0.12	0.33	0.06	0.03	0.03	-0.10	0.01	-0.01	0.01	-0.02	0.00
19.Year 2009	0.13	0.33	0.03	-0.01	0.02	-0.07	0.04	-0.02	0.04	-0.01	-0.03

Variable	10	11	12	13	14	15	16	17	18	19
1.Gross profit on sales										
2.Net income										
3.Debt- Equity ratio										
4.Age										
5.Internal capability										
6.Number of alliances										
7.Number of partners										
8.Structural hole										
9.Diversity of industries										
10.Year 2000	1.00									
11.Year 2001	-0.05	1.00								
12.Year 2002	-0.05	-0.06	1.00							
13.Year 2003	-0.06	-0.07	-0.07	1.00						
14.Year 2004	-0.06	-0.07	-0.07	-0.09	1.00					
15.Year 2005	-0.07	-0.08	-0.08	-0.09	-0.09	1.00				
16.Year 2006	-0.07	-0.08	-0.08	-0.10	-0.10	-0.11	1.00			
17.Year 2007	-0.07	-0.08	-0.08	-0.10	-0.10	-0.11	-0.11*	1.00		
18.Year 2008	-0.08	-0.09	-0.09	-0.11*	-0.11*	-0.12*	-0.12*	-0.12*	1.00	
19.Year 2009	-0.08	-0.09	-0.09	-0.11*	-0.11*	-0.12*	-0.13*	-0.13*	-0.14**	1.00

Table 2.6. Two-step GMM estimates for the comprehensive alliance portfolio

	Model 1	Model 2	Model 1	Model 2
	coef/se	coef/se	coef/se	coef/se
	Gross profit on sales		Net income	
Past performance	0.83***	0.79***	0.73***	0.75***
	(0.14)	(0.13)	(0.07)	(0.06)
Debt-Equity ratio	-15.14	-22.89	-51.24**	-56.19**
	(21.35)	(19.45)	(25.19)	(23.46)
Age	98.27	17.26	102.59	53.60
	(85.20)	(68.86)	(63.03)	(71.07)
Internal capability	7.37	7.18	4.08	3.99
	(4.64)	(4.45)	(3.54)	(3.69)
Number of alliances		10.97		-4.71
		(37.08)		(24.12)
Number of partners		288.23**		196.78**
		(138.39)		(82.08)
Structural hole		1,025.54		1,494.73
		(1,471.62)		(1,141.68)
Diversity of layers		1,524.94		1,303.00*
		(1,262.43)		(764.09)
Diversity of pub. institutes and industries		-1,383.91		-2,214.07**
		(1,192.33)		(871.04)
Cons	-2,217.80	-544.12	274.46	1,244.32
	(3,211.59)	(2,477.57)	(2,195.76)	(2,106.48)
Year dummies	Included	Included	Included	Included
# of observations	326	326	326	326
# of firms	54	54	54	54
AR(2) test	0.22	0.2	0.11	0.17
Sargan test	0.35	0.32	0.39	0.24

• P-values are reported for AR(2) and Sargan tests.
• The instrumental variables in GMM used the first–fifth lags for the past performances.
• Note: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table 2.7. Two-step GMM estimates for the up-stream alliance portfolio

	Model 1	Model 2	Model 1	Model 2
	coef/se	coef/se	coef/se	coef/se
	Gross profit on sales		Net income	
Past performance	0.66***	0.69***	0.44	0.46*
	(0.18)	(0.21)	(0.31)	(0.24)
Debt-Equity ratio	10.75	-1.40	-43.72*	-49.09*
	(23.10)	(23.30)	(25.84)	(25.60)
Age	-2.70	-56.97	-45.67	-64.57
	(81.74)	(98.42)	(99.91)	(76.86)
Internal capability	9.74	10.22	9.90	8.65
	(6.00)	(7.18)	(8.33)	(7.29)
Number of alliances		-29.82		18.83
		(27.07)		(70.74)
Number of partners		506.90***		352.93
		(130.04)		(336.43)
Structural hole		-2,554.27*		-1,927.20
		(1,477.29)		(2,062.81)
Diversity of pub. Institutes		2,097.75*		558.55
		(1,252.56)		(1,371.87)
Cons	-757.15	461.70	2,997.47	3,716.26
	(2,047.89)	(2,744.09)	(2,543.75)	(2,713.43)
Year dummies	Included	Included	Included	Included
# of observations	221	221	221	221
# of firms	35	35	35	35
AR(2) test	0.25	0.25	0.18	0.26
Sargan test	0.23	0.54	0.44	0.37

• P-values are reported for AR(2) and Sargan tests.
• The instrumental variables in GMM used the first–second lags for the past performances.
• Note: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table 2.8. Two-step GMM estimates for the down-stream alliance portfolio

	Model 1	Model 2	Model 1	Model 2
	coef/se	coef/se	coef/se	coef/se
	Gross profit on sales		Net income	
Past performance	0.79***	0.71***	0.78***	0.79***
	(0.07)	(0.14)	(0.08)	(0.10)
Debt-Equity ratio	-33.27	-39.64*	-71.76*	-76.40***
	(64.77)	(23.46)	(37.07)	(25.92)
Age	257.26**	234.99***	194.02***	174.66
	(118.59)	(90.52)	(70.51)	(139.29)
Internal capability	7.29**	7.55*	4.20	3.84
	(3.22)	(4.36)	(3.40)	(5.19)
Number of alliances		182.37		174.21*
		(156.86)		(95.84)
Number of partners		523.38		173.52
		(379.54)		(348.53)
Structural hole		3,200.05		3,747.84***
		(2,044.96)		(1,199.02)
Diversity of industries		-4,220.68*		-4,159.61**
		(2,312.78)		(1,716.59)
Cons	-5,664.92	-5,867.69**	-1,359.66	-1,375.93
	(4,759.14)	(2,518.11)	(4,013.90)	(4,993.44)
Year dummies	Included	Included	Included	Included
# of observations	239	239	239	239
# of firms	43	43	43	43
AR(2) test	0.18	0.19	0.12	0.13
Sargan test	0.21	0.21	0.23	0.39

• P-values are reported for AR(2) and Sargan tests.
• The instrumental variables in GMM used the first–third lags for the past performances.
• Note: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

2.5.1 Tests of hypotheses

Hypothesis 1a, which involves the positive effect of the number of alliances, is supported in the vertical down-stream alliance portfolio. Hypothesis 1b, which involves the negative effect of the number of alliances, is not supported in any of the alliance portfolios. Hypothesis 2a, which involves the positive effect of the number of partners, is supported in the comprehensive alliance portfolio and the vertical up-stream alliance portfolio. Hypothesis 2b, which involves the negative effect of the number of partners, is not supported in any of alliance portfolios. Although hypotheses 3a and 3b, which involve the effect of structural holes, are not supported in the comprehensive alliance portfolio, hypothesis 3a is supported in the vertical down-stream alliance portfolio. Furthermore, hypothesis 3b is supported in the vertical up-stream alliance portfolio. Lastly, hypothesis 4a concerning the diversity of layers in the comprehensive alliance portfolio, and the diversity of public institutes in the vertical up-stream alliance portfolio, is supported. Hypothesis 4b concerning the diversity of public institutes and industries in the comprehensive alliance portfolio, and the diversity of industries in the vertical down-stream alliance portfolio, is also supported. The results are summarized in table 2.9.

Table 2.9. Summary of results of hypothesis tests

Hypothesis Contents	Hypothesis number	Expected	Result of comprehensive alliance portfolio	Result of vertical up-stream alliance portfolio	Result of vertical down-stream alliance portfolio
The number of alliances	H1a	+	n.s.	n.s.	1
	H1b	-	n.s.	n.s.	n.s.
The number of partners	H2a	+	2	1	n.s.
	H2b	-	n.s.	n.s.	n.s.
Structural hole	H3a	+	n.s.	n.s.	1
	H3b	-	n.s.	1	n.s.
Network diversity	H4a	+	1 (layers)	1 (pub. institutes)	n.s.
	H4b	-	1 (pub. institutes and industries)	n.s.	2 (industries)

• n.s. means "not significant."

• The number in the cells means the number of significant variables among the two variables.

2.6 Discussion

So far, this chapter has studied the relationships between the properties of alliance portfolios and firm performance in the comprehensive, vertical up-stream and down-stream alliance network. Table 2.10 shows the results of previous studies about the relationships between the properties of the alliance portfolio of a firm and its performance. It is not difficult to see that there was a fragmented focus on horizontal networks and comprehensive networks. If this empirical study had been approached like these past studies, dull or lackluster conclusions might have been reached about the properties of alliance portfolios affecting corporate performance. For instance, let us consider the case of studying the aspects of horizontal or comprehensive networks to illustrate the alliance

portfolio properties affecting firm performance. If alliance portfolios from the perspective of the horizontal network had been studied, no analysis would have been done, because the relationships within the defense industry are hard to identify, due to the unique segmented and specialized characteristics of the defense industry. If the issue had been studied from the perspective of the comprehensive alliance network, not much difference would have been discovered from previous works. However, by examining the dimensions of the comprehensive network and the vertical up-stream and down-stream alliance networks in this chapter, it was possible to establish that the properties of alliance portfolio are different in each layer and in the comprehensive network. In other word, properties that were not significant in the comprehensive network were significant in the vertical up or down-stream alliance network, and vice versa. These results appeal to managers to think of the alliance portfolio specifically rather than broadly or fragmentarily. To compare in detail the alliance portfolio, the vertical up-stream and down-stream alliance portfolios shall be focused principally upon.

Table 2.10. Scope of layer of past studies

Study	Industry	Network measures	Dependent variables	The scope of layer
Ahuja (2000)	Chemicals industry of USA	Number of alliances or partners, structural hole	Patents	Horizontal network
Stuart (2000)	Semiconductor industry of USA	Number of alliances	Rate of sales growth, Innovation rates	Horizontal network
Baum et al. (2000)	Canadian Biotech.	Number of alliances depending on the characteristics of partners, efficiency, relative scope	Revenues, Non-R&D employees, R&D employees, R&D expenses, Patents	Comprehensive network
Zaheer & Bell (2005)	Canadian mutual fund firms	Structural hole	Market share	Horizontal network

In the results on alliance size (the number of alliances, the number of partners), the number of alliances is positive in the vertical down-stream alliance portfolio, whereas the number of partners is positive in the vertical up-stream alliance portfolio. These results imply that the benefits of external networks deriving from alliance portfolio size could be different depending on the characteristics of partners. In the vertical down-stream alliance portfolio, the number of alliances itself may affect corporate performance more than the number of partners. In contrast, in the vertical down-stream alliance portfolio, the number of partners may affect corporate performance more than the number of alliances. The

larger number of alliances in the vertical down-stream alliance portfolio might be favorable for obtaining complementary assets from other partner firms because the quantity of complementary assets might be important for corporate performance. Further, the larger number of partners in the vertical up-stream alliance portfolio might be a favorable factor for acquiring knowledge from other partner institutes because a focal firm could get diverse ideas from many partners.

Additionally, model 2 in the vertical up-stream and down-stream alliance portfolio is a basis for good intuitions regarding the configuration of the relationships between the number of alliances and the number of partners for better corporate performance, a topic suggested by Wassmer (2010) for any future research agenda:

> A promising research opportunity would be to combine the two dimensions and conduct some comparative research on different alliance portfolio configurations (e.g., alliance portfolios with many alliances and many partners versus alliance portfolio with many alliances but few partners, i.e., many close partners.) (2010: 163)

From the fact that the number of alliances is a significant positive factor in the vertical down-stream alliance portfolio, it follows that a larger number of alliances is better for performance where the number of partners is constant. Similarly, the fact that the number of partners is a significant positive factor in the vertical up-stream alliance portfolio

implies that a larger number of partners are better for performance where the number of alliances is constant. Figure 2.12 represents these relationships, where the configuration (a)→(a′)→(a″) is better in the vertical down-stream alliance portfolio, and (b)→(b′)→(b″) is better in the vertical up-stream alliance portfolio for performance.

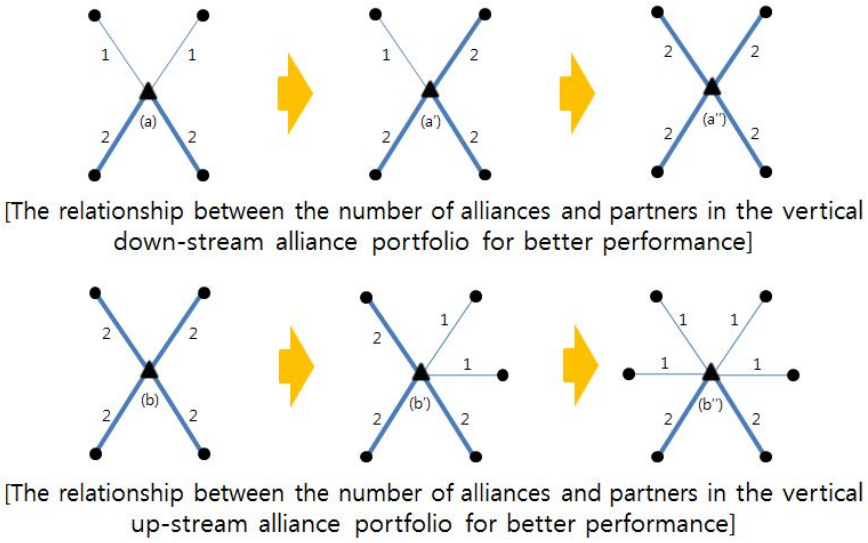

Figure 2.12. The relationships between the number of alliances and partners

Spanning structural holes is negatively significant for performance in vertical up-stream alliance portfolios. In other words, densely embedded networks are a better choice for performance. However, in vertical down-stream alliance portfolios, the spanning of structural holes is positive for performance. Figure 2.13 summarizes these facts. The left configuration is better for vertical up-stream alliance portfolios, and the right one is better for vertical down-stream alliance portfolios. To explain the reason why densely embedded

networks are better for vertical up-stream alliance portfolios, it is necessary to note the argument of Uzzi (1997), which developed the arguments in Coleman (1988, 1990). The structure of densely embedded networks is economically beneficial because of trust, fine-grained information transfer, and joint problem-solving agreements. Mechanisms may exist in which a focal firm might be stronger with strong partners, such as universities or research institutes, which offer these benefits through the vertical up-stream alliance portfolio. In addition, in vertical down-stream alliance portfolios, spanning structural holes is better for performance. The reason is clear from the benefits a focal firm obtains from vertical down-stream alliances. The key reason to ally is to access complementary assets (competence, manufacturing, etc.) rather than to acquire new knowledge (Rothaermel & Deeds, 2006; Silverman & Baum, 2002). For reasons of non-redundancy, this form seems to be better in order to access complementary assets or resources, and it affects performance.

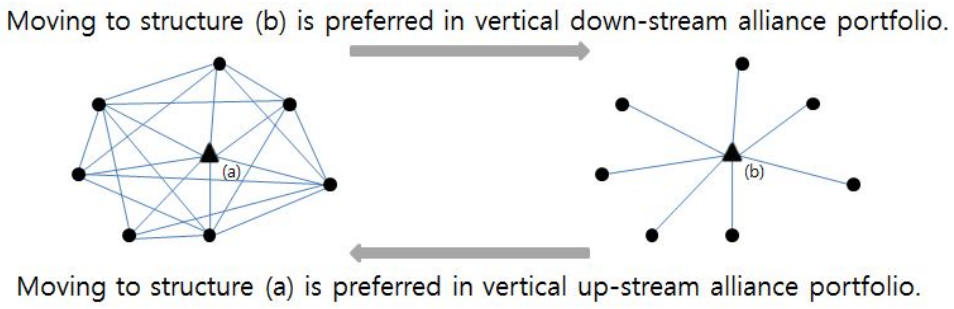

Figure 2.13. The difference of ideal structure between the vertical up-stream and down-stream alliance portfolios

Diversity of layers is significantly positive in the comprehensive alliance portfolio. Although the diversity of public institutes and industries is a significant negative in the comprehensive alliance portfolio, the diversity of public institutes in the vertical up-stream alliance portfolios is a significant positive; similarly, the diversity of industries in the vertical down-stream alliance portfolio is a significant negative. As shown in figure 2.14 below, diversity of layers shows the importance of balancing layers. In other words, performance is affected positively by combining the knowledge from the vertical up-stream alliance portfolio and complementary assets from the vertical down-stream alliance portfolio that are related in practice. This means that the value-added products are produced not just by knowledge or practice but by a combination of the two. In vertical up-stream alliance portfolios, a focal firm is better able to get ideas or knowledge from several sorts of sources, which may contribute to value-added product development. In vertical down-stream alliance portfolios, the configuration that is focused on specific industries rather than industry diversity seems related in the case of the Korean defense industry. Although firms are included in the single category of the defense industry, they are specialized in some particular technology, unlike other industries. This characteristic suggests that industry diversity affects performance negatively.

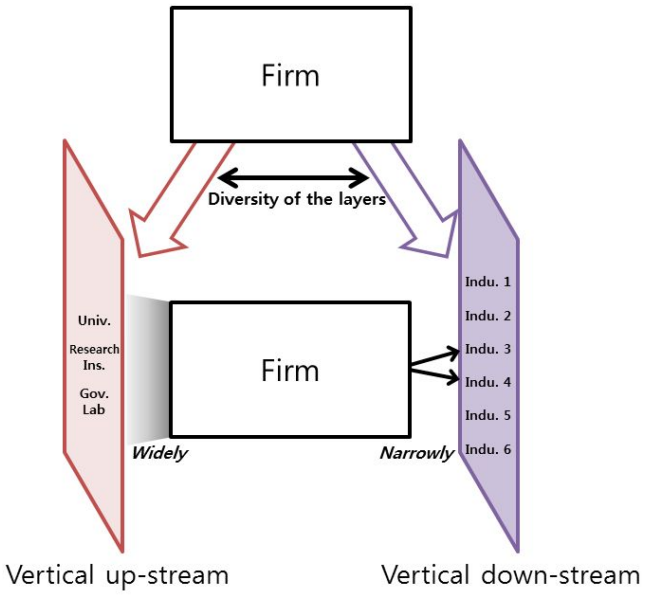

Figure 2.14. Conceptual alliance strategy based on network diversity

Chapter 3. External resources, relative capabilities, spanning structural holes, and firm performance

3.1 Introduction

This chapter is about the role of the alliance partners and structural characteristics among six research streams (e.g., portfolio size, the role of the alliance partners, role of structural and relational alliance portfolio characteristics, etc.) affecting firm performance (Wassmer, 2010). Past studies about the role of the alliance partners emphasized the importance of having larger resources and capability endowments of partners (Stuart, 2000; Lavie 2007). For example, Stuart (2000) concluded that 'both from a resource access and reputation standpoint, large and innovative firms are likely to be the most valuable associates' (Stuart, 2000: 808). This conclusion might be the requirements of good partners that we have understood. More generally, this logic is based on the social networks literature emphasizing the potential advantages of a relationship depending on the social and material capital possessed by a focal firm's partners (Burt, 1992). In other words, collaborating with good partners means a value creation mechanism exists.

The current study cautions, however, that firms that follow this suggestion may suffer a decline in market performance because dominant partners may appropriate a larger share of joint value creation at the focal firm's expense (Lavie, 2007). In other words,

selecting objectively good partners unconditionally would be not appropriate for a focal firm. Such a value appropriation effect can be explained by the transaction costs theory (Williamson, 1989; Pisano, 1990). The transaction cost in alliance is like a product made by coordinating, managing, and controlling activities between a focal firm and partners. The reason of incurred costs is related to asymmetric information, possible opportunistic behavior of partners, and uncertainty between two firms (Tripsas et al., 1995).

It is true that scholars have tended to neglect the appropriation hazards that partners impose. In this regard, it is necessary to review accessible partners' resources and compare the capabilities between a focal firm and a partner in order to select a more suitable candidate partner for better performance, rather than unconditionally selecting larger, better endowed partners. The relationship of the relative capabilities between a focal firm and a partner and the spanning of structural holes will also be represented.

So far, research into the role of the alliance partners is rare since work on alliance portfolios is a relatively new research area in the widely studied field of strategic alliances (Lavie, 2007; Wassmer, 2010). Stuart (2000) also pointed out about the paucity of literature on the topic of the role of the alliance partners.

Alliance portfolio can be classified into three sorts according to the types of a focal firm's partners: vertical up-stream, horizontal, and down-stream alliance portfolios

(Haeussler & Patzelt, 2008; Rothaermel & Deeds, 2006; Silverman & Baum, 2002); see figure 3.1. The overall perspective of the three levels is referred to as the comprehensive alliance portfolio (Baum et al., 2000). This study concentrates on the technological vertical down-stream alliance portfolios of Korean defense firms, in order to discuss external resources, the relative capabilities between a focal firm and partners, and the spanning of structural holes in vertical down-stream alliance portfolios and firms, because it is hard to define the capabilities of partners in vertical up-stream alliance portfolios. Furthermore, horizontal alliances of Korean defense firms are hard to find since the firms are segmented and specialized.

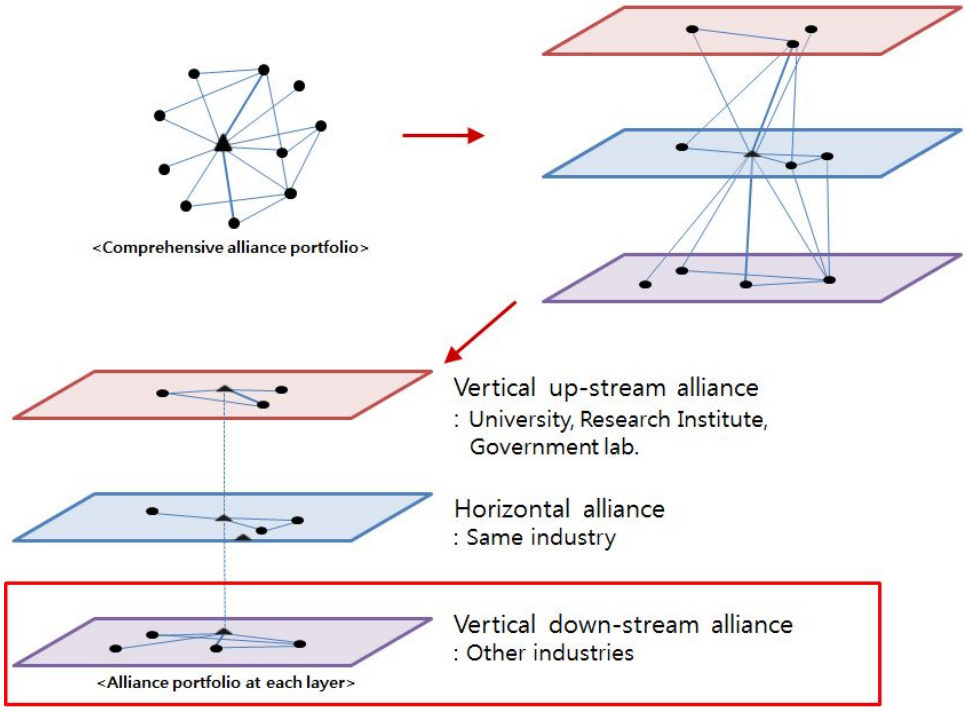

Figure 3.1. The scope of this chapter

In the remainder of this chapter, establishing hypotheses, describeing methods, and outlining results are followed. In the sections on theory and hypotheses, identical hypotheses are presented for accessible resources of focal firm partners, the relative capabilities between a focal firm and a partner, and the spanning of structural holes; outlining the findings in the results sections. Finally, conclusions from the statistical results are discussed.

3.2 Theory and hypotheses

3.2.1 The accessible resources

Through alliances, a focal firm can access resources that it does not itself possess. The reason that firms engage in co–development is that they can use external resources in pursuit of their goals (Becker & Dietz, 2004). External resources make alliances more efficient and richer in the cases where these may constitute necessary complementary assets (Nieto & Santamaría, 2007). A focal firm can leverage these external resources through the associated value-creation mechanisms (Lavie, 2007). Value–creation is referred to as the creation of economic or monetary value (e.g., increases in stock price, additional cash flows, etc.) (Wassmer & Dussauge, 2011). The importance of alliances has become ever more evident in terms of resource accessibility, development, and value–creation, as well as from the cost-benefit perspectives highlighted by scholars (Gulati, 2007; Wassmer & Dussauge, 2011). In this way, a focal firm can use alliances as opportunities for value–creation through resource pooling and combination. In addition,

alliances enable the firm to internalize external resources and to enhance its internal capabilities, a potentially positive factor for firm performance (Lavie, 2006). Therefore, the following hypothesis is proposed.

Hypothesis 1a: the more a focal firm has access to external resources, the better it performs.

However, the rapidly burgeoning literature on alliance portfolios focuses on the effect of value–creation, and overlooks the effect of value–appropriation (Lavie, 2007). As the resources that a focal firm can access increase, so it is more likely to encounter unfamiliar resources. This situation may interfere with the process of assembling resources, and increase costs by unnecessary or inefficient alliances. In this situation, a focal firm may not be able to internalize the external resources, despite its opportunity to acquire accessible resources. In this scenario, the resources could prove useless as well as increase costs. Therefore, the following hypothesis is proposed

Hypothesis 1b: the more a focal firm has access to external resources, the worse it performs.

3.2.2 Relative innovativeness of a focal firm compared with partner firms

Alliances with innovative partners can provide opportunities to learn new routines, and facilitate the acquisition of advanced technical know–how (Stuart, 2000; Lavie, 2007). In this mechanism, strategic alliances with well-endowed or innovative partners could support a focal firm's performance. Nahapiet and Ghoshal (1998) argued that the process of sharing ideas with innovative partners is likely to generate new knowledge. As partners are more innovative, a focal firm may learn and create more from its interaction with them. In their examination of the Canadian biotech industry, Baum et al. (2000) showed that startup firms involving with innovative partners tended to perform better. Stuart (2000), in a study of the U.S. semiconductor industry, also found that more innovative partners play an important role in delivering endowments. These works emphasize the importance of the absolute innovativeness of the partners. From a relative perspective, relative superiority of the partners also affects firm performance positively, if one thinks of the importance of the absolute innovativeness of the partners along a continuum. Thus, a focal firm having relatively innovative partner firms may be able to replicate innovative ideas including the process generating insightful new ideas that will improve firm performance. Therefore, the following hypothesis is proposed.

Hypothesis 2: a focal firm's performance is negatively associated with the relative innovativeness of a focal firm.

3.2.3 Relative reputation of a focal firm compared with partner firms

A firm's reputation is a set of attributes characterizing a focal firm (Weigelt & Camerer, 1988). An alliance partner could affect a focal firm's performance through its influence on an organization's reputation, because a good reputation is viewed as a rent-generating asset (Fombrun & Shanley, 1990) and because of the evolution of reputations of partners (Stuart et al., 1999). The transfer of tangible and knowledge-based resources from partners having good reputations may confer social status on a focal firm. Although these factors also emphasize the importance of the absolute reputation of the partners, it is valuable to consider the issue from a relative perspective. Therefore, the following hypothesis is proposed.

Hypothesis 3: a focal firm's performance is negatively associated with the relative reputation of a focal firm.

3.2.4 Relative bargaining power of a focal firm compared with partner firms

Bargaining power can be defined as the ability to obtain favorable conditions in contract negotiations between two parties (Yan & Gray, 1994). Thus, the relative bargaining power between a focal firm and partner affects the distribution of rents in alliances (Hamel, 1991). If a focal firm has a weaker bargaining power relative to a

partner, a focal firm could lose its share (Yan & Gray, 1994). Conversely, the relative strong bargaining power of a focal firm could allow it to take an excessive share. Therefore, the following hypothesis is proposed.

Hypothesis 4: a focal firm's performance is positively associated with the relative bargaining power of a focal firm.

3.2.5 Contingencies exerted by spanning structural hole

The spanning of structural holes by a focal firm can have social structural advantages (Burt, 1992). Burt (1992) suggested that the spanning of structural holes is favorable for obtaining diverse information. In conjunction with highly innovative partners, it could create joint positive effects because partner firms could offer new opportunities in niche markets (Zaheer & Bell, 2005). In this context, partner firms having superior uncorrelated innovativeness could provide new market opportunities for a focal firm. Similar logic suggests that reputation could also make joint positive effects in the sense that a focal firm's reputation is a set of attributes that observers perceive to characterize a firm.

Hypothesis 5: the relative innovativeness of a focal firm spanning structural holes reduces firm performance.

Hypothesis 6: the relative reputation of a focal firm spanning structural holes reduces firm performance.

The spanning of structural holes by a focal firm having high bargaining power could produce joint effects. Partners who are not connected to each other could not share the information about the focal firm's bargaining power, and a focal firm's bargaining skills are only exposed in a restricted way to other partners. In this sense, a focal firm could gain an edge at the negotiating table against partners by spanning structural holes.

Hypothesis 7: the relative bargaining power of a focal firm spanning structural holes enhances firm performance.

3.3 Method

3.3.1 Data

The technological alliances of 44 leading Korean defense firms were investigated. As in chapter 2, firms that have alliances in the vertical down-stream alliance network are considered. Co-patenting is also used as an indicator of technological alliance (Lecocq & Van Looy, 2009). 239 alliances are found from 1995 to 2009 in vertical down-stream alliances, with each alliance involving two to six participants. To measure the *decay effect* of the alliances, their financial data were also collected from the Korea Investors Service Value (KIS–Value) database for the period 2000–2010.

3.3.2 Dependent variables

Three dependent variables were used: gross profit on sales, revenue growth rate, and profit growth rate of current year over the database for 2000–2010. These three variables are used on account of their different properties. Gross profit on sales indicates profitability of firm. Revenue growth rate and profit growth rate indicate increments of growth and profitability.

3.3.3 Explanatory variables

3.3.3.1 Accessible innovativeness resources

As described in the definition of alliance effect, the strength of an alliance decreases for five years when a focal firm has an alliance with a partner. Then, the matrix of relationship between a focal firm or partner *i* and *j* can be described as a matrix $W_t = [w_{ijt}]$ from *t–5* to *t–1* with the *decay effect* affecting *t* year performance (Stuart, 2000). d_{it} means firm *i*'s resources or endowments, which is calculated as the mean number of patents from *t–5* to *t–1* affecting *t* year performance. Base on Stuart (2000) concept, the accessible resources of focal firms can be calculated in equation (1)

$$P_t = \begin{pmatrix} p_{1t} \\ \vdots \\ p_{nt} \end{pmatrix} = \begin{pmatrix} w_{11t} & \cdots & w_{1nt} \\ \vdots & \ddots & \vdots \\ w_{n1t} & \cdots & w_{nnt} \end{pmatrix} \begin{pmatrix} d_{1t} \\ \vdots \\ d_{nt} \end{pmatrix} \quad \cdots\cdots\cdots\cdots\cdots\cdots \text{Eq. (6)}$$

However, Stuart (2000)'s method missed a consideration. For example, firm 1 and 2

has the same accessible resources base on the Stuart (2000)'s method though firm 2 has a redundancy alliance between partner 1 and 2 in below figure 3.2.

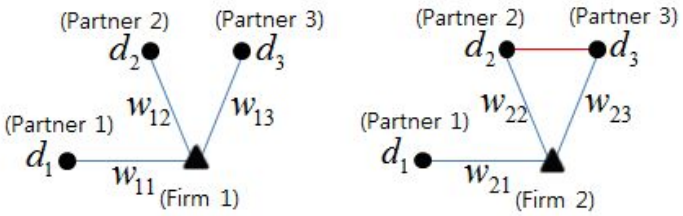

Figure 3.2. The limitation of Stuart (2000)'s method of measuring accessible resources from partners

Also, Zaheer & Bell (2005) and Lavie (2007) measured the resources by the mean value of the overall firm innovativeness scores for all partners and R&D investments. Among these researches, the Stuart (2000)'s method of measuring the accessible resources is the most appropriate in the aspect of network perspective. Pointed out above, however, it will be more appropriate if considering redundancy among partners. So, the concept of "network efficiency" of a firm's ego-network as a measure of non-redundancy was adopted (Burt, 1992: chap. 2), and the accessible resources of firm1 and 2 was calculated in figure 3.2 below table 3.1.

Table 3.1. Efficiencies comparison of firm 1 and 2

	Partner A	Partner B	Partner C	Efficient size	Efficiency
Redundancy of firm A	$\frac{0}{3}$	$\frac{0}{3}$	$\frac{0}{3}$	3	100%
Redundancy of firm B	$\frac{0}{3}$	$\frac{1}{3}$	$\frac{1}{3}$	2.33	77.78%

If all the redundancies of firm B's partners are added, it is $\frac{2}{3}$. If the number of partner minuses the redundancy value, it is 2.33, which is called "effective size of Ego network". Then, the efficiency is $\frac{2.33}{3} = 77.8\%$. Consequently, the accessible resources p'_{it} of firm *i* can be calculated like below considering efficiency.

$$\mathrm{P}'_{\mathrm{t}} = \begin{pmatrix} p'_{1t} \\ \vdots \\ p'_{nt} \end{pmatrix} = \begin{pmatrix} p_{1t} \times Efficiency_{1t} \\ \vdots \\ p_{nt} \times Efficiency_{nt} \end{pmatrix} \quad \cdots\cdots\cdots\cdots\cdots\cdots \text{Eq. (7)}$$

3.3.3.2 Relative innovativeness, reputation and bargaining power

Equation (8) is the mean difference for previous five year innovativeness affecting t year performance. P_i is the number of patent of firm *i*, and *m* is the number of partners that firm *i* is connected.

$$(Relative\ innovativeness)_{n,t} = \frac{1}{5}\left(\sum_{k=1}^{5} P_{n,t-k} - \frac{\sum_{m}\sum_{k=1}^{5} P_{m,t-k}}{m} \right) \quad \cdots\cdots\cdots\cdots \text{Eq. (8)}$$

U.S. firms' reputation can be evaluated by reputation score of Forturn Magzine (Swaminathan & Moorman, 2009). In case of Korean company, however, the data does not exist. So, the credit grades from the Korea Investors Service Value (KIS–Value) database are used. This variable is also calculated in the same manner with relative innovativeness. P_i is the reputation score of firm *i*. These two variables represent partners' higher capabilities relatively as the scores are larger negatively.

$$(Relative\ repuation)_{n,t} = \frac{1}{5}\left(\sum_{k=1}^{5} R_{n,t-k} - \frac{\sum_{m}\sum_{k=1}^{5} R_{m,t-k}}{m} \right) \quad \cdots\cdots\cdots\cdots \text{Eq. (9)}$$

ROA (Return on assets) is used as proxy of bargaining power (Lavie, 2007). The return on assets (ROA) shows how profitable a company's assets are in generating revenue. The meaning of having a good profitability is that firms take larger steaks in several projects. In this sense, ROA can represent the bargaining power. This variable is also calculated in the same manner with other variables. This variable represent partners' higher capabilities relatively as the scores are larger positively.

$$(Relative\ bargaining\ power)_{n,t} = \frac{1}{5}\left(\sum_{k=1}^{5} (ROA)_{n,t-k} - \frac{\sum_{m}\sum_{k=1}^{5} (ROA)_{m,t-k}}{m} \right) \quad \cdots\cdots \text{Eq. (10)}$$

3.3.4 Controls

First, past performance was controlled. Firms that have been good performance of the past are likely also to be good (Tsai, 2001; Baum, 2000; Kaiser et al., 2011). Thus, past performance measures for previous years from 1999 to 2009 was included. Second, debt/equity which is measured by debt divided by equity was controlled (Y. M. Kim, 2005). Third, firm age which is calculated by counting the number of years after establishing year of firms was controlled. (Goerzen, 2007; Zaheer & Bell, 2005). As firms have existed longer, they are more likely to perform better owing to established reputation, developed social networks, brand power and recognition (Zaheer & Bell, 2005). Fourthly, the structural hole variable is controlled. Information travels not only through proximate ties in networks, but through the structure of the network itself (Gulati, 1998). This variable expresses the number of partner as well as redundancy among the partners. The higher the number of partners is, the higher the variable is. The more the redundancy among partners, the less the variable is. Lastly, year dummies are controlled in the models for economy-wide shocks (Uotila et al., 2009).

3.4 Data analysis

The data are also unbalanced longitudinal data sets where the alliance data during

1995–2009 considering *decay effect* and financial data during 2000–2010. The models are estimated using the two–step generalized method of moments (GMM) by Arellano and Bond (1991), which involves transforming the equation into first differences. It also uses lagged values of the endogenous variables as instruments. This procedure was use to obtain estimates for the dynamic longitudinal model, using STATA, version 11.0. This methodology should satisfy two tests–the Sargan test and the second–order serial correlation test. The Sargan test is used for over–identifying restrictions for the GMM estimators, and AR(2) tests for second–order serial correlation. The baseline models in first were introduced then added variables of accessible resources and representing differences. Lastly, the third model uses the complete model including interaction terms for three dependent variables.

$$
\begin{aligned}
&\text{Performance}_{it} \\
&= \alpha_0 + \beta_1 \text{Past performance}_{it-1} + \beta_2 \left(\frac{\text{Debt}}{\text{Equity}}\right)_{it} + \beta_3 \text{Firm age}_{it} + \beta_4 \text{Structural hole}_{id} + \\
&\quad \beta_5 \text{Innovation resources}_{id} + \\
&\quad \beta_6 \text{Reputation difference}_{id} + \beta_7 \text{Bargaining power difference}_{id} + \beta_8 \text{Innovativeness difference}_{id} + \\
&\quad \beta_9 (\text{Reputation difference}_{id} \times \text{Structural hole}_{id}) + \\
&\quad \beta_{10} (\text{Bargaining power difference}_{id} \times \text{Structural hole}_{id}) + \\
&\quad \beta_{11} (\text{Innovativeness difference}_{id} \times \text{Structural hole}_{id}) + \text{dummy}_{year} + \varepsilon_{it}
\end{aligned}
\qquad \text{Eq. (11)}
$$

Where $d \in [t-5, t-1]$

The *decay effect* is applied to the variables with subscript "d".

3.5 Results

Table 3.2 presents the correlation matrix and descriptive statistics for the relative capabilities of partner firms and performances dataset, while table 3.3 shows the standardized coefficients for the explanatory variables. No models encountered any problems regarding over–identifying restrictions and second–order serial correlation. Therefore, all the models are suitable for two–step GMM. Further, to show how the study of the relative capabilities of partner firms and firm performance differs from the study of the absolute capabilities of partner firms and firm performance, six variables are changed in order to represent the absolute capabilities of partner firms and the interaction terms with structural hole spanning in the same models. Table 3.4 presents the correlation matrix and descriptive statistics for the absolute capabilities of partner firms and performances dataset, while table 3.5 shows the standardized coefficients for the explanatory variables.

Table 3.2. Means, standard deviations, and correlations for relative capabilities of partner firms and performances

	Mean	Std. Dev.	1	2	3	4	5	6	7	8	9	10
1.Gross profit on sales	2,441.39	5,134.70	1.00									
2.Revenue growth rate	22.00	46.76	0.04	1.00								
3.Profit growth rate	121.90	706.15	-0.02	0.14**	1.00							
4.Debt/Equity	56.16	18.38	0.22***	0.13**	-0.02	1.00						
5.Age	25.72	17.32	0.17**	0.08	-0.06	0.05	1.00					
6.Structural hole	0.20	0.28	0.50***	0.15**	-0.04	0.24***	0.42***	1.00				
7.Innovation resources	1.86	4.33	-0.01	-0.06	0.26***	0.01	0.00	-0.01	1.00			
8.Relative innovativeness	39.56	66.67	0.65***	-0.10	-0.05	0.24***	-0.01	0.45***	-0.05	1.00		
9.Relative reputation	3.06	2.82	-0.07	-0.16**	-0.02	0.18**	0.02	-0.02	0.00	-0.08	1.00	
10.Relative bargaining power	-2.78	15.06	-0.03	0.14**	-0.04	-0.26**	-0.09	-0.06	-0.15**	-0.12*	-0.02	1.00
11.Relative innovativeness X Structural hole	16.42	39.19	0.72***	-0.06	-0.03	0.17**	0.13*	0.65***	-0.01	0.80***	-0.09	0.02
12.Relative reputation X Structural hole	0.59	1.08	0.25***	0.06	-0.01	0.22***	0.29***	0.72***	0.02	0.23***	0.30***	-0.05
13.Relative bargaining power X Structural hole	-0.80	3.29	-0.02	0.01	0.02	-0.18**	-0.23***	-0.23***	-0.03	-0.02	0.01	0.41***
14.Year 2000	0.05	0.21	0.00	0.07	-0.01	-0.01	0.06	0.07	0.11	0.02	-0.24***	-0.02
15.Year 2001	0.05	0.23	-0.02	0.01	-0.03	-0.03	0.07	0.05	0.09	-0.01	0.23***	0.00
16.Year 2002	0.06	0.24	-0.03	-0.06	-0.02	-0.09	0.07	0.00	0.09	-0.03	0.19***	0.06
17.Year 2003	0.08	0.27	-0.05	0.07	0.04	-0.04	0.06	0.01	0.07	-0.06	0.03	-0.02
18.Year 2004	0.08	0.27	-0.05	0.04	0.19***	0.01	0.03	0.01	0.01	-0.02	0.08	-0.04
19.Year 2005	0.09	0.29	-0.06	-0.03	-0.01	-0.01	0.02	-0.01	-0.02	-0.02	-0.01	-0.03
20.Year 2006	0.10	0.30	-0.04	-0.01	-0.03	-0.03	0.03	-0.01	-0.02	-0.01	-0.03	-0.02
21.Year 2007	0.10	0.30	0.01	0.07	-0.01	0.04	-0.04	0.03	-0.02	0.01	-0.11*	0.01
22.Year 2008	0.12	0.33	0.06	0.03	-0.04	0.03	-0.10	-0.02	-0.05	0.01	-0.06	0.04
23.Year 2009	0.13	0.33	0.03	-0.09	-0.02	0.02	-0.07	-0.01	-0.06	0.04	-0.02	-0.01

	11	12	13	14	15	16	17	18	19	20	21	22	23
1.Gross profit on sales													
2.Revenue growth rate													
3.Profit growth rate													
4.Debt/Equity													
5.Age													
6.Structural hole													
7.Innovation resources													
8.Relative innovativeness													
9.Relative reputation													
10.Relative bargaining power													
11.Relative innovativeness X Structural hole	1.00												
12.Relative reputation X Structural hole	0.33***	1.00											
13.Relative bargaining power X Structural hole	0.02	-0.16	1.00										
14.Year 2000	-0.04	-0.12	0.01	1.00									
15.Year 2001	-0.05	0.23***	0.01	-0.05	1.00								
16.Year 2002	-0.02	0.11	-0.02	-0.05	-0.06	1.00							
17.Year 2003	-0.05	0.01	0.00	-0.06	-0.07	-0.07	1.00						
18.Year 2004	-0.02	0.06	-0.05	-0.06	-0.07	-0.07	-0.09	1.00					
19.Year 2005	-0.01	-0.01	-0.07	-0.07	-0.08	-0.08	-0.09	-0.09	1.00				
20.Year 2006	0.02	-0.05	0.01	-0.07	-0.08	-0.08	-0.10	-0.10	-0.11	1.00			
21.Year 2007	0.03	-0.06	-0.05	-0.07	-0.08	-0.08	-0.10	-0.10	-0.11	-0.11*	1.00		
22.Year 2008	0.03	-0.07	-0.06	-0.08	-0.09	-0.09	-0.11	-0.11	-0.12	-0.12	-0.12	1.00	
23.Year 2009	0.03	0.00	0.03	-0.08	-0.09	-0.09	-0.11*	-0.11*	-0.12*	-0.13*	-0.13*	-0.14**	1.00

Note: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table 3.3. Two–step GMM estimates for relative capabilities of partner firms and performances

	Model 1	Model 2	Model 3	Model 1	Model 2	Model 3	Model 1	Model 2	Model 3
	coef/se	coef/se	coef/se	coef/se	coef/se	coef/se	coef/se	coef/se	coef/se
Dependent variables	**Gross profit on sales**			**Revenue growth rate**			**Profit growth rate**		
Controls									
Past performance	0.89***	0.54***	0.46***	0.24	0.26**	0.27**	-0.05***	-0.04**	-0.04**
	(0.12)	(0.15)	(0.15)	(0.15)	(0.11)	(0.11)	(0.02)	(0.02)	(0.02)
Debt/Equity	-18.96	-18.48	-18.74	0.40	0.41	0.57	-2.01	-3.78	-3.62
	(25.04)	(24.86)	(21.26)	(0.53)	(0.45)	(0.42)	(2.10)	(2.89)	(2.70)
Age	346.14*	354.32***	247.89***	-4.52*	-1.87	-2.12	4.96	46.54	52.16
	(180.42)	(102.95)	(92.75)	(2.43)	(2.41)	(2.67)	(22.76)	(33.95)	(36.70)
Structural hole	1,128.11	1,519.30	920.32	12.67	-2.31	-4.99	325.02	333.87	545.06
	(1,145.38)	(1,325.46)	(1,429.49)	(10.66)	(10.82)	(21.47)	(332.39)	(367.70)	(551.91)
Accessible resources									
Innovation resources		84.36	48.08		0.09	0.01		31.57**	31.96**
		(100.59)	(83.08)		(1.09)	(1.17)		(13.18)	(13.44)
Mean difference with partners									
Relative innovativeness		41.54*	22.88*		-0.10	-0.18		1.70	2.63
		(23.22)	(13.91)		(0.19)	(0.22)		(1.84)	(2.42)
Relative reputation		79.50	153.63		5.56**	7.76**		88.27**	94.13*
		(116.89)	(134.34)		(2.57)	(3.38)		(44.80)	(48.98)
Relative bargaining power		14.73	0.92		1.24***	1.65***		-0.95	-0.45
		(15.98)	(16.64)		(0.35)	(0.35)		(1.97)	(3.06)

Interaction									
Relative innovation X Structural hole			36.67**			0.28*			-2.57
			(14.46)			(0.15)			(2.73)
Relative reputation X Structural hole			-331.00*			-6.05			-32.64
			(184.15)			(7.38)			(62.74)
Relative bargaining power X Structural hole			88.13			-1.62*			-0.49
			(59.55)			(0.98)			(8.79)
Year dummies	Included	Included	Included	Included	Included	Included	Included	Included	Included
Cons	-7,430.25	-9,308.19**	-5,638.34**	112.23*	30.58	26.87	-104.23	-1,617.99	-1,817.53
	(4,894.93)	(3,638.18)	(2,686.55)	(68.10)	(72.25)	(80.82)	(728.29)	(1,188.99)	(1,268.59)
# of observations	239	239	239	239	239	239	239	239	239
# of firms	43	43	43	43	43	43	43	43	43
AR(2) test	0.16	0.18	0.16	0.14	0.19	0.21	0.57	0.31	0.30
Sargan test	0.09	0.14	0.32	0.17	0.45	0.24	0.43	0.71	0.66

• Note: *** p <0.01, ** p <0.05, * p <0.1

• P-values are reported for AR(2) and Sargan tests.

• The instrumental variables in GMM used the first–third lags for the past performances.

Table 3.4. Means, standard deviations, and correlations for absolute capabilities of partner firms and performances

	Mean	Std. Dev.	1	2	3	4	5	6	7	8	9	10
1.Gross profit on sales	2,441.39	5,134.70	1.00									
2.Revenue growth rate	22.00	46.76	0.04	1.00								
3.Profit growth rate	121.90	706.15	-0.02	0.14**	1.00							
4.Debt/Equity	56.16	18.38	0.22***	0.13**	-0.02	1.00						
5.Age	25.72	17.32	0.17**	0.08	-0.06	0.05	1.00					
6.Structural hole	0.20	0.28	0.50***	0.15**	-0.04	0.24***	0.42***	1.00				
7.Innovation resources	1.86	4.33	-0.01	-0.06	0.26***	0.01	0.00	-0.01	1.00			
8. Absolute innovativeness	0.64	0.70	0.14**	0.13*	0.00	0.13**	0.06	0.12*	-0.03	1.00		
9. Absolute reputation	2.22	2.09	0.03	-0.07	0.04	0.15**	0.06	0.03	0.14**	0.09	1.00	
10. Absolute bargaining power	6.83	12.95	-0.14**	0.04	0.09	-0.09	-0.02	-0.12*	0.29***	0.20***	0.09	1.00
11. Absolute innovativeness X Structural hole	0.10	0.21	0.50***	0.14**	-0.04	0.25***	0.41***	0.82***	-0.05	0.35***	0.12*	-0.13*
12. Absolute reputation X Structural hole	0.51	0.95	0.30***	0.02	-0.04	0.19***	0.33***	0.61***	0.03	0.25***	0.29***	-0.06
13. Absolute bargaining power X Structural hole	1.48	3.18	0.25***	0.04	-0.03	0.02	0.23***	0.64***	0.08	0.03	0.04	0.26***
14.Year 2000	0.05	0.21	0.00	0.07	-0.01	-0.01	0.06	0.07	0.11	-0.23***	-0.01	0.12*
15.Year 2001	0.05	0.23	-0.02	0.01	-0.03	-0.03	0.07	0.05	0.09	-0.20***	-0.02	0.04
16.Year 2002	0.06	0.24	-0.03	-0.06	-0.02	-0.09	0.07	0.00	0.09	-0.17**	-0.03	0.10
17.Year 2003	0.08	0.27	-0.05	0.07	0.04	-0.04	0.06	0.01	0.07	-0.12*	0.03	0.13**
18.Year 2004	0.08	0.27	-0.05	0.04	0.19***	0.01	0.03	0.01	0.01	-0.06	0.06	0.12*
19.Year 2005	0.09	0.29	-0.06	-0.03	-0.01	-0.01	0.02	-0.01	-0.02	0.06	0.04	0.03
20.Year 2006	0.10	0.30	-0.04	-0.01	-0.03	-0.03	0.03	-0.01	-0.02	0.08	0.05	0.01
21.Year 2007	0.10	0.30	0.01	0.07	-0.01	0.04	-0.04	0.03	-0.02	0.15**	0.02	-0.04
22.Year 2008	0.12	0.33	0.06	0.03	-0.04	0.03	-0.10	-0.02	-0.05	0.05	-0.03	-0.12*
23.Year 2009	0.13	0.33	0.03	-0.09	-0.02	0.02	-0.07	-0.01	-0.06	0.12*	-0.05	-0.10

	11	12	13	14	15	16	17	18	19	20	21	22	23
1.Gross profit on sales													
2.Revenue growth rate													
3.Profit growth rate													
4.Debt/Equity													
5.Age													
6.Structural hole													
7.Innovation resources													
8.Absolute innovativeness													
9. Absolute reputation													
10. Absolute bargaining power													
11. Absolute innovativeness X Structural hole	1.00												
12. Absolute reputation X Structural hole	0.71***	1.00											
13. Absolute bargaining power X Structural hole	0.48***	0.45***	1.00										
14.Year 2000	-0.12*	-0.02	0.16**	1.00									
15.Year 2001	-0.10	-0.02	0.13*	-0.05	1.00								
16.Year 2002	-0.06	-0.02	0.04	-0.05	-0.06	1.00							
17.Year 2003	-0.05	-0.02	0.01	-0.06	-0.07	-0.07	1.00						
18.Year 2004	-0.02	0.05	0.02	-0.06	-0.07	-0.07	-0.09	1.00					
19.Year 2005	0.02	0.04	-0.06	-0.07	-0.08	-0.08	-0.09	-0.09	1.00				
20.Year 2006	0.05	-0.01	-0.08	-0.07	-0.08	-0.08	-0.10	-0.10	-0.11	1.00			
21.Year 2007	0.12*	0.09	0.08	-0.07	-0.08	-0.08	-0.10	-0.10	-0.11	-0.11*	1.00		
22.Year 2008	0.04	0.03	-0.06	-0.08	-0.09	-0.09	-0.11	-0.11	-0.12	-0.12	-0.12	1.00	
23.Year 2009	0.06	-0.01	-0.06	-0.08	-0.09	-0.09	-0.11*	-0.11*	-0.12*	-0.13*	-0.13*	-0.14**	1.00

Note: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table 3.5. Two–step GMM estimates for absolute capabilities of partner firms and performances

	Model 1	Model 2	Model 3	Model 1	Model 2	Model 3	Model 1	Model 2	Model 3
	coef/se	coef/se	coef/se	coef/se	coef/se	coef/se	coef/se	coef/se	coef/se
Dependent variables	**Gross profit on sales**			**Revenue growth rate**			**Profit growth rate**		
Controls									
Past performance	0.89***	0.85***	0.84***	0.24	0.25**	0.26**	-0.05***	-0.05***	-0.05***
	(0.12)	(0.11)	(0.14)	(0.15)	(0.12)	(0.12)	(0.02)	(0.02)	(0.02)
Debt/Equity	-18.96	-31.64	-28.88	0.40	0.66	0.66	-2.01	-1.28	-2.10
	(25.04)	(29.52)	(26.73)	(0.53)	(0.53)	(0.52)	(2.10)	(2.80)	(2.52)
Age	346.14*	407.31**	396.90**	-4.520*	-3.33	-3.01	4.96	24.62	23.60
	(180.42)	(172.57)	(156.80)	(2.43)	(2.33)	(2.21)	(22.76)	(22.19)	(21.36)
Structural hole	1,128.11	1,599.27	-210.69	12.67	9.88	11.60	325.02	323.89	714.75
	(1,145.38)	(1,258.10)	(1,802.81)	(10.66)	(10.11)	(33.76)	(332.39)	(331.30)	(689.72)
Accessible resources									
Innovation resources		98.83	106.92		-0.48	-0.59		24.50**	22.71**
		(128.03)	(121.55)		(1.24)	(1.15)		(12.09)	(10.58)
Mean difference with partners									
Absolute innovativeness		-40.34	-57.17		-5.38*	-5.01		-47.12*	-32.14
		(200.38)	(226.69)		(3.22)	(3.47)		(27.88)	(30.77)
Absolute reputation		22.41	29.24		-1.54***	-1.51***		-1.72	-1.81
		(34.15)	(31.55)		(0.43)	(0.48)		(3.35)	(3.43)
Absolute bargaining power		1,249.71**	742.06**		-0.66	-1.50		-38.18	19.42
		(574.70)	(353.36)		(10.13)	(10.44)		(94.73)	(86.73)

Interaction									
Absolute innovation X Structural hole			325.27			-1.86			-66.88
			(446.90)			(8.29)			(78.03)
Absolute reputation X Structural hole			-73.77			-0.45			-3.00
			(75.63)			(1.30)			(10.90)
Absolute bargaining power X Structural hole			2,714.40			12.10			-287.33
			(1,727.25)			(23.84)			(311.95)
Year dummies	Included	Included	Included	Included	Included	Included	Included	Included	Included
Cons	-7,430.25	-9,358.07*	-8,932.72*	112.23*	86.39	76.33	-104.23	-599.58	-610.43
	(4,894.93)	(4,868.98)	(4,574.77)	(68.10)	(64.44)	(61.05)	(728.29)	(684.00)	(684.21)
# of observations	239	239	239	239	239	239	239	239	239
# of firms	43	43	43	43	43	43	43	43	43
AR(2) test	0.12	0.13	0.17	0.79	0.55	0.64	0.43	0.41	0.38
Sargan test	0.08	0.11	0.25	0.12	0.32	0.21	0.24	0.32	0.28

• Note: *** p <0.01, ** p <0.05, * p <0.1

• P-values are reported for AR(2) and Sargan tests.

• The instrumental variables in GMM used the first–third lags for the past performances.

3.5.1 Tests of hypotheses

Hypothesis 1a, which involves the positive effect of resource innovation, is supported in the profit growth rate variable. Hypothesis 1b, which involves the negative effect of resource innovation, is not supported in any of dependent variables. Hypothesis 2, which involves the negative effect of relative partner's innovation capability, is supported in gross profit on sales. Hypothesis 3, which involves the negative effect of relative partner's reputation, yields contradictory results in the rates of revenue growth and profits growth. Hypothesis 4, which involves the positive effect of relative partner's bargaining power, is supported in the revenue growth rate variable. Hypothesis 5, which involves the negative effect of the interaction between relatively innovative partners and structural hole spanning, yields contradictory results in gross profit on sales and revenue growth rate. Hypothesis 6, which involves the negative effect of the interaction between relative reputation and structural hole spanning, is supported in the gross profit on sales variable. Lastly, hypothesis 7, which involves the positive effect of the interaction between relative bargaining power and structural hole spanning, yields contradictory results in the revenue growth rate variable. The results are summarized in table 3.6.

Table 3.6. Summary on the results of hypotheses tests

Hypothesis contents	Hypothesis number	Expected	Result
Resource innovation	H1a	+	+ (1/3)
	H1b	–	n.s.
Relative innovativeness	H2	–	– (1/3)
Relative reputation	H3	–	+ (2/3)
Relative bargaining power	H4	+	+ (1/3)
Relative innovativeness X Structural hole	H5	–	+ (2/3)
Relative reputation X Structural hole	H6	–	– (1/3)
Relative bargaining power X Structural hole	H7	+	– (1/3)

• n.s. means "not significant."

• Parenthesis indicates the number of estimated coefficients significant in the direction of the result.

3.6 Discussion

So far, this chapter concentrated on the external resources that are accessible to a focal firm, the relative capabilities between a focal firm and partner, structural holes in vertical down-stream alliance portfolios, and firm performance. Consideration of the *decay effect* also improves the calculation of the quantity of resources that focal firms can access; evidence again was found supporting H1a about the positive effect of accessible resources on firm performance. This result appears reasonable in light of past studies, since in extreme cases, the internalization of all the external resources is possible. In

realistic circumstances, some of the external resources could be internalized, and some of them could not. According to this result, the more focal firms have opportunities of accessing external resources, the more focal firms could internalize those resources.

The results show negative impacts on relative innovativeness, positive impacts on relative reputation, and positive impacts on relative bargaining power in connection with the hypotheses about the capability differences between a focal firm and its partner. In other words, relatively smaller innovativeness, larger reputation, and larger bargaining power of a focal firm are better for performance. Figure 3.3 shows definitely how these differences affect firm performance.

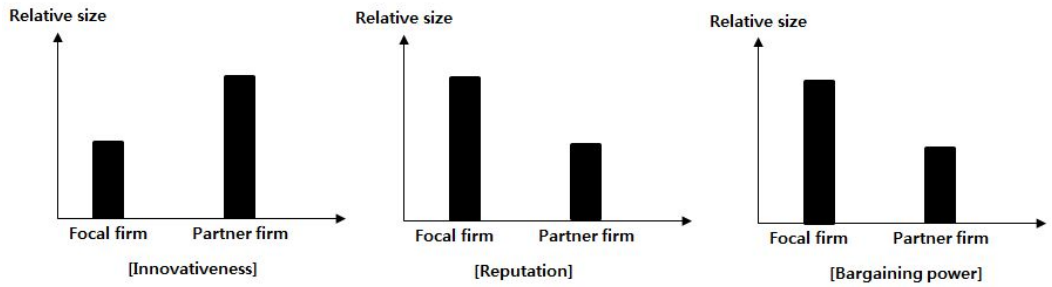

Figure 3.3. The relative capabilities between a focal firm and a partner affecting firm performance positively

The same results were estimated with the hypotheses on relative innovativeness and bargaining power between a focal firm and partners. However, the superiority of a focal

firm in relative reputation is positive for firm performance. The KIS–Value credit grade is calculated from a firm's stability, liquidity, profitability, growth, and activity indicators, which affect firm credit, through the statistical analysis of bankrupted firms in the past. This credit grade has close relationship with firm financing. So, the implication of a firm's low credit grade is that it is highly likely to require financing assistance. The internal problems that the focal firm has could be obstructive factors inhibiting the inflow of external resources. In this situation, if the focal firm has a lower reputation than its partner, it could also experience difficulties in obtaining external resources because of these obstruction factors.

In the results concerning the relative interactions of the three capabilities and structural hole spanning, the less a focal firm is innovative in relative terms, the less a focal firm should span a structural hole. Also, the higher the relative reputation and bargaining power of a focal firm, the less a focal firm should seek to span a structural hole, and vice versa. The results are shown in Figure 3.4. As a focal firm spans more structural holes, partners can engage in opportunism, despite the benefits in terms of accessing non–redundant information (Ahuja, 2000; Burt, 1992). It appears that partner opportunism in the presence of relatively strong innovativeness could cause leakage of the capability of a focal firm, because partners have a larger capacity to internalize the other firm's capability. So, the result shows that a densely closed network is preferable in order to avoid the dangers of partner opportunism.

In the perspective of relative reputation and bargaining power, a focal firm should avoid spanning a structural hole when the partner's reputation and bargaining power are lower. Since the less reputable partner could try to find the exit or solutions from a focal firm, partner opportunism may occur. So, it is better not to span structural holes but to make a densely closed network. Also, as mentioned earlier, bargaining power is the ability to obtain favorable conditions in contract negotiations. Although it might have been anticipated that unconnected partners would give a focal firm the chance to gain an edge at the negotiating table against partners by spanning structural holes, the contrary result was obtained. From this result, the following explanatory mechanisms can be considered. As a focal firm spans a structural hole, it is placed in a 1:1 relationship. In this negotiating situation, a partner firm's own behavior renders a focal firm's position disadvantageous. In a densely embedded network, however, the relationships between partner firms restrict a partner firm's own behavior since there are other negotiating relationships with other partner firms. In other words, a partner firm must interpret the "body language" of other partner firms. For this reason, if a focal firm has higher relative bargaining power, a densely embedded network structure appears preferable.

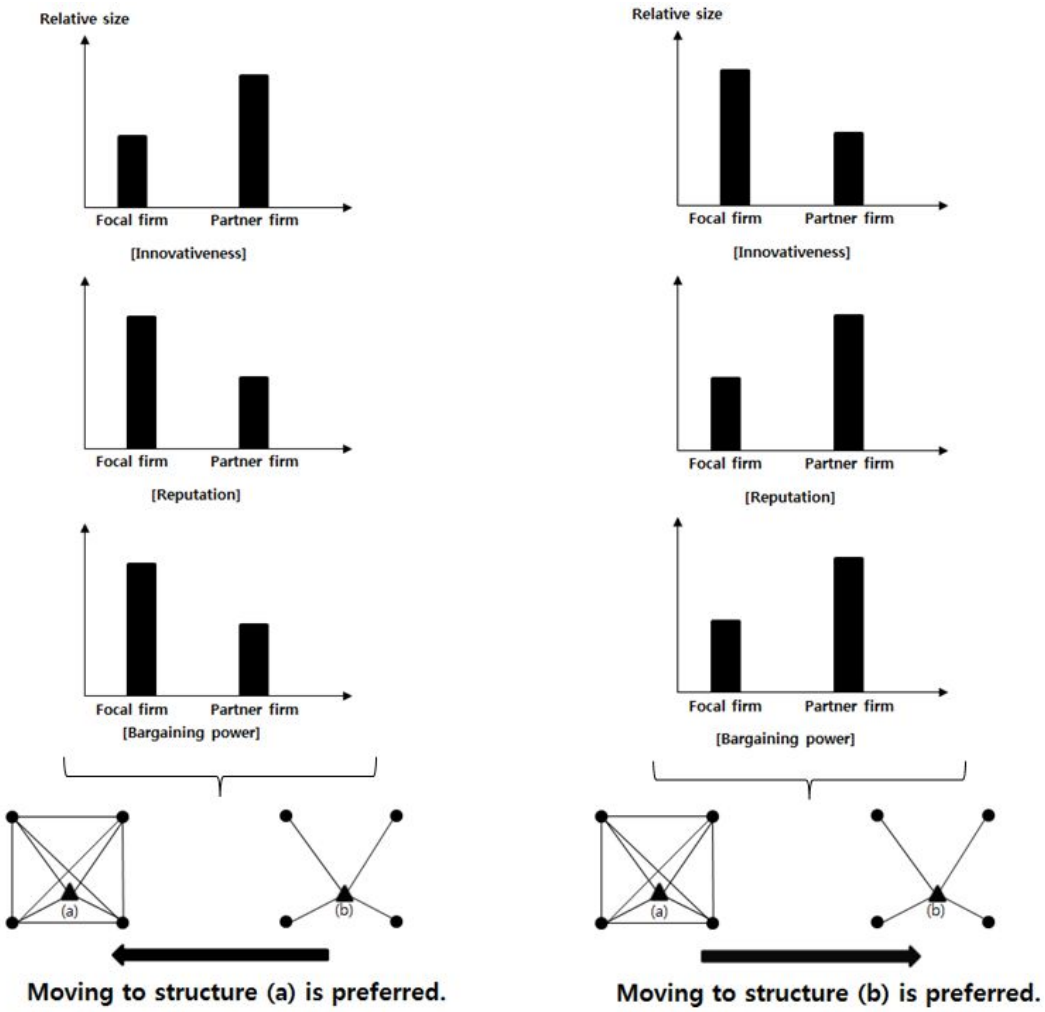

Figure 3.4. The relative capabilities between a focal firm and a partner and the structure of the alliance portfolio affecting firm performance positively

The study of the relative capabilities of partner firms and the focal firm performance, which has been discussed so far, gives different intuitions compared to the results of the absolute capabilities of partner firms and firm performance (table 3.5). Table 3.7

summarizes the results of table 3.5 in a comparative way. The results establish that there is not significant information as to which partners a focal firm should select when allying with partners having low reputation or high bargaining power that affect firm performance positively. However, focal firms all have different capabilities, and hence should vary the criteria for the selection of partners, depending on their individual capabilities.

Table 3.7. Summary on the results of absolute capabilities of partners and interaction effect of structural hole spanning

Variables	Result
Absolute innovativeness	n.s.
Absolute reputation	– (1/3)
Absolute bargaining power	+ (1/3)
Absolute innovativeness X Structural hole	n.s.
Absolute reputation X Structural hole	n.s.
Absolute bargaining power X Structural hole	n.s.

• n.s. means "not significant."

• Parenthesis indicates the number of estimated coefficients significant in the direction of the result.

The stream of research on the role of the alliance partners in alliance portfolios has emphasized that good partners affect firm performance positively. It has, however, overlooked the effect of value–appropriation in alliance portfolios (Lavie, 2007). This study supports the intuition that good partners could simply threaten a focal firm's

performance. Our findings emphasize three points. First, the focal firm should weigh carefully whether a candidate partner is proper and right as a partner and whether the candidate has any reasons to engage in opportunism in any respect (e.g., innovativeness, reputation, bargaining power, etc.). Second, firm should examine whether the candidate partner's capabilities and alliance portfolio structure are the correct ones in order to avoid opportunism. Although past studies have emphasized the benefits of spanning structural holes and densely embedded networks, the right response can differ depending on the relationship between a focal firm and partners.

Chapter 4. Conclusions and Implications

4.1 Summary of results

According to Wassmer (2010), research on alliance portfolio configurations is growing gradually. While being confident in the completion of research in this relatively new area, additional empirical studies are necessary to produce useful results for researchers and managers in a variety of institutions and organizations. A firm's capability can be divided into internal and external capabilities (Zaheer & Bell, 2005). Resource based view (RBV) scholars concentrated on internal capability, while network scholars focused on external capability. This thesis focuses on the effects of network structures in firms' access to external resources, finding that alliance portfolio configurations may affect the performance of a focal firm depending on the characteristics of the relevant markets or industries. These empirical studies may guide researchers and managers.

Chapter 2 concerns alliance portfolio configuration and firm performance, not from a uni-dimensional perspective, but from a multi-dimensional approach involving vertical up-stream and down-stream alliance portfolios and the comprehensive portfolio. In addition, it seeks to explain why "ambidexterity in technological alliance portfolios" exists between vertical up-stream and down-stream alliance portfolios. These results provide managers with good intuitions specifically how they should construct alliance portfolios at each layer. As regards the size issue, the number of alliances is positive in

the vertical down-stream alliance portfolio, whereas the number of partners is positive in the vertical up-stream alliance portfolio. A larger number of alliances in the vertical down-stream alliance portfolio might be favorable for obtaining complementary assets from other partner firms, because the quantity of complementary assets might be important for corporate performance. On the contrary, a larger number of partners in the vertical up-stream alliance portfolio might be a favorable factor for acquiring knowledge from other partner institutes, because a focal firm could get diverse ideas from many partners. This difference between two layers reveals a basis for good intuitions regarding the configuration of the relationships between the number of alliances and the number of partners for better corporate performance, a topic suggested by Wassmer (2010) for any future research agenda. Spanning structural holes affect performance negatively in vertical up-stream alliance portfolio. However, in vertical down-stream alliance portfolios, the spanning of structural holes is positive for performance. These results have important implications because information travels not only through proximate ties in networks but also through the structure of the network itself (Gulati, 1998). Balancing layers, the diversity of public institutes in the vertical up-stream alliance portfolios, and the diversity of industries in the vertical down-stream alliance portfolio can all be different depending on the perspective, notwithstanding the uni-dimensional arguments of past studies.

In the chapter 3, several hypotheses are tested concerning firm performance, including the quantity of accessible resources, the relative capabilities between a focal firm and its

partner where a structural hole is spanned. In this chapter, the calculating method for measuring accessible resources is improved, and it is argued that large amounts of resources could improve firm performance with improved accessible resource measurement. This study also explored the relative capability (innovativeness, reputation, and bargaining power) between a focal firm and its partners, the spanning of structural holes, and tested their impact on firm performance within a vertical down-stream alliance portfolio in the Korean defense industry. The results show negative impacts on relative innovativeness, positive impacts on relative reputation, and positive impacts on relative bargaining power in terms of the capability differences between a focal firm and its partner. In other words, relatively smaller innovativeness, larger reputation, and larger bargaining power of a focal firm are better for performance. This research thus contextualizes and relativizes the benefits of alliances with dominant partners. The basic assumption for this research is that there exist proper partner for a focal firm depending on its capabilities. In the interaction between the relative strength of the three capabilities and structural hole spanning, the less a focal firm is innovative relatively, the less a focal firm should span a structural hole. Also, the higher the relative reputation and bargaining power of a focal firm, the less a focal firm should seek to span a structural hole. The results show that the alliance portfolio structure is also different depending on capability differences of a focal firm. Work on the role of the alliance partners is rare, since alliance portfolio analysis is a relatively new area in the widely researched field of strategic alliances (Stuart, 2000; Lavie, 2007; Wassmer, 2010). This result will give scholars and

managers new and fruitful intuitions about the role of partners within alliance portfolios in the context of firm performance.

4.2 Implications and directions of future research

The global defense industry has recently been reorganized with the large US defense firms at its center. They have grown and globalized through M&A. Recently, the defense firms of European countries have also begun following this trend (J. H. Kim, 2008). These larger and globalized defense firms are cooperating with several firms from different countries in various ways, such as securing international production bases, strategic alliances, and so on, to dominate the worldwide market. International production bases are sought for their cost-saving effect as well as the new opportunities they give for exporting weapons systems. There has been a rapid increase in the number of strategic alliances to spread the risk of firms and to acquire resources that firms do not have (H. B. Ro, 2006). Examples of strategic alliances include Boeing cooperating with Mistubishi, Fuji, and Kawasaki of Japan to design a wings-fuselage interface in a 787 project, for a new aircraft model being developed. Further, other defense firms in the U. S., such as Lockheed Martin, Northrop Grumman, and General Dynamics, have global partnerships to share the work of developing weapons systems with several firms (J. H. Kim, 2008). Such strategic alliances will rapidly spread to other countries from the U.S. and Europe if they are beneficial for firms.

The trend of globalization in the defense industry cannot be avoided because economic, technological, and human resource demands are increasing for the production of advanced weapons systems. Further, globalization is necessary for technological breakthroughs, the rationalization of production processes, R&D for weapons systems, economic rationality, economies of scale, and successful penetration in the international market. If this logic is accepted, Korea's defense industry will likely witness fierce competition among defense firms, personnel and production cuts, international joint development and production, joint ventures, and M&A with domestic and foreign firms as did those in the U.S. and Europe.

The heavy dependence of Korea's defense industry on developed countries has limited its export of weapons systems to third countries. In the case of the U.S., trading in arms with Korea is restricted by the Arms Export Control Act (AECA), the International Traffic in Arms Regulations (ITRA), and the Foreign Assistance Act (FAA). Therefore, the government and firms should promote domestic R&D programs to achieve technical autonomy from the U.S. and other developed countries. This will assist the Korean defense firms to increase their exports, and a positive feedback structure could be made by investing the profits from exporting to other R&D projects.

Korea's defense industry faces intense competition since the abolition of the specialization-systematization legislations. Although the development paradigm of the

Korean defense industry has been that of the government leading an overseas-dependent policy, the future paradigm should be a firm-centered technology development strategy. Currently, one of the major difficulties facing the defense firms is that of acquiring the necessary technologies for product development and production (H. B. Ro, 2006). There are methods for solving this problem such as M&A, vertical integration, and so on. Among these, the strategic alliance is considered one of the most economical and efficient methods (Barney & Hesterly, 2008). If the costs of managing a strategic alliance are lower than the costs of acquiring new skills or competencies in any industry, the strategic alliance could be worthwhile. Ro (2006) showed the importance of strategic alliances for the growth of Korea's defense industry using a case study of the alliance between Samsung Electronics and Thales. It seems that the Korean defense industry needs to develop various technologies for entering the world market. To do this, firms should strive to develop their own technologies as well as growing their capabilities from various strategic alliances.

The strategic alliance is not unconditionally favorable, but strategies are necessary when implementing one. Chapter 2 shows how the configuration of a strategic alliance portfolio should be different from the comprehensive alliance portfolio, the vertical up-stream, and the down-stream alliance portfolio. Further, a partner firm's characteristics and alliance portfolio structure will affect firm performance differently in a vertical down-stream alliance portfolio, as explained in chapter 3. As the results show,

indiscriminately creating an alliance portfolio with external firms could affect firm performance negatively. As noted earlier, previous studies on Korea's defense industry have concentrated on the development strategies and the features of the industry at national level, and the institutional development plan at industry level. However, with the abolition of the specialization-systematization legislations, firm level studies are all the more necessary. Given the current underdeveloped state of empirical research in the area of alliance portfolio theory (Wassmer, 2010), it is hoped that the present study will mark the next step in alliance research. Of course, findings specific to the defense industry of Korea cannot be generalized without further analysis, and follow-up studies to cover other industries are necessary.

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Abstract (Korean)

기업의 전략적 제휴를 하는 파트너는 그 특성에 따라 수직 up-stream, horizontal, 그리고 down-stream 제휴로 구분할 수 있다. 2장에서는 이와 같은 세 가지 제휴 수준을 층(layer)으로 정의하고, 한 기업이 가지는 기술 제휴 포트폴리오를 전체적 관점과 수직 up-stream, down-stream 층의 관점에서 성과에 영향을 주는 기술 제휴 포트폴리오의 특징을 분석하였다. 그리고, 3장에서는 기업의 수직 down-stream 제휴 포트폴리오에 대해서 세 가지 연구질문을 제시한다: 첫째, 기업이 접근 가능한 자원이 많으면 성과에 긍정적인가? 둘째, 기업과 제휴 파트너간 상대적 특성 차이가 기업의 성과에 어떤 영향을 미치는가? 셋째, 이러한 특성 수준에 따라서 기업의 제휴 포트폴리오의 구조는 달라져야 하는가? 연구 대상은 한국의 방산기업 54개이며, 분석기간은 1995–2010까지로 하였고, 분석 도구로는 2단계 일반 적률법을 사용하였다. 분석 결과 2장에서는 전체적 관점에서 수직 up-stream, down-stream 제휴 포트폴리오의 균형이 중요함을 알 수 있었고, 수직 up-stream, down-stream 층에서 성과에 긍정적인 영향을 미치는 제휴 포트폴리오의 특징이 다름을 알 수 있었다. 3장에서는 기업이 접할 수 있는 자원이 많다는 것은 그 만큼 내부화 할 수 있는 역량이 많아 진다는 것을 알 수 있었고, 기업이 가진 파트너의 세 가지 역량의 종류에 있어서 상대적 차이에 따라서 성과에 미치는 영향이 다름을 알 수 있었다. 또한, 이러한 차이로 인해서 기업의 제휴 포트폴리오 구조도 달리해야 함도 주장한다. 본 연구의 결과는

학자 및 관리자에게 제휴 포트폴리오를 층(layer)라는 개념의 도입으로 세부적으로 어떤 전략적 제휴 포트폴리오를 해야 할지에 대해 도움을 줄 것이며, 파트너의 특성 연구는 그 동안 많지 않았던 분야로써 본 연구의 다각적인 분석 결과는 한 단계 업그레이드된 직관을 줄 것이다.

주요어 : 제휴포트폴리오, 전체 제휴 포트폴리오, 수직 up-stream 제휴 포트폴리오, 수직 down-stream 제휴 포트폴리오, 2단계 일반적률법, 전문화·계열화 제도

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