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The Impact of Strategic Fit on Innovation Performance: Focusing on Manufacturing Industry

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Abstract

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In a rapidly changing business management environment, continuous technological innovation is necessary in order to sustain a competitive advantage. However, technological innovation, by itself, does not necessarily guarantee success in firm

management. There are many examples of firms that have failed to create values through technological innovation, despite the fact that they possess excellent innovative resources. I can easily find examples of firms that have failed to innovate because they could not seamlessly integrate their internal and external resources and because of inconsistencies in the strategies within the organization. The mutual interaction of various stakeholders, including top management teams (TMTs), suppliers, competitors and shareholders in exploring and developing innovative technologies, the convergence of a firm's resources within a consistent strategy direction, and the creation of a synergistic effect are important. In other words, the way in which all the resources of technological innovation align is important in improving innovative performance.

This dissertation emphasizes the importance of strategic fit in firm innovation. This study first criticizes that the concept of fit is used inconsistently and indiscriminately in many literatures, and develop a framework of strategic fit that is suitable for the study in technological innovation. Based on this framework, this dissertation examines the effect of the strategic fit of various factors, especially centered on the three major factors such as the top management team attribute, the internal context as well as the external context

of the firm.

As the first study, this dissertation examines the effect of TMT cognitive characteristics on fir innovation contingent upon internal context such as organizational search behavior. The central premise of upper echelons theory is that the organization is a reflection of the top management team. The top management team has the authority to formulate, execute and evaluate a firm's innovation strategies. The knowledge base of the top management team is a key variable in predicting the firm's innovation strategy tendencies. This study focuses on this knowledge diversity. The decision-making tendencies of a top management team with a diverse knowledge base and one with a homogeneous knowledge base are bound to differ. The majority of pre-existing study concludes that the greater the knowledge diversity, the better the innovation performance. However, just as the existing quantitative analysis shows, this tendency does not apply to all firms across the board. This is due to the fact that the top management team's strategy direction is executed by the internal organization of the firm, and the TMT effect can be distorted through the firm's organizational behavior and routine. Therefore, this dissertation analyzes how the relationship between the TMT's knowledge diversity and

the innovation performance changes because of the organization's internal structure. As a result of conducting quantitative analysis of 120 manufacturing companies in the U.S., a positive correlation was determined between the knowledge diversity founded on the past industrial experience of the top management team and innovation performance. However, the results vary depending on the organizational search scope. The more expansive the organizational search scope, the greater the effect of the TMT's knowledge diversity on innovation performance. Conversely, the narrower the organizational search scope, the more constrained the top management team effect. When TMT with diverse knowledge leads to a broad search organization, therefore, fit as internal complementarity increases, which improves innovation performance.

The effect of the TMT's knowledge diversity must also match the managerial discretion of the firm. The managerial discretion indicates the extent of the TMT's direct and proactive intervention into corporate affairs, and there is a high degree of variance depending on the type of industry. The effect of the TMT's knowledge diversity is greater in industries with high managerial discretion like computer or semi-conductor industries. In contrast, the TMT effect is limited in industries with low managerial discretion like

forestry or simple manufacturing industries. Therefore, industries with high discretion are more likely to achieve fit as external complementarity with TMT with diverse knowledge, which improve innovation performance.

This dissertation also analyzes the relationship of external collaboration strategy and innovation performance. Firms can create innovative values by collaboration with many external partners. Some forms of external collaboration for innovations are mergers and acquisitions, alliances, and joint ventures. For the purpose of this study, the analysis focuses on alliances. In particular, the study analyzes the effect of alliance portfolio diversity on innovation performance. Alliance portfolio diversity refers to how many alliances firms forge with a diverse array of partners. Even if alliances are forged with great companies, alliances, by themselves, do not impact the innovation of the organization. From this perspective, I argue that the internal capability of value creation plays a critical role in leveraging alliance portfolio diversity. The alliance portfolio diversity can be represented as a pool of external resources which the focal firm can access. The extent of benefit that the focal firm gains from the portfolio will depend upon the internal capacity to create the value from the external resource pool.

Based on the dynamic capabilities framework that emphasizes competitive advantage is generated from the capabilities to combine and recombine internal and external resources (Teece, 1996; Teece, Pisano, &, Shuen, 1997), this study empirically investigates how the fit between an alliance portfolio strategy and internal capabilities affects innovation performance. First, I confirm the direct relationship between innovation performance and alliance portfolio diversity in terms of industry, then examine how internal capabilities of value creation leverage this relationship. In this study, the internal capabilities of value creation are examined in two aspects: routine (organizational search routine) and ability (technological capabilities).

The results of this analyses show that the alliance portfolio diversity alone cannot explain the relationship with innovation performance, and this relationship is determined by internal contexts such as organizational search routine or technological capabilities.

Apart from the hypotheses tests, this study conducted additional analysis by adding interaction terms with industry volatility as dummy variable, to examine how interplay of alliance portfolio diversity and internal capabilities is applied in certain environment such as high volatile industries. The result of this analysis shows the interaction of alliance

portfolio diversity and organizational search routines becomes more significant in industries with high volatility while interaction of alliance portfolio diversity, technological capabilities, and high volatility have no significance. This study analyzed the impact of alliance portfolio diversity on innovation performance in terms of fit as integrated complementarity that considers internal and external components simultaneously.

Keywords: strategic fit, innovation performance, top management team, organizational search, alliance portfolio, managerial discretion

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Chapter 1. Introduction

1.1. Backgrounds

Scholars of contingency theory have long argued that there is a relationship between organizational fit and firm performance (Burns & Stalker, 1961; Lawrence & Lorsch, 1967; Miles & Snow, 1978; Mintzberg, 1979; Miller & Friesen, 1984). They confirm that organizations that produce successful results have a better alignment of typical patterns when compared to their less successful counterparts (Powell, 1992; Woodward, 1965). Miller & Friese (1984) states that firms can experience misfit as a result of natural selection, organizational inertia, and tendency toward quantum change, and emphasizes the need for a good fit in order for a firm to achieve its desired purpose.

Organization theory and strategy theory consider the concept of strategic fit as a fundamental role in their study (Fry & Smith 1987; Venkatraman & Prescott 1990). Scholars of strategy theory argue that the appropriateness of a firm's strategy depends on the alignment of organizational contingencies and context that firms are exposed to (Ginsberg & Venkatraman, 1985; Miles & Snow, 1978). Organization theories emphasize that the utilization of the internal structure of an organization increases when it has a good fit with environmental variables and predispositions of members (Lawrence & Lorsch, 1967; Powell, 1992). Despite the fact that strategic fit is a central focus in various research fields, the importance of strategic fit has received scant attention in the field of

technological innovation (Wei, Yang, Sun, & Gu, 2014).

A number of studies that deals with innovation theory allude to importance of fit. Extant innovation theories emphasize that in order to create value, innovation strategies must be well-aligned with regimes of appropriability, dominant design paradigm, complementary assets (Teece, 1986; Hurmelinna-Laukkanen & Puumalainen, 2007; Ritala & Hurmelinna-Laukkanen, 2013), and that they must be converged (Thomae & Bizer, 2013). Even if firms possess highly innovative resources, without seamless integration of internal and external resources, firms can fail to create value through technological innovation (Teece, 1986, 2010). However, despite the importance of strategic fit in the field of technological innovation, there is not yet a fit framework to which relevant studies can refer. Therefore, this dissertation develops a framework of strategic fit that is specific to technology innovation. This study will also present empirical studies on the specific fits to enhance innovation performance.

This study will first confirm the sub-components of strategic fit that need to be taken into consideration for innovation management and take a look at whether a positive correlation exists between firm-level innovativeness and the strategic fit of these factors. Ultimately, this dissertation suggests the series of ideal fits that leads to maximize firm innovativeness.

1.2. Research purpose

Venkatraman (1990) classifies the conceptualization of strategic fit into two orientations: descriptive orientation and normative orientation. Descriptive orientation

focuses on investigating the theoretical relationship between the factors involved in strategic fit instead of associating it with firm performance. Conversely, normative orientation is clearly focused on the relationship between fit and performance. In other words, it focuses on the fact that organizations with a good fit between various factors has better performance than organizations that do not and in doing so, it studies what a well-aligned fit is. This dissertation is based on the normative orientation. Its objective is to determine what the key factors that improve a firm's technological innovation performance are, and provide insight into the specific performance implications that result from the strategic fit between these factors.

Based on the dynamic capabilities framework (Teece, 1996; Teece, Pisan, & Shuen, 1997; Teece & Pisano, 1994), and strategy formulation in terms of the knowledge based view (Sveiby, 1997, 2001), this dissertation develop the framework of strategic fit for innovation management. Figure 1 provides an overview of the components of strategic fit of innovation management.

In the framework of innovation management, there are three major components of strategic fit, including the top management team characteristics, internal context, and external context. The basic proposition of this dissertation is that the strategy formulation that provides for a well-aligned strategic fit between these components enhances the innovativeness of a firm. In particular, TMT characteristics and organizational context; TMT characteristics and external environment; internal and external innovation strategy; management and technology orientation are linkages that many innovation theories take a deep interest in.

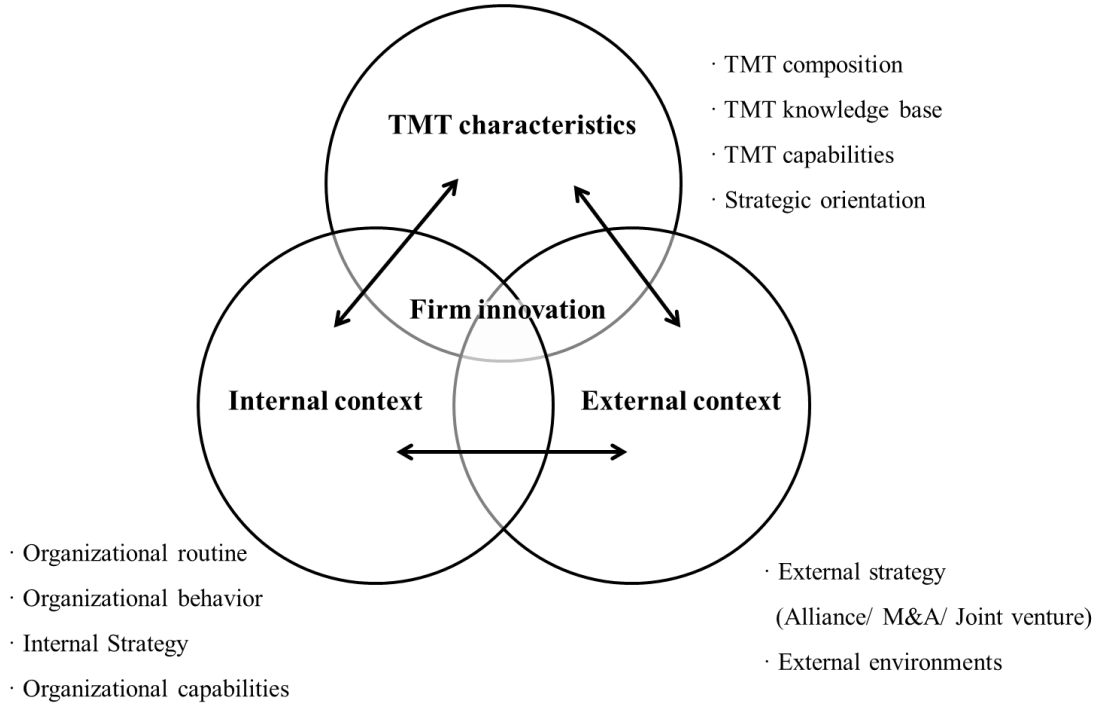

Figure 1. The framework of strategic fit on innovation management

In this boundary, this dissertation will analyze the specific fit that must be taken into consideration in order to enhance firm innovation performance, as stated below.

(1) TMT knowledge diversity and organizational search scope (ch.3)

(2) TMT knowledge diversity and managerial discretion at industry level (ch.3)

(3) Alliance portfolio diversity and organizational search routine (ch.4)

(4) Alliance portfolio diversity and technological capabilities (ch.4)

(5) Alliance portfolio diversity, internal capabilities, and industrial volatility (ch.4)

This dissertation focuses on manufacturing field for several reasons. First, manufacturing industry has the most abundant pool of innovation activities that can be the item of technological innovation study. Manufacturing firms account for the largest proportions in most developed countries (Evangelista, Rapiti, Perani, & Archibugi, 1997). Manufacturers generally use a wide range of innovation sources, and the patterns of innovation activities are diverse (Evangelista, Rapiti, Perani, & Archibugi, 1997). As a result, manufacturing industry has much more diversity, frequency, and output of innovation activities than other industries. This allows researchers available to study various aspects of technological innovation.

Second, manufacturing sector is easy to conduct an empirical study. Manufacturers usually produce a formal output. Most commonly used is the record of patent citation (Acs, Anselin, & Varga, 2002). Other industries such as service industry or the restaurant industry have innovation activities, but many cases in those industries are not available to analysis with objective measurement because outputs are informal or unmeasurable. When analyzing with samples from overall industries, it may be difficult to find a common measurements of innovation output. In case of using patent citation data, it causes another problem that is concentrated in a specific industry such as manufacturing. However, if the industrial sector is limited to manufacturing sector, researchers can conduct study based on abundant objective data.

Third, this dissertation aims to provide insights to firms belonging to the technology-intensive area. I believe the best area to apply research finding on technological innovation is manufacturing. Thus, this study targets scholars and businessmen in manufacturing sector as a major audience. In order to provide optimized insights for these

targets, it is better to align research areas with their industries.

Through these analyses, the dissertation will shed light on the important fits to improve firm innovation performance and provide scholars and practitioners with valuable insight.

1.3. Research outline

The main body of this dissertation consists of four different parts: the literature review, two different empirical studies corresponding to each strategic fit on innovation management, and finally the overall conclusions of this dissertation.

Chapter 2 covers the literature review. Specifically, this chapter reviewed the existing literature on strategic fit with critical perspective, and presented a framework for strategic fit that is well suited to technological innovation. Moreover, Chapter 2 introduces the theoretical backgrounds of the subsequent empirical studies of this dissertation and connects the arguments of this study with the realm of the extant literature.

Two different empirical studies are covered in Chapters 3, and 4. In Chapter 3, This study analyzes mainly the effect of the fit between TMT characteristics and internal routine, and the fit between TMT characteristics and external environment on innovation performance. TMTs have been shown to play an instrumental role in driving innovation within a firm (Bantel & Jackson, 1989; Jehn, Northcraft, & Neale, 1999; Pegels, Song, & Yang, 2000; Wiersema & Bantel, 1992). After all, senior executives of a TMT exercise authority, and formulate and implement strategies relevant for organizational

innovativeness (Barker & Mueller, 2002, Zahra & Pearce, 1989). Especially, the knowledge diversity based on the prior industrial experiences of a TMT has a critical impact on firm-level innovation. This chapter highlight that examining the industrial knowledge diversity of the TMT is important to facilitate firm-level innovation performance. Basically, this chapter suggests that knowledge diversity of TMT has positive relationship with innovation performance. To understand the impact of TMT's knowledge base on innovation of the firm more accurately, however, we need to look over with internal context simultaneously. This is because the TMT's effort is utilized by an internal routine or organizational behavior. It means that the effect of TMT knowledge diversity can be changed according to the such internal context. Especially, this chapter focuses on the organizational search scope as an internal context. Organizational search scope is a crucial factor that affects organizational processes of creation and recombination of novel ideas (Nelson and Winter, 1982), and innovation outcome (Katila & Ahuja, 2002).

While upper echelon perspective regards the organization as a reflection of its top managers (Hambrick & Mason, 1984), in reality, TMT's needs and organizational behavior can be constantly decoupled due to the difference of their volatilities. TMT undergoes changes in its membership through retirement, recruitment, and promotion of the members. Subsequently, the frequent changes in TMT composition result in fluctuations in TMT knowledge diversity. In contrast, search routines at the organizational level are characterized with stickiness and rigidity; standard operating procedures and protocols become routinized and build inertia with organizational path dependence (David, 1994). Due to this difference of volatility, misfit between TMT knowledge base

and organizational search scope is inevitable. To maximize the effect of TMT knowledge diversity on innovation, firms need to minimize the restraint due to the misfit. Thus, This study examines the interaction effect of organizational search scope to identify the appropriate match between TMT knowledge diversity and search scope.

This study shows that the positive effect of TMT knowledge diversity on firm innovation is further strengthened when the organizational search scope is broader. An appropriate fit between broad search and TMT with a diverse knowledge base fosters the condition to enhance innovation.

Additionally, this chapter analyzes the relationship between knowledge diversity of TMT and environment variable such as managerial discretion at industry level on firm innovation. The managerial discretion, or the latitude of action of the TMT, is the important moderator in the TMT knowledge diversity-innovation linkage. This is because the impact of the TMT on organization is likely to be more prominent in a high-discretion situation (Crossland & Hambrick, 2007; Finkelstein and Boyd, 1998), and so is the impact of TMT knowledge diversity. This study shows that the diversity of the TMT knowledge base would lead to greater innovation performance if the industry environment endows a high level of managerial discretion.

Chapter 4 focused on the fit of alliance portfolio diversity and internal capabilities of value creation on innovation performance. This chapter point out that arguments about the effect of alliance portfolio diversity on innovation performance are not consist in prior literatures. A stream of literature stresses that the positive effect of high-degree alliance portfolio diversity on innovation performance (Cui & O'connor, 2012; Duysters & Lokshin, 2011; Faems, Janssens, & Neyens, 2012). This literature focuses on the

advantage of diverse partners such as diverse resources, low redundancy in resources, and innovative combinations of the resources acquired. On the other hand, another stream of literature suggests that the high degree of alliance portfolio diversity impedes firms' innovation (Bae & Gargiulo, 2004; Faems et al., 2008; Gualti & Singh, 1998). The managerial cost for diverse relationships crosses out the benefit of diverse and affluent resources. Thus, some studies acknowledge both the advantage and disadvantage of alliance portfolio diversity and recommends a moderate level of diversity (Oerlemans, Knoben, & Pretorius, 2013; Vasudeva & Anand, 2011).

In my view, this inconsistency stems from the fact that previous studies have not sufficiently considered internal (within firms) which might interrelate the outcome of alliance portfolio diversity. No matter how great the alliance partners are, they do not create value in themselves. Firms' internal context also might affect the impact of alliance portfolio diversity on firm performance. Accordingly, to thoroughly examine the influence of alliance portfolio diversity on innovation performance, it is required to investigate the internal context which firms are encountering with. In this paper, I attempt to show that the relationship between alliance portfolio diversity and innovation performance depends on the focal firms' internal capabilities such as organizational search routine or technological capabilities. This study examined the statistical significance of alliance portfolio diversity on innovation performance of the firm. Then, This study analyzes how relationship of alliance portfolio diversity and innovation performance can be moderated by internal capabilities of value creation such as organizational search routine and technological capabilities. Additionally, This study analyzed how this interplay of alliance portfolio diversity and internal capabilities of

value creation on innovation performance is moderated by external context such as the industry volatility.

Finally, Chapter 5 provides a summary of this dissertation and concludes with a discussion of implications, limitations, and directions of future research.

Chapter 2. Literature review

2.1. The concept of strategic fit

2.1.1 Definition

The concept of fit is founded on the population ecology model and is based in the contingency theory tradition (Van de Ven, 1979). Strategic fit refers to congruency, contingency, matching, or coalignment, and the central concept regarding strategic fit refers to the aligning of organizational resources as well as various internal and external contexts (Andrews, 1997, Chandler, 1962). Fit recognizes the key components of strategy, and can also be defined as the seamless integration of traditionally mismatched ideas (Andrews, 1980; Venkatraman 1990).

The majority of contingency-theory based studies have utilized the concept of fit, primarily focusing on the relationship between bi-variates. However, recently, there are more studies that analyze the fit among a larger set of elements, (Nightingale & Toulouse, 1977) as well as study on gestalts style strategic fit (Miller, 1981; Miller & Friesen, 1978).

2.1.2 Strategic fit in various theories

Scholars of contingency theory have sought to validate the fact that strategic fit has, by design, no choice but to exist because of reasons such as natural selection,

organizational inertia, and tendency toward quantum change (Miller & Friese, 1984). They argue that firms must have an alignment of internal-external resources, strategies and typical patterns in order to achieve successful results. For example, Powell (1992) emphasizes that successful results are achieved through fit between endogenous design variables such as organization structure and exogenous context variables such as environmental uncertainty and organization size routine.

Using these contingency concepts, strategy and organization theory each use its own logical frame to emphasize the importance of strategic fit (Ginsberg & Venkatraman, 1983). In the field of strategy theory, Hofer (1975) argues that the development of business unit strategy must match the product's life cycle, emphasizing for the first time the need for contingency-based empirical study. After Hofer's study, a number of strategy study began to use this concept of fit. The majority of strategy theories focus on the fit between organization strategy and external environment (Anderson & Zeithaml 1984; Hoffer 1975; Jauch, Osborn, & Glueck 1980). But there is also study on internal fit that looks at the relationship between strategy and structure (Chandler 1962; Vorhies & Morgan 2003). For example, Chandler (1962) emphasizes that a transition in business strategy can only be successful if it is accompanied by structural adjustments. Child (1975) states that high-performing organizations have consistent internal structural configurations as opposed to low-performing organizations. There is also study that emphasizes the fit between manager and strategy. For example, Wissema et al. (1980), suggest that the explosive strategy will be best administered by a pioneer-styled manager, and that this fit improves competitive position in the short run.

Some studies address the importance of strategic fit from a broader perspective. Jauch

and Osborn (1981) state that in order for a firm to survive, its environmental, contextual, and structural complexities must match. Peters and Waterman (1982) emphasize that a firm's excellence results from the alignment between seven factors: strategy, structure, systems, style, staff, shared values, and skills.

Organization theory study is deeply associated with structural contingency theory (Thompson, 1967; Lawrence & Lorsch, 1967; Donaldson, 1995). As opposed to strategy theories, which focus on environment–strategy relationships, these studies emphasize environment–structure relationships. For example, Lawrence and Lorsch (1967) state that firms that succeed in an environment of uncertainty have more differentiated, sophisticated, and integrated structures compared to their unsuccessful counterparts. They emphasize that the effectiveness of the organization's internal structure increases when it is well-aligned with diverse environmental variables and the predispositions of members. Organizational theory literature aims to clearly define the structures that correspond to the environment. This is because the environment–structure framework is unidimensional (Zajac, Kraatz, & Bresser, 2000), Thus, particular environmental conditions require particular structures.

The importance of strategic fit is also underscored in resource-based view (RBV) study. According to the RBV viewpoint, firms generate profits to the extent that they accumulate rent-producing resources that, in addition to providing economic value, meet the tests of scarcity, imperfect imitability, and imperfect trade ability in factor markets (Barney, 1986a, b; Dierickx & Cool, 1989; Peteraf, 1990). The ability to align corporate resources to fit becomes important in order to meet these tests (Powell, 1992).

Table 1. Theoretical backgrounds on strategic fit in various literatures

Theoretical fields	Related studies (selected)	Components of Fit
Strategy theory	Hofer (1975)	Strategy (business unit) and product life cycle
	Anderson & Zeithaml (1984)	Strategy and product life cycle
	Jauch. Osborn, & Glueck (1980)	Strategy and external environment
	Chandler (1962)	Strategy and organization structure
	Vorhies & Morgan (2003)	Strategy and marketing organization structure
	Wissema et al. (1980)	Strategy and manager style
	Jauch & Osborn (1981)	Environmental, contextual, and structural complexities
	Peters & Waterman (1982)	Strategy, structure, systems, style, staff, shared values, and skills.
Organization theory	Lawrence & Lorsch (1967)	Organizational structure and environment
	Zajac, Kraatz, & Bresser (2000)	Organizational competences and environments
	Child (1975)	Organizational structure consistency/ organizational characteristic and environment conditions (variability)
	Thong (1995)	Organizational structure and manager characteristics
Technological innovation theory	Woodward (1965)	Technology characteristics and organization structure
	Litschert, & Ramaswamy (1991)	Innovation policy and managerial characteristics
	Teece (1996)	Organizational determinants and industrial structure
	Cassiman & Veugelers (2006)	Internal R&D activities and external technology acquisition
	Kim, Arthurs, Sahaym, & Culler (2013)	Diversification strategy and internal search strategy
	Song, Almeida, & Wu (2003)	Engineer's technological expertise and firm's expertise
	Kuo & Lee (2011)	Organizational task and technology

The knowledge-based view primarily looks at the need for fit from the perspective of establishing an optimized structure that maximizes knowledge transfer or sharing. According to the knowledge-based view, the organizations establish both internal and external structures in order to accomplish their strategic objectives. Internal structures would include innovation process or organizational search routine, while external structures technological acquisitions, alliances or strategic relationship (McLuhan, 1967; Sveiby, 1997). When market conditions change, TMTs may become pressured by the board and other stakeholder groups to change the internal structure in response. Sveiby (1997) emphasizes that the alignment between manager's competence, internal structure, and external structure must be in place in order for the firm to generate intangible value such as innovativeness, and proposes that the way for firms to establish strategy formulations that create intangible values is to enhance the 1:1 relationship between these factors.

Despite the fact that strategic fit has been addressed to a large extent in a myriad of research fields, this concept has received relatively scant attention in the field of technological innovation (Wei, Yang, Sun, & Gu, 2014). However, many innovation scholars adopting contingency perspective allude to the importance of strategic fit in firm innovation management. Researchers in this field reiterate that in order to generate values in technological innovation, there must be an alignment of strategy with regimes of appropriability, dominant design paradigm, complementary assets, etc., (Teece, 1986; Hurmelinna-Laukkanen & Puumalainen, 2007; Ritala & Hurmelinna-Laukkanen, 2013), and that there must be a convergence of these factors, as well (Thomae & Bizer, 2013). Technological innovation alone does not guarantee business success, and even if firms

possess highly innovative resources, they can fail to generate values through technological innovation (Teece, 1986, 2010). In particular, during the process in which firms either explore or exploit resources, internally, various resources must be integrated while, externally, seamless interaction must exist between users, suppliers, competitors, and other stakeholders in the business system (Chesbrough, 2003). Also, when the firm undergoes structural change, it must have the appropriate business model logic, and all of the different resources must be properly integrated in order for the firm to take hold of opportunities (Casadesus-Masanell & Ricart, 2010).

A number of technological innovation studies provides for performance implications in relation to fit. For example, Kim, Arthurs, Sahaym, and Culler (2013) argue that the fit between a firm's internal search strategy and external diversification strategy enhances its innovation performance. Also, Woodward (1965) emphasizes that technological development is influenced by the organizational characteristics of the firm, explaining that technological development performance is improved when the characteristics of the technology that the firm is developing matches the structure of the organization. Thomas, Litschert, & Ramaswamy (1991) state that a firm's managers play a pivotal role in the successful administration of innovation strategy, and argue that organizational innovation policy and managerial characteristics must be aligned.

2.2. Critical review on strategic fit

2.2.1 Critical review on prior studies

Fit is widely used in broad theoretical fields. However, the concept of fit is used in various expressions such as congruence, contingent, match and alignment, but the scheme is inconsistent. If concepts are used disorderly without a certain consistent scheme, they cannot be analyzed appropriately and cause improper interpretation (Venkatraman, 1989). This constrains building elaborate theories.

Scholars having such a sense of problem have tried to develop the scheme of strategic fit. In the strategy theory, Venkatraman (1989) classified the fit according to degree of specificity of the functional form of fit-based relationship and choice of anchoring the specification of fit-based relationship: fit as moderation, fit as mediation, fit as profile deviation, fit as matching, fit as covariation, fit as gestalts. These six perspectives highlight the isomorphic nature of correspondence between a particular concept and its subsequent analyzing scheme.

Venkatraman and Camillus (1984) distinguished classified six schools of thought on fit based on two underlying dimensions such as domain of fit and conceptualization of fit: strategy formulation school, strategy implementation school, integrated formulation-implementation school, interorganizational networks school, strategic choice school, overarching gestalts school.

Porter (1996) argued that strategic fit among many activities is fundamental not only to competitive advantage but also to the sustainability of that advantage, and suggest three type of fits. In his study, first-order fit indicates consistency of functions, activities, and the overall strategies. Consistency makes the strategy easier to communicate to customers, employees, and shareholders, and improves implementation through single-

mindedness in the corporation. Second-order fit occurs when activities are reinforcing. It refers to fit when one activity enhances another activity. Third-order fit is the optimization of effort, which goes beyond activity reinforcement. All efforts are optimized for a particular strategy and raise the sum of the total. Porter highlighted that the whole matters more than any individual part in all three types of fit. The fit among activities substantially reduces cost or. increases differentiation, which leads to enhance competitive advantage.

Scholars in Organization theory also developed conceptualization on fit. Organization research focuses on the relationship between strategy and one or more organizational environmental variables. Ensign (2001) proposed a six celled matrix as a conceptual scheme to distinguish different perspectives of fit. The matrix includes three common dimensions: strategy, organization, and environment. The metrix also suggest two different units of analysis such as business or corporate.

In the field of human resource management, Edwards, et. al (2006) distinguished 3 types of fit based on the streams of P-E (Person and Environment) fit research (Kristof, 1996), suggesting first type is needs–supplies fit which refers to the comparison between the psychological needs of the person and the environmental supplies that serve as rewards for needs, and second type is demands–abilities fit which involves the comparison of the demands of the environment to the abilities of the person. Third type is supplementary fit which refers to the similarity between the person and the environment, where the environment refers to other people individually or collectively in groups, organizations, orvocations (Muchinsky & Monahan, 1987).

Thus, each theory field has its own scheme on strategic fit. On the other hand, there is

no framework for technological innovation. As a result, the fit used in the technological innovation research is still not clearly classified. This may lead to a bias for readers to understand and interpret the meaning of the concept. Several scholars refer to the existing fit framework in other fields to develop the theory on technological innovation (e.g., Hitt, Ireland, Camp, & Sexton, 2001; Kim & Pae, 2007). However, the scheme is not perfectly matched because the theoretical orientations of the concept are different depending on the field of theory. Moreover, the components of fit which are commonly used in technology innovation study such as patent citations, complementary knowledge, combinational or recombinational technologies are not easily assimilated in existing frameworks. That's why it is difficult to accurately classify the fit concept of technological innovation based on existing frameworks. Therefore, it is necessary to develop a unique framework that reflects the characteristics of the technological innovation research.

2.2.2. Suggesting new framework for technological innovation study

This dissertation seeks to establish a framework for strategic fit in the realm of technological innovation management. This framework provides (1) set of fit which is theoretically defined based on existing theories, (2) contains dimensions that reflect the nature of innovation study, (3) and provides with an analyses methodology for modeling each concept of fit.

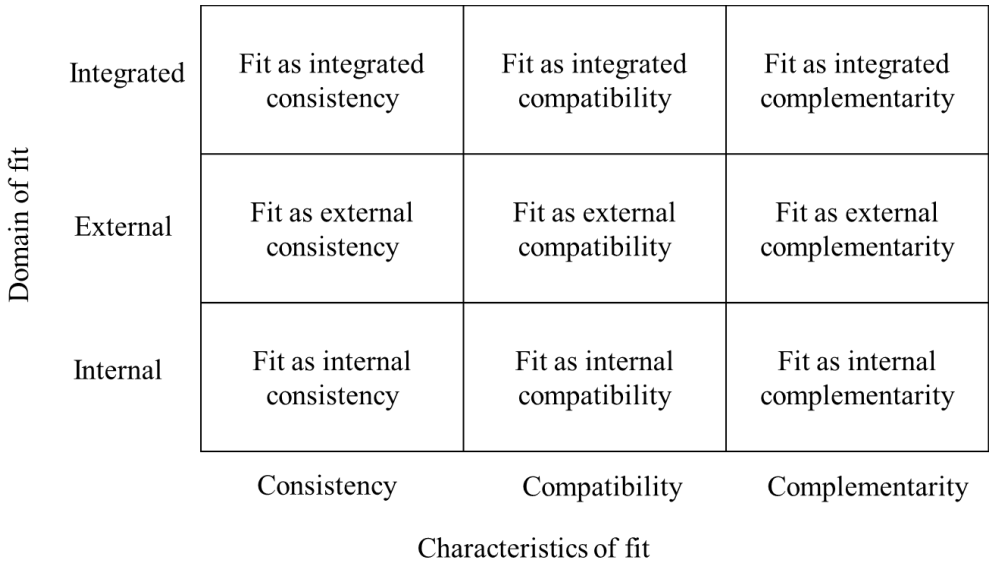

Figure 2. Framework of strategic fit

Figure 2 shows the proposed framework. Horizontal dimension represents the characteristics of fit. Previous studies in technological innovation argues that compatibility and complementarity between components must be satisfied in order to create technological synergies (Dhebar, 1995; Mitsuhashi & Greve, 2009; Sarkar, Echambadi, Cavusgil, & Aulakh, 2001). Farrell & Saloner (1985) suggested that standardization (consistency) and compatibility are needed to improve innovation performance. Other studies claim that consistency must be met in order to create operational efficiency in innovation (Fiol, 1996; Schwartz, Bransford, & Sears, 2005). Overall, the most representative nature of fit in technological innovation can be specified in three characteristics: *consistency*, *compatibility*, and *complementarity*. These three characteristics are the primary conditions to generate technological synergy and enhance the responsiveness of technology development.

Vertical dimension represents the domain of fit. There are paradigmatic differences depending on the domains of the components in which the fit occurs (Jemison, 1981), which raises the need to distinguish between internal, external, and integrated domains. Venkatraman and Kamillus (1984) suggested that fit with internal components is related to implementation while fit with external components is related to formulation. This means that the function of fit can be differ depending on which domain the components are associated with. In the same vein, this study specifies the vertical dimension by distinguishing whether the domain of components is internal, external area, or both of internal and external area. Internal (organizational) components contain the aspects such as structure, process, people, task, and rewards (Galbraith & Nathanson, 1978). External components contains general environment or task environment such as competitors, suppliers, customers, regulatory groups (Bourgeois, 1985). An integrated dimension is a combination of internal and external domains.

Consistency dimension

The fit in this dimension represents the degree of consistency between components. This focuses on whether the pattern or contents of components are coherent to each other. The difference with other fit dimensions such as complementarity or compatibility is that there is no referent or interaction between the components. Components in consistency fit take an equivalent and independent position with respect to each other. Venkatraman (1990) examined the relationship between strategic consistency of three functions such as marketing, manufacturing, and administration in organization and firm performance. Each function in the firm will have its own goals and strategic direction. However, when

all strategies are consistent, the overall efficiency can be enhanced. He examined the pattern of covariation for each strategy of departments and proved that the performance of the entire firm is enhanced when the internal consistency among strategies is achieved.

Fit as consistency is classified into internal, external, integrated dimension according to the domains of components. The study of Venkatraman (1990), which examines the relationship between the strategic consistency of the three divisions and performance, is a typical internal consistency. Song, Almeida, and Wu (2003) conducted a study related to fit as internal consistency in the perspective of knowledge management. They found that the degree to which recruiting companies can efficiently transfer the knowledge of hired engineer's former firm depends on coherence of the technological expertise between the hired engineer and the hiring firm. If the expertise of a hiring firm and a hired engineer is coherent, the hiring firm can be better transferred knowledge of hired engineer's prior firms. This study examined the consistency of contents while Venkatraman (1990)'s study examined the consistency of pattern.

Fit as external consistency is the dimension which examines fit with environment variables or external components while fit as integrated consistency is the dimension which examining fit with external and internal altogether. Mitsuhashi and Greve (2008) found that when a company forms alliances with external partners, the greater the homogeneity of the product market between the two companies, the higher the firm performance such as ROA. Sears & Hoetker (2014) studied the impact of technological consistency on post-acquisition performance when a firm acquires an outside firm. They measured the degree of coherence of the knowledge between two companies through the concept of technological overlap. That is, the overlap between the knowledge bases

between the acquirer and the target significantly influences the acquirers' performance such as the cumulative abnormal returns (CAR) of the, which indicate acquiring firm's stock market reaction to the announcement of the acquisition. They suggested that the technological synergy evaluated by the market will increase as the degree of consistency in terms of knowledge base between acquiring companies and targets increase.

Fit as consistency is modeled by measuring the coherence between variables. As a representative method, Venkatraman (1989) suggested that modeling covariation among the components through factor analysis such as exploratory factor analysis (EFA) or confirmatory factor analysis (CFA) is appropriate. Venkatraman (1990) used the degree of covariation to measure the consistency of the pattern among three departments' strategies in his study. Unlike the consistency of pattern, the consistency of contents can be examined by determining the extent of common content (e.g. overlap of knowledge base) between components.

Compatibility dimension

The second dimension is fit as compatibility. Fit as compatibility has the referent to specified profile while fit as consistency has no referent relationship between components. That is, compatibility is determined by how much of a certain component meets the required conditions in a particular context. This fit can be examined by the degree of adherence to a specified profile.

Fit as internal compatibility indicates the compatible relationship with internal variable. Kuo and Lee (2011) conducted a study on the compatibility of task-technology by analyzing the introduction of knowledge management system of 500 IT companies. In

this study, they suggested that the task compatibility of the system is determined by the extent to which the knowledge management system meets the conditions required by the task of the organization, and it affects behavioral outcomes such as perceived ease of use or perceived usefulness.

Fit as external compatibility or integrated compatibility mainly contains environment variables. Venkatraman and Prescott (1990) presented a comparative profile of the 17 variables for eight environmental typologies. They measured the weighted Euclidean distance of the strategy variables and ideal profile along those variables to assess the compatibility. Unit deviation from such an ideal profile represents a unit of misfit, which is shown to have a negative relationship with performance such as ROI.

In measuring this fit, the profile deviation analysis of Drazin and Van de Ven (1985) and Govindarajan (1988) is the most representative. This methodology sets the ideal profile expected in a particular context and measures how much of the predict variable adhere to in this profile. The higher the degree of adherence, the higher the compatibility, which improves the performance positively.

Complementarity dimension

Third dimension represents the degree of complementarities between variables. This fit focuses on how the impact of certain components on the criteria (e.g. performance) leverage by other components. This fit is specified by interaction among the variables, unlike fit as consistency or fit as compatibility. The impact that the X variable (predictor) has on the Y criterion is dependent on the level of a Z variable (moderator). Interaction between X variable and Z variable is primary determinant of Y variable.

Internal complementarity is usually applied when certain components are leveraged by internal context such as internal capabilities or organization structures. Kim, Arthurs, Sahaym & Cullen (2013) presented performance implications for the fit of diversification strategy and organizational search strategy. They argued that the type of diversification strategy leads to greater innovation output when the appropriate technological search strategy is employed. When firms use a narrow technological search strategy, a related diversification strategy leads to greater innovation. When a broader technological search strategy is used, on the other hand, an unrelated diversification strategy leads to greater innovation. Fit with internal strategy enhances the effectiveness of corporate strategy such as related or unrelated diversification.

External complementary refers to the complementary relationship with external components. Stuart (2000), for example, emphasized the importance of considering the complementary relationship of industry and the characteristics of external partners when establishing an alliance strategy. In other words, the capabilities of an alliance partner are basically important to enhance innovation performance of focal firm, but the environmental characteristics of high-tech industries leverage the impact of the capabilities. Thus, alliance strategies should be formulated taking into account that the high-tech industry and alliance partners' capabilities have complementary relationship.

Jauch, Osborn, and Glueck (1980) studied fit between the environment and strategy as external components. This study constructed 72 interaction combinations based on 8 strategic decision categories and 9 environmental attributes and analyzed the impact of certain strategies in specific environments. They identified the complementary fit between strategy and environment that had a significant impact on financial performance.

Cassiman and Veugelers (2006) shows fit as integrated complementarity. This study confirms firm performance depends on the combination of both internal R&D activities and external technology acquisition. They examined complementary relationship by directly testing the difference in marginal returns to combinations of innovation activities. This study suggested that the combinations of external and internal innovation activities are positively related.

Typical methodology to measure fit as complementarity is the moderated regression analysis with a test of the statistical significance of the interaction terms and the incremental variance (Venkatraman, 1989). Subgroup analysis with tests of differences between the correlation coefficients across the various sub group is another way to measure complementary fit. In addition, Joyce et al. (1982) and Van de Ven and Dazin (1985) suggested the ANOVA scheme to measure moderation relationship. Arnold (1982) argued to need to distinguish two types of moderated regression or sub-sample analysis. If the strength of relationship between dependent variable and independent variable depends on the certain contexts, it reflects the strength of moderation, and the sub-sample analysis is appropriate. On the other hand, if the form of relationship between dependent variable and independent variable depends is jointly determined by interaction with other components, it means the form of moderation, and it is appropriate to use moderated regression analysis (Arnold, 1982).

Table 2. Summary of dimensions on strategic fit

	Fit as consistency	Fit as compatibility	Fit as complementary
Definition	Degree of consistency or coherence among components	Degree of adherence to an specified profile	Extent of complementarities
Attributes of relationship	Equivalence (Is patterns or contents coherent?)	Referent (Does it meet required conditions?)	Interaction (Does it reinforce other's impact?)
Exemplary Analyses	Factor analysis Covariations	Profile deviation analysis	Moderated regression analysis Subgroup analysis ANOVA
References	Wang, et., al (2008) Galbraith & Venkatraman (1990) Song, et., al (2003) Mitsuhashi & Greve (2008) Sears & Hoetker (2014)	Kuo & Lee (2011) Venkatraman & Prescott (1990) Drazin & Van de Ven (1985) Govindarajan (1988)	Kim, et., al (2013) Stuart (2000) Cassiman & Veugelers (2006) Jauch, et., al (1980)

2.2.3. Empirical studies on strategic fit for innovation performance

Damanpour (1991) suggests that moderating analyses are the most general in the field of innovation study through his a meta-analytic review. Among the three dimensions of consistency, compatibility, and complementarity in this dissertation, I believe fit as complementarity would be most often used in technological innovation study. In reality, many scholars are modeling the fit by the moderation analyses (e.g. Cassiman & Veugelers, 2006; Kim, et., al, 2013; Stuart, 2000). Thus, in order to examine the fit as complementarity more specifically, this study carries out two empirical studies on this dimension.

First empirical study examines fit as internal complementarity and external complementarity. This study analyzes the direct relationship of the impact of the

knowledge diversity of the top management team and firm level innovation performance. Next, this study examines the interaction effect of the organizational search scope to analyze the internal complementary fit with TMT knowledge diversity on innovation performance. Then, examine the interaction effect of managerial discretion at industry level to analyze the external complementary fit with TMT knowledge diversity on firm innovation.

A second empirical study examines the impact of alliance portfolio diversity (APD) on innovation performance in an integrated way. As many scholars have reported that the alliance strategy should be considered in terms of contingency (Srivastava & Gnyawali, 2011; Wuyts & Dutta, 2014; Zaheer & Bell, 2005), it is appropriate to examine the impact of alliance portfolio on innovation performance with different contexts.

In this study, I first examine the fit between alliance portfolio diversity and the internal capabilities of value creation on innovation performance. Alliance portfolio diversity indicates a pool of external resources that firms can access. Leveraging benefits from alliance portfolio depends on the firm's internal capabilities of value creation including routine (organizational search routine) and ability (technological capabilities). Thus I examine the interaction effects of alliance strategy and internal capabilities on innovation performance. This interaction effect may works differently in a certain environment such as high volatile industries. To better understand the effect of alliance portfolio diversity on innovation, we need to analyze it in aspect of fit as integrated complementarity. Thus, this study adds the interaction term with the high volatile industry as dummy variables.

2.3. Top management team and internal-external context

2.3.1 TMT's Knowledge base

Firms need to cultivate, protect, and leverage their firm-specific assets in order to acquire competitiveness (Chakravarthy, McEvily, Doz, & Rau, 2003; Grant, 1996). Drawing from this literature, the top management team is a critical embodiment of these knowledge assets. Members of the TMT play a pivotal role in organizational decision-making; in fact, a substantial body of study indicates that TMTs have a significant impact on their organization's processes and outcomes (Hambrick, 1994, 2005; Hambrick & Mason, 1984: Tushman, Virany, & Romanelli, 1985).

The upper echelons view, put forth by Hambrick and Mason (1984) and others, draws on the concept of bounded rationality (Cyert & March, 1963). Namely, managers are constantly bombarded with ambiguous and complex information cues and, thus, will fall back on their experiences, preferences, and other biases. Therefore, the upper echelons perspective is principally a theory of information processing, with managers acting on the basis of their filtered construals of the situations they face (Hambrick, 1994, 1998, 2005; Cho & Hambrick, 2006; Hambrick & Mason, 1984: Tushman et al., 1985).

Scholars of innovation have also noted the importance of the characteristics of the members of TMTs (Bantel & Jackson, 1989; Jehn et al., 1999; Pegels et al., 2000; Wirersema & Bantel, 1992). A top executive team assumes responsibility and exerts authority to control the budgets required for planning and executing innovation (Zahra &

Pearce, 1989); its demographic characteristics, such as average age, tenure, educational background, and career experience are significantly associated with the level of R&D expenditures and the directions of innovation initiatives (Baker & Mueller, 2002). In addition, the upper echelon theory highlights the importance of the collective traits of a TMT. In fact, the collective characteristics of the entire top team have greater predictive power for organizational performance than the characteristics of the individual executives (Bantel & Jackson, 1989; Hambrick & Mason, 1984). This study draws from this stream of literature on the scope and diversity of the TMT knowledge base in this examination of organizational innovation.

In order to understand the innovation mechanism from the upper echelons perspective, it is important to consider the cognitive base and collective traits of the TMT. TMT members process information and make decisions according to their cognitive base. Cyert & March (1963) and March & Simon (1958), proponents of behavioral theory, suggested that TMT members tend to make irrational decisions because of their limited information-processing capability, decision-making complexity, and incomplete information. Indeed, it is very difficult for TMT members to be aware of all the issues concerning the organization and the surrounding environment. Thus, their limited field of vision predisposes them to focus only on phenomenal issues, which further deepens their perceptual limitations. Such limited information is interpreted and processed based on the cognitive base of each TMT member (Hambrick & Mason, 1984). They interpret their organization's circumstances according to their individual values and matters of concern, and subsequently make strategic decisions based on their interpretations (Hambrick & Mason, 1984). Hence, the cognitive base is the very foundation for TMT members'

decision-making styles and capabilities (Souitaris & Maestro, 2010).

The cognitive base of the TMT is formed by the reservoirs of accumulated knowledge, such as education, experience, and functional background of the executives (Smith, Olian, Sims, O'Bannon, & Scully, 1994; Tushman & Nadler, 1978). In particular, knowledge gained on the job is a highly influential factor in the development of the cognitive base. Many scholars have argued that the prior work experience of TMTs influences the decision-making process and the scope of business activities of their current firms (Baty & Evan, 1971; Hambrick & Mason, 1984; Kraatz & Moore, 2002; Sorensen, 1999). Their industrial background and prior work experience determine the cognitive scope in which they perceive technological opportunities (Shane, 2000) and combine existing expertise with new knowledge, thus improving their value-creation capabilities (Talke et al., 2011). Therefore, this accumulated knowledge based on the TMT's prior work experience is decidedly significant in shaping their decision-making styles.

2.3.2 Organizational search behavior

For better understanding the mechanism of the effect of TMT knowledge diversity on firm innovation, we need to simultaneously examine the internal context such as organizational search. Organizations search constantly for ways to solve problems and cope with uncertainty. Such search activities are, simultaneously, a part of organizational learning (Hurber, 1991) and an important innovation process (Nelson & Winter, 1982). Selecting the optimal search process is, therefore, a crucial component of managing innovation opportunities.

Previous scholars have classified organizational search behavior into two categories according to the scope of search: a narrow search scope (i.e., local search) and a broad search scope (i.e., distant search) (Greve & Taylor, 2000). With a narrow search scope, local search based on knowledge closely related to the firm's internal knowledge is utilized (Helfat, 1994; Martin & Mitchell, 1998; Stuart & Podolny, 1996). These firms seek exploitative, rather than explorative, ways to create profits based on the existing knowledge base rather than by acquiring new knowledge (Smith & Tushman, 2005). Narrow searchers are also likely to pursue cohesiveness instead of openness (March, 1996). Narrow searchers try to decrease uncertainty by preventing problems before they happen or solving them as soon as possible, which is inherently variance-decreasing (Flynn & Chatman 2001; Rivkin & Siggelkow, 2003). They also strive to exploit technologies along their established trajectory (Benner & Tushman, 2003; Rosenkopf & Newkar, 2001; Vermeulen & Barkema, 2001). A firm with a broad search scope, however, would tend to perform distant searches that often necessitate a knowledge base far removed from the firm's existing knowledge and routines (Helfat, 1994). Explorative in their outlook, these firms strive to acquire new knowledge (Smith & Tushman, 2005).

2.3.3 TMT Knowledge base and organizational search behavior

From this perspective, alignment between the knowledge diversity of the TMT and search behavior is crucial for innovation performance; conversely, improper alignment will decrease the firm's performance. Previous scholars have formed a consensus on the

importance of the alignment between the TMT and the organizational strategy (Govindarajan, 1989; Hofer & Davouat, 1977; Kerr, 1982; Miles & Snow, 1978). A mismatch between the TMT characteristics and organizational strategy results in suboptimal decision-making and capability building (Kathuria & Porth, 2003; Thomas, Litschert, & Ramaswamy, 1991) and gives rise to compromised strategic vision (Thomas et al., 1991). Hence, in generating innovation outcomes, it is important to take into consideration the alignment between the TMT's knowledge base of decision-making and the organization's search strategies. In other words, a specialized TMT knowledge base is consistent with narrow search because both are associated with the pursuit of knowledge or technologies in a specific and limited area. In contrast, a generalized TMT knowledge base is consistent with broad search because both are associated with the pursuit of knowledge in a wide area. Thus, alignment between the knowledge diversity of the TMT and the search behavior enhances a firm's innovation performance. Conversely, improper alignment will be detrimental to the firm's performance. That is, the fit of TMT knowledge diversity and organizational variable is important strategic considerations.

2.3.4 TMT Knowledge base and managerial discretion

The relationship between TMT attribute and external context also needs to be considered. Noting that executives are not uniform in their influence over their organizations, organizational scholars have increasingly studied the notion of managerial discretion (Hambrick & Finkelstein, 1987). The upper echelons perspective puts

emphasis on the influences of the TMT on organizational performance. However, the executives do not always have complete latitude of action, or managerial discretion (Hambrick and Finkelstein, 1987; Lieberson & O'Connors, 1972). Defined as the latitude of action available to managers, managerial discretion accounts for different levels of constraint for members of the top management teams (Hambrick & Finkelstein, 1987).

Previous studies have found that managerial discretion influences the impact of TMT members on decisions and outcomes (Hambrick, 2007; Hambrick & Finkelstein, 1987). In a high-discretion situation, a TMT has wide latitude for action; thus, their impact on the organizational outcomes is greater (Crossland & Hambrick, 2007; Finkelstein & Boyd, 1998; Finkelstein & Hambrick, 1990). In a low-discretion situation, however, a TMT has limited latitude of action; therefore, attributes such as their knowledge base would not necessarily be reflected in the organizational outcomes. In other words, if the environment has a low level of managerial discretion, the degree of TMT knowledge diversity would not have much impact on the level of firm innovativeness. Drawing from this literature, managerial discretion influences the relationship between TMT knowledge diversity and innovation performance.

2.4. Alliance portfolio and internal and external contexts

2.4.1 Alliance portfolio diversity

Firms can create innovative values by cooperating with many external partners. Some forms of external cooperation for innovations are M&A, alliances, and joint ventures. This focuses on alliances. Firms engage in alliances based on diverse purposes. These purposes include having an access to capabilities or knowledge in promising fields (Powell, Koput, & Smith Doerr, 1996), pooling complementary resources (Eisenhardt & Schoonhoven, 1996), and reducing cost and risk of highly uncertain projects (Hagedoorn, 1993). Firms combine their own resources with the partners' and generate synergy and profits (Lavie, 2007). Thus, alliances are an attractive tool which helps to overcome the limitation of internal resources and enable additional benefits (Ahuja, 2000; Gulati, 2007).

A firm usually engages in multiple alliances at the same time. An alliance portfolio, a set of a focal firm's active formal alliances (Baum et al, 2000; Ozcan & Eisenhardt, 2009) is regarded to be significant in a firm's alliance strategy. Since an alliance portfolio allows the focal firm to have an access to diverse resources of its partners (Wassmer & Dussauge, 2011, 2012), it also represents the scope of external resources the focal firm can reach (Cui & O'Connor, 2012). The knowledge within these external resources blends with the focal firm's existing knowledge and contributes to creating innovation (Swaminathan & Moorman, 2009; Wuyts, Dutta, & Stremersch, 2004).

Choosing partners is a critical issue in forming an alliance portfolio (Doz & Hamel,

1998; Hagedoorn, 1993; Park, Kim, & Kang, 2015). The composition of an alliance portfolio leads to the character of the portfolio and affects the performance of the focal firm. Hagedoorn and Schakenraad (1994) also suggest that the partner characteristics in an alliance portfolio affects firm performance more than the number of partners does. Thus, it is significant to examine the characteristics of alliance portfolios in terms of alliance strategy. Among the characteristics of alliance portfolios, alliance portfolio diversity has received much scholarly attention (Baum et al, 2000; Ozcan & Eisenhardt, 2009). Alliance portfolio diversity represents the distribution of differences in the characteristics of alliance partners such as industry, geographical location, their size or age (Harrison & Klein, 2007; Isobe, Makino, & Montgomery, 2000).

Alliance portfolio diversity brings about two-sided influences on the focal firm's innovation performance. A number of existing studies suggest the relationship between alliance portfolio diversity and the focal firms' innovation performance. Studies based on resource-based view suggest that diverse partners within an alliance portfolio contribute more to the focal firm's innovation than its internal innovation efforts due to the advantage of diversity (Deeds & Rothaermel, 2003; Poot, Faems, & Vanhaverbeke, 2009). Higher diversity is likely to provide complementary assets and allows the inflow of new resources and knowledge (Burt, 1992). The inflow of various resources and knowledge leads to their unexpected combinations and results in innovative ideas and solutions for developing new technology (Swaminathan & Moorman, 2009; Wuyts, Dutta, & Stremersch, 2004).

However, according to the attention-based view, higher alliance portfolio diversity might lead to the risk of information overflow. The information overflow disperses the

attention of the focal firm and reduces the utilization of key resources. Moreover, among diverse ideas, only a few can be taken seriously and even only a part of them have a chance to contribute to a given innovation (Leeuw, Lokshin, & Duysters, 2013). Sometimes, despite their potentials, resources and ideas which came across an irrelevant timing or field might not lead to implementing innovation (Koput, 1997).

2.4.2 Alliance portfolio diversity and internal capabilities

Existing studies account for the influence of alliance portfolio diversity on the focal firm's innovation performance, however, it is difficult to argue an unconditional relationship between the diversity and innovation performance. The effect of alliance portfolio diversity is not determined by itself. Several recent studies tend to approach the impact of alliance portfolio diversity from a contingency perspective. Wuyts and Dutta (2014) argued that the impact of portfolio diversity varies according to internal knowledge strategy. Zaheer and Bell (2005) argued that obtaining utility from network positions depend on internal contexts. Following the research flow, this study examines how internal contingency affects the impact of alliance portfolio diversity on innovation performance.

Alliance portfolio diversity can be represented as a pool of external resources that focal firm can access. The extent of benefit that the focal firm gains from the portfolio depends on the internal capacity to create the value from the external resource pool. Companies with well-established internal capabilities gain more benefits from external resources (Cohen & Levinthal, 1990). In this study, I examine the moderation effect of

the internal capabilities of value creation in the aspects of routine and ability. That is, this study investigates how the organizational search routine as value creation routines and technological capabilities as value creation ability leverage the hypothesized effect of alliance portfolio diversity on innovation performance.

In the perspective of dynamic capability theory, organizational capabilities is a collection of routines (Winter, 2003). Routine represents behavior that is learned, highly patterned, repetitious, or founded in tacit knowledge (Winter, 2003). Especially, organizational search is the routine that implements value from various resources at the initial stage of the innovation process, which impacts the organizational processes of creation and the recombination of novel ideas (Nelson and Winter, 1982), as well as innovation outcome (Katila and Ahuja, 2002).

Technological capabilities as the other internal context of value creation is the ability of a firm to actually create impactful innovations (Sears & Hoetker, 2014, Teece, 1987). It is difficult to imitate a firm's technological capabilities which include technological knowledge, know-how generated by R&D and other technology-specific intellectual assets (Dollinger, 1995). Although focal firms of alliance portfolios obtain appropriate knowledge from alliances, they cannot turn it into performance without sufficient capabilities for creating values. Firms' technological capabilities contribute to drawing the potential value of the obtained knowledge and should be taken into account in studying the link between knowledge and innovation (Stuaty & Podolny, 1996).

2.4.3 Alliance portfolio diversity, internal capabilities, and industry volatility

To examine fit as integrated complementarity, this study conducted additional analysis by adding interaction terms with industry volatility as dummy variable, to examine how interplay of alliance portfolio diversity and internal capabilities is applied in certain environment such as high volatile industries. Industry volatility is defined as the level of instability or unpredictability faced within a certain industry (Dugal and Gopalakrishnan 2000, Dess and Beard 1984). High volatile industries include electronic computing equipment, electronic components, and medical chemical products.

Scholars in management and organization fields have constantly studied volatility (Dill, 1958; Kast & Rosenzweig, 1978). Industry volatility is regarded to be significant in determining firm performance because firms are involved in an open system and exposed to uncertainty. To improve performance, they have to coordinate their structure and strategy with the internal context and external environment (Lawrence & Lorsch, 1967; Thomson, 1967).

Chapter 3. Strategic fit of TMT knowledge base and internal-external contexts

3.1. Introduction

Organizational scholars have long argued that firm-specific knowledge is a key asset in sustaining a competitive advantage (Bahra, 2001; Boisot, 1998; Doz, Santos, and Williamson, 2001; Von Krogh, Ochijo, and Nonaka, 2000). Since firm-specific knowledge cannot easily be replicated or substituted, it can serve as a valuable source of competitive advantage (Helfat, 1994) and competence (Teece, 2000). Since organizational knowledge is held and maintained at the individual level (Argyris and Schön, 1978; Nonaka and Takeuchi, 1995), previous researchers have argued that firms need to cultivate, protect, and leverage their firm-specific human assets in order to acquire competitiveness (Chakravarthy, McEvily, Doz, and Rau, 2003; Grant, 1996). Drawing from this literature, in this paper I focus on the top management team (TMT) as a critical embodiment of these knowledge assets. Members of the TMT play a pivotal role in organizational decision-making; in fact, a substantial body of study indicates that TMTs have a significant impact on their organization's processes and outcomes (Hambrick, 1994, 2005; Hambrick and Mason, 1984: Tushman, Virany, and Romanelli, 1985). In particular, TMTs have been shown to play an instrumental role in driving innovation within a firm (Bantel and Jackson, 1989; Jehn, Northcraft, and Neale, 1999; Pegels, Song, and Yang, 2000; Wiersema and Bantel, 1992). After all, senior executives of a TMT exercise authority, and formulate and implement strategies relevant for

organizational innovativeness (Barker and Mueller, 2002, Zahra and Pearce, 1989).

In recent years, researchers have increasingly been interested in linking cognition of TMT with firm-level innovation (Choi, Sung, Lee, and Cho, 2011; Hodgkinson and Sparrow 2002; Lant and Shapira 2001; Miller, Burke, and Glick, 1998; Rodan and Galunic, 2004; Tegarden, Tegarden, and Sheetz, 2007). Among different processes relevant in this linkage is the role of knowledge diversity of the TMT (Kilduff et al. 2000; Knight et al. 1999; Rodan and Galunic, 2004), which refers to the heterogeneity of the background knowledge, know-how, and expertise gained through prior experiences (Rodan and Galunic, 2004). Knowledge diversity of TMTs based on the members' prior work experiences influences the decision-making and information processing of their firms (Baty and Evan, 1971; Hambrick and Mason, 1984; Kraatz and Moore, 2002; Sørensen, 1999). This is mainly because knowledge diversity of the TMT is associated with a broadened pool of cognitive resources, and in turn, determine their attention patterns, strategic choices, and reorientation (Cho and Hambrick, 2006). Knowledge diversity also influences the process and the level of sharing and creating knowledge within the top team (MacCurtain, Flood, Ramamoorthy, West, and Dawson, 2010; Smith, Collins, and Clark, 2005), problem-solving competencies (Jehn and Mannix, 2001; Gatignon and Xuereb, 1997), and ultimately the level of innovation performance at the firm-level. Despite the importance of TMT knowledge diversity, however, researchers have not yet addressed the relationship between knowledge diversity at the top team-level and technological innovation of the firm.

This study examines the effects of knowledge diversity, defined as the degree of heterogeneity in industry experience, of the TMT on firm-level innovation. Prior studies

usually examined diversity using the functional background (eg. Cohen and Bailey, 1997; Monge and Eisenberg, 1987), the educational background (eg. Carpenter and Fredrickson, 2001; Wiersema and Bantel, 1992), or demographical characteristics such as age diversity or gender diversity (eg. Ruiz-Jiménez, Fuentes-Fuentes, and Ruiz-Arroyo, 2016; Yoon, Kim, and Song, 2015). However, previous researchers have found that recognizing technological opportunities and developing technologies are driven primarily by industrial background, rather than by functional experience or academic major (Shane, 2000). Hence, in this study, I chose to focus on the prior industry experience of the top executives in order to gauge the degree of TMT-level knowledge diversity. Although previous studies such as Bantel and Jackson (1989) have considered various types of demographic heterogeneity of TMTs, this study, to date, would be the first to test the impact of knowledge diversity in industry experience on the innovation performance of the firm.

In pursuing this theoretical query on the linkage between TMT knowledge diversity and firm-level innovation, this study also considers two factors that are expected to moderate the relationship: the scope of organizational search and managerial discretion. First, organizational search scope is a crucial factor that affects organizational processes of creation and recombination of novel ideas (Nelson and Winter, 1982), and innovation outcome (Katila and Ahuja, 2002). Organizational search scope defines the boundary of innovation efforts at the TMT-level and determines the degree to which the members of the TMT utilize their knowledge base. In addition, managerial discretion, or the latitude of action of the TMT, is the second moderator in the TMT knowledge diversity-innovation linkage. This is because the impact of the TMT on organization is likely to be

more prominent in a high-discretion situation (Crossland and Hambrick, 2007; Finkelstein and Boyd, 1998), and so is the impact of TMT knowledge diversity. This study shows that the diversity of the TMT knowledge base would lead to greater innovation performance if the industry environment endows a high level of managerial discretion. Figure3 summarized all hypothesized relationships.

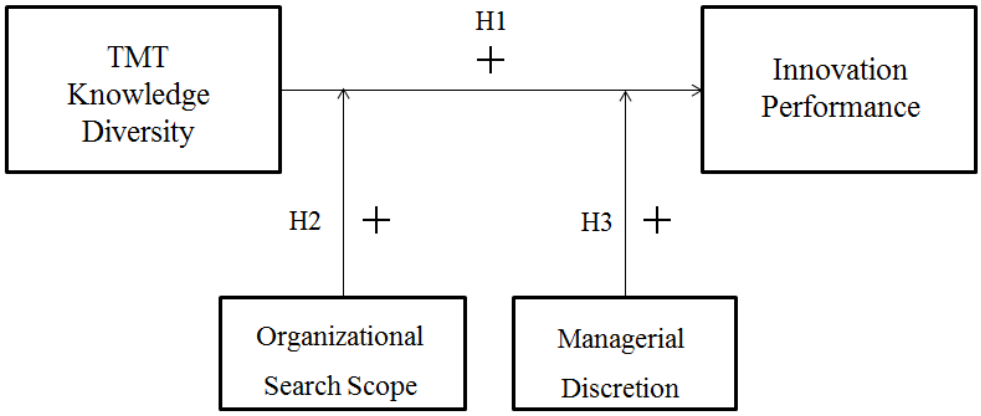

Figure 3. Summary of Hypotheses

The potential contribution this study offers to the extant literature are as follows: First, this study broadens the literature on diversity theory in the upper echelon perspective by linking industrial knowledge diversity of the TMT and innovation of the firm. This expands the breadth of the perspective on the origin of firm innovation. Second, building on the works of McLuhan (1967), Sveiby (1997), and Sveiby (2001) on the knowledge-based view, this study linked the TMTs' knowledge base to organizational search behavior, which explains that an appropriate fit with organizational behavior representing the internal structure and decision makers' knowledge capacity allows leveraging

intangible value such as innovativeness. Third, this study extends the literature on organizational innovation by introducing the role of managerial discretion. Defined as the latitude of actions the top managers are endowed with (Hambrick and Finkelstein, 1987), this study found that managerial discretion plays a significant role in the relationship between TMT knowledge diversity and the firm's innovation performance. To this knowledge, this is the first study to incorporate the notion of managerial discretion into the literature on firm innovation.

3.2. Research hypotheses

3.2.1. Top Management Team Knowledge Diversity and Organizational Innovation

Based on prior literature, several scholars have classified the composition of the TMT as specialized or generalized depending on its knowledge breadth or diversity (Buyl, Boone, Hendriks, and Matthyssens, 2011; Datta and Iskandar, 2014; Usher, 1999). A *generalized TMT*, or a TMT with a high level of knowledge diversity, has a broad knowledge scope from its members' prior experience in a heterogeneous set of industries. In contrast, a *specialized TMT*, or a TMT with low level of knowledge diversity holds expertise in just a few industries and has a narrow knowledge scope.

Generalized TMTs have an advantage in generating greater innovativeness compared

to specialized TMTs because of their diverse knowledge base. First, with a broad range of knowledge, they are aware of new opportunities and developments in various fields, which facilitate the development of new technology in new fields (Li, Maggitti, Smith, Tesluk, and Katila, 2013; Walsh and Fahey, 1986). Especially, experiential knowledge of the industry helps managers assess emerging technologies and position new technologies strategically (Castanias and Helfat, 2001). Thus, they are superior in predicting, interpreting and responding to changes in the industry (Eisenhardt, Kahwajy, and Bourgeois, 1997; Keck, 1997). P&G, well known for its pursuit of Connect & Development, focuses on and combines its core technologies to develop transformational technologies (Nagji & Tuff, 2012). It is stage-gate process by which P&G evaluate their technology development projects on a regular basis to improve its innovation performance. The heterogeneous TMT members examine the business potential of the innovative technologies on the basis of consideration of insights on markets and technological trends, ruling out the unsaleable or obsolete technologies in a changing market environment. This selection process has helped it achieve a success rate of nearly 50% (Brown & Anthony, 2011).

Second, recent studies have confirmed that faced with high uncertainty, TMTs with a broad knowledge scope have an advantage in solving problems effectively (Talke, Salomo, and Kock, 2011). TMTs equipped with a diversified cognitive base, tend to review problems from various perspectives and to seek solutions in a variety of ways (Lawrence, 1997). The knowledge based on industrial experience includes technological trends, demand and supply of technologies as well as opportunities, threats, competitive conditions and regulations (Kilduff, Angelmar, and Mehra, 2000; Kor, 2003). A diverse

knowledge base helps managers build a sound understanding of the relationships between elements in the complex environment, which helps them to navigate a project to a successful outcome (McGrath, Tsai, Venkataraman, and MacMillan, 1996). Thus, a TMT with a diverse industrial knowledge base has a greater opportunity to accomplish complex projects of technological innovation.

Third, a generalized TMT is superior in terms of creativity. Knowledge diversity raises the odds of finding feasible exploratory innovations that are quite far from the firm's existing trajectory (Heyden, Sidhu, and Volberda, 2013). Therefore, it reduces groupthink and derives creative alternatives to solve difficult problems (Carpenter et al., 2004; Doz and Kosonen, 2007; Jackson, 1992; Wiersema and Bantel, 1993; Zenger and Lawrence, 1989). Moreover, there is a higher likelihood for a TMT with more non-redundant knowledge to arrive at a novel synthesis during the decision-making process (Rodan and Galunic, 2002).

Conversely, a specialized TMT with a relatively narrow knowledge base shows different characteristics. A specialized TMT has the tendency to strengthen the capacity of the existing trajectory rather than explore new trajectories. If the knowledge base of the TMT is narrow or homogeneous, it overlooks the critical opportunities and signs in the external environment because it fails to recognize its importance (Lyles and Schwenk, 1992). A specialized TMT may find it more difficult to apply new stand-alone technologies that are distant from their core competencies to the existing technology base; integrating diverse knowledge in disparate fields would also be a challenge (Bantel and Jackson, 1989). Such difficulties hinder a specialized TMT from conducting innovation especially in new fields or volatile industries.

Infineon Technologies, a late runner of the D-ram semiconductor industry in the mid-2000, is a good example. Faced with a lack of knowledge in the D-ram, next generation memory technology and new markets, its TMT members with homogeneous background failed to make accurate decisions on technology development or transition of processes. Even, its technological capabilities for developing next generation memory did not lag behind compared to competitors, decision error and the delayed progress led to setbacks in the transition of processes and production.

Scholars of innovation have also noted the importance of the characteristics of the members of TMTs (Bantel and Jackson, 1989; Jehn et al., 1999; Pegels et al., 2000; Wirersema and Bantel, 1992). A top executive team assumes responsibility and exerts authority to control the budgets required for planning and executing innovation (Zahra and Pearce, 1989); its demographic characteristics, such as average age, tenure, educational background, and career experience are significantly associated with the level of R&D expenditures and the directions of innovation initiatives (Barker and Mueller, 2002). In addition, the upper echelon theory highlights the importance of the collective traits of a TMT. In fact, the collective characteristics of the entire top team have greater predictive power for organizational performance than the characteristics of the individual executives (Bantel and Jackson, 1989; Hambrick and Mason, 1984). This study draws from the stream of literature on the scope and diversity of the TMT knowledge base in this examination of organizational innovation.

Knowledge diversity of TMT is closely related to firm innovation because it determines the strategic orientation of firm innovation (Talke, Salomo, and Kock, 2011). Specifically, assessing technological potential and expecting technological trends

(Gatignon and Xuereb, 1997), understanding market needs (Narver and Slater, 1990), knowledge sharing with team members (MacCurtain, Flood, Ramamoorthy, West, and Dawson, 2010), creating new knowledge (Smith, Collins, and Clark, 2005) depends on the knowledge base of TMT. This ultimately affects the performance of firm innovation (Rodan and Galunic, 2004; Talke, Salomo, and Kock, 2011).

The previous literature classified the knowledge of the TMT by function, such as finance, marketing, and HR (Cannella, Park, and Lee, 2008) or by academic major (Carpenter, 2002). However, for tasks relevant to innovation, recognizing technological opportunities and developing technologies is more important. Previous researchers have found that such recognition and development are driven primarily by industrial background, rather than by functional experience or academic major (Shane, 2000). Especially, in the innovation study based on patent activities, industrial knowledge is critical because it is closely related to the technological domains. As several scholars argued that classification of patents are strongly synchronized with industry classification (Kortum and Putnam, 1997; Shane, 2001; Schmookler, 1966; Hirabayashi, 2003), it is easy to compare industrial knowledge with technological outcome such as patent. Hence, this study measures the degree of TMT knowledge diversity by the prior industry experience of its members to examine its effect on innovation performance of the firm.

Overall, a generalized TMT is more beneficial to generate greater innovativeness of the firm than a specialized TMT. In other words, innovation performance of the firm will increase as the TMT knowledge diversity increases. Therefore, this study suggests the following hypothesis.

Hypothesis 3-1: TMT knowledge diversity will be positively associated with the innovation performance of the firm.

3.2.2. Top Management Team Knowledge Diversity and Organizational Search Scope

Although knowledge diversity of TMT has a significant impact on firm innovation performance, this study also acknowledges the importance of the role organizational context plays in such a linkage. In particular, organizational search behavior, more specifically the scope of search, would be the crucial moderator that strengthens or weakens the impact of TMT-level knowledge base on organizational innovation. Organizational search scope is the routine that executes the efforts of the TMT at the initial stage of the innovation process, which impacts the organizational processes of creation and the recombination of novel ideas (Nelson and Winter, 1982), as well as innovation outcome (Katila and Ahuja, 2002).

Organizational search scope is classified into two categories: a narrow search scope (i.e., local search) and a broad search scope (i.e., distant search) (Greve and Taylor, 2000). With a narrow search scope, local search based on knowledge closely related to the firm's internal knowledge is utilized (Helfat, 1994; Martin and Mitchell, 1998; Stuart and Podolny, 1996). These firms seek exploitative, rather than explorative, ways to create profits based on the existing knowledge base rather than by acquiring new knowledge

(Smith and Tushman, 2005). Narrow searchers are also likely to pursue cohesiveness instead of openness (March, 1996), with the ultimate goal of reducing uncertainty and preventing problems pre-emptively, which is inherently variance-decreasing (Flynn and Chatman 2001; Rivkin and Siggelkow, 2003). They also strive to exploit technologies along their established trajectory (Benner and Tushman, 2003; Rosenkopf and Nerkar, 2001; Vermeulen and Barkema, 2001). In contrast, a firm with a broad search scope would tend to perform wide and distant searches that often necessitate a knowledge base far removed from the firm's existing knowledge and routines (Helfat, 1994). Explorative in their outlook, these firms strive to acquire new knowledge (Smith and Tushman, 2005).

According to the upper echelons perspective, the scope of organizational search, in theory, is a manifestation of the TMT-level traits such as the diversity of knowledge base and others (Hambrick and Mason, 1984) In reality, however, the knowledge diversity of TMT and organizational search scope are often decoupled for the following reasons: First, a TMT constantly undergoes changes in its membership through retirement, recruitment, and promotion of the members. Subsequently, the frequent changes in TMT composition result in fluctuations in TMT knowledge diversity. In contrast, search routines at the organizational level are characterized with stickiness and rigidity; standard operating procedures and protocols become routinized and build inertia with organizational path dependence (David, 1994), growing more irreversible over time (Sydow, Schreyögg, and Koch, 2009). Even reasonable time frames or cost parameters would not be sufficient to modify the search routines with such irreversibility (Vergne and Durand, 2011). Thus, once a pattern of search is established, it would be rather difficult to change it unless there is a significant threat or performance downturn (David, 1994). Due to this difference of

volatility, misalignment between TMT knowledge base and organizational search scope is inevitable.

In addition, TMT knowledge base and organizational search behavior often become incongruent with each other due to shifts in the strategic posture of the firm. According to the knowledge-based view, the organizations establish both internal and external structures in order to accomplish their strategic objectives. Internal structures would include innovation process or organizational search routine, while external structures technological acquisitions, alliances or strategic relationship (McLuhan, 1967; Sveiby, 1997). When market conditions change, TMTs may become pressured by the board and other stakeholder groups to change the internal structure in response. If the TMT had originally maintained a broad knowledge base and was accustomed to exploration, a shift toward an internal structure that aims for narrow search gives arises to a misalignment between the two. Similarly, misalignment can also arise when a TMT with a broad knowledge base acquires a firm with technological specialization in specific areas. The pre-existing internal structure of the firm, optimized for narrow search, would not fit with the exploratory nature of the TMT with the broad knowledge base.

In sum, it is easy for the organizational search behavior to be misaligned with the configuration of the TMT knowledge base. Misalignment between the TMT's knowledge capacity and internal structure has the potential to limit the creation of intangible values such as innovativeness (Sveiby, 2001). To maximize the effect of TMT knowledge diversity on innovation, therefore, the configuration of the TMT knowledge base should be aligned with the scope of organizational search.

In this light, this study expects that a broad search will fortify the effect of TMT

knowledge diversity on innovation performance; on the other hand, a narrow search will weaken the effect. Although knowledge diversity of a TMT is more likely to foster entrepreneurship and innovation at the firm-level, such positive outcomes would not be actualized if the scope of the organizational search is narrow and routinized by inertia (Benner and Tushman, 2002; Sull, 1999). This misalignment of direction and the scope of organizational search would compromise the process of innovation even if the intended strategy of the TMT is to pioneer a new market, which induces inefficiency. However, broad search organizations which prefer to increase new knowledge constantly through exploring new areas and recombinatory search will fit well with a generalized TMT's needs. A knowledge pool obtained through a broad search will enrich the alternatives to solve complex problems in the area which the TMT pursues (March, 1991).

Meanwhile, the same logic applies when the knowledge diversity of TMT is low. A specialized TMT has a disadvantage in achieving innovation performance, but if the organizational search scope increases, the negative effects will worsen. It is difficult for a specialized TMT to pursue the development of technologies distant from the core or increase the variance. Such difficulties, therefore, hinder a specialized TMT from conducting a broad search. In addition, an organization that conducts broad searches requires more knowledge and skill sets, while incurring higher costs (Grant, 1996; Katila and Ahuja, 2002). Considering the specialized TMT's tendency to stay with the status quo rather than to explore new territory, broad searches would create more obstacles for developing a new technology. Therefore, conducting a broad search in a firm which possesses specialized TMT aggravates the innovation performance of the firm while broad search in a firm with generalized TMT improves the performance.

In sum, the diversity of the TMT knowledge base would lead to greater innovation performance, as organizational search scope becomes wider. Therefore, this study suggests the following hypothesis.

Hypothesis 3-2: Organizational search scope positively moderates the effect of TMT knowledge diversity on innovation performance.

3.2.3. Top Management Team Knowledge Diversity and Managerial Discretion

Managerial discretion is expected to enhance the hypothesized effect through the following conduits. First, it affects the potential marginal productivity of TMTs (Finkelstein and Boyrd, 1998). TMTs endowed with high discretion would have a greater impact on the firm's innovation activities; consequently, the impact of the configuration of the TMT's knowledge base would be more immediate. In other words, if the top managers are endowed with a high level of discretion, the negative effects of specialized TMT would be detrimental to firm-level innovation. In high-discretion environment, for example, technologies are likely to experience more rapid change, thereby requiring TMTs to make changes to remain congruent with the industry environment (McClelland, Liang, and Barker, 2010). Firms that fail to respond to the change and that remain committed to the rigidity will be at greater risk of becoming incongruent with the environment. Therefore, the weakness of specialized TMT will be worsened in high-discretion environments. Conversely, the positive effects of knowledge diversity could

foster efficient and productive organizational activities if the top managers are endowed with a high level of discretion and allowed to exploit a full set of strategic options.

Although Hambrick and Finkelstein (1987) identified multiple sources of managerial discretion at the environmental, organizational, and individual levels, researchers so far have primarily focused on the industry-level factors (Finkelstein and Hambrick, 1990; Hambrick and Abrahamson, 1995). Indeed, Hambrick, Geletkanycz and Finkelstein (1993) emphasized that the external environment is the fundamental determinant of managerial discretion. Drawing from this literature, this study focuses on the factors stemming from the industry environment to decipher the effects of discretion on the linkage between TMT knowledge base and innovation. Specifically, this study expects that managerial discretion as an external context can moderate the relationship between the TMT knowledge diversity and innovation performance of the firm.

The diversity of the TMT knowledge base would lead to greater organizational performance, if and only if, the industry environment endows a high level of managerial discretion to a TMT equipped with a broad and rich knowledge base. However, with a low level of managerial discretion, such linkage between the TMT knowledge base and firm-level innovation would be severely weakened. Therefore, this study hypothesizes the following:

Hypothesis 3-3: Managerial discretion positively moderates the effect of TMT knowledge diversity on innovation performance.

3.3 Methods

3.3.1. Data and Sample

In this study, I collected data on TMT attributes, firm-level innovation in terms of patenting activities, and firm-level accounting measures of U.S. manufacturing firms with SIC codes 2011 through 3999. The Sample of US based firms are used by many studies since they are ranged various sectors, and it is relatively easy to collect the data. Asset status and patent data were extracted from the COMPUSTAT business segment file and the National Bureau of Economic Research (NBER) patent citation data file, respectively. Data and information on TMTs were obtained from Dun and Bradstreet's Reference Book of Corporate Managements as well as the 10K (Annual Report) of each firm. Information on managerial discretion is acquired from Hambrick and Abrahamson's (1995) industry discretion ratings for 4-digit SIC code industries.

This study define focal year as 2006 since it is the time the most patents are applied within 10 years from 2000 according to Triadic Patent Families of OECD. In order to build a lag structure, this study measures innovation performance over the next four years (2006 through 2009). This study then measures search scope in each of the four years before the focal year of 2006 (2002 through 2005). Focal patents are defined as the patents applied for in the focal year of 2006. The TMT data are collected on the TMT members at the vice president level and above in each company for the focal year. However, because the executives with short firm tenure have little impact on corporate

search activities, I excluded TMT members who joined the firm in focal year from the TMT data.

With 2006 as the focal year, I also collected firm-level accounting data between 2002 and 2009, four years before and after the focal year of 2006. I then randomly selected 503 manufacturing firms which existed during this period. Then, I filtered the samples by next steps. First, I matched COMPUSTAT financial and NBER patent data in the period using CUSIP numbers. I limited the firms that had both financial and patent data available in this time window. Second, I also limited the sample to firms listed in Dun and Brad street's Reference Book of Corporate Management, source for TMT information. These two processes left us with 142 samples. Furthermore, I excluded firms without information on industrial discretion among them, which resulted in 120 samples of firms. The final sample consisted of 40 firms in the chemical and allied products industry, 23 firms in computer and office equipment industry, 18 firms in laboratory apparatus and analytical, optical, measuring, and control equipment industry, 29 firms in surgical, medical and dental instruments and supplies industry, and 10 firms in other manufacturing industries. The organization size in terms of employees in this sample ranges from 22 to 140,000 employees. The average size is 16,570 employees. Therefore, this analysis is based on 1,058 TMT members and on 6,059 focal patents. In this sample, the number of forward citations earned was 8,095, and the number of backward citations was 99,036.

3.3.2. Dependent variable

Innovation performance. Dependent variable of innovation performance is the output index, which indicates outputs produced by firms through R&D efforts. This study measures the innovation performance of the focal firm by counting the total number of times its patents are cited by other patents during the four-year period from the focal year (Miller, Fern, and Cardinal, 2007). This measurement is an indication of the qualitative outcomes of R&D activities. Since the number of forward citations is closely related to the technological importance of patents (Trajtenberg, 1990), many researchers have adopted this qualitative outcome as a key performance measure of innovation (Kim, Arthurs, Sahaym, and Cullen, 2013; Trajtenberg, 1990).

3.3.3. Independent variables

TMT Knowledge Diversity. Because Gunz and Jalland (1996) maintained that the work experience of TMT members is the foundation for their knowledge base, this study regards their industrial background as their knowledge base. I first classified each TMT member's dominant industrial background by the 3-digit SIC code of the company where they worked for the longest period of time. To determine TMT knowledge diversity, I used the Herfindahl-Hirschman index (Bantel and Jackson, 1989; Blau, 1977; Michel and Hambrick, 1992) which is most commonly used to measure industry diversity (Simon, 1988).

$$1 - \sum_{i}^{N} Pi^2$$

Here, Pi is the proportion of the dominant industry in the 3-digit SIC code i, for a firm with N different 3-digit SIC industries. The index ranges between 0 and 1. That is, the closer to 1 the result is, the higher the diversity, whereas the closer to zero the result is, the lower the diversity.

Search Scope. Previous studies have used patent classification to measure the scope of innovation activities (Katila and Ahuja, 2002; Kim et al., 2013), which shows the heterogeneity among patents (Li, Vanhaverbeke, and Schoenmakers, 2008). In this study, I review the total number of backward citations of the focal patents during the four-year period prior to the focal year. Then, this study used the entropy measure developed by Palepu (1985) to determine the scope of patent classes among its backward citations. According to Jacquemin and Berry (1979), the entropy measure performs best as a measure of concentration:

$$\sum_{j}^{N} Pj \times \ln(\frac{1}{Pj})$$

Pj is the portion of the 3-digit technological category j. The broader the search scope is, the broader the technological roots of the underlying study are (Trajtenberg, Henderson, and Jaffe, 1997). In other words, more diverse citation of focal patents suggests that a firm pursues a broader search scope (Argyres and Silverman, 2004). The closer to zero the search scope is, the more concentrated the backward-cited patent classes are, and the closer to one the search scope is, the more diverse the classes are.

Managerial Discretion. Finkelstein and Hambrick (1990) have identified six sets of determinants of managerial discretion: product differentiability, demand instability, low

capital intensity, competitive market structure, market growth, and freedom from government regulation. Based on this model, a substantial number of previous studies have used Hambrick and Abrahamson's (1995) industry discretion ratings for seventeen 4-digit SIC code industries to analyze industrial discretion (Adams, Almeida, and Ferreira, 2005; Baum and Wally, 2003; Finkelstein and Boyd, 1998). Consistent with this stream of research, this study also uses the industry ratings to classify the industries of this sample firms into high discretion categories. To maximize the positive matches with this data, this study average their measures by 3-digit SIC industry and construct an indicator variable (Adams et al., 2005), thereby noting managerial discretion as a dummy variable. High discretion industry, for industries at the top 20% of the distribution of the 3-digit SIC code rating of managerial discretion such as computer equipment and engineering/scientific instruments, is marked as 1.

3.3.4. Control variables

Since a variety of factors can influence firm performance, this study includes several control variables, such as firm size, R&D expenditure, TMT size, and TMT tenure. Except for R&D expenditure, all control variables are calculated using the data from the focal year. Firm size is measured by calculating the log of total sales of the focal year (Hall and Weiss, 1967; Montgomery, 1979). Previous studies have reported that firm size could affect positively on innovation (Cohen and Klepper, 1996). R&D expenditure is measured by calculating the log of accumulated R&D expenses for the four-year period

prior to the focal year. R&D expenditure could potentially improve innovation performance, since it allows a firm to initiate new R&D projects and expand the support of existing project (Kim et al., 2013). For TMT size, this study used the number of TMT members, which is also positively associated with innovation outcome (Alexiev and Jansen, 2010). TMT tenure have a significant influence on innovation (Barkema and Shvyrkov, 2007), which is averaged by the number of years that each TMT member has worked for the focal firm.

3.3.5. Empirical model specification

Firm-level innovation is used as the unit of this analysis. This study tests the hypotheses using negative binomial regression (NBR). Dependent variable (i.e., the number of forward citations of patents held by a firm) is a discrete variable. The variable does not satisfy the assumption of homoscedasticity required by classical linear regression models, but follow a Poisson distribution. Therefore, Poisson regression is better suited for this case (Hausman, Hall, and Griliches, 1984). However, data could not satisfy the assumption of Poisson distribution, mainly that the variance should be the same as the mean. Negative binomial regression, or the extended Poisson regression model, can provide better predictions if there is over-dispersion in the data (Hausman, Hall, and Griliches, 1984). Therefore, negative binomial regression has been used in most of the existing studies where the number of patents granted to a firm is used as a dependent variable (Song, Almeida, and Wu, 2003).

3.4. Results

Table 3 provides descriptive statistics and correlations between each variable. The sample data comprise of observations across 120 firms for the year 2002 through 2009. No strong correlation is found in any combinations of variables. The average value of the variance inflation factor (VIF) is lower than 2, and highest VIF is 2.88, which is an indication of absence of serious multicollinearity.

Table 4 shows the results of the negative binomial model. Model 1 includes all of the control variables. Model 2 adds TMT knowledge diversity to show the main effect of this model. Models 3-6 provide the interactions one at a time. Model 3 adds search scope, while Model 4 adds both TMT knowledge diversity and search scope altogether. Model 5 adds managerial discretion dummy, while Model 6 adds both TMT knowledge diversity and managerial discretion dummy altogether.

Table 3 Descriptive Statistics and Correlations

Variables	VIF	Mean	s.d.	1	2	3	4	5	6	7
1. Innovation performance	-	69.0	153.14							
2. TMT knowledge diversity	1.05	0.4	0.29	.18*						
3. Search scope	1.45	1.4	0.96	.62*	-.12					
4. Managerial discretion	1.12	0.2	0.40	.12	.08	.12*				
5. Sales	2.88	13.4	2.74	.39*	-.19*	.50*	.02			
6. R&D expenditure	2.57	12.3	2.11	.45*	-.14*	.49*	-.07	.76*		
7. TMT size	1.29	8.8	4.20	.12	-.12*	.20	-.17*	.43*	.36*	
8. TMT tenure	1.15	12.5	4.27	.11	-.14*	.23*	-.12*	.30*	.26*	.10

* $p < .05$

The results in Model 2 show that the higher the TMT knowledge diversity, the greater its effect on the innovation performance (β=.87, $p<0.05$). Pseudo R-square for Model 2 (0.0603) is much higher than that for Model 1 (0.0568). Thus, Model 2 has higher explanatory power than Model 1. In short, the empirical results for this model strongly support the Hypotheses 1 predicting that TMT knowledge diversity is positively associated with innovation performance of the firm.

Model 4 add an interaction term between TMT knowledge diversity and managerial discretion by search scope. The results show that Model 4 has a higher pseudo R-square (0.1218) than that of Model 2 (0.0603) or Model 3 (0.1165). The interaction effect between TMT knowledge diversity and search scope of Model 4 is statistically significant (β=.76, $p<0.05$) and has the same sign (positive) as TMT knowledge diversity of Model 2. In other words, innovation outcome increases as TMT knowledge diversity increases, and this propensity becomes stronger as organizational search scope is broader, indicating support for Hypotheses 2.

The results for Model 6 also show that the moderating effects of managerial discretion on the relationship between TMT knowledge diversity and firm-level innovativeness are highly significant and positive (β=2.06, $p<0.05$). Model 6 has a higher pseudo R-square (0.0658) than that of Model 2 (0.0603) or Model 5 (0.0592). This suggests that the higher the TMT knowledge diversity, the greater the firm-level innovativeness; in addition, this propensity becomes even greater in high-discretion industries. This finding indicates that the effects of the diversity of TMT knowledge base on organizational innovation will be stronger when firms are in high-discretion industry.

Table 4 Result of the Negative Binomial Model Predicting Innovation Output

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
Firm size	.15*	.15*	.11*	.10*	.13	.15*	0.11*
R&D expenditure	.24**	.20**	.14*	.12*	.24**	.18*	0.10
TMT size	.07**	.07***	.00	.02	.08***	.07**	0.01
TMT tenure	.01	.02	-.03	-.02	.02	.03	-.02
TMT knowledge diversity		.87**		-.53		.21	-.70
Search scope			.92***	.54***			.54***
TMT knowledge diversity×search scope				.76**			.74**
Managerial discretion					.48*	-.68	-.57
TMT knowledge diversity×Managerial discretion						2.06**	.89
N of firms	120	120	120	120	120	120	120
Log likelihood	-563.37607	-561.31797	-527.74519	-524.57075	-561.93347	-558.00185	-523.66586
Pseudo R-square	0.0568	0.0603	0.1165	0.1218	0.0592	0.0658	0.1233

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

Model 7 includes all main effects and interactions. However, significance of interaction of TMT knowledge diversity and managerial discretion reported in the individual model was not maintained. this study assumes that the correlation coefficient of the interaction variable is changed by interference of other variables. While this full model provides partially insignificant result, I find empirical evidence to support all hypotheses in the results of the additional sensitivity tests.

3.5. Sensitivity analysis

To improve the robustness of my test results and to conclude whether the hypotheses are supported even in the full model, I conducted additional analyses with different test setting. I tested my model by changing the measurement of the dependent variable in several ways since there are different ways to measure innovation performance. First, I conducted the analysis using a 'patent count' measure for innovation performance. The number of patent applications is generally accepted as one of the most frequently used indicators for innovation performance (Acs and Audretsch, 1989; Cantwell and Hodson, 1991; Hagedoorn and Cloodt, 2003). This approach generates a quantitative measure while number of forward citations includes a measure of the quality of innovations. this study measured innovation performance by calculating the number of patent applications in focal year.

Second, number of citation-weighted patents is another approach to measure innovation performance. Trajtenberg (1990) demonstrates that citation-weighted patents

count is more closely correlated with their output measures of innovation. For this reason, many studies have adopted citation-weighted patents count to calculate innovation output (Ahuja, 2000; Henderson and Cockburn, 1994). To analyze the sensitivity with this approach, this study measures the dependent variable by the number of patents applied in focal year weighted by the number of citations subsequently received.

Table 5 presents the test results of two different setting. Model 1 to Model 5 show the results that dependent variable is measured by the number of patents while Model 6 to Model 10 show the results that innovation performance is measured by the number of citation-weighted patents.

For both of these analyses, the results not only suggest additional support for all hypotheses in individual models, but also provide significant results in full models. The concern of inconsistent results in the previous main analysis was mitigated by these two additional analyses. As multiple tests show significant results for each hypothesis, I can argue all hypotheses in this study are supported

Table 5 Result of the Negative Binomial Model Predicting Innovation Output (Sensitivity Analyses)

	Patent counts					Citation-weighted patent counts				
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model7	Model 8	Model 9	Model 10
Firm size	.21**	.10	.03	.07	.01	.19**	.14*	.08	.12	.08
R&D expenditure	.24**	.27**	.30***	.30***	.31***	.23**	.20**	.18***	.21**	.18***
TMT size	.05	.07**	.02	.11***	.03	.06*	.07***	.01	.09***	.01
TMT tenure	-.024	.03	-.01	.04	.00	-.01	.02	-.02	.03	-.01
TMT knowledge diversity		2.52***	1.34**	1.67***	.95*		1.68***	.37	.86*	.02
Search scope			.65***		.68***			.58***		.60***
TMT knowledge diversity× Search scope			.84**		.63*			.80**		.68**
Managerial discretion				.31	-.12				-.25	-.47
TMT knowledge diversity× Managerial discretion				1.74*	1.56**				2.04**	1.58**
N of firms	120	120	120	120	120	120	120	120	120	120
Log likelihood	-557.7050	-543.2835	-506.7760	-534.4257	-500.8473	-650.0936	-641.820	-602.7967	-635.5046	-599.0590
Pseudo R-squere	0.0414	0.0662	0.1289	0.0814	0.1391	0.0454	0.0576	0.1149	0.0668	0.1204

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

3.6. Discussion

This study offers a new perspective on the linkage between the knowledge base of the top management team (TMT) and organizational innovation by broadening the concept of the knowledge diversity and examining factors reflecting internal context such as organizational search scope and external context such as industrial discretion. This study argued that the effects of TMT knowledge diversity on firm-level innovation performance depend upon both how knowledge diversity is conceptualized and the context in which it is embedded.

This finding results show that the knowledge diversity based on the prior industrial experiences of a TMT has a critical impact on firm-level innovation. The generalized TMT with various industry experiences can generate greater innovativeness thanks to their capability to recognize new opportunities with a broad range of knowledge, to solve complex problems effectively in uncertain an environment, and to generate creative alternatives (Li, Maggitti, Smith, Tesluk, and Katila, 2013, Kilduff, Angelmar, and Mehra, 2000; Kor, 2003). These finding results highlight that examining the industrial knowledge base of the TMT is important to facilitate firm-level innovation performance.

In this study, organizational search behavior is also an important consideration. This finding results show that the positive effect of TMT knowledge diversity on firm innovation is further strengthened when the organizational search scope is broader. An appropriate fit between broad search and TMT with a diverse knowledge base fosters the condition to enhance innovation. Sveiby (2001) argued that a firm can create intangible

value through strategic formulation by linking managers' knowledge capability and internal structure closely to transfer knowledge or relay a vision. Building on this perspective more specifically, this study suggested that the appropriate fit between TMT's knowledge base and organizational behavior as an internal structure fosters the strategic formulation to leverage intangible values such as innovativeness.

This chapter also demonstrates that the degree of managerial discretion at the industry-level has a critical role in moderating the relationship between TMT knowledge diversity and innovation performance of the firm, thus contributing to the extant literature. My finding results show that the effect of the TMT knowledge diversity on innovation performance becomes stronger in a high-discretion context. In a low-discretion context, however, the effect of the TMT knowledge diversity is found to have less impact on innovation performance.

The managerial implications of this study are as follows. The findings highlight the importance of an appropriate configuration of top executives' knowledge base, and alignment with search strategies in managing organizational innovation. Specifically, this study offers guidelines for selecting and retaining new TMT members. Whether promoting existing employees to management positions or recruiting TMT members from outside, firms generally tend to focus on individual level attributes, such as academic background, professional credentials, and the relevance of their prior work. The cognitive fit of the new member with the rest of the top management team is not given much weight. However, the findings of this study highlight the importance of the configuration of the TMT knowledge base, and alignment with the context of the firm's search scope. Therefore, a holistic view of the candidate's compatibility with the rest of the top team

with respect to the strategic objectives of the firm should be adopted, including its intended search method and innovation strategies.

Chapter 4. Strategic fit of alliance portfolio strategy and internal-external contexts

4.1. Introduction

Collaborations between firms are regarded as one of the key elements for driving their innovation. Solely on their own resources, firms are not sufficiently able to address the environmental changes. Collaborations allow access to new ideas and resources, encourage a new way of combination of existing resources, and increase the participants' innovation capabilities (Gupta, Tesluk, & Taylor, 2007).

Firms can create value through collaborations with diverse parties. Collaborations with suppliers contribute to increasing the input quality and realizing process innovation and cost reduction (Sobrero & Roberts, 2002). Collaborations with buyers contribute to obtaining the feedback on their products and service, improving their existing processes and developing new products (Lee & Wong, 2009; Von Hippel, 2007). Collaborations with competitors allow access to specific knowledge in the industry and relieve the burden for the investment on facilities and research (Kim & Higgins, 2007; Miotti & Sachwald, 2003). The type of collaborations varies from joint ventures, alliances to M&As. Firms choose a relevant type of collaboration according to their goals and situations and increase their competitive advantage (Man & Duysters, 2005). This study focuses on alliances among various type of inter-firm collaborations. Without spending a

great deal of cost, alliances allow firms to flexibly cooperate with external parties and allow access to their resources.

To fully take advantage of alliances, a firm simultaneously participates in multiple alliances with different partners (Gulati & Singh, 1993) and possesses what is referred to as an alliance portfolio. With the interest of its diverse nature and relating consequences, a number of recent studies examine the relationship between alliance portfolio diversity and innovation performance. Alliance portfolio diversity represents the distribution of differences in partners' characteristics within a firm's alliance portfolio. The belief that alliance portfolio diversity has important performance implications is widespread. However, consensus on the optimal degree of diversity which maximizes innovation performance is not clearly reached.

As reported in previous studies, alliance portfolio diversity has both advantages and disadvantages such as a double-edged sword (Oerlemans, Knoben, & Pretorius, 2013; Vasudeva & Anand, 2011). A stream of literature stresses the advantage of diverse partners such as diverse resources, low redundancy in resources, and innovative combinations of the resources acquired (Cui & O'connor, 2012; Duysters & Lokshin, 2011; Faems, Janssens, & Neyens, 2012). On the other hand, another stream of literature points out the drawbacks of the high degree of alliance portfolio diversity such as complexity derived from extramural resources or the managerial cost for diverse relationships (Bae & Gargiulo, 2004; Faems et al., 2008; Gualti & Singh, 1998). The two-dimensional arguments for this alliance portfolio diversity are often equally compelling (Jiang, Tao, & Santoro, 2010).

It would be difficult to fully understand the mechanism of alliance portfolio in firm

innovation unless considered from a contingency perspective. Alliance portfolio diversity does not affect performance by itself, but rather depends on the context within the organization (Srivastava & Gnyawali, 2011; Wuyts & Dutta, 2014; Zaheer & Bell, 2005). Even if firms build a strong portfolio with great partners, the impact on performance will vary depending on how the firms utilize it within organization.

From this perspective, this study argues that the internal capability of value creation plays a critical role in leveraging alliance portfolio diversity. The alliance portfolio diversity can be represented as a pool of external resources which the focal firm can access. The extent of benefit that the focal firm gain from the portfolio will depend upon the internal capacity to create the value from the external resource pool.

Based on the dynamic capabilities framework that emphasizes competitive advantage is generated from the capabilities to combine and recombine internal and external resources (Teece, 1996; Teece, Pisano, &, Shuen, 1997), this study empirically investigates how the fit between an alliance portfolio strategy and internal capabilities affects innovation performance. First, this study confirms the direct relationship between innovation performance and alliance portfolio diversity in terms of industry, then examine how internal capabilities of value creation leverage this relationship. In this study, the internal capabilities of value creation are examined in two aspects: routine (organizational search routine) and ability (technological capabilities).

Apart from these hypothesized analyses, this study conducted additional analysis with the environmental variable to investigate the fit as integrated complementarity of alliance portfolio diversity. For this, I added interaction terms with industry volatility as dummy variable, to examine how interplay of alliance portfolio diversity and internal capabilities

is applied in certain environment such as high volatile.

4.2. Research hypotheses

4.2.1. Alliance portfolio diversity and firm innovation

As alliance portfolio diversity increases, firms face trade-offs. Although portfolio diversity provides the advantage of providing broaden search options and extending resource pools, there is also disadvantage such as an increase in complexity and cost of potential conflicts among partners. In order to punctuate arguments for such two-dimensional attributes, this study attempts to examine the relationship between alliance portfolio diversity and innovation performance by a curvilinear perspective

Basically, diverse partners within an portfolio provide more benefits to the focal firm's innovation than its internal innovation efforts due to the advantage of diversity (Deeds & Rothaermel, 2003; Poot, Faems, & Vanhaverbeke, 2009). Higher portfolio diversity is likely to provide complementary assets and allows the inflow of new resources and knowledge (Burt, 1992). The inflow of various resources and knowledge leads to their unexpected combinations and results in innovative ideas and solutions for developing new technology (Swaminathan & Moorman, 2009; Wuyts, Dutta, & Stremersch, 2004). Superior innovation performance can be attained by combining diverse market and technological knowledge sources in the alliance portfolio and

exploiting possible complementarities and synergies (de Leeuw, Lokshinb, & Duysters, 2013; Nieto & Santamaria, 2007).

Partner diversity also helps cope with the scarcity of excellent resources and uncertainty. When developing new technologies, firms are required to make choices of more valuable and rare resources to create outputs different from the past in uncertain environments (Bowman & Hurry, 1993). In this situation, alliance portfolio diversity provides more alternatives to solve problems and create new knowledge, which increase expected value of choice (Gavetti & Levinthal, 2000).

However, in order to take these advantages of diverse partners, firms must overcome several hurdles (Jiang, Tao, & Santoro, 2010). When the distant knowledge comes in, the firm engages in search to fill in gaps and correct transmission errors in the knowledge (Sorenson, Rivkin, & Fleming, 2006). This leads to the cost and difficulty of which increase with knowledge complexity. In addition, conflicts due to cultural differences with heterogeneous partners and coordination costs to establish cohesive ties arise as diversity increases (Koka & Prescott, 2008). The fundamental differences between the specific processes of resource transfer between firms restrict synergies with partners (Goerzen & Beamish, 2005).

These limitations arise from the moment a firm increases the diversity of its partners. As the learning effect accumulates and managing portfolio becomes more proficient, however, the influence of the limitations will eventually decreases (Jiang, Tao, & Santoro, 2010). As diversity increases, routines for managing external networks are gradually established. Negative effects such as the conflicts caused by the diverse networks will be reduced as the external routines are established (Pelled, Eisenhard, & Xin, 1999). If the

firm has various partners, it can more easily find alternative solutions that will make up for conflicts or deficits on other sides. In addition, the benefits from various resources are increasing (Jiang, Tao, & Santoro, 2010). As a result, as the alliance portfolio diversity increases, advantages of diversity will surpass the disadvantages from the moderate point, and innovation performance turns to upward.

In sum, in keeping with previous research exploring the nonlinearity of network partners' industry diversity (Jiang, Tao, & Santoro, 2010; Goerzen & Beamish, 2005), this study expects alliance portfolio diversity to have a U-shaped relationship with innovation performance of the firm.

Hypothesis 4-1: Alliance portfolio diversity has U-shaped curvilinear relationship to innovation performance of the firm.

4.2.2. Alliance portfolio diversity and internal capabilities of value creation

This study further suggests that the U-shaped relationship is not a complete account of the association between alliance portfolio diversity and innovation performance. Several recent studies tend to approach the impact of alliance portfolio diversity from a contingency perspective. Wuyts and Dutta (2014) argued that the impact of portfolio diversity varies according to internal knowledge strategy. Zaheer and Bell (2005) argued that obtaining utility from network positions depend on internal contexts. Following the research flow, this study examines how internal contingency affects the impact of alliance portfolio diversity on innovation performance.

Alliance portfolio diversity can be represented as a pool of external resources that focal firm can access. The extent of benefit that the focal firm gains from the portfolio depends on the internal capacity to create the value from the external resource pool. Companies with well-established internal capabilities gain more benefits from external resources (Cohen & Levinthal, 1990). This study examines the moderation effect of the internal capabilities of value creation in the aspects of routine and ability. That is, this study investigates how the organizational search routine as value creation routines and technological capabilities as value creation ability leverage the hypothesized effect of alliance portfolio diversity on innovation performance.

4.2.3. Organizational search routine as an internal value creation routine

In the perspective of dynamic capability theory, organizational capabilities is a collection of routines (Winter, 2003). Routine represents behavior that is learned, highly patterned, repetitious, or founded in tacit knowledge (Winter, 2003). Especially, organizational search is the routine that implements value from various resources at the initial stage of the innovation process, which impacts the organizational processes of creation and the recombination of novel ideas (Nelson and Winter, 1982), as well as innovation outcome (Katila and Ahuja, 2002).

Firms usually retain their own search routine (Greve & Taylor, 2000). For example, the scope of search varies from a narrow one to a broad one depending on each firm's routine. A narrow search represents the search routine based on existing knowledge base and related problem solving (Helfat, 1994; Martin & Mitchell, 1998; Stuart & Podolny,

1996). A narrow search tends to pursue profit opportunities in near fields around existing knowledge base rather than explore opportunities in remote fields (Smith & Tushman, 2005). Moreover, a narrow search pursues cohesiveness rather than openness (March, 1996) and reduces variance, uncertainty and unexpected problems (Rivkin & Siggelkow, 2003; Flynn & Chatman 2001).

On the contrary, broad search organizations strive to move on to new technological trajectories. They combine their existing knowledge base with new ones and obtain novelty (March, 1991; Miller, 2006). A broad search represents having an access to remote knowledge that contributes to solving problems (March, 1991; Minor, Bassoff, & Moorman, 2001). A broad search tends to pursue new opportunities which address the change of external environment (Smith & Tushman, 2005). Moreover, a broad search increases variance and emphasizes learning by doing by trial and error (Rivkin & Siggelkow, 2003; Flynn & Chatman 2001).

Organizations with broad search routines are more exposed to the risk of complexity. They are already constantly deal with diverse variables during their search process (Rivkin & Siggelkow, 2003). Meanwhile, diverse knowledge from external partners adds more variables to their existing knowledge base and increases the complexity of knowledge to manage (Srivastava & Gnyawali, 2011). In the situation that complexity is leveraged, managing and choosing relevant knowledge among the overflow of knowledge is a major challenge for broad search firms (Cohen & Levinthal, 1990, Koput, 1997, Sampson, 2007). Thus, I would expect that combination of broad search routine and alliance portfolio diversity reinforces complexity and constrains the innovation until the moderate point.

However, the benefit of portfolio diversity will be also amplified for broad search firms as the alliance portfolio diversity increases. A huge pool of diverse knowledge increases the selection effect of variation which represents that there are more choices for problem solving and creating novel innovations (March, 1991). The broad search firms are accustomed to new experimentation and integration based on a heterogeneous pool of knowledge (March & Simon, 1958), and proficient in creative combination and recombination using internal and external resources (March, 1991; Miller, 2006), generating more positive synergies as knowledge diversity increases.

In general, a reliability problem that means ability to respond to new information correctly is raised when knowledge variances increases in organization (Katila & Ahuja, 2002). While the narrow search firms cannot proficiently handle the knowledge variance, the broad search firm can create valuable technologies and knowledge without being bound by reliability problem, since they have a technological interface to identify and evaluate heterogeneous knowledge (Wuyts & Dutta, 2012). Thus, the broad search firms gain more benefits from the alliance portfolio as the partner diversity increases, and their benefits will outweigh costs from the certain point. We, therefore, expect that the synergy created by broad search routines will become greater and have a positive impact on innovation performance after the potential of diverse resources are sufficiently accumulated.

Hypothesis 4-2: Organizational search routine moderates the U-shaped relationship between alliance portfolio diversity and innovation performance, such

that the relationship will be strengthened when the firm pursues broad search but weakened when the firm pursues narrow search.

4.2.4. Technological capabilities as an internal value creation ability

Technological capabilities as the other internal context of value creation is the ability of a firm to actually create impactful innovations (Sears & Hoetker, 2014, Teece, 1987). It is difficult to imitate a firm's technological capabilities which include technological knowledge, know-how generated by R&D and other technology-specific intellectual assets (Dollinger, 1995). Although focal firms of alliance portfolios obtain appropriate knowledge from alliances, they cannot turn it into performance without sufficient capabilities for creating values. Firms' technological capabilities contribute to drawing the potential value of the obtained knowledge and should be taken into account in studying the link between knowledge and innovation (Stuaty & Podolny, 1996).

Technological capabilities largely offset the shortcomings of portfolio diversity. Firms with strong technological capabilities are less vulnerable in situations with high complexity (Rush, Bessant, & Hobday, 2007). Technological capabilities enable firms to maintain their absorptive capacity, and to achieve the expected outputs of knowledge creation without constraints in a large variance environment. Since the threat of complexity from diverse portfolio is reduced by technological capabilities, firms are not constrained to enhance innovation performance.

More specifically, technological capabilities contribute to leveraging resources obtained from alliance partners and to generate more breakthrough innovations (Ahuja &

Lampert, 2001; Srivastava & Gnyawali, 2011). Technological capabilities make focal firms' own innovation process more eligible to assimilate the diversity of its alliance portfolio (Cohem & Levinthal, 1990; Rosenkopf & Almeida, 2003), and combine external resources with internal ones to create novel technologies (Afuah, 2002). Thus this study predicts that a moderate level of alliance portfolio diversity is ideal for a firm with strong technological capabilities. Beyond moderate levels, however, this study expects a different effect.

Technological capabilities induce high resource consumption in its nature (Kumar, Kumar, & Persaud, 1999; McCutchen & Swamidass, 1996). Technological capabilities drive the firm to absorb and assimilate new external knowledge through long-term resource allocation and various collaborations to create novel knowledge (Zahra & George, 2002). Firms with higher technological capabilities aggressively consume resources and capabilities to find and develop novel knowledge (Wales, Parida, & Patel, 2013).

For firms with high technological capabilities, increasing knowledge diversity provides a positive synergy until moderate level. If the diversity becomes extremely high, however, resources which are needed to consumed for leveraging diverse knowledge would be overcharged. As resource commitments to absorb and assimilate vast knowledge are overloaded, the efficiency of resource allocation becomes sharply decreased (Wales, Parida, & Patel, 2013). With a significant increase in knowledge diversity, the technologically strong firms eventually bear a unaffordable burden to maintain further novelty (Nooteboom et. al, 2007).

Firms with high technological capabilities also tend to establish strong mechanisms to protect proprietary resources (Srivastava & Gnyawali, 2011). When much of external knowledge flows, the technologically strong firms increase controls to protect knowledge expropriation and not to be overwhelmed by too many opportunities by constructing governance structures (Heiman & Nickerson, 2004). These protective reactions and risk mitigating actions hinder integrating the partner's knowledge and creating breakthrough innovation that requires an open mindset.

For firms with high technological capabilities, therefore, the increase in alliance portfolio diversity generates positive synergies on innovation performance to moderate level of diversity, but extremely high level of portfolio diversity will rather dampen innovation performance. This represents a shift from the earlier curvilinear predictions, outlined in Hypotheses 1 and 2. The first hypothesis suggests that alliance portfolio diversity and innovation performance have a U-shaped relationship, and the second hypothesis suggests that the broad search routine strengthen a U-shaped relationship. In the third hypothesis, however, technological capabilities flip over hypothesized relationships, suggesting that alliance portfolio diversity and innovation performance have an inverse U-shaped relationship.

Hypothesis 4-3: Technological capabilities moderates the relationship of alliance portfolio diversity and innovation performance, such that low and high, but not moderate, levels of alliance portfolio diversity will negatively relate to innovation performance, resulting in an inverted U-shaped relationship.

4.3. Methods

4.3.1. Data and sample

This study investigated data on patent activities, alliance contract and asset data of U.S.-based manufacturing firms corresponding to SIC codes 2011–3999. Patent data were obtained from the patent citation record provided by US Patent and Trademark Office (USPTO). Alliance contract records were obtained from the SDC Platinum alliance database provided by Thomson Reuter. Firm asset data were obtained from the Compustat database.

I use a panel data model to analyze this study. For this analysis, I set the panel form with four focal years from 2004 to 2007. For each focal year t, the innovation performance, dependent variable, was measured in the period of t+1 to t+4. The independent and moderating variables such as search scope, alliance portfolio diversity, technological capabilities were measured in the period of t-1 to t-4. The control variables were measured in the focal year.

To operate this rag design, I collected firm-level financial, patenting, alliance data during the period 2000-2011, eight years around the each focal year of 2004-2006. I then randomly selected 3,000 manufacturing firms. Then, I filtered the sample according to the following steps. First, I matched Compustat financial data to USPTO patent data using CUSIP numbers. Thus, firms that had both financial and patent data remained. Second, I limited the sample to firms listed in SDC platinum database. This process left us with 332 sample firms. Third, I limited the sample to firms which had lasted in the analysis time

period 2000-2011. During this process, 182 sample firms remained in thus sample. Finally, the fixed-effect model this study adopts for analyze the models allows 509 observations from 152 firms. The sample consist of 57 firms in the chemical and allied products industry, 42 firms in computer and office equipment industry, 24 firms in laboratory apparatus and analytical, optical, measuring, and control equipment industry, 38 firms in surgical, medical and dental instruments and supplies industry, and 21 firms in other manufacturing industries. The organization size in terms of employees in the sample ranges from 21 to 475,000 employees. The average size is 18,342 employees. The analysis is based on 1,703 technological alliance contractions and on 21,973 focal patents. Therefore, the total number of longitudinal observations was 539 from 182 firms for 2000-2011.

4.3.2. Dependent variable

Innovation performance. As the dependent variable, innovation performance stands for the output generated by firm R&D. I measured forward citations as the innovation performance of the focal firm by counting the total number of times its patents are cited by other patents during the four year period from the focal year (Miller *et al.*, 2007). This way of measurement focuses on the qualitative performance of firms' R&D. As the number of forward citations of patents is closely associated with their technological importance (Trajtenberg, 1990), many researchers have adopted this qualitative measurement as the key performance of innovation (Kim, Arthurs, Sahaym, & Cullen, 2013; Trajtenberg, 1990).

4.3.3. Independent variables

Alliance Portfolio Diversity. Focal firms' APD was measured based on the industries in which their partner firms were involved. This measurement is attributed to the fact that firms in the same industry tend to have not only similar assets and operations but also similar intangible resources such as market knowledge, manufacturing processes, and management expertise (Wang & Zajac, 2007). Thus, I identified the three digit SIC codes of partner firms and used the entropy measure developed by Palept (1985) to measure APD. Jaquemin & Berry(1979) suggests that the entropy measure performs best to measure concentration (or diversity) (Jaquemin & Berry, 1979).

$$\sum_{i}^{N} Pi \times \ln(\frac{1}{Pi})$$

Within an alliance portfolio which consists of N different three digit SIC industries, Pi indicates the portion of industry i among the entire industries constituting the portfolio. The higher the value of the entropy, the higher the level of APD.

Organizational search routine. Organizational search routine in terms of scope of search activity represents the degree to which the patents of focal firms are citing from diverse technology domains. A number of previous studies investigate the patent classification to measure the scope of innovation activity (Katila & Ahuja, 2002; Kim et al., 2013). Patent classification allows identifying the heterogeneity and distance between patents (Ying, Wim, & Wilfred, 2008). I calculated the search scope of each focal firm based on the backward citation of their focal patents applied in each focal year.

$$1 - \sum_{j}^{N} Pj^2$$

Pj is the portion of the three digit technological classification j among the entire three digit technological classifications from which a focal firm's focal patents are citing. The higher level of search scope represents the expanded technological root of focal firms' search activities (Trajtenberg, Henderson, & Jaffe, 1997). As the search scope approaches 0, it indicates a focal firm's search is being concentrated, and vice versa.

Technological Capabilities. Technological capabilities is a firm's ability to identify, assimilate, and integrate external knowledge (Cohen & Levinthal, 1990). Higher technological capabilities lead to leveraging external knowledge and creating impactful innovation. As done in prior studies, I used the total amount of research & development (R&D) expenditure for the empirical proxy of each focal firm's technological capabilities (Kumar, Kumar, & Persaud, 1999; McCutchen & Swamidass, 1996; Morbey & Reithner, 1987).

4.3.4. Control variables

This study also included several control variables in our empirical models which might affect firms' innovation output. They are firm size, alliance portfolio size, firm age, experience of alliance portfolio diversity, and industry volatility. All control variables were measured in the focal year. Firm size was measured by the log value of total number of employees of each firm in the focal year. Firm size is a typical control variable in innovation studies because larger firms have greater ability to innovate and strategic

freedom than smaller firms do (Duysters and Hagedoorn, 2002). For measuring alliance portfolio size, I counted the number of alliance partners. Alliance portfolio size is regarded to positively affect firm performance in a number of prior studies (Ahuja, 2000a; Baum et al., 2000; Stuart et al., 1999). Firm age was also controlled because previous literature suggests that older firms tend to intensify their organizational rigidity and inertia which negatively affect their innovation performance (Kelly and Amburgey, 1991; Van de Venet et al., 1999). APD Experience is also control variable. If firms have experience with APD, it influences the effectiveness and performance gained from APD (Leeuw, Lokshin, & Duysters, 2014). A dummy variable with the value of one was created if the focal firm had an APD experience before observation period. I calculated industry volatility following the approach used by Synder and Glueck (1982) and Tosi, Aldag, and Storey (1973). I simply distinguish high volatility industries from others by designating a dummy. I assigned the value 1 for firms those who correspond to top 20% industries in terms of the volatility. I assume that external factors such as general economic environments or market conditions are changing over time and may significantly influence patenting activities. Therefore, the year effect was controlled for by including year dummies for each focal years.

4.3.5. Empirical model specification

The unit of analysis in this study was firm-level innovation. Thus, this study used negative binomial regression for the analysis. The dependent variable of this study was measured by counting the forward citations of the focal firms' patents and has non-

negative integer values. In this case, the variable does not follow the assumption of homoscedasticity in linear regression but follows Poisson distribution (Hausman,Hall, and Griliches, 1984). However, the strict assumption of Poisson regression, i.e. the equality of the mean and variance of the event count, cannot be easily met. In the case of a dependent variable with over-dispersed count data, negative binomial regression is an appropriate method to analyze the model (Hausman, Hall, and Griliches, 1984). Most of the extant literature which adopts the number of patents as the dependent variable also uses negative binomial regression for its empirical studies (Song, Almeida, and Wu, 2003). With respect to unobserved individual specific effects, Hausman test suggests a fixed effects model is appropriate for analyzing the data. It helps partial out unobserved differences among firms, and appropriate for the data. Thus, this study analyzes the data with the Negative Binomial Model with fixed effects (Benner and Tushman, 2003).

4.4. Results

Table 6 provides descriptive statistics and correlations between each variable. The sample data are comprised of the observations across 182 firms from the year 2000 to 2011. For the multicollinearity check, this study conducted the variance inflation factor (VIF) test for all the variables. The average value of VIF is 1.30 and the highest value is 1.663. These figures are well below the recommended cutoff value of 10 (Chatterjee, Hadi, & Price, 2000; Neter, Kutner, Wasserman, & Nachtsheim, 1996). Thus the multicollinearity issue is not present in this results.

Table 6. Descriptive statistics and correlations

Variables	VIF	Mean	s.d.	1	2	3	4	5	6	7	8
Innovation performance	-	159.83	443.18								
APD	1.484	0.63	0.68	0.31*							
Search routine	1.076	0.67	0.25	0.21*	0.18*						
Technological capabilities	1.379	11.19	2.40	0.20*	0.26*	0.14*					
Firm size(employee)	1.567	7.83	2.11	0.29*	0.30*	0.20*	0.50*				
Firm age	1.173	42.02	41.44	0.14*	0.21*	0.05	0.16*	0.29*			
Portfolio size	1.587	5.66	10.01	0.47*	0.54*	0.17*	0.27*	0.36*	0.26*		
APD experience	1.027	0.80	0.40	-0.04	0.07*	0.11*	0.08*	0.03	0.06	0.07	
Industry volatility	1.101	0.29	0.45	0.11*	-0.09*	0.03	-0.04	-0.16*	-0.19*	0.05	0.07

* $p < .05$

Table 7 shows the results of the negative binomial model with fixed effects. Model 1 includes all of the control variables. Model 2 adds independent variables including alliance portfolio diversity and its squared term to show the main effect of this model. Model 3 adds interaction of alliance portfolio diversity and search routine while Model 4 adds another interaction of alliance portfolio diversity and technological capabilities. Model 5 includes all main effects and interactions.

Hypothesis 1 predicts that alliance portfolio diversity and innovation performance has a U-shaped relationship. Model 2 shows the root term for alliance portfolio diversity is significant and negative (β=-0.28, $p<0.1$), while the squared term is significant and positive (β=0.17, $p<0.05$). In Model 3 and Model 5 which include interaction terms, however, the significant effect for alliance portfolio diversity disappeared. Thus, the result did not support the presence of U-shaped relationship between alliance portfolio diversity and innovation performance in the sample.

Hypothesis 2 predicts that organizational search routine has a positive moderation effect on the relationship between alliance portfolio diversity and innovation performance. Model 3 of Table 2 exhibits the result of this hypothesis. The coefficient for the interaction between alliance portfolio diversity and search routine is statistically significant and negative (β=-1.05, $p<0.1$) and the coefficient of the interaction with squared term is significant and positive (β=0.60, $p<0.1$). Thus, these results support Hypothesis 2.

Table 7. Result of the Negative Binomial Model with Fixed-Effects Predicting Innovation Performance

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Firm size (employees)	.06 (.02)**	.05 (.03)*	.04 (.03)	.05 (.03)**	.04 (.03)	.04 (.03)
Firm age	.00 (.00)	.00 (.00)	.00 (.00)	.00 (.00)	.00 (.00)	.00 (.00)
Portfolio size	.01 (.01)**	.01 (.01)	.01 (.01)	.01 (.01)	.01 (.01)	.00 (.01)
APD experience	-.16 (.19)	-.11 (.19)	-.11 (.19)	-.11 (.19)	-.09 (.20)	-.05 (.19)
Industry volatility	.45 (.17)***	.30 (.16)*	.26 (.16)	.32 (.17)*	.30 (.17)*	.53 (.20)***
APD		-.28 (.17)*	.57 (.50)	-1.45 (.64)**	-.68 (.75)	-.69 (.77)
APD squared		.17 (.08)**	-.32 (.27)	.54 (.26)**	.10 (.34)	.08 (.35)
Search routine		1.10 (.19)***	1.20 (.26)***	1.07 (.20)***	1.19 (.26)***	1.18 (.26)***
Technological capabilities		.01 (.02)	.02 (.02)	-.03 (.03)	-.03 (.03)	-.02 (.03)
APD × search routine			-1.05 (.61)*		-1.21 (.62)*	-.90 (.68)
APD squared × search routine			.60 (.31)*		.69 (.32)**	.63 (.34)*
APD × technological capabilities				.10 (.05)*	.12 (.05)**	.11 (.06)*
APD squared × technological capabilities				-.03 (.02)	-.04 (.02)**	-.03 (.02)*
APD × search routine × volatility						-.83 (.45)*
APD × tech capabilities × volatility						.03 (.03)
Year effects	Y	Y	Y	Y	Y	Y
Firm fixed effects	Y	Y	Y	Y	Y	Y
Log likelihood	-1549.8714	-1530.5936	-1528.3622	-1528.6983	-1525.9327	-1522.5019
Wald chi2	129.13	186.83	195.62	190.15	202.82	217.23

N = 182

* p< .10; ** p < .05; *** P < .01

Hypothesis 3 predicts that technological capabilities moderate the relationship between alliance portfolio diversity and innovation performance. Model 4 shows the result of this hypothesis. The coefficient for the interaction between alliance portfolio diversity and technological capabilities is statistically significant and positive (β=0.10, $p<0.1$) while the coefficient of the interaction with squared term in Model 4 is insignificant. However, Model 5 including all main effects and interactions represents that the coefficient for the interaction between alliance portfolio diversity and technological capabilities is statistically significant and positive (β=0.12, $p<0.05$), as well as the interaction between technological capabilities and squared term of alliance portfolio diversity is significant and negative (β=-0.04, $p<0.05$), indicating Hypothesis 3 is supported.

These results show that the alliance portfolio diversity alone cannot explain the relationship with innovation performance, and this relationship is determined by internal contexts such as organizational search routine or technological capabilities. Thus, this result demonstrates the premise of this study that 'benefit from alliance portfolio diversity depends on internal capabilities of value creation'.

Apart from the hypotheses tests, I conducted additional analysis by adding interaction terms with industry volatility as dummy variable, to examine how interplay of alliance portfolio diversity and internal capabilities is applied in certain environment such as high volatile. In Model 6 in Table 2, the interaction of alliance portfolio diversity and organizational search routines becomes more significant in industries with high volatility while interaction of alliance portfolio diversity, technological capabilities, and high volatility have no significance. This result will be discussed again in the discussion part.

4.5. Sensitive analyses

To improve the robustness of my test results, I conducted sensitivity analyses with two different test setting. First, I conducted the analysis using random-effects techniques in the model (Model 7 in Table 8). Random-effects allow retaining firms with only one observation and time invariant variables. Though Hausman test suggestes a fixed effects model is more appropriate for analyzing our data, our model will be more robust if the random-effects also support the results in the original analysis.

Moreover, this study tested our model by changing the measurement of the dependent variable. Number of citation-weighted patents is another approach to measure innovation performance. Trajtenberg (1990) demonstrates that citation-weighted patent counts is more closely correlated with their output measures of innovation. For this reason, many studies have adopted citation-weighted patent counts to calculate innovation output (Ahuja, 2000; Henderson and Cockburn, 1994). To analyze the sensitivity with this approach, I measured the dependent variable by the number of patents applied in each focal year weighted by the number of citations subsequently received (Model 8 in Table 8).

These results of the two robustness tests are almost similar to those presented in the original analysis. While the curvilinear relationship between alliance portfolio diversity and innovation performance is not significant, the interactions with organizational search routines or technological create significances respectively. For both of these analyses, the results suggest additional support the conclusions drawn from the original analysis.

Table 8. Result of the Negative Binomial Model with Fixed-Effects Predicting Innovation Performance (Sensitivity analyses)

(Dependent variable, Model)	Model 5 (Citation counts, FE)	Model 7 (Citation counts, RE)	Model 8 (Citation weighted counts, FE)
Firm size (employees)	.04 (.03)	-.01 (.03)	.07 (.02)***
Firm age	.00 (.00)	-.00 (.00)	.00 (.00)
Portfolio size	.01 (.01)	-.01 (.01)	.01 (.01)
APD experience	-.09 (.20)	-.02 (.18)	.00 (.14)
Industry volatility	.30 (.17)*	.02 (.16)	.20 (.12)*
APD	-.68 (.75)	-.77 (.71)	-.48 (.70)
APD squared	.10 (.34)	.06 (.32)	0.10 (.33)
Search routine	1.19 (.26)***	.84 (.24)***	1.24 (.23)***
Technological capabilities	-.03 (.03)	-.01 (.03)	-.01 (.03)
APD × search routine	-1.21 (.62)*	-.67 (.60)	-1.08 (.59)*
APD squared × search routine	.69 (.32)**	.73 (.31)**	.71 (.32)**
APD × technological capabilities	.12 (.05)**	.09 (.05)*	.10 (.05)**
APD squared × technological capabilities	-.04 (.02)**	-.03 (.02)*	-.04 (.02)**
Year effects	Y	Y	Y
Firm fixed effects	Y	Y	Y
Log likelihood	-1525.9327	-2136.2572	-2639.7338
Wald chi2	202.82	129.17	293.81

N = 182
* P < .10; ** p < .05; *** P < .01.

4.6. Discussion

This study offers a new perspective on the linkage between the alliance portfolio diversity and organizational innovation by examining factors reflecting internal context such as organizational search routine and technological capabilities. This study argued that the effects of alliance portfolio diversity on firm-level innovation performance depend upon internal capabilities of value creation.

Although the empirical results did not fully support the hypothesized curvilinear relationship between alliance portfolio diversity and innovation performance of the firm, this study did confirm that such effects are evident in specific strategic contexts. More specifically, in firms with broad search routine, both low and high portfolio diversity were associated with higher innovation performance than was moderate diversity. Combination of broad search routine and alliance portfolio diversity amplifies complexity and constrains the innovation until the moderate point. However, the benefit of portfolio diversity such as selection effect of variation is eventually reinforced for broad search firms. After benefits surpass constraints, broad searchers' innovation performance is improved. Thus, this finding suggests that broad search firms are more advantageous, in enhancing innovation performance, as they acquire abundant heterogeneous resource pools through high diversity of alliance portfolio or avoid complexity risk through low diversity of portfolio. In case of narrow search firms, they can enhance innovation performance by complementary synergy through moderate diversity of alliance portfolio.

On the other hand, technological capabilities as value creation ability flip the

hypothesized relationship between alliance portfolio diversity and innovation performance. Firms with strong technological capabilities are less vulnerable in situations with high complexity. The firm achieves the full benefits of diversity since technological capabilities offset the constraints of complexity, leverage resources obtained from partners, and firm's own innovation process become more effective.

However, technological capabilities are costly. This nature makes the firm bear a heavy burden when diversity becomes extremely high. In situations of high diversity, resource commitments to assimilate various knowledge are overloaded and the efficiency of resource allocation sharply decreases. In addition, the typical weaknesses of high technological capabilities such as risk mitigating mindset on too much opportunities decrease innovation performance. Thus, firms with strong technological capabilities can maximize innovation performance through moderately diverse portfolio rather than extremely heterogeneous or homogeneous portfolio.

Alliance portfolio diversity has both advantages and disadvantages. However, the results show that the mechanisms that firms gain benefits from partners portfolio are completely different contingent upon internal capabilities of value creation.

Apart from hypothesis testing, I conducted additional study to see how these results applied in certain environments such as high volatile industries including electronic computing equipment, electronic components, and medical chemical products. Industry volatility is defined as the level of instability or unpredictability faced within a certain industry (Dugal and Gopalakrishnan 2000, Dess and Beard 1984). Scholars in management and organization fields have constantly studied volatility (Dill, 1958; Kast & Rosenzweig, 1978). Industry volatility is regarded to be significant in determining firm

performance because firms are involved in an open system and exposed to uncertainty. To improve performance, they have to coordinate their structure and strategy with the condition of external environment (Lawrence & Lorsch, 1967; Thomson, 1967).

In high volatile industries, the interaction effect of alliance portfolio diversity and organizational search routines is strengthened. Because volatile industries have their own risk of complexity, broad search firms will face a greater risk of losing sight in a flurry of opportunities as the portfolio diversity and resulting complexity increase. Moreover, broad searcher's capability to quickly develop new technologies, and overcome uncertainty by strategic collaboration is especially more critical in environment characterized by high volatility (Tushman & Anderson, 1986; Brown & Eisenhardt, 1997; Teece et al., 1997).

It also gives implications for firms with narrow search routine. Narrow search firms are usually focused on a certain field and tend to make a delayed or insufficient reaction even in response to volatile environment (Meyer, Brooks & Goes, 1990; Hendersn, 1993). The capability to quickly develop new technologies is especially critical in environment characterized by rapid innovation and change (Tushman & Anderson, 1986; Brown & Eisenhardt, 1997; Teece et al., 1997). Due to insufficient variances in the search scope, narrow se arch firms may fail in obtaining relevant technology which address rapid environmental change (Burgelman, 1994). Accordingly, in volatile industries, it is more critical for narrow search firms to overcome the limitation of their search scope and take advantage through moderately diverse portfolio.

Chapter 5. Conclusions

5.1. Summary and contributions

This study developed a unique framework of strategic fit that is suited to the research field of technological innovations. Based on this, two empirical studies were conducted. The present dissertation highlights the importance of strategic fit of top management team, internal context, and external context that sequentially contribute to the focal firm's innovation performance. The dissertation provides following a number of significant findings and implications corresponding to each linkage of strategic fit. Following the concept of normative orientation (Venkatraman , 1990), this dissertation has shown that strategic fit is important in technological innovation.

The finding shows that there is a significant relationship between appropriate fit of the top executives and internal and internal-external contexts and firm leve innovation performance. Especially this study provide the innovation performance implication in terms of the fit of (1) TMT characteristics and organizational search scope (2) TMT characteristics and managerial discretion as an industry variable (3) Alliance portfolio diversity and organizational search scope (4) Alliance portfolio diversity, search scope, and technology capabilities (5) Alliance portfolio diversity, search scope, and industrial volatility.

In addition to the aforementioned overall findings, each chapter of the present thesis provides theoretical and managerial contributions. Based on the findings of Chapter 3,

one of the important contributions of this chapter is the consideration of industrial knowledge diversity of TMT. This concept has received much less attention than by functional diversity (eg. Cohen & Bailey, 1997; Monge & Eisenberg, 1987), educational background diversity (eg. Carpenter & Fredrickson, 2001; Wiersema & Bantel, 1992) in upper echelon theory. However, the finding results show that the knowledge diversity based on the prior industrial experiences of a TMT has a critical impact on firm-level innovation. The generalized TMT with various industry experiences can generate greater innovativeness thanks to their capability to recognize new opportunities with a broad range of knowledge, to solve complex problems effectively in uncertain an environment, and to generate creative alternatives (Li, Maggitti, Smith, Tesluk, & Katila, 2013, Kilduff, Angelmar, & Mehra, 2000; Kor, 2003). These finding results highlight that examining the industrial knowledge base of the TMT is important to facilitate firm-level innovation performance.

In this chapter, organizational search behavior is also an important consideration. TMT's needs and organizational behavior can be constantly decoupled due to the difference of their volatilities while upper echelon perspective regards the organization as a reflection of its top managers (Hambrick & Mason, 1984). The result of the statistic model also shows there is no correlation between TMT knowledge diversity and organizational search scope. In the case that TMT pursues the development of new technology by internal organization based on the source technology obtained from different industries through technological acquisition, for example, an organization which has pursued a narrow search so far will not be able to perform smoothly. It is difficult to change their behavior at once due to the path dependence (David, 1994). To maximize the

effect of TMT knowledge diversity on innovation, firms need to minimize the restraint due to the mismatch. Thus, this study examined the interaction effect of organizational search scope to identify the appropriate match between TMT knowledge diversity and search scope. Our finding results show that the positive effect of TMT knowledge diversity on firm innovation is further strengthened when the organizational search scope is broader. An appropriate fit between broad search and TMT with a diverse knowledge base fosters the condition to enhance innovation. Sveiby (2001) argued that a firm can create intangible value through strategic formulation by linking managers' knowledge capability and internal structure closely to transfer knowledge or relay a vision. Building on this perspective more specifically, this study suggested that the appropriate fit between TMT's knowledge base and organizational behavior as an internal structure fosters the strategic formulation to leverage intangible values such as innovativeness.

Another important and unique contribution of this study is to introduce and explain the issue of managerial discretion. Even though managerial discretion has been a key factor in the explanation of the influences of the TMT on organizational outcomes, it has been neglected in the innovation literature. This study demonstrates that the degree of managerial discretion at the industry-level has a critical role in moderating the relationship between TMT knowledge diversity and innovation performance of the firm, thus contributing to the extant literature. The finding results show that the effect of the TMT knowledge diversity on innovation performance becomes stronger in a high-discretion context. In a low-discretion context, however, the effect of the TMT knowledge diversity is found to have less impact on innovation performance.

The managerial implications of this chapter are as follows. The findings highlight the

importance of an appropriate configuration of top executives' knowledge base, and alignment with search strategies in managing organizational innovation. Specifically, this study offers guidelines for selecting and retaining new TMT members. Whether promoting existing employees to management positions or recruiting TMT members from outside, firms generally tend to focus on individual level attributes, such as academic background, professional credentials, and the relevance of their prior work. The cognitive fit of the new member with the rest of the top management team is not given much weight. However, the findings of this study highlight the importance of the configuration of the TMT knowledge base, and alignment with the context of the firm's search scope. Therefore, a holistic view of the candidate's compatibility with the rest of the top team with respect to the strategic objectives of the firm should be adopted, including its intended search method and innovation strategies.

In Chapter 4, one of key contributions is advancing understanding on the influence of alliance portfolio diversity through the contingency perspective, which extends prior work focused solely on partner attributes. Although it is critical to manage innovation activities by considering diverse contexts, the contingency view has not received sufficient attention in alliance literatures. This study develops the concept of fit through a comprehensive empirical test. This is noteworthy at both the theoretical and practical levels.

For practicing managers, the findings suggest the strategic importance of developing a comprehensive firm-level innovation strategy, adopting a portfolio perspective, establishing appropriate internal-external routine, and actively managing such a integrated complementary system to further develop capabilities for improving firm

performance.

Especially, the study in this chapter provides a new guideline for choosing new alliance partners. When allying with new partners, firms generally pay attention to individual level attributes of partners such as their organizational capabilities, past performance, executives' capabilities, etc. Recent studies have expanded this point of view to alliance portfolio perspectives and incorporated the view of composing the whole alliance portfolios. On top of this, this study differentiates internal capabilities of value creation from alliance formations and highlights the importance of strategic fit between alliance strategy and internal capabilities as organizational routine and ability. Beyond considering the composition of alliance portfolios and their diversity, this study adopts more holistic view on alliances and their performance by overseeing organizational learning in a wider perspective.

In conclusion, I have developed a model of strategic fit between alliance portfolio diversity and internal capabilities of value creation for innovation activity. This study suggest researchers and practitioners to regard the fit as an important strategic tool by which firms build their collaboration strategy and effectively harness it in pursuit of value-creating innovations.

5.2. Limitations and future research

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

In chapter 3, this study examined the effect of TMT knowledge diversity on firm innovation. This study measured the knowledge diversity based on dominant industrial experience by identifying the industry where they spent the longest period of time. The study did not take into consideration the other remaining industries of each member. The longest working career is the dominant factor in forming knowledge base (Cannella, park, & lee, 2008), and this study focuses on the collective characteristics of the entire top team, rather than that of individual executives. Therefore, knowledge scope at the top team-level based on the managers' dominant industry is deemed to be more suitable for this study, considering that the remaining experiences are also needed to fully investigate the effect of industrial knowledge. Aside from team-level knowledge scope based on a manager's dominant industry, for example, intra-personal knowledge scope offers another way to gauge the degree of knowledge scope of the team. This measure is calculated by computing an intra-personal industrial scope score for each team member and then taking the average of this score across all team members (see Burke & Steensma, 1998). While dominant industry based knowledge scope concerns a team's scope of experience across industries, intra-personal industrial scope concerns the scope of industrial experiences of the individuals on the team. Considering these two methods together will be a more comprehensive approach to understand the effect of industrial knowledge of TMT.

Moreover, this study relied on Hambrick and Abrahamson (1995)'s industry discretion ratings for 4-digit SIC code industries to distinguish high-discretion industries. However, because the index is based on data from around 1995, it may not capture the more current industry environment. In fact, some industrial fields have appeared or disappeared. To narrow the gap between the past and present, this study chose high-discretion industries

by using the 3-digit SIC code that covers a wider range of industries than the 4-digit SIC code. However, a more accurate analysis would require an update of the ratings so that they reflect the current industrial environment.

In addition, dependent variable of innovation performance was measured by counting the forward citation which is the total number of times its patents are cited by other patents. Even though many researchers have adopted this qualitative outcome as a key performance measure of innovation (Kim, Arthurs, Sahaym, & Cullen, 2013; Trajtenberg, 1990), there are alternative methods to measure the innovation performance such as quantitative outcome measured by the number of successful patent applications by a firm in a given year (eg. Ahuja & Katila, 2001) or radical innovation measured by the fraction of the firm's turnover relating to products or technologies new (eg. Laursen & Salter, 2006) or product innovation measured by innovative sales productivity (eg. Tsai, 2009). Attempts to link the industrial knowledge diversity of TMT with other types of innovation performance will further broaden upper echelon theory.

In Chapter 4, adopting the idea of path dependency might have contributed to studying concept in this research. Due to the embedded path dependency (Syow, Schreyogg, & Koch, 2009) in organizational routine, I may doubt some constraints on pursuing the relationship across firm boundaries. For instance, the exploitative tendency of narrow search firms may extend to their alliance formation. They might prefer partners from similar fields or absorb knowledge in similar domains even in case of alliances with diverse partners. In the same vein, the explorative tendency of broad search firms may affect their alliance formation. In the meantime, a number of prior studies suggest not only organizational tendency of maintaining their knowledge acquisition propensity but

also their inverse incentives on pursuing something contrary. For instance, firms those who pursue exploitative search tend to seek for complementary resources through diverse alliances (Eisenhardt & Schoonhoven, 1996) and recombine their core competency with diverse knowledge. On the contrary, broad search firms seeking exploratory innovation also build focused alliance formations to exploit a specific technology intensively (Srivastava & Gnyawali, 2011). In line with these literatures, this study assumes that path dependency is not a critical factor which prevents the strategic fit across firm boundaries. However, this study expects future research to operationalize the influence of path dependency on alliance formations and innovation performance and suggest a more detailed mechanism.

Moreover, this study tried to conduct the additional analysis with logarithm sales as the dependent variable to examine how this model is applied to profit related performance. However, all of the significances supported by original analyses predicting the innovation performance were disappeared in this analysis. The result shows that this model does not affect profit relate performance although the empirical validity of the models predicting innovation variables is demonstrated. However, in order for these models to be more useful in academia and practical areas, it should be able to provide broader performance implications. Future studies need to extensively analyze the impact of this strategic fit on more diverse performances.

In addition, investigating the overlap of domain will contribute to strictly examining the consistency fit between organizational search scope and alliance portfolio diversity. This study investigates the breadth of organizational search scope and the diversity of alliance portfolios and simply matches them to discern their fit. However, such a scope fit

may have nothing to do with the fit of knowledge domain. Depending on the coherence between the knowledge base of external partners and the knowledge base within the organization, the interaction effects of alliance portfolio diversity and internal capabilities may change. For example, the complexity problem of broad search firms may be alleviated if the overlap scope of external and internal knowledge is large even though the firms sets up a diverse alliance portfolio. Thus, I expect future research to incorporate the overlap or the fit of contents and corroborate the suggestion of this study in a different perspective.

Moreover, this dissertation was developed focusing on manufacturing industry. In manufacturing, however, the nature and the scope of industry are constantly changing over time. Recently, the term of industry 4.0 has emerged, which represent that many changes are occurring in the manufacturing sector. Future manufacturing will differ in many respects from the point at which this dissertation was developed. Therefore, in order to further advance research on manufacturing, it should be able to reflect these changes. In other words, it is needed to develop on how firms will achieve innovative success in the Industry 4.0 era. I hope there will be many attempts to address the future of manufacturing and new innovation strategies based on this study.

Finally, while this dissertation focus on manufacturing, I cannot assure that this finding can be applied equally in other industries such as service, banking, or entertainments because market conditions or technology development environment may be different according to industries. Therefore, it is necessary to further analyze how this model is applied with the samples in other industry sectors in order to obtain more universal and academic value.

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국 문 초 록

빠르게 변하는 경영환경 속에서 경쟁우위를 유지하기 위해, 지속적인 기술혁신은 필수다. 그러나 기술혁신은 그 자체로 기업경영의 성공을 보장하지는 않는다. 우수한 혁신 자원을 보유했음에도, 기술혁신을 통한 가치창출에 실패한 사례는 많다. 내·외부 자원의 유기적 결합 부재, 또는 조직 내 전략간 불일치로 인해 혁신에 실패하는 경우를 어렵지 않게 찾아볼 수 있다. 혁신적인 기술을 탐색하고 개발하는 데 있어서 최고경영진, 공급자, 경쟁자, 주주 등 다양한 이해관계자들이 유기적으로 상호작용을 하고, 일관된 전략방향 하에 보유 자원들이 적절히 융합, 시너지를 내는 것은 중요하다. 다시 말해, 기술혁신에 있어서 모든 요소들이 적절한 정합성을 이루는 것은 혁신 성과를 높이는 데 있어서 매우 중요하다.

이 논문에서는 기업 혁신에 있어서 전략적 정합성 (Strategic Fit)의 중요성을 강조한다. 이를 위해 기업 내외부 요소들의 전략적 정합성과 혁신성과 사이에 유의한 관계가 존재하는 지 살펴보고, 주요 요소들 간 어떠한 적합성을 이룰 때 혁신성과가 극대화되는지를 밝혀내고자 한다. 이 논문에서는 우선, 여러 문헌에서 정합성에 대한 개념이 일관성 없이 무분별하게 활용되고 있는 점을 지적, 기술혁신 연구에 적합한 전략적 정합성의 프레임을 제시한다. 이러한 프레임을 기반으로, 최고경영진, 기업 내부요소, 기업 외부요소 등 3가지 요소 간 전략적 정합성과 혁신성과의 관계를 분석한다.

상위계층이론은, 조직의 행동 및 성과는 최고경영진의 특성을 반영한다는 점을 전제로 한다. 최고경영진은 기업의 혁신과 관련한

전략을 수립하고, 실행하고, 평가하는 권한을 갖고 있다. 최고경영진의 영향력은 매우 크기 때문에 결국 조직의 전략 방향 및 실행은 최고경영진의 성향이나 의도대로 이뤄지기 쉽다. 따라서 최고경영진의 지식기반은 기업의 혁신전략을 주도하는 성향을 예측하는 주요 변수로 활용된다. 이 연구에서는 지식기반 다양성에 집중한다. 다양한 지식을 갖고 있는 최고경영진과, 동질적인 지식을 갖고 있는 경영진은 서로 의사결정하는 성향이 다를 수밖에 없다. 다양성에 대한 주제를 다룬 대다수 기존 연구들은 지식다양성이 높을수록 혁신성과는 높아진다는 결과를 보이고 있다. 하지만 기존 계량분석 문헌들이 보여주듯, 이 같은 경향이 모든 기업에게 동일하게 적용되지는 않는다. 왜냐하면 최고경영진의 전략 방향은 내부 조직에 의해 실행되는데, 조직이 갖고 있는 행동 및 루틴에 의해 최고경영진 효과는 변질될 수 있기 때문이다. 따라서 이 논문에서는 최고경영진의 지식다양성과 혁신 성과 사이의 관계가, 조직의 내부 구조에 의해 어떻게 변하게 되는지를 분석했다. 미국 제조업체 120개 기업을 대상으로 계량분석을 실시한 결과, 최고경영진 구성원들의 과거 산업경험에 기반한 지식 다양성은 혁신성과에 긍정적인 영향을 주는 것으로 나타났다. 하지만 이 관계는 조직의 탐색 범위에 의해 조절되는 경향을 보였다. 조직의 탐색범위가 높을수록, 혁신 성과에 대한 최고경영진의 지식 다양성 효과는 더욱 커지고, 반대로 조직의 탐색범위가 작을수록, 최고경영진 효과는 반감되는 것으로 나타났다. 즉, 다양한 지식을 가진 최고경영진이 넓은 범위의 탐색을 하는 조직을 이끌 때 보완적 정합성 (fit as internal complementarity)이 높아지고 이는 혁신성과를 높인다.

최고경영진의 지식 다양성 효과는 자유재량 (managerial discretion)

환경과도 정합성이 잘 맞아야 한다. 자유재량은 최고경영진이 경영사안에 얼마나 직접적, 적극적으로 관여할 수 있는지를 나타내는 것으로, 산업마다 그 정도에 차이가 있다. 컴퓨터 및 반도체처럼 자유재량도가 높은 산업에서는 최고경영진의 지식 다양성 효과가 더욱 커진다. 반대로 목재 및 단순제조업 등 자유재량도가 낮은 산업에서는 최고경영진 효과는 작다. 따라서 자유재량도가 높은 산업은 최고경영진의 지식 다양성과 보완적 정합성 (fit as external complementarity)을 이루며, 혁신성과를 더욱 높인다.

두 번째 연구는 제휴 다양성의 혁신 성과에 대한 영향에 대해 살펴본다. 기업은 다양한 외부 파트너들과의 협력을 통해 혁신 가치창출을 할 수 있다. 혁신을 위한 외부 협력의 유형으로는 인수합병, 제휴, 조인트벤처 등이 있다. 이 연구는 제휴에 집중한다. 특히 제휴 포트폴리오 다양성이 혁신성과에 미치는 영향을 중점적으로 분석했다. 제휴 포트폴리오 다양은 기업이 얼마나 다른 종류의 파트너와 제휴를 맺고 있는지를 나타내는 정도다. 하지만 아무리 훌륭한 기업들과 제휴를 맺고 있다 하더라도 제휴 자체가 조직의 혁신에 단독으로 영향주는 것은 아니다. 기업의 내부 전략과의 정합성에 따라 제휴기업들이 기업에 미치는 영향은 달라질 수 있다. 제휴 포트폴리오 다양성이 기업의 혁신성과에 미치는 영향을 보다 정확하게 분석하려면 내부 전략도 함께 고려해야 한다. 이 연구에서는 182개 미국 제조업체의 샘플을 토대로 조직 내부의 가치창출 역량과 제휴 포트폴리오 다양성의 정합성이 혁신 성과에 어떠한 영향을 주는지 분석했다.

제휴 포트폴리오 다양성은 그 자체로 성과에 영향을 미치기 보다는,

조직 내부의 상황에 따라 다르게 작용한다. 아무리 훌륭한 파트너들과 견고한 포트폴리오를 구축한다 해도 조직 내부에서 이를 어떻게 활용하냐에 따라 성과에 미치는 영향은 달라지기 때문이다. 이런 관점에서, 이 논문은 기업의 내부 가치창출 역량이 제휴 포트폴리오 다양성의 이점을 조절하는 중요한 요인이라고 주장한다. 제휴 포트폴리오 다양성은 기업이 접근할 수 있는 외부 자원의 크기라고 할 수 있다. 이로부터 가치를 창출하는 역량에 따라 포트폴리오로부터 얻게 될 이점은 달라진다는 게 이 연구의 가정이다.

이 연구는 먼저 제휴 다양성과 기업의 혁신성과의 직접적 관계를 확인한다. 제휴 포트폴리오 다양성은 장단점을 동시에 보유하고 있는 점을 감안해 비선형 분석을 실시, 둘 사이의 관계는 U 모양을 가질 것으로 예상한다. 이어서 내부 가치창출 역량이 이 관계를 어떻게 조절하는지 살펴본다. 여기서 기업 내부의 가치창출 역량은 루틴과 능력 두 관점으로 살펴본다. 즉 조직의 탐색 루틴 (organizational search routine)과 기술 역량 (technological capabilities)이 혁신성과에 대한 제휴 다양성의 영향력을 어떻게 조절하는지 분석한다.

분석 결과, 제휴 포트폴리오 다양성과 혁신성과의 직접적 관계는 나타나지 않았지만 그러나 내부 가치창출 역량에 따라 관계는 분명해졌다. 즉, 조직의 탐색 루틴은 제휴 포트폴리오 다양성과 혁신성과 간 U 모양을 더욱 분명하게 조절하는 역할을 한다. 반대로 기술 역량은 제휴 포트폴리오 다양성과 혁신성과 사이에 역 U 모양을 띄도록 하는 것으로 나타났다.

이 연구에서는 더 나아가, 이 같은 관계가 변동성이 높은 환경에서는 어떻게 조절되는지도 분석한다. 이 분석에서 조직의 탐색

루틴이 제휴 포트폴리오 다양성과 혁신성과 간 U 모양을 더욱 분명하게 만드는 조절효과는 변동성이 높은 산업에서 더욱 분명해지는 것으로 나타났다. 이 연구는 내외부 요인을 동시에 고려한 통합적 정합성 (fit as integrated complementarity)의 관점으로 제휴 포트폴리오 다양성의 혁신성과에 대한 영향을 분석했다.

주요어: 전략적 정합성, 혁신 성과, 최고경영진, 조직 탐색, 제휴 포트폴리오, 경영재량권

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