

**AMBIDEXTERITY IN STRATEGIC ALLIANCES: HOW DO FIRMS MANAGE
EXPLORATION AND EXPLOITATION ALLIANCES? AN EXAMINATION OF U.S.
HIGH TECHNOLOGY INDUSTRIES FROM 1985 TO 2009**

WAN LI

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ABSTRACT

This dissertation examines the antecedents and consequences of exploration and exploitation in the context of strategic alliances. Research interest in the framework of exploration-exploitation has increased significantly with much progress made in current literature, yet many questions remain open. In this dissertation, I examine how environmental force (i.e., market uncertainty) and organizational features (i.e., innovative capacity and slack resources) drive organizations' decisions on forming exploration versus exploitation alliances. In addition, I investigate the performance outcome of balancing exploration and exploitation alliances, by examining multiple approaches including the balance versus focus perspectives, the temporal separation approach, and the domain separation approach.

My study of the antecedents reveals that firms with higher innovative capacity are more likely to form more exploitation alliances than exploration alliances; in contrast, those with more slack resources are inclined to engage in more exploration alliances than exploitation alliances. Under market uncertainty, firms tend to be risk adverse and reduce forming both types of alliances. Furthermore, higher innovative capacity and more slack generally mitigate the negative impact of market uncertainty on alliance formation. My findings regarding performance outcome of exploration and exploitation alliances suggest that balancing them simultaneously may hurt performance. Instead, balance can be executed via temporal separation (i.e., balancing through sequential emphasis on exploration and exploitation over time), or domain separation (i.e., balance through focus on exploration in one domain while exploitation in another), which is particularly important for smaller firms. Organizational ambidexterity does benefit firm performance, given that it is achieved tactically. On the aggregate, my findings confirm that exploration and exploitation are in tension. Organizational features may trigger a firm's choice between exploration and exploitation in diverse directions; superior performance tends to be more dependent on effective management of the tension. In Previous research, inconsistent conclusions have been drawn regarding the antecedents of exploration and exploitation, and few studies have demonstrated how balance between exploration and exploitation alliances generates favorable outcomes. I have examined both the antecedents and consequences of this framework in the context of strategic alliances, in hope of contributing to a more coherent and complete body of work on this phenomenon.

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1. Chapter One: Introduction

1.1 Research Question

One of the major concerns of corporate strategy is making choices about investing in different types of organizational activities (He & Wong, 2004), which entail distinctive learning processes, management processes, and resource endowments. March (1991) proposed two sets of organizational behavior, exploration and exploitation, as two forms of learning activities. Organizations capable of integrating both exploration and exploitation are considered ambidextrous (Gupta, Smith, & Shalley, 2006). Accordingly, ambidextrous firms are capable of both efficiently exploiting existing competencies and skillfully exploring future opportunities without compromising each other (Raisch, Birkinshaw, Probst, & Tushman, 2009; Simsek, 2009). Since Duncan's seminal work (1976) that suggests a dual-structure design to facilitate innovation in ambidextrous organizations, increasing attention has been paid to organizational ambidexterity in the literature of strategy and organizational theory (Kauppila, 2010). The application of this framework has now been extended to many disciplines and phenomena, such as knowledge management and innovation (He & Wong, 2004; Markman, Siegel, & Wright, 2008; Tushman & O'Reilly, 1996), organizational design (Adler, Goldoftas, & Levine, 1999; Gibson & Birkinshaw, 2004; Jansen, van Den Bosch, & Volberda, 2005; Sheremata, 2000), organizational learning and adaptation (Baum, Li, & Usher, 2000; Benner & Tushman, 2003; Gupta et al., 2006), and strategic management (Jansen, George, Van Den Bosch, & Volberda, 2008; Lavie, Kang, & Rosenkopf, 2011; Lavie & Rosenkopf, 2006; Smith & Tushman, 2005). Several scholars have reviewed the development of ambidexterity research in various disciplines

(e.g., Gupta et al., 2006; Lavie et al., 2010; Raisch & Birkinshaw, 2008; Simsek, 2009). Readers can refer to those review articles for an overview on this subject. Despite the amount of research devoted to this subject, ‘organizational ambidexterity remains an under-theorized, under-conceptualized, and therefore, poorly understood phenomenon’ (Simsek, 2009: p. 598). What does organizational ambidexterity entail? Why and when do firms engage in exploration or exploitation? How does ambidexterity affect organizational outcome? There is still lack of clarity on the conceptualization, antecedents, and consequences of organizational ambidexterity. In this study, I examine organizational ambidexterity in the discipline of strategic management, in particular, strategic alliances. As an emerging area of research, alliance ambidexterity has received limited research efforts investigating its antecedents or consequences, with inconclusive and incomplete findings. Incorporating organizational learning perspective and the resource-based view, this study examines both antecedents and performance consequences of exploration and exploitation alliances, attempting to contribute to the current literature by providing a more comprehensive model of exploration and exploitation in alliances.

During the past decades, the business world has witnessed a growing population of alliances between firms (Dacin, Oliver, & Roy, 2007; Gulati, 1998). Particularly, in many high-tech industries such as computer hard- and software, electronics, and pharmaceuticals, strategic alliances have become an essential part of firm strategy (Wassmer, 2010). Strategic alliances can be viewed as a type of corporate strategic choice employed by firms in response to changes in organizational and environmental contexts (Park et al., 2002). Koza and Levin (1998) laid the ground work of distinguishing between exploration and exploitation alliances by considering whether alliance activity is motivated by the need to explore for new opportunities or to exploit

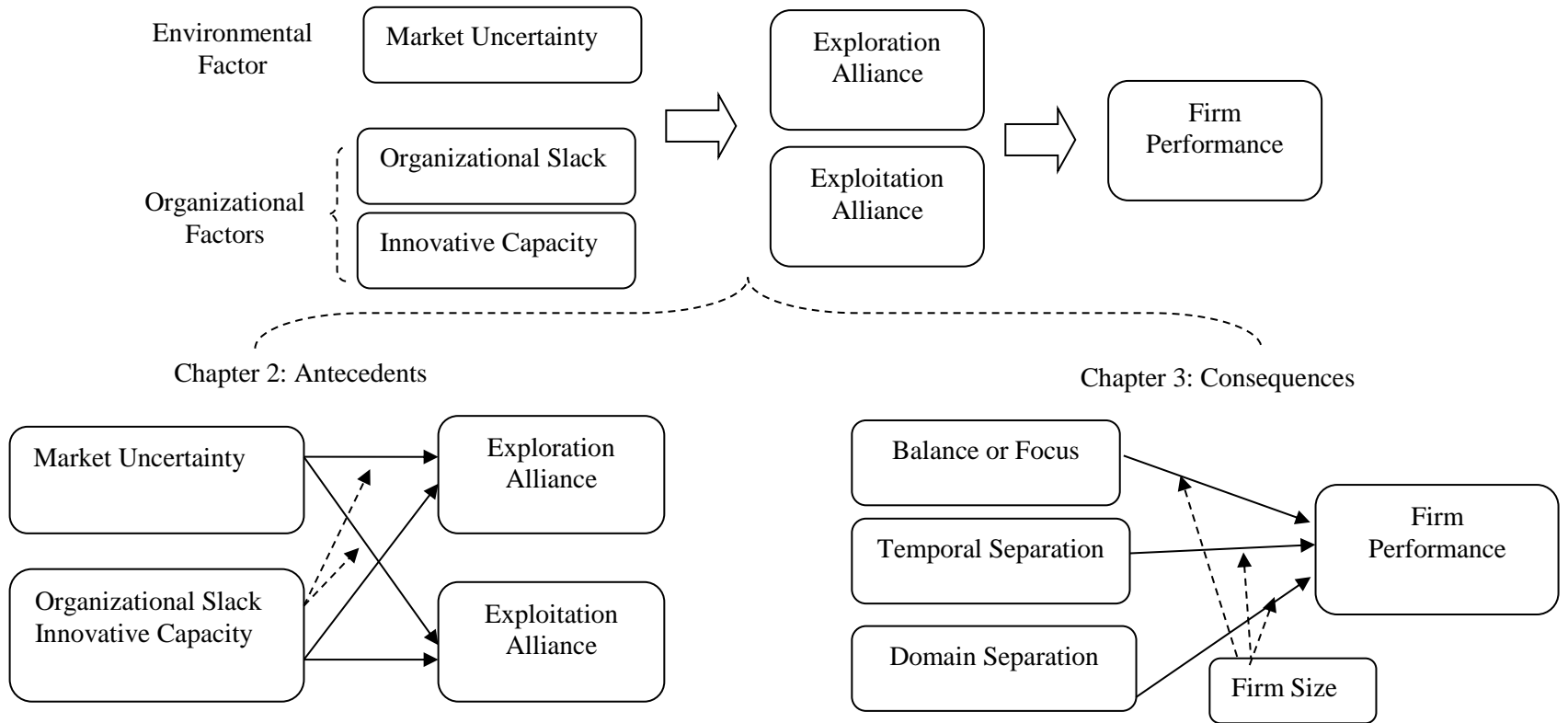
known knowledge and capabilities. The theoretical lens of exploration-exploitation has been applied in the literature of strategic alliances (e.g., Hoang & Rothaermel, 2010; Lavie & Rosenkopf, 2006; Rothaermel & Deeds, 2004; Yamakawa, Yang, & Lin, 2011), and is calling for more research attention (Lavie et al., 2010). First, there has been scant attempt to uncover why organizations pursue exploration versus exploitation alliances, among which empirical research has produced limited or mixed evidences (Danneels & Sethi, 2011; Lavie et al., 2010). Second, research on the performance implications of exploration and exploitation alliances has been sparse. In particular, the vast majority of previous research focuses on exploration versus exploitation in the domain of R&D and innovation, with few exceptions investigating other domains (Lavie et al., 2011). A more comprehensive model incorporating the antecedents and consequences of exploration versus exploitation alliances has not been attempted in previous literature. Given the gaps in current research, this dissertation aims to answer the following questions:

What are the antecedents of exploration and exploitation alliance formation? What are the performance implications of exploration and exploitation alliances within and across different domains?

Given that the framework of exploitation-exploration has been broadly applied, scholars may form distinctive interpretations of this framework while studying different contexts. It is suggested that the application and interpretation of this framework shall be treated with caution (Lavie et al., 2010). Therefore, it is important to define the context and boundary of studies on exploration and exploitation (Gupta et al., 2006). Prior research has conceptualized the twin concepts from different perspectives, including whether the alliances focus on upstream or

downstream activities along the value chain (Rothaermel & Deeds, 2004), whether the alliances involve learning from new or existing partners (Beckman, Haunschild, & Phillips, 2004), or whether the alliances entail learning from partners with various organizational attributes (Lavie & Rosenkopf, 2006). In this study, I investigate alliance ambidexterity in the setting of U.S. high-technology industries and build my arguments and analyses based on previous research with similar contexts (e.g., Hoang & Rothaermel, 2010; Rothaermel & Deeds, 2004). Following the domain approach proposed by Lavie and Rosenkopf (2006), I focus on two domains: function-based and structure-based domains. In the function-based domain, alliance activities that aim at exploring new competencies and new opportunities in the upstream of the value chain are considered as exploration alliances, whereas those formed to exploit existing competencies and to leverage known opportunities in the downstream of the value chain are referred to as exploitation alliances. In the structure domain, I focus on whether the partner is an old one or a new one in the year of alliance formation. An alliance is structure exploratory when it is a new partner that the focal firm has never formed alliances with before, and structure exploitative otherwise. Embracing the theoretical framework of exploration and exploitation (March 1991), in the following sections of this dissertation, I first present the literature review and define the assumptions and boundary of exploration and exploitation alliances, following Lavie and Rosenkopf's (2006) domain approach. Second, I investigate the antecedents of exploration and exploitation alliances by including the environmental and organizational factors to untangle the mechanisms that affect the choice of exploration and exploitation in alliance formation. Third, I examine the performance implication of balancing exploration and exploitation alliances within and across domains (See Figure 1 for the theoretical framework).

Figure 1 Theoretical Framework



1.2 Literature Review

March (1991) proposed two forms of organizational behavior, exploration and exploitation, to distinguish between two fundamentally different learning activities. Activities involving “refinement, efficiency, selection, and implementation” are associated with exploitation, whereas those including “search, variation, experimentation, and discovery” are referred to as exploration (March, 1991: p. 71). Since his foundational work, there has been a proliferation of subsequent research in different literature streams employing the framework of exploitation-exploration, and the scope of application has been greatly extended after two decades (Lavie et al., 2010; Raisch & Birkinshaw, 2008). Organizational ambidexterity has now become an emerging research paradigm in organizational theory (Raisch & Birkinshaw, 2008; Simsek, Heavey, Veiga, & Souder, 2009). Strategic alliances, as one of the contexts recently incorporating this framework, “have become a noteworthy vehicle for exploration and exploitation” (Lavie & Rosenkopf, 2006: p. 798), calling for more research attention (Lavie et al., 2010). Table 1 provides a summary of selected recent studies in this area.

Table 1 Review of Selected Studies on Exploration-Exploitation Alliances

Study	Theoretical Lens	Conceptual Handling of EX/EI Alliances	Empirical Handling of EX/EI Alliances	Focus	Method	Key Findings
Beckman et al. (2004)	Social network perspective	Structure	Counts of alliances with new/existing partners	Antecedents	3,333 alliances between 240 service and industrial firms between 1998-1992	Firms reinforce its alliance network through past partners under market uncertainty
Hoang & Rothaermel (2010)	Organizational learning	Function	Percentage of upstream/downstream alliances of the value chain	Consequences	412 R&D projects in biotechnology conducted by large pharmaceutical companies between 1980 and 2000	Alliance exploitation experience has positive effects on R&D project performance, while alliance exploration experience has negative effects
Kauppila (2010)	Ambidextrous context Structural separation	Function	Examples of alliance activities in upstream/downstream of the value chain	Consequences	In-depth field investigation of a medium-sized firm in Finland	Ambidextrous organizational context enables a firm to reap the benefits of exploration and exploitation partnerships
Lavie et al. (2011)	Organizational learning Tension view	Function Structure	Percentage of exploration/exploitation alliances in each domain	Consequences	2,587 firm-year observations of US-based firms in the software-industry from 1990-2002	Balance within domains is disadvantageous. Balance across domains increases performance. Increase in firm size reinforces both relationships.
Lavie and Rosenkopf (2006)	Absorptive capacity Organizational inertia	Function Structure Attribute	Percentage of exploration/exploitation alliances in each domain	Antecedents	19,928 alliances formed by U.S. software firms from 1990 to 2001	Path dependency reinforces exploration/exploitation in each domain; firms balance them over time and across domains.
Li et al. (2008)	Organizational learning TCE	Structure	Counts of alliances with new/existing partners	Antecedents	1,159 R&D alliances between high-tech firms during 1994-2003	Firms prefer 'friend' partners when alliances' innovation goals are radical

Lin et al. (2007)	RDT Social network perspective	Structure	Alliance ambidexterity as a categorical variable based on the exploration index	Consequences	282 alliances formed by 95 U.S. firms from 1988 to 1995; Simulation model	Alliance ambidexterity benefits large firms and in uncertain environment, focused strategy benefits small firms and in stable environment.
Park et al. (2002)	RDT Strategic behavior view RBV	Function	Counts of upstream/downstream alliances of the value chain	Antecedents	171 U.S. semiconductor start-ups; 471 alliances between 1979 and 1989	Resource-rich firms are more likely to form alliances in volatile markets; resource-poor firms become more active in stable markets.
Rothaermel & Deeds (2004)	Organizational learning RBV	Function	Counts of upstream/downstream alliances of the value chain	Antecedents & Consequences	2565 alliances formed by 325 biotechnology firms between 1973 and 1997.	An integrated product development path from exploration alliances to products in development, to exploitation alliances, to products on the market.
Yamakawa et al. (2011)	RBV Relational perspective	Function Structure	Exploration alliance ratio	Consequences	95 firms from five industries over eight years (1988 – 1995)	The analyses reveal the importance of organizational, strategic, and environmental fit in relation to a firm's alliance portfolio and its performance consequences.
Yang et al. (2014)	Alliance benefits & risks	Function	Counts of upstream/downstream alliances of the value chain	Consequences	753 firm-year observations of alliances between small U.S. biotech firms and large pharmaceutical firms from 1984 to 2006	Exploitation alliances with large firms generate higher values for small firms than exploration alliances with large firms due to a heightened risk of appropriation in exploration alliances.

1.2.1 Organizational Exploration and Exploitation: Conceptualization

In their review article, Gupta et al. (2006) discussed four related questions of the interplay between exploration and exploitation, starting from the clarity of their definitions. They presented two streams of definitions in previous literature regarding how to distinguish between exploration and exploitation: one stream of research focuses on the differences in the type of learning, the other on the presence versus the absence of learning. They argued that the logic of original work by March (1991) leads to the former approach of definition. All activities, be it exploration or exploitation, include at least some degree of learning. Even when it engages in replication of past actions, an organization experiences a certain level of learning accumulation, although in an incremental manner (Gupta et al., 2006). Accordingly, it is more logical to consider the type or amount of learning to differentiate between exploration and exploitation, which is the logic employed in this study. Learning in exploitation activities is generally incremental and improvement-oriented, whereas learning in exploration activities is typically radical and experiment-oriented. Built upon this fundamental definition of exploitation and exploration, recent studies have applied this theoretical lens to various contexts and examined exploitation and exploration in vastly diversified subjects, including (but not limited to) known and new versus internal and external knowledge/ technology applications (Fang et al., 2010; Hoang & Rothaermel, 2010; Im & Rai, 2008; Rothaermel & Alexandre, 2009; Wagner, 2011; Zhou & Wu, 2010), product development to cater existing or new customers/markets (Jansen et al., 2012; Piao, 2010), alignment and adaptability of organizational management systems (Gibson & Birkinshaw, 2004), new product development and design (Andriopoulos & Lewis, 2009; Boumgarden et al., 2012; Cao et al., 2009; Danneels & Sethi, 2011; Voss, Sirdeshmukh, &

Voss, 2008), exploitation or exploration orientation in organizational activities (Uotila, Maula, Keil, & Zahra, 2009), and exploitation alliances versus exploration alliances (Beckman et al., 2004; Kauppila, 2010; Lavie et al., 2011; Lavie & Rosenkopf, 2006; Lin, Yang, & Demirkan, 2007; Rothaermel & Deeds, 2004; Yamakawa et al., 2011). The specific activity examined in each study is recognized as the application of this lens in a particular context. Various approaches in both technical and social contexts have been adopted to distinguish between exploitation and exploration (Rosenkopf & McGrath, 2011). Given such a wide span of application, empirical findings in prior research have been inconclusive and sometimes even inconsistent. The objective of this study is not to reconcile the contradictory findings of exploration-exploitation research across all fields, if possible. Instead, it is argued that context-specific characteristics play an important role in shaping the mechanisms of exploitation and exploration (Gupta et al., 2006). Thus it is of importance to clearly lay out the setting of research, before digging into further details.

The research setting of this study is exploration and exploitation alliances in high-technology industries. Previous research studying exploitation and exploration alliances has taken different approaches. Koza and Lewin (1998) are among the first to theorize exploitation and exploration alliances. They integrated March's framework in this context and conceptually discussed the distinctive features of exploitation and exploration alliances. According to them, firms may form alliances to exploit an existing capability or to explore new opportunities. As such, the value chain function of the alliances (e.g., leveraging existing capability or developing new opportunities) serves as the key to distinguish them. As mentioned before, exploration and exploitation differ in the type or amount of knowledge entailed. In the inter-organizational

context, firms that engage partners in upstream activities such as R&D are likely to develop new knowledge which eventually leads to innovative technologies; in contrast, firms that establish alliances engaging in downstream activities such as commercialization and marketing tend to leverage and combine partners' existing knowledge and capabilities (Lavie & Rosenkopf, 2006; Rothaermel 2001). As such, "the distinction between acquiring and generating new knowledge through exploration and accessing, integrating, and implementing existing knowledge through exploitation has been linked to firms' polar tendencies to engage in R&D alliances [upstream] versus marketing alliances [downstream]" (Lavie & Rosenkopf, 2006: p. 799). Specifically, if an alliance involves a new knowledge-generating agreement such as R&D, technology co-development, or new product co-development, it is considered an exploration alliance; if an alliance involves an agreement based on combining and integrating existing knowledge, such as product testing, clinical trials, joint marketing, original equipment manufacturer, or licensing, it is viewed as an exploitation alliance (Ranganathan & Rosenkopf, 2014). It is important to note that, although there is likely to be a certain degree of overlap between these two kinds of alliances, a distinction is whether developing exploratory new knowledge and relatively uncertain technology is the focus of alliances. Especially in high-technology industries, alliances driven by commercialization needs (e.g., product marketing) involves, for instance, the technology venture's exploiting its current technologies and the partner's leveraging its existing marketing capabilities. Whereas in exploration alliances such as R&D ones, firms undertake exploratory search in an attempt to discover new knowledge/technology. There is likely to be new knowledge generated in the former type of alliances; however, the pattern of knowledge flows underlying firms' knowledge bases in the latter type of alliances is generally more

exploratory (Ranganathan & Rosenkopf, 2014). A dichotomy of exploration and exploitation alliances based on the value chain function has been prevalently and overwhelmingly adopted in subsequent empirical research (Hoang & Rothaermel, 2010; Kauppila, 2010; Lavie et al., 2011; Lavie & Rosenkopf, 2006; Park et al., 2002; Rothaermel & Deeds, 2004; Yamakawa et al., 2011; Yang et al. 2014). For example, as presented in Table 1, Rothaermel and Deeds (2004) examined the biotechnology industry and classified alliances that engage in the upstream activities of the value chain as exploration alliances, whereas alliances that focus on the downstream activities of the value chain as exploitation alliances. Kauppila (2010) conducted an in-depth field investigation and coded alliance activities in upstream or downstream of the value chain as exploration or exploitation partnerships. Ranganathan and Rosenkopf (2014) examined the voting behavior of technological standards in computer industry and considered knowledge network of R&D alliances exploratory and commercialization network of alliances focusing on downstream activities exploitative. In the same vein, Park et al. (2002) studied the semiconductor industry and divided alliances into exploration and exploitation ones based on the upstream activities (e.g., joint R&D) and downstream activities (e.g., manufacturing, marketing, and technology-licensing) of the value chain. Current literature examining the function of alliances in technical context tends to exhibit convergence on this line of conceptualizing and operationalizing exploration and exploitation alliances.

Meanwhile, another stream of research in strategic alliances has been studying the social characteristics of alliance partners (e.g., Beckman et al., 2004; Li, Eden, Hitt, & Ireland, 2008). A number of studies have been devoted to investigating alliance partner choices, with a small portion adopting the exploitation-exploration framework. In the form of social context, the

relationships themselves are considered as learning activities (Kogut and Zander 1992) to distinguish between exploration and exploitation alliances which are evaluated with respect to the pre-existing partnerships. Beckman et al. (2004), for instance, regard forming alliances with new partners as a form of exploration, whereas entering alliances with existing partners as a form of exploitation. As shown in Table 1, several studies have employed this structure domain to study exploration and exploitation alliances (e.g., Beckman et al., 2004; Lavie et al., 2011; Lavie & Rosenkopf, 2006; Li, Eden, Hitt, & Ireland, 2008; Lin et al. 2007; Yamakawa et al., 2011). It is considered that firms have developed routines of governance and have been exposed to each other's knowledge when working with repeat partners. In this regard, they experience less novelty. In contrast, collaborating with new partners entails a high level of novelty of all relevant issues (Rosenkopf & McGrath, 2011). Firms may expand their knowledge and access to resources through new alliance partners as a form of exploration, and extend their current knowledge base with existing alliance partners as a form of exploitation (Beckman et al. 2004). Forming exploration alliances by searching for partners beyond a firm's local network can potentially broaden its reach and seek new knowledge, offering new opportunities with a certain level of uncertainty and risk; in contrast, when firms form recurrent alliances with existing partners, prior experience and inter-firm trust facilitate the exploitation of current knowledge base and enhance the predictability and reliability of collaboration (Lavie & Rosenkopf, 2006). As such, March's (1991) notion of exploration-exploitation corresponds to the structure dimension of alliance formation, which is conceptually different from the function dimension of exploration-exploitation alliances discussed above. Given the conceptualization multiplicity of the exploitation-exploration construct in strategic alliances which may lead to mixed empirical

evidences and interpretations, Lavie et al. (2006) proposed a domain approach by identifying three domains of exploration-exploitation in alliance formation: the function domain which focuses on the value chain function of the alliance, the structure domain which looks at whether the alliance partner is a new partner or a recurrent one, and the attribute domain which pertains to the variance in organizational attributes of a firm's partners. Indeed, current research of exploitation-exploration in alliance formation have studied one of the domains separately, but rarely examined them simultaneously. It is of importance to bear in mind the examined domain of each study when interpreting its findings on the one hand, and to conduct more research examining multiple domains for further understanding of this phenomenon on the other hand.

In addition to the different views in conceptualization and operationalization of the constructs per se, a variety of perspectives have been employed by scholars to address the balance and dynamics between exploration and exploitation (Rosenkopf & McGrath, 2011). Although March (1991) emphasized the necessity of a balance between exploration and exploitation for long-run adaptation, theorization of such a balance varies across different studies. One typical debate is whether exploration and exploitation shall be regarded as competing behaviors at two ends of a continuum or shall be interpreted as orthogonal dimensions (Gupta et al., 2006; Rosenkopf & McGrath, 2011). Scholars who theorize exploitation and exploration as opposing ends of a continuum basically acknowledge the fundamental conflict and incompatibility between the two behaviors. As argued by March (1991), exploitation and exploration are at odds because they compete for scarce resources, tend to be self-reinforcing and to drive each other out, and entail conflicting routines to carry out. In this regard, balancing between exploitation and exploration translates into effective management of the conflicts and

tension between the two activities. Many previous studies explicitly or implicitly assume this line of logic to build the arguments. For example, Uotila et al. (2009) grounded their argument on March's assumption and viewed exploitation and exploration as a continuous spectrum. They employed a quite unique approach by analyzing the news documents of 279 manufacturing firms between 1989 and 2004 to derive their exploitation versus exploration orientation. The authors posited that a balance between exploitation and exploration involves trade-offs between them and firms are pressured to take such trade-offs into account. In a similar vein, Lavie et al. (2011) examined exploitation and exploration alliances in multiple domains and theorized that within each domain, exploitation and exploration alliances "are often at odds, requiring firms to manage trade-offs when pursuing these activities simultaneously" (p.1520). They proposed that firm performance will be negatively related to a balance between exploration and exploitation of alliance formation decisions within domains. In contrast, other scholars take a different approach and consider exploitation and exploration as orthogonal dimensions which could positively interact with each other (e.g., Katila & Ahuja, 2002). In this sense, organizational ambidexterity does not necessarily mandate a trade-off but rather could be achieved by organizations simultaneously and successfully (Rosenkopf & McGrath, 2011). Scholars adopting the orthogonality perspective put emphasis on the synergy of exploration and exploitation as well as the potential for mutual reinforcement between the two activities. Cao et al. (2009), for instance, argue that firms should not only balance exploitation and exploration by simultaneously pursuing both activities, they should also parallel such a balance with a high level of combined magnitude of exploitation and exploration in order to generate synergistic benefits. Similarly, in their study examining the structure-based domain of exploitation and exploration alliance formation, Lin et

al. (2007) argued for a positive impact of an ambidextrous formation of both types of alliances, which is akin to acknowledging the orthogonal nature of exploitation and exploration.

At first sight, continuity or orthogonality may pose as competing views. Indeed, it has been acknowledged that March's assumption of fundamental incompatibility between exploitation and exploration is difficult to dispute and many empirical evidences have lent support to his logic. However, Gupta et al. (2006) suggested that context plays an important role in the resolution. As a matter of fact, empirical studies supporting either continuity or orthogonality are generally contingent upon certain conditions, which include, for example, resource scarcity manifested by firm size (Lavie et al., 2011; Lin et al., 2007) or organizational slack (Voss et al., 2008), organizational capability to create ambidextrous context (Gibson & Birkinshaw, 2004; Hoang & Rothaermel, 2010), and the domain setting examined. It is acknowledgeable that under different contextual conditions, the tensions and trade-offs between exploitation and exploration may be relaxed or circumvented. When resources are scarce, organizational capability is limited in managing ambidexterity, or the unit of analysis is treated as a single domain setting, exploitation and exploration are generally mutually exclusive and compete against each other. To the contrary, in organizations that have munificent resources, possess the capacity of managing ambidexterity, or encompass multiple loosely coupled domains, exploitation and exploration could be orthogonal and coexist in high levels (Rosenkopf & McGrath, 2011). In addition to the contextual conditions, I argue that static versus dynamic perspectives on ambidexterity also account for the dynamism between exploitation and exploration (Raisch et al., 2009). A static or dynamic perspective may allow different observations of the interaction between the two activities. In particular, a dynamic perspective

could uncover more orthogonal nature of exploitation and exploration, and potentially provide scholars a window to investigate the synergy between the two. Several recent empirical studies have taken such a perspective and advocated their complementarity as well as synergistic fusion. Piao (2010) analyzed the hard disk drive industry from 1980 to 1999 and suggested that a moderate level of temporal overlap between an exploration process and an exploitation process facilitates a firm's longevity. He posited that exploitation and exploration are two interdependent and complementary processes: exploration may depend on exploitation for resource supply, whereas exploitation may rely on exploration for sources of exploitation. A temporal approach could demonstrate the alignment of exploitation and exploration. Boumgarden et al. (2012) examined two canonical cases and found that compared to a static balance in lower levels of exploitation and exploration, a dynamic approach of organizational vacillation help create higher levels of both exploration and exploitation, thus higher performance. Whether a static or a dynamic approach is employed to examine organizational ambidexterity may reveal different aspects of the dynamism between the two activities. Overall, I posit that the fundamental tension and trade-off do exist between exploitation and exploration. Meanwhile, there is also a dimension for complementarity and synergy. The contextual conditions and research approach employed in each study could influence the corresponding findings. An integration of both the tension view and the complementarity perspective would enrich our understanding.

1.2.2 Antecedents of Exploration and Exploitation

As discussed above, both inherent tension and potential synergy reside in the relationship between exploitation and exploration. Given such complexity, it is still unclear that what factors

trigger these contradictory yet possibly complementary activities (Lavie et al., 2010). There have been limited research endeavors devoted to uncover why some organizations pursue exploration while others favor exploitation. Among these endeavors, previous studies have mainly focused on two categories of antecedents: environmental factors (e.g., environmental uncertainty, exogenous shocks, and competitive intensity) and organizational characteristics (e.g., organization size, slack resources, absorptive capacity). An organization's tendency to explore versus exploit could be affected by a variety of factors. However, empirical evidences to date have produced limited and mixed results regarding the causes of exploration and exploitation. There hasn't been any consensus reached yet.

Environmental approaches of exploitation versus exploration alliance formation

Organization theory and industrial economics literature have suggested the role of external environmental forces in affecting a firm's search strategy (e.g., Hannan & Freeman, 1984; Porter, 1981). The sociological perspective also examines a diffuse set of social, political and cultural pressures in studying organizations (Fligstein & Freeland, 1995). Lavie et al. (2010) provide an overview of environmental antecedents of exploitation and exploration. They discussed that previous studies have paid attention to examine several aspects of environmental factors including environmental dynamism, exogenous shocks, competitive intensity, and appropriability regime. Systematic differences across industries, such as environmental dynamism and exogenous shocks, tend to affect a firm's strategic choice toward exploration or exploitation (Lavie et al., 2010; Wang & Li, 2008). For example, unpredictable change of market demand often renders existing products and services obsolete (Jansen, Van den Bosch, & Volberda, 2006; Lavie et al., 2010). Institutional pressures such as the change of regulation could

also influence a firm's tendencies of exploration and exploitation (DiMaggio & Powell, 1983). Firms need to explore new opportunities in order to keep updated and adapted with the changing environment (Teece, Pisano, & Shuen, 1997; Wang & Li, 2008). Some scholars have treated environmental dynamism as an effect moderating the impact of other factors. Danneels and Sethi (2011) analyzed data from 145 U.S. public manufacturing firms and examined how the turbulence of the customer, competitive and technological environments in those industries affects organizational propensity to explore. They found that a firm's tendency to explore new products driven by organizational factors is contingent on the turbulence in different sectors of its environment. Voss et al. (2008) looked into 214 non-profit professional theaters and suggested that when perceived environmental threat is high, organizations tend to shift to higher levels of exploration and lower levels of exploitation. The type of environmental factors, the operationalization of these constructs, and the contexts examined in previous research vary across different studies. Lavie et al (2010) concluded that very few factors have been shown to empirically produce consistent effects on driving organization's inclination to explore versus exploit. As such, it is suggested that we need to be cautious about generalizing the interpretation of prior empirical evidences.

This study pays particular attention to the antecedents of exploration and exploitation alliances. Despite the increasing amount of research on organizations' exploration and exploitation propensity, there has been little attempt to uncover what triggers organizations' tendency to explore versus exploit in the practices of alliance formation (Danneels & Sethi, 2011; Lavie et al., 2010). Table 1 presents representative studies examining the antecedents of exploration and exploitation alliances. Few studies have investigated the role of environmental

turbulence as an antecedent of exploration versus exploitation alliance formation (Kim & Rhee, 2009). Existing empirical research analyzing environmental forces that drive exploration versus exploitation in the context of strategic alliances has generated divergent evidences. Theoretical argumentation regarding the impact of environmental forces on exploration versus exploitation generally advocates that turbulent and dynamic environment requires organizations to explore whereas stable and unfluctuating environment nurtures exploitation (e.g., Jansen et al., 2006; Sidhu, Volberda, & Commandeur, 2004). However, research in the context of strategic alliances tends to suggest the impact of environmental forces in the other direction. Beckman and her colleagues (2004), for instance, studied both interlock and alliance networks of 300 largest U.S. firms during the 1988-1993 period and found that the higher the level of market uncertainty, the more likely a firm is to reinforce its networks through establishing more exploitation alliances in order to manage exogenous uncertainty. Li et al. (2008) argued that in a turbulent technological environment, firms tend to prefer forming alliances with ‘friends’ they trust, essentially, in order to rely on the exploitation of existing alliance partnerships. In this regard, both studies tend to converge on the opinion that organizations tend to favor exploitation alliances in uncertain environments.

The interesting yet inconsistent insights offered by previous studies could be attributed to the variety in conceptualizations of the exploration-exploitation constructs. Studies examining exploration-exploitation have dramatically different focuses. For example, Jansen et al. (2006) looked at exploratory and exploitative innovations and found that firms tended to pursue exploratory innovation in dynamic environment. Sidhu et al. (2004) focused on the dimension of information acquisition to distinguish between exploration and exploitation and suggested that

environmental dynamism lead to information exploration. These studies generally suggest that dynamic environment leads to the pursuit of exploration, however, within organizational boundary. Beckman et al. (2004), however, focused on the structure-based domain of alliance formation and defined forming alliances with similar and familiar partners as exploitation alliances whereas forming alliances with new partners was considered as exploration alliance. They reported that organizations might form exploitation alliances to reduce market uncertainty. Similarly, Li et al. (2008) examined alliance partner selection by categorizing the partners into friends, acquaintances, and strangers. The findings suggest that uncertain environment stimulates exploitation. However, these studies focus on the boundary-spanning mechanisms of alliances and consider recurrent partnerships as exploitation. It does not exclude the possibility that firms engage in recurrent partnerships to explore new technology or products, neither does it exclude the possibility of these firms' endeavors of pursuing internal exploration. The variety of conceptualizations has yielded distinctive prescriptions which may not be mutually exclusive to each other, on which we should cautiously draw conclusion. It is therefore suggested that we tailor the conceptualization and argument to the specific phenomenon so that valuable analogies can be drawn between similar phenomena (Lavie et al., 2010).

Organizational approaches of alliance formation

Scholars have pointed out that, besides environmental conditions as external stimuli, internal organizational features play a role in influencing firms' decisions of exploration and exploitation (Lavie & Rosenkopf, 2006). According to previous research, organizational antecedents differentially influence organizations' exploration and exploitation activities (Jansen et al., 2006; Wang & Li, 2008). Organizational characteristics, routines, and capabilities differ

from one organization to another, as they evolve along their own idiosyncratic trajectories (Dierickx & Cool, 1989; Wang & Li, 2008). Due to such path-dependency, organizations develop distinct routines and knowledge bases which affect their ability to process information and to understand the signals about the opportunities available in the environment, leading to various strategic responses (Wang & Li, 2008). Therefore, internal organizational features are argued to substantially influence a firm's strategic actions.

However, there has been little systematic evidence on whether certain organizational features lead to exploratory or exploitative search so far (Jansen et al., 2006). For instance, studies examining organizational slack have generated mixed results (Lavie et al., 2010). Some scholars suggest that slack resource facilitates risk taking and innovation because it allows firms to engage in activities such as search and experimentation by cushioning environmental fluctuations and downside risks (Greve, 2007; Lavie et al., 2010). Exploratory activities are thus encouraged. Other scholars, in contrast, argue that slack resource discourages organizations from exploration because firms may rely on consuming current slack resources to sustain their performance objectives rather than continuously look for new opportunities (Lavie et al., 2010). Curvilinear effect is also suggested in the literature as a reconciliation of the opposing views (Nohria & Gulati, 1996). Some scholars further decompose slack resources into multiple dimensions and posit that different types of slack resources may have distinctive impact on organizations' exploitation versus exploration choices. Voss et al. (2008) look at how slack resources interact with environmental threat appraisal to influence product exploration and exploitation. The authors argue that slack resources should be further investigated based on the dimensions of rarity and absorption. Accordingly, they categorize slack resources into financial

slack, operational slack, customer relational slack, and human resource slack. Based on a survey of non-profit professional theaters in the U.S., this article finds that the choice of product exploration versus exploitation depends on the extent to which a resource is rare and absorbed in operations, and the extent of perceived environmental threats. In particular, absorbed, generic resources are associated with increased exploitation and decreased exploration. Unabsorbed resources result in higher exploration and lower exploitation when perceived environmental threat is high. The authors suggested that firms make pragmatic decisions to ‘balance the benefits of superior strategic position against the risks of jeopardizing viability’ (p. 147).

Inconsistent results are also found when scholars examine the impact of organizational factors on choices between exploration versus exploitation in alliance formation (Lavie et al., 2010). A variety of organizational factors have been investigated in previous research in attempt to uncover their impact on exploitation-exploration orientation, including firm size (Beckman et al., 2004; Rothaermel & Deeds, 2004), firm-specific uncertainty (Beckman et al., 2004), dyad-specific factors such as technological relatedness, technological capability, and radicalness of alliance’s innovation goals (Bierly, Damanpour, & Santoro, 2009; Li et al., 2008), as well as the interaction between exploitation and exploration alliances themselves (Lavie & Rosenkopf, 2006; Rothaermel & Deeds, 2004). For example, diverging results have been suggested regarding the influence of firm size on its propensity to explore versus exploit in alliance formation. The tendency to engage in exploitation alliances was found to increase as firm size increases because of increased organizational inertia and path-dependency (Rothaermel & Deeds, 2004). To the contrary, larger firms are argued to form more exploration alliances due to their better access to internal resources (Beckman et al., 2004). Other studies, however, did not

find significant association between size and exploration alliances (Lavie & Rosenkopf, 2006; Sidhu et al., 2004). It is worth noting that these studies tend to focus on different domains of alliance formation. Beckman et al. (2004) looked at the structure-based domain and distinguished exploration from exploitation by new versus prior partners, whereas Rothaermel and Deeds (2004) considered an alliance exploratory or exploitative by looking at whether it was formed for R&D or commercialization purposes. Lavie et al. (2006), nevertheless, encompass multiple domains together in their research.

Another factor, technological capacity is examined in both internal and external exploitation and exploration, although not in the context of exploration and exploitation alliances. Zhou and Wu (2010) examine the role of technological capability in product innovation based on absorptive capacity perspective and organizational inertia theory. By testing the hypotheses on 192 firms from high-tech industries in China, the authors found that technological capability fosters internal exploitation at an accelerating rate and has an inverted U-shaped relationship with exploration. Besides, greater technological capability is associated with more exploration innovation when strategic flexibility is high. In contrast, Bierly et al. (2009) examined the collaboration between firms and university research centres and looked at how firms applied external knowledge in product exploitation versus exploration. Their findings suggested that high level of technological capability tends to benefit both product exploitation and exploration when the knowledge transferred is tacit.

A limited amount of studies have shed light on the dynamics between exploitation and exploration alliances to untangle the interaction between these two activities. Rothaermel and Deeds (2004) studied 325 biotechnology firms over a 25-year period to examine the causal

relationship between strategic alliances and new product development. They suggested an integrated product development path where exploration alliances generate more products in development, and in turn lead to more exploitation alliances in order to push them towards markets. Rooted in the literature of absorptive capacity and organizational inertia, the work of Lavie et al. (2006) investigated alliances formed by U.S. software firms spanning the years 1990 to 2001. They found that due to path dependence, prior experience in exploration/exploitation alliances tends to reinforce the tendency to explore/exploit within the function, structure and attribute domains, but firms tend to balance exploitation and exploration alliances within domains over time. Regarding the dynamics of exploitation and exploration alliances across domains, their findings indicated that the tendency to explore/exploit in one domain is compensated by the tendency to exploit/explore in other domains, and firms tend to strive for such a balance over time. The abovementioned studies suggest that, in addition to organizational features, other internal factors such as the interactive dynamism between exploitation and exploration could also be valuable predictors.

Overall, despite the lack of consistent and systematic findings in the realm of exploitation and exploration, current research has spawned an increasing interest in revealing what triggers exploitation and exploration alliance formation decisions. Given the mixed results and divergent prescriptions, it is worthwhile to further investigate the role of organizational antecedents in firms' propensity of engaging in exploration and exploitation alliances.

1.2.3 Performance Implications of Exploration and Exploitation

Early research in strategy and organization has suggested that the exploitation-exploration paradox demands organizations pursue one of the activities separately (Kauppila, 2010). Ebben and Johnson (2005), for example, proposed that small firms that pursue either efficiency strategies or flexibility strategies outperform those that attempt to pursue both. Giarratana and Fosfuri (2007) also found that firms in the U.S. security software industry tend to be more likely to survive if they focus on either versioning strategy or portfolio broadening strategy, as opposed to adopting a mixed strategy. Although the efficiency versus flexibility strategies or versioning versus portfolio broadening strategies examined in these studies do not explicitly map the exploitation-exploration paradox, the notion is akin to such a framework. The focus view resonates with contingency theory which advocates that organizations should achieve a fit between their environment, structure, strategy and processes (Burns & Stalker, 1961; Lawrence & Lorsch, 1967). However, recent research aiming to address the trade-off between exploration and exploitation has suggested that focusing on one type of activities tends to result in overemphasis on one at the expense of the other (Fang et al., 2010). For example, organizations focusing on mere exploitation may enjoy immediate and certain returns from exploitation, but could become trapped in suboptimal solutions and poorly equipped to adapt to a changing environment due to lack of exploration (Denrell & March, 2011). Furthermore, a growing body of ambidexterity literature indicates that joint pursuit of exploitation and exploration can yield positive outcomes coupled with effective organizational arrangements. Firms are argued to perform better with an ambidexterity of exploitation and exploration (Lavie, Stettner, & Tushman, 2010; Raisch & Birkinshaw, 2008). For example, Gibson and Birkinshaw

(2004) were among the first to empirically support the positive influence of ambidexterity on a unit's performance by leveraging innovation and flexibility as well as accumulated experience and efficiency simultaneously. As Levinthal and March (1993: 105) have argued, 'the basic problem confronting an organization is to engage in sufficient exploitation to ensure its current viability and, at the same time, devote enough energy to exploration to ensure future viability.' Organizational scholars have sided with this logic advocating that exploration and exploitation complement each other in delivering high levels of organizational performance (Boumgarden et al., 2012; O'Reilly & Tushman, 2008). When he proposed the twin concepts, March (1991: 71) posited that "maintaining an appropriate balance between exploration and exploitation is a primary factor in system survival and prosperity". However, he also argued that there is strategic contradiction between exploration and exploitation; they are self-reinforcing and tend to crowd each other out. Inherent challenges arise when organizations attempt to balance exploitation and exploration because the two behaviors entail distinctive (even conflicting) organizational design elements regarding structure, incentives, and culture (Boumgarden et al., 2012). Such challenges could generate negative externalities and undermine organizational capacity to deliver the desired performance. Effectively addressing these challenges is essential to achieving high organizational performance. As Gupta et al. (2006: p.697) note, 'although near consensus exists on the need for balance [between exploration and exploitation], there is considerably less clarity on how this balance can be achieved'. To address this gap, existing literature has devoted much attention to how organizations could stay ambidextrous, i.e., engaging in high levels of both exploration activity and exploitation activity. To date, multiple resolutions have been offered in

current literature, including structural, temporal, contextual, leadership-based, and domain-based approaches.

The structural separation approach argues for the simultaneous pursuit of exploration and exploitation by different organizational units in order to avoid the trade-off and conflicts between these two types of activities (Benner & Tushman, 2003; Gupta et al., 2006). Duncan's (1976) seminal work first proposed a dual-structure design for facilitating innovation in ambidextrous organizations. The underlying assumption is that individuals with operational responsibilities and bounded rationality are not capable of exploiting and exploring simultaneously. Structural autonomy of units allows independence of conflicting routines, structures and culture between the exploitation and exploration units. Recent research has shed light on the mechanism of organization structure as an approach to manage the balance between exploration and exploitation (e.g., Nickerson & Zenger, 2002; O'Reilly & Tushman, 2004; Siggelkow & Levinthal, 2003). For example, O'Reilly and Tushman (2004) suggested that an "ambidextrous" structure with isolated divisions of the firm utilizing different routines, norms, and incentives would facilitate both exploration of new product lines and exploitation of existing product lines. Using an agent-based simulation model, Siggelkow and Levinthal (2003) showed that the optimal organizational structure to moderate the balance of exploration and exploitation is a temporarily decentralized structure which starts with a decentralized structure and later reintegrate to a centralized one. In contrast, Jansen, Simsek and Cao (2012) examined the relationship between unit-level ambidexterity and performance. The authors argued that organizational contingencies, i.e., structural and resource attributes significantly shape this relationship. Based on survey data from 285 organizational units in the commercial banking

industry, they found that the relationship between unit ambidexterity and performance is boosted when the organization is decentralized, more resource munificent, or less interdependent. Fang et al. (2010) also argued that organizations can balance exploration and exploitation by dividing into semi-isolated subgroups. Based on simulation models, they found that a moderate level of cross-group linking leads to the highest equilibrium performance. A semi-isolated subgroup structure allows the diffuse of superior ideas across groups without reducing organizational diversity too quickly. Through an in-depth field study of a medium-sized firm, Kauppila (2010) investigated how the firm manages ambidexterity by employing its inter-organizational exploration and exploitation partnerships. He found that, on the one hand, separation between exploitation and exploration is needed to conduct radical exploration and exploitation, and inter-organizational partnerships are a fitting instrument for this. On the other hand, firms need to balance exploitation and exploration internally. It is argued that there has been limited amount of large-sample archival research to provide empirical evidence for structural separation approach. In addition, current literature tends to demonstrate how firms can improve exploration processes as opposed to how firms can better manage a balance between exploitation and exploration (Fang et al., 2010).

The temporal separation approach, sometimes referred to ‘organizational vacillation’ (Boumgarden et al., 2012) or ‘organizational oscillation’ (Gibson & Birkinshaw, 2004), proposes that organizations can achieve ambidexterity by focusing on exploration at one point of time and exploitation at another (Brown & Eisenhardt, 1997) due to bounded rationality and sequential attention to divergent goals (Cyert & March, 1963). This approach emphasizes a dynamic alternative to achieve high levels of both exploration and exploitation by temporally and

sequentially modulating between the two activities. By doing so, organizations may be able to reach higher levels of both activities than that could be achieved by an approach merely based on a static design choice. Scholars advocating this approach argue that in the long run, organizational performance is derived from the existence of high levels of exploitation and exploration, rather than their degree of balance or simultaneity (Boumgarden et al., 2012). However, empirical research in this direction is rather limited (Piao, 2010). Enlightened by the organizational change literature (Brown & Eisenhardt, 1997; Gersick, 1994), a few studies included time dimension in examining how firms can temporally separate exploitation and exploration into different time horizons. Boumgarden et al. (2012) studied two approaches for achieving high levels of exploration and exploitation: organizational ambidexterity and organizational vacillation. They defined organizational ambidexterity strictly as simultaneous pursuit of exploitation and exploration. Based on the analysis of two canonical cases, this paper suggests that vacillation may offer higher long run performance than ambidexterity, while ambidexterity enhances performance on the margin when utilized within larger epochs of vacillation. Ambidexterity and vacillation are complementary with respect to performance, although through different mechanisms. Piao (2010) studied the temporal balance of exploration and exploitation. An analysis of 1980-1999 data from the hard disk drive industry suggested that exploitation to the exclusion of exploration generally undermines firms' long-term viability. Besides, if the temporal overlap between exploitation and exploration processes is too long or too short, a firm tends to lose its longevity; however, if it remains at a moderate level, a firm can extend its longevity. The examination of temporal separation is theoretically and

methodologically challenging. Scholars have called for more work on the investigation of the longevity implication of exploitation-exploration balance in specific temporal contexts.

The above two approaches essentially advocate a 'separation' of exploitation and exploration, be it spatial or temporal. In contrast, contextual ambidexterity emphasizes a contextual configuration of both exploitation and exploration (Andriopoulos & Lewis, 2009; Gibson & Birkinshaw, 2004). Instead of focusing on the structure of the organization, Gibson and Birkinshaw (2004) suggested that ambidexterity should be present in the mindset of each individual within an organization. They assert that contextual ambidexterity is achieved 'by building a set of processes or systems that enable and encourage individuals to make their own judgements about how to divide their time between conflicting demands for alignment and adaptability' (p. 210). Given that not all organizations have the resources to support separate structures for exploitation and exploration, building an organizational context at the business unit level that allows both alignment and adaptability of knowledge could be a valuable alternative for organizational ambidexterity. In their study, Gibson and Birkinshaw (2004) collected data from 4,195 individuals in 41 business units and found that a context featured by a combination of stretch, discipline, support and trust fosters contextual ambidexterity, and in turn yield higher performance. Attempting to develop a comprehensive model, Andriopoulos and Lewis (2009) studied five leading firms in the product design industry and suggested that a mindset of exploitation-exploration paradox should be a shared responsibility across organizational levels. Contextual ambidexterity emphasizes behavioral and social means of integrating exploitation and exploration throughout the entire organization. In contrast, the leadership-based ambidexterity anchors the function and leadership of the top management (Smith & Tushman, 2005). This

alternative puts emphasis on the ambidextrous function of top-level managers who are expected to balance exploration and exploitation by selectively integrating and addressing any negative externalities or inconsistencies in organizational design (Hambrick, 1994; Lubatkin, Simsek, Ling, & Veiga, 2006). Behavioral integration of top management is critical for effectively maintaining organizational ambidexterity. Nevertheless, existing research is mainly limited to conceptual, anecdotal, or single-case studies in this area, lacking holistic empirical research (Andriopoulos & Lewis, 2009).

Last but not least, the domain-separation approach is raised by Lavie and his colleagues (2011) to address the balance of exploitation and exploration in alliance formation. They argue that previous research on this subject has dominantly focused on exploration and exploitation within a single domain, e.g., engaging in innovation versus commercialization of technologies. Therefore the efforts of balance are bound to encounter conflicting routines and trade-offs. However, a balance could actually be realized across different domains, such as exploring through innovation and R&D alliances whereas exploiting recurrent alliance relationship with existing partners. This approach acknowledges that firms can engage in exploratory and exploitative activities in multiple domains, thus circumvent the trade-offs and conflicts. Lavie et al. (2011) argued that structural separation creates operational redundancy while the challenges of coordinating exploration and exploitation still exist. Top management team needs to make additional efforts to manage such challenges. In this regard, the negative externalities may outweigh the benefits of balance, rendering negative performance consequences. In contrast, a domain separation approach can relieve firms from certain inherent trade-offs and conflicts. By studying U.S. based firms in the software industry, Lavie et al. (2011) found that balancing

exploration and exploitation across domains enhanced performance. Specifically, firms that engage in R&D alliances while collaborating with their prior partners, or form marketing and production alliances with new partners gain in profits and market value. Although their study has thus far been the only evidence among existing empirical research adopting the domain separation approach, Lavie et al. (2011) offer new insights into how firms can benefit from balancing exploration and exploitation in alliance formation. Furthermore, the domain separation approach could potentially be extended to organizational ambidexterity research in general. Multiple domains can be investigated when studying exploitation and exploration within organizations.

In the area of exploitation and exploration alliances, current research has also examined other factors that could influence the performance implications of the balance. For example, Yamakawa et al. (2011) proposed that whether the exploration versus exploitation orientation of an alliance portfolio may benefit firm performance depends on how such an orientation fits the firm's international organizational characteristics, strategic orientations, and the industry environment. Embracing the resource-based view and the relational perspective, this article examined the fit of three factors: firm age, strategic orientation (cost leadership or differentiation), and industry growth. Testing the hypotheses by using data of 95 firms from five industries over eight years (1988 – 1995), this article found that it is important to understand the relationships among firms, their alliances, the external environment, and their impacts on firm performance. In particular, younger firms benefit more from a higher ratio of exploitation alliance while older firms benefit more from a higher ratio of exploration alliances in their alliance portfolio. Cost leadership strategy strengthens the link between an exploitation alliance

orientation and firm performance. Finally, firms benefit more by forming more exploration alliances in a high-growth industry whereas they benefit more by forming more exploitation alliances in a low-growth industry. Im and Rai (2008) investigated the impact of ambidextrous learning on long-term inter-organizational relationships. Based on a survey of 238 customers and 76 vendors in the U.S. logistics industry, the authors found that both exploratory and exploitative knowledge sharing lead to relationship performance gains. The knowledge sharing is enabled by the ambidextrous management of the relationship and facilitated by ontological commitment. Their findings indicated that exploratory knowledge sharing and exploitative knowledge sharing are reinforcing and synergistic in long-term inter-organizational relationships. Rothaermel and Alexandre (2009) examined the organizational and technological boundaries of technology sourcing. The authors argued that there are two dimensions in technology sourcing: (1) whether a firm engages in exploration or exploitation, and (2) whether a firm sources its technology internally or externally. Based on a survey of 141 firms in the manufacturing sector in the U.S., the authors found that pursuing ambidexterity in technology sourcing enhances firm performance. Besides, higher levels of absorptive capacity allow a firm to more fully capture the benefits resulting from ambidexterity in technology sourcing. Since Koza and Lewin (1998) brought the exploitation-exploration framework into the alliance literature, there have been increasing yet not abundant research endeavors employing this theoretical lens. More studies are encouraged to uncover the mechanisms of balancing exploitation versus exploration alliances and its performance implications.

In sum, balancing exploration and exploitation is inherently challenging. Despite that multiple approaches have been proposed in the literature to provide guidance on how firms can

balance these two activities and successfully benefit from such a balance, limited empirical evidence has not yielded systematic or holistic prescriptions, if possible. Scholars have also pointed out that research attempts to synthesize multiple approaches or span multiple levels of organizing would help fill the void of organizational ambidexterity research (Raisch et al., 2009; Simsek, 2009). For instance, Cantarello et al. (2012) examined the search phase of the innovation process of an innovative technology-based company and argued that ambidexterity capability is built through a multi-level and integrated approach. The authors posited that a firm's survival and growth depend greatly on its ability to balance the exploitation of existing knowledge and the exploration of new possibilities. They found that ambidexterity capability is the result of a process of three interconnected steps: a phase where managers with a double and paradoxical mindset recognize tensions and define the suitable practices to face these tensions, a phase where these practices are performed by employees, and a phase where these different pieces of knowledge are integrated and checked by the top management. An integration of multiple approaches may provide new insights into this phenomenon.

2. Chapter Two: The Antecedents of Exploration and Exploitation Alliance Formation in the U.S. Biopharmaceutical Industry

2.1 Introduction

The question of what drives strategic action has occupied a central position in the strategic management literature (Nadkarni & Barr, 2008). Although multiple perspectives on strategic action drivers have been developed, two views have been particularly dominant: industry structure and organizational features. The industry structure view contends that industry structure and environmental conditions influence the timing and effectiveness of strategic actions (Bain, 1956; Caves, Fortunato, & Ghemawat, 1984; Ghemawat, 1991; Porter, 1981). In contrast, the perspective of organizational features posits that distinctive organizational routines and knowledge bases developed along unique trajectories affect an organization's ability to process and analyze internal and external environments, thus determine how an organization formulates its strategic responses (Dierickx & Cool, 1989; Wang & Li, 2008). Strategic alliance is viewed as a type of corporate strategic choice employed by firms in response to changes in the environment (Park et al., 2002). In this study, I examine exploration and exploitation alliances as two forms of strategic actions. March (1991) proposed two forms of organizational behavior, exploration and exploitation, to distinguish between two fundamentally different learning activities. Since his foundational work, there has been a proliferation of subsequent research in different literature streams employing the framework of exploitation-exploration and the scope of application has been greatly extended after two decades (Lavie et al., 2010; Raisch & Birkinshaw, 2008).

Organizational ambidexterity has now become an emerging research paradigm in organizational

theory (Raisch & Birkinshaw, 2008; Simsek et al., 2009). Strategic alliances, as one of the contexts recently incorporating this framework, “have become a noteworthy vehicle for exploration and exploitation” (Lavie & Rosenkopf, 2006: p. 798), calling for more research attention (Lavie et al., 2010).

Scholars have argued that a firm’s formation decision of strategic alliances is embedded within its competitive environment and the internal resource/endowment conditions which may interactively affect a firm’s incentive and/or capability to establish alliances (Park et al., 2002). Despite the fact that the early seminal work has spawned an increasing amount of research on exploration and exploitation alliances, why organizations pursue exploration versus exploitation alliances remains unclear (Danneels & Sethi, 2011; Lavie et al., 2010). The existing exploration-exploitation research in alliances has paid little attention to the role of environmental turbulence as an antecedent of alliance ambidexterity, with a few exceptions (Kim & Rhee, 2009). Those studies examining environmental forces have yielded results diverging from conventional wisdom. For example, Beckman and her colleagues (2004) suggested that market uncertainty would generate exploitation alliances, whereas Rowley et al. (2000) argued that uncertain environment requires more exploration for new innovations and alternatives. The finding that uncertain environment leads to exploitation alliances seems to be at odds with the traditional view that uncertain environment requires exploratory innovation. Meanwhile, scholars have pointed out that, besides industry conditions as external stimuli, internal organizational features which influence firms’ formation decisions of exploration and exploitation alliances should also be considered (Lavie & Rosenkopf, 2006). However, research on internal drivers of ambidexterity in general has not reached consensus either. For instance, studies looking at

organizational slack have suggested that slack resources may generate either exploration (Sidhu et al., 2004), exploitation (Bourgeois, 1981), or curvilinear effects (Nohria & Gulati, 1996). Even fewer studies have shed light on the organizational conditions for driving exploration and exploitation alliances. Given the mixed results and divergent prescriptions, the following research questions remain ambiguous: What are the factors affecting exploitation versus exploration alliance formation decisions? How do internal organizational features and environmental pressures influence firms' formation of exploration and exploitation alliances?

The inconsistency in evidences provided by prior research on the antecedents of exploration and exploitation can be at least partially attributed to the differences in the conceptualization and contextualization of the exploration-exploitation constructs (Lavie & Rosenkopf, 2006). The lens of exploration-exploitation has been applied to examine various phenomena and contexts, such as strategic alliances, product diversification, internationalization, and new product development, and simply generalizing the interpretations of this framework to different contexts may be misleading (Lavie et al., 2010). Prior research on alliance ambidexterity has conceptualized the twin concepts from different perspectives, including whether the alliances focus on upstream or downstream activities along the value chain (Rothaermel & Deeds, 2004), whether the alliances involve learning from new or existing partners (Beckman et al., 2004), or whether the alliances entail learning from partners with various organizational attributes (Lavie & Rosenkopf, 2006). In this chapter of study, embracing organizational learning perspective and resource-based view, I investigate exploration and exploitation alliances in the setting of U.S. biopharmaceutical industry and build the arguments and analyses based on previous research in similar contexts (e.g., Hoang & Rothaermel, 2010;

Rothaermel & Deeds, 2004). I focus on the value chain function and follow prior literature (Hoang & Rothaermel, 2010; Rothaermel & Deeds, 2004) by leveraging Koza and Lewin's (1998) typology of alliance activity. Alliance activities that aim at exploring new competencies and new opportunities in the upstream of the value chain are considered as exploration alliances, whereas those formed to exploit existing competencies and to leverage known opportunities in the downstream of the value chain are referred to as exploitation alliances. The reasons for choosing this domain to study exploration and exploitation alliances are two folds. First, the value chain function in the technical context is of particular importance for firms in high-tech industries such as biopharmaceutical industry. Effective development and commercialization of new products is vital to firms' success. Second, previous research has shed some light on the antecedents of exploration and exploitation alliances in the structure domain (e.g., Beckman et al., 2004; Li et al., 2008). It is worthwhile to direct research endeavor to other domains in an attempt to paint a bigger picture. To uncover the contexts that trigger exploration and exploitation alliances, I examine both types of antecedents by focusing on market uncertainty as an environmental factor, as well as organizational antecedents including innovative capacity and organizational slack. Given the fact that the biopharmaceutical industry is characterized of great uncertainty and heavy regulation (Aldrich & Fiol, 1994) and that product development is highly risky due to intensive investments in time and capital (Giovannetti & Morrison, 2000), I propose that firms in this industry tend to carefully craft their strategic alliances, taking both internal and external conditions into account. I hypothesize that both environmental uncertainty and organizational endowments affect the formation of exploitation and exploration alliances.

I empirically test the hypotheses on a sample of 581 publicly traded biopharmaceutical firms that established 1,614 alliances in the 25-year period between 1985 and 2009. The remainder of this article is organized as follows. I first present the theoretical background for this research and develop the hypotheses. This is followed by a discussion of the research design and methods. Then I describe the analysis of the results and the findings, followed by a discussion of the implications.

2.2 Theory and Hypotheses

2.2.1 Exploration and Exploitation in Strategic Alliances

The framework of exploration and exploitation proposed by March (1991) has attracted substantial research (Raisch & Birkinshaw, 2008). The pursuit of new knowledge is regarded as exploration and the leverage of known knowledge is considered exploitation (Levinthal & March, 1993). This framework has been applied in the area of strategic alliances, since Koza and Lewin (1998) formulated the concepts of exploration and exploitation alliances. Alliance ambidexterity has been in the process of developing into an emerging research paradigm, yet without consistency. Theoretical and empirical research on the antecedents of exploration and exploitation alliances generates mixed findings due to the differences in conceptualization and contextualization (Lavie & Rosenkopf, 2006; Lavie et al., 2010). Scholars have taken different angles (e.g., learning from activities or learning from partners) to define exploration and exploitation alliances, thus resulting in the divergence of findings. Therefore generalizing findings about the antecedents of exploration and exploitation alliances in different contexts is

groundless (Lavie et al., 2010). I posit that this is not a right-or-wrong world and we should not interpret different phenomena with the unifying lens of exploration-exploitation.

Conceptualization of the twin constructs in strategic alliances shall be grounded in the specific context examined.

As mentioned earlier, this chapter focuses on the value chain function of exploration and exploitation alliances. I build the conceptualization of exploration and exploitation alliances following prior research on alliance ambidexterity in similar contexts (e.g., Hoang & Rothaermel, 2010; Rothaermel & Deeds, 2004). March's (1991) framework of exploration-exploitation suggests that exploration involves experimentation and variation in new knowledge and opportunities whereas exploitation includes refinement and leverage of existing knowledge and opportunities. In their conceptual treatment, Koza and Lewin (1998) established that the type of alliances firms enter depends on the type of knowledge that they seek to acquire (Hess & Rothaermel, 2011). Consequently, firms may be motivated to enter an alliance to explore new knowledge and opportunities or exploit existing ones. In a similar vein, Rothaermel and Deeds (2004) points out that 'precursor' is an important source to distinguish between exploration and exploitation alliances: 'The precursor to exploration is simply desire, the wish to discover something new. The precursor to exploitation, however, is the existence of an exploitable set of resources, assets, or capabilities under the control of the firm (p. 203)'. Firms can form upstream alliances for the purpose of exploring for new knowledge and opportunities, while downstream alliances are undertaken to exploit an existing capability (Rothaermel & Deeds, 2004). This functional view emphasizes the position of an alliance along the value chain. Upstream alliances tend to primarily focus on generating new knowledge, while downstream alliances often focus on

combining and integrating existing knowledge. Firms conduct upstream research alliances to discover something new, allowing the partners to acquire new knowledge. In the biopharmaceutical industry, these types of alliances are usually undertaken with universities and other research institutions and technology ventures, and are often characterized by high uncertainty and frequent failure (Rothaermel, 2001). On the other hand, firms conduct downstream alliances to leverage complementary assets and to combine existing knowledge (Teece, 1992). Downstream alliances often join the drug development efforts of new ventures with larger, more well-established firms that provide manufacturing capabilities, regulatory know-how, and market knowledge and access (Rothaermel, 2001). Under this typology, exploration alliances are time consuming, require heavy commitment in resources, and the returns are not predictable; exploitation alliances are less risky with lower level of uncertainty and more predictable returns (Hoang & Rothaermel, 2010).

Following the above argument, in the biopharmaceutical industry, exploration alliances focusing on basic research, drug or biomedicine discovery and development are formed to explore new products and opportunities; exploitation alliances that are associated with commercialization or downstream activities on the value chain, such as clinical trials, licensing, marketing and sales, are designed to leverage a firm's existing knowledge residing in the later stage of the value chain. For example, a biotechnology firm Biogen formed an exploration alliance with University of Zurich, leading to the discovery of Intron A for the treatment of certain types of leukemia and hepatitis C (Rothaermel & Deeds, 2004). This exploratory collaboration was featured with new knowledge generation used by the partners to create novel molecular compound, i.e., Intron A, which was the first product of such treatments to enter

clinical trials. Upon the discovery of this innovative drug, Biogen engaged the pharmaceutical company Schering-Plough in an exploitation alliance for commercialization. The alliance involved exclusive licensing agreement in which Schering-Plough undertook clinical trials, regulatory activities, marketing, distribution, and sales. To some extent, Biogen exploited its existing knowledge/technology and Schering-Plough exploited its commercialization capabilities in the alliance which combined their complementary knowledge and capabilities. Therefore, if an alliance involves a new knowledge-generating agreement such as R&D or technology co-development, it is considered an exploration alliance; if an alliance involves an agreement based on combining and integrating existing knowledge, such as product testing or licensing, it is viewed as an exploitation alliance (Ranganathan & Rosenkopf , 2014). Although it is acknowledged that there is likely to be new knowledge generated in exploitation alliances, the type and pattern of knowledge flows in exploration alliances are generally more exploratory. I therefore follow this approach of conceptualization which is prevalently adopted in previous research.

Another dimension of conceptualization pertains to the nature of tension between the two activities. When March (1991) first introduced the twin concepts of exploration and exploitation to the management literature, he argued that they should be viewed as two ends of a single continuum (Cao et al., 2009). In March's characterization, exploration and exploitation place inherently conflicting resource demand and organizational demand on the firm. From this perspective, trade-offs between exploration and exploitation are seen as unavoidable. Other scholars following March's work similarly focus on the conflicting aspects of exploratory and exploitative orientations, their competition for scarce resources, and the desirability of achieving

an optimal balance between the two (Auh & Mengue, 2005). Alternatively, another school of researchers have recently begun to characterize exploration and exploitation as independent activities that are orthogonal to each other, such that firms can manage to engage in high levels of both activities at the same time (Gupta et al., 2006). From this perspective, ambidexterity has been emphasized to pertain to the capacity of a firm to pursue high levels of exploration and exploitation concurrently (e.g., Cao et al., 2009) rather than managing trade-offs to find the optimal balance between the two. I posit that both trade-off and synergy coexist in the relationship between exploration and exploitation. Organizations can adopt various configurations to minimize the trade-off and generate synergistic effects (Gibson & Birkinshaw, 2004; Gupta et al., 2006). This conceptualization lays the premise of this study and will guide the arguments and hypotheses development in later sections.

2.2.2 Innovative Capacity and Exploration versus Exploitation Alliances

March's (1991) framework of exploration-exploitation builds on organizational learning literature. Strategic alliances are regarded as an important process for learning in which firms may discover new opportunities (Hagedoorn & Duysters, 2002; Osborn & Hagedoorn, 1997). As an representation of an organization's level of learning capability and absorptive capacity (Zhou & Wu, 2010), innovative capacity refers to a set of organizational processes and principles used to develop new products and explore new opportunities (Kogut & Zander, 1992; Mahmood et al., 2011),. Construction of innovative capacity entails the accumulation of technological knowledge, investment in R&D activities, and new product discovery (Afuah, 2002; Zhou & Wu, 2010). As such, building innovative capacity over time in turn promotes organizational learning (Cohen &

Levinthal, 1990) and increases its level of absorptive capacity (Mahmood et al., 2011; Zhou & Wu, 2010). Consequently, innovative capacity plays an important role in a firm's exploration activities and is worthy of research attention (Zhou & Wu, 2010).

Organizational learning perspective suggests that firms endowed with higher learning capability and absorptive capacity are more likely to engage in exploration and innovation (Cohen & Levinthal, 1990; Kogut & Zander, 1992; Lavie & Rosenkopf, 2006; Mahmood, Zhu, & Zajac, 2011; Zhou & Wu, 2010). Such exploration and innovation are mainly the general technological output, and, in many cases, developed within organizational boundaries. The absorptive capacity perspective also points out that higher innovative capacity naturally leads to a higher level of exploration (Rosenkopf & Nerkar, 2001). A firm, as it builds innovative capacity, accumulates absorptive capacity. With higher level of absorptive capacity, the firm is more receptive to new knowledge and information, encouraging the development of explorative innovation internally (Lavie & Rosenkopf, 2006). As a firm continuously builds innovative capacity and develops exploration activities internally, it runs the risk of embarking on the self-reinforcing journey in which the firm further directs its resources and routines towards exploration (Gilbert, 2005). Should it be true, the firm may tend to overly emphasize exploration at the end of the day. When a firm overemphasizes exploration to the exclusion of exploitation, it increases the risk of failing to appropriate returns from its costly search and experimentation activities (Cao et al., 2009). Teece (1986) cites company examples, such as EMI's experience with the CT scanner, and contends that investment in innovation without an attendant plan to develop the complimentary processes to exploit the fruits of such exploration is pointless. Other researchers have also emphasized the need for efficient and reliable manufacturing, marketing,

and financial capacities for a firm to capitalize on their investments in developing new products and markets (Utterback, 1994).

Organizational learning perspective suggests that a firm with higher level of innovative capacity tends to emphasize internal exploration and innovation, and neglect exploitation. Accordingly, with respect to forming alliances as a strategic choice, seeking exploitation externally by forming exploitation alliances therefore serves as a good complementary measure to its internal focus on exploration. The resource-based view argues that firms essentially create alliances in order to access valuable resources that are unavailable to them and cannot be purchased through markets. The motive of forming alliances is value maximization through pooling such value-generated resources together (Das & Teng, 2000). A firm with high level of innovative capacity is thus more likely to look for complementary capacities from alliance partners. For example, Rothaermel and Deeds (2004) found that firms with strong technological capabilities tend to engage in more exploitation alliances, in order to gain access to complementary assets (e.g., manufacturing and marketing resources) to commercialize new products. In the biopharmaceutical industry, a technology venture with high level of innovative capacity is usually not strong when it comes to commercialization capabilities. It tends to seek exploitation alliances to facilitate product commercialization. In addition, a firm with higher level of innovative capacity is very likely to have more new product development projects waiting for commercialization and marketing. In this case, it needs to develop complementary measures to exploit the existing opportunities, leading to more exploitation alliances. In contrast, firms with higher level of innovative capacity may form exploration alliances, but will be less incentivized to do so. On the one hand, forming exploration alliance to co-develop new products

might not yield leveraging effects as exploitation alliances do and is less appealing given that such a firm can well develop explorative projects on its own. On the other hand, exploration alliances tend to involve higher level of intangible resources and tacit knowledge transfer, therefore are more susceptible to opportunistic behavior (Das & Teng, 2000; Tallman & Shenkar, 1990). As a result, a firm with high level of innovative capacity might be more willing to take exploration in house, to protect its tacit knowledge from potential opportunistic appropriation. Forming exploitation alliances is therefore a more attractive option. Consequently, I hypothesize that:

H1: Firms with higher levels of innovative capacity are more likely to form exploitation alliances than exploration alliances.

2.2.3 Organizational Slack and Exploration versus Exploitation Alliances

It has been demonstrated in previous research that there is an inherent trade-off between exploration and exploitation (March, 1991). Organizations face resource-allocation constraints due to the opposing nature of exploration and exploitation activities (Lavie et al., 2010). In this regard, organizational slack resources play an important role in the decision of exploration versus exploitation tendencies. Slack resources refer to “the pool of resources in an organization that is in excess of the minimum necessary to produce a given level of organizational output” (Nohria & Gulati, 1996: p. 1246).

Organizational slack has been studied by scholars with diverging arguments regarding its impact on innovation and exploration (Lavie et al., 2010). Some scholars maintain that organizational slack fosters exploration because it allows firms to search for and to experiment

with new opportunities identified, and buffers some downside risks of failure (Greve, 2007; Lavie et al., 2010; Levinthal & March, 1993; Nohria & Gulati, 1996; Sidhu et al., 2004). In contrast, others challenge this point of view by arguing that organizations with slack resources tend to sit on their gold mines, consuming current endowments to meet performance objective as opposed to exploring new opportunities (Bourgeois, 1981). These organizations are less motivated to innovate (Lavie et al., 2010), bearing the risk of overlooking the long term prospects. Firms susceptible to this type of risk may enjoy short-term success from exploiting existing products and markets, but their success may be ephemeral—unsustainable in the face of significant market and technological change (Tushman & Anderson, 1986). Under this circumstance, existing competencies can quickly become outdated and lead to powerful path dependencies (Christensen & Overdorf, 2000) or core rigidities (Leonard-Barton, 1992) that impede the firm's learning and renewal (Cao et al., 2009).

These two opposing views of the impact of organizational slack depict two types of organizations: proactive ones and complacent ones. Lavie et al. (2010) suggest that this seeming contradiction can be resolved with a contingency view. One contingency is the changing environment. The view noting that organizations would be complacent with consuming current slack resources was formed in the early 80s, when business environment was relatively stable. However, as the environment has become much more volatile and fast changing, firms need to be proactive in order to survive and thrive. The characteristics of the biopharmaceutical industry make it a typical industry with high speed of changes and suggest a need for a proactive and effective way of using resources. On the one hand, R&D and innovation are costly, time consuming and risky, especially in the biopharmaceutical industry (Rothaermel & Deeds, 2004).

In U.S., the average R&D cost of bringing a new compound to market was estimated at \$802 million which took 8-12 years of development, and only 5 percent of the compounds under development would be able to make it into clinical trials (DiMasi & Hansen, 2003; Giovannetti & Morrison, 2000). Only firms with munificent endowments are capable of investing in exploration. On the other hand, biopharmaceutical firms face intense competition from generic manufacturers after the expiration or loss of patent protection and the U.S. patent system leaves firms with a limited period of protection. Thus capable firms are urged to innovate and develop new products in order to sustain their competitive advantage. During the enquiry interviews with practitioners, a manager emphasized the importance of new product development: “The patent of our cash cow is expiring next year. We have been pushing new drug development.” Consequently, biopharmaceutical firms are highly motivated to explore and innovate. The perspective that advocates a positive association of slack resources and exploration better explains how biopharmaceutical firms may be motivated.

In general, organization theory suggests that slack can become a resource for conflict solution, buffer the organization from environmental turbulence, and facilitate firms’ search and experiment with new strategies such as new product development (Tan & Peng, 2003).

When there are excess resources, firms are able to allocate more resources to exploration and innovation, and to explore external opportunities of collaboration. With abundant resources, investing in exploration activities becomes plausible and more reliable because the munificence in resources offers strong support and helps to buffer the risks of exploration. Therefore, the condition that firms are capable of investing in exploration activities is met. Firms will also be motivated to invest in exploration alliances. Previous research has indicated that a firm’s

tendency to form exploration and exploitation alliances is related to its resource endowments (Park et al., 2002). According to the resource-based view, a primary reason for entering alliances is the differences in needs and resources (Eisenhardt & Schoonhoven 1996; Walker, Kogut, & Shan, 1997). Slack resource does not power new engines of growth as exploration and innovation does in the long run. In order to sustain long-term competitive advantage, firms would choose to devote more resources to develop complementary advantages through exploration alliances. In contrast, when firms have sufficient organizational slack resources such as financial slack, modest returns generated from exploitation alliances are less attractive, thus less likely to obtain organizational investment (Voss et al., 2008). In addition, a firm with slack resources are capable of taking exploitation in house given that it has plenty of organizational resources required by exploitation activities, decreasing the need for seeking external exploitation opportunities such as forming exploitation alliances. Therefore I suggest:

H2: Firms with higher levels of organizational slack are more likely to form exploration alliances than exploitation alliances.

2.2.4 Market Uncertainties and Exploration versus Exploitation Alliances

Although it has been widely acknowledged in the strategy and organization literature that external environment has critical impact on firms' strategic decisions and subsequent performance (Eisenhardt, 1989; Soh & Roberts, 2003), the role that the environmental context plays in the nature of exploration versus exploitation still remains unanswered (Gibson & Birkinshaw, 2004; O'Reilly & Tushman, 2004). Environmental conditions are argued to be particularly important for firms and their strategic alliances (Lin et al., 2007; Yamakawa et al.,

2011). The fit between the environment and a firm's choice of exploitation versus exploration alliances may have a significant impact on its alliance portfolio. A few studies have examined the roles of environmental dynamism in organizations' tendencies to engage in exploration and exploitation alliances (Lavie et al., 2010). In this study, I focus on market uncertainty, i.e., the changes of market demand, in organizations' industry environment. Prior research that examines how environmental dynamism affects exploration versus exploitation has not reached a consensus yet. Whereas some scholars argue that dynamic environment requires organizations to explore (e.g., Jansen et al., 2006; Sidhu et al., 2004), others advocate exploitation (e.g., Beckman et al., 2004; Kim & Rhee, 2009). There has been a general consensus reached in product/innovation exploration versus exploitation that turbulent and dynamic environment requires organizations to explore whereas stable and unfluctuating environment nurtures exploitation (e.g., Jansen et al., 2006; Sidhu et al., 2004). However, recent studies examining exploitation versus exploration alliances tend to suggest that uncertain environment results in more exploitation activities. For example, Beckman et al. (2004) found that the higher the level of market uncertainty, the more likely a firm is to reinforce its networks through establishing more exploitation alliances in order to manage exogenous uncertainty. Li et al. (2008) argued that in a turbulent technological environment, firms tend to prefer forming alliances with 'friends' they trust, essentially, in order to rely on the exploitation of existing alliance partnerships. It is noteworthy to point out that studies reaching these two divergent conclusions examine exploration-exploitation with different focuses, including innovation (Jansen et al., 2006), information acquisition (Sidhu et al., 2004), and alliance formation/partner selection (Beckman et al., 2004; Li et al., 2008). It is suggested that analogies can only be drawn between

similar phenomena (Lavie et al., 2010). This study is set in the context of strategic alliances, in particular, the function domain of alliances.

Despite the distinctive definitions and disparate phenomena investigated in prior research, a central premise remains the same: organizations aim at reducing uncertainty in dynamic environments. Market uncertainty translates into obscure and unpredictable market demand (Sorenson & Stuart, 2000). Under high market uncertainty, customer preferences are unstable and changing which is beyond the firm's control and shared across the industry. Organizations tend to seek stability and trust when faced with market uncertainty (Hansen, 1999). Firms are inclined to maintain the 'status quo' by continuing to do what they are doing as a form of threat-rigidity response (Beckman et al., 2004). However, forming alliances under market uncertainty involves two layers of uncertainty: the uncertainty of alliance activity and that of collaboration relationship. On the one hand, in the biopharmaceutical industry, exploration alliances involve development and discovery of new products which are associated with high level of risk and uncertainty. Market returns of exploration activities become even more unpredictable in highly uncertain markets. Organizations tend to prefer stable and immediate returns. On the other hand, with market uncertainty, quality assessment of potential partners are difficult (Podolny, 1994). Actors in the market would have difficulty determining the quality of a potential relationship or project. A qualified and trustworthy partner is particularly important for exploration initiatives because of the risk and uncertainty in exploratory projects per se and the potential opportunistic behavior that firms are susceptible to in such collaborations. Previous research has indicated that the challenge of negotiating and structuring contracts in the face of uncertainty often causes frictions between partners

(Rothaermal & Deeds, 2004). It will be more challenging to handle another layer of uncertainty regarding collaboration on exploratory projects. Therefore, when the potential benefits of alliances may be offset by the high costs and risks under high level of market uncertainty, firms will tend to refrain from the formation of exploration alliances. Although compared to exploration alliances, exploitation alliances may be able to generate more reasonable and predictable returns; I argue that firms will tend to rely on themselves or existing relationships for exploitation as opposed to forming more exploitation alliances. To mitigate the market threats of unpredictable demand, firms may want to leverage exploitation of existing products. However, as the difficulty of assessing the potential partners' quality increases in highly uncertain markets, firms may turn to internal sources for commercialization or marketing or simply depend on existing partnerships due to reinforced stability and trust. Exploitation alliances are also argued to be exposed to substantial hazards stemming from disputes and from investments in specialized assets in biopharmaceutical industry (Rothaermal & Deeds, 2004). Forming exploitation alliances would be discouraged by the uncertain future of the partnership and the market (Park et al., 2002). Thus firms are less likely to engage in new exploitation alliances for the benefits of exploitation under market uncertainty. As a result, I hypothesize that:

H3: At higher levels of market uncertainty, firms are less likely to form either exploration or exploitation alliances.

2.2.5 Interaction Effect between Innovative Capacity and Market Uncertainty

As argued in the previous section, in uncertain markets, firms might be reluctant to establish external collaborations (either exploitation alliances or exploration alliances) due to

additional uncertainty these collaborations may entail. On another note, previous research has acknowledged the benefits of exploration in dynamic environment (e.g., Jansen et al., 2006; Sidhu et al., 2004). Branching into a new to the firm technology domain increases the stock of opportunities to which the firm has access (Fleming, 2001). The knowledge components that the firm acquires in the new domain can then be recombined with its existing knowledge to introduce heterogeneity that facilitates problem solving (Kotha, Zheng, & George, 2011). The variety in problem-solving approaches increases the likelihood that solutions can be found for technological and market bottlenecks (Kotha et al., 2011), enabling firms to better address market uncertainty. As such, searching through exploration may have positive implications in uncertain markets in this regard. Although exploration and innovation are desired in uncertain markets, whether a firm is able to achieve it tends to depend on its endowments and capabilities. I argue that from the perspective of organizational learning, a firm with higher level of innovative capacity will be more capable of engaging in external collaborations for exploration, compared to a firm with lower level of innovative capacity. First, a firm with higher level of innovative capacity will be endowed with the capability of leveraging the benefits of exploration, even in uncertain environment. A firm's capacity to learn and assimilate knowledge from partners determines the benefits it can receive from exploration alliances. The presence of an infrastructure to innovate, such as research laboratories and scientific human capital, increase the potential for a firm to absorb and assimilate information, sailing through uncertainty (Zucker, Darby, & Brewer, 1998). Second, a firm with higher level of innovative capacity generally possess and information advantage and is likely to be more capable of assessing the partners' quality under market uncertainty (Lerner, Shane, & Tsai, 2003). It will be easier for them to find

the qualified ones to collaborate on explorative projects. Third, high innovative capacity signals high quality, making the firm an attractive candidate for other firms that seek partnerships. Therefore, firms with higher level of innovative capacity are more likely to overcome the impediments of forming exploration alliances in uncertain markets. The likelihood is also higher with respect to forming exploitation alliances. A firm with higher level of innovative capacity is likely to possess more promising product development in the pipeline. In uncertain markets, it needs and tends to be more proactive to ‘reap the corn’ before it is outdated by uncertain markets. With a relative strength in developing innovative projects, a firm tends to develop the complimentary processes through exploitation alliances. Commercialization, manufacturing, or marketing resources provided by alliance partners could well complement its capability to exploit the explored product development. In a similar vein, other researchers have stressed the need for efficient and reliable manufacturing, marketing, and financial capacities for a firm to capitalize on their investments in developing new products and markets in uncertain environments (Utterback, 1994). Consequently, I hypothesize that:

H4: Firms with higher innovative capacity tend to be more willing to form exploration and exploitation alliances in uncertain markets.

2.2.6 Interaction Effect between Organizational Slack and Market Uncertainty

It has been established in previous literature that a firm’s stock of slack resources, such as financial capital, functions as a buffer that mitigates the effects of exogenous risks and shocks in turbulent environment (Bourgeois, 1981; Thompson, 1967). Slack resources such as uncommitted financial resources are highly flexible. Organizations are able to redeploy and

reallocate them whenever needed (Voss et al., 2008). They can thus be easily dedicated to some specialized departments and functions in order to effectively respond to potentially damaging risks in highly uncertain environment (Thompson, 1967). Therefore, it is argued that with higher level of organizational slack as a better buffer, the risks of engaging in exploitation or exploration alliances in uncertain markets will be less threatening (Cao et al., 2009). A ‘deeper pocket’ cushions the potential adverse effects on performance in this respect. Firms with larger resource bases will tend to perceive fewer threats and be more able to cope with threats in uncertain environment. Firms with slack resources thus have higher capability and opportunity to use exploration and exploitation alliances to overcome market uncertainty or threats (Park et al., 2002). They will be more encouraged to engage in strategic alliances under this circumstance.

Furthermore, resources play an important role in providing effective support to fuel a firm’s activities, and I reason that, where possible, the enhancement of exploration and exploitation through alliances will be enormously taxing on available resources. Because exploration and exploitation represent very different organizational processes, they may each require different sets of supporting resources (March 1991). For instance, because of the need for different processes, values, and culture, a firm may have to create and deploy alliances that are devoted to searching for new products and separate them from those dedicated to appropriating returns from existing products and markets (Christensen, 1997; Tushman & O’Reilly, 1996). The exploitative alliance activities need to mobilize information and knowledge within the firm to improve the efficiency of existing organizational routines (Benner & Tushman, 2003; March, 1991), whereas the exploratory alliance activities need to get detached from the existing routines with more scanning of information and knowledge external to the firm (McGrath, 2001). With

munificent slack resource, firms will be able to support both kinds of activities, especially in uncertain markets. In fact, higher level of organizational slack means that additional resources can be allocated timely to more effectively leverage exploration and exploitation alliances in response to the dynamic markets (Sirmon, Hitt, & Ireland, 2007). The proactive management of slack resources through forming exploration and exploitation alliances is likely to help firms handle the risks and uncertainty (Dickson & Weaver, 1997). Therefore I suggest,

H5: Firms with more slack resources tend to be more willing to form exploration and exploitation alliances in uncertain markets.

2.3 Method

2.3.1 Research Setting and Sample

This study is designed as a pooled time series analysis of alliances formed by U.S. biotechnology firms (SIC codes 2833-2836). The pharmaceutical industry offers an appropriate setting because the high level of innovative activities and the commercialization of technology are characterized by intensive alliance relations (Rothaermeli & Boeker, 2008). The intensity of alliance in pharmaceutical industry accounts for a high proportion of the observed strategic alliances in high-technology industries (Hagedoorn, 1993). Besides, firms in this industry develop in an environment of great uncertainty as well as heavy regulations from multiple departments (Aldrich & Fiol, 1994), which greatly influences organizations' strategic actions.

This study's time frame spanned the years 1985 to 2009. Prior work employing the same time frame suggests that a 25-year period serves well in capturing the upturns and downturns in

the growth of the industry (e.g., Nadkarni & Barr, 2008). In addition, previous research studying alliances also sets 1985 as a base year or the starting year (e.g., Beckman et al., 2004; Lavie & Rosenkopf, 2006) and there were much fewer alliances formed in this industry before 1985. The sample included 581 publicly traded United States-based pharmaceutical firms that had records in both Securities Data Corporation (SDC) and COMPUSTAT datasets. 1,614 alliances were identified between 1985 and 2009, and the number of alliances formed by a focal firm ranged between 1 alliance to 11 alliances in a given year.

2.3.2 Data Collection

The bulk of the data on alliances was retrieved from the SDC database. The SDC database is one of the most commonly used and comprehensive alliance databases (Schilling, 2009). The alliance data was verified and corrected using the Securities and Exchange Commission (SEC) filings, the Bloomberg database, and corporate websites. The validity of the alliance data was therefore enhanced by relying on multiple sources. Overall, I identified 1,995 alliances formed by 812 focal firms with the SIC codes of 2833-2836. Firm-specific data, such as total assets, R&D expenses, net income, and retained earnings, were extracted from COMPUSTAT database.

To match the data from the SDC database and the COMPUSTAT database, I took several steps. First, I compared and matched the CUSIP codes in both databases. CUSIP code in SDC is recorded in 6 digits whereas that in COMPUSTAT is in 9 digits. I extracted all 9-digit CUSIP codes of firms with the SIC codes of 2833-2836 from COMPUSTAT then identified those firms whose first 6 digits of COMPUSAT CUSIP codes were the same as SDC CUSIP codes. The first round of matching yielded 372 focal firms. Second, due to changes in company names, CUSIP

codes, and the differences of recording systems, the discrepancy between SDC and COMPUSTAT could result in substantial loss of data. I tracked the name of each company in the Company Code database of COMPUSTAT as well as the SEC filings, resulting in 209 more focal firms identified. Overall, I identified 1,614 alliances involving 581 publicly traded focal firms in the sample, accounting for 80.9 percent of the alliances and 71.6 percent of the firms. High percentage of the public firms therefore limited the potential biases that may come from the lack of financial information for private partners (Lavie & Rosenkopf, 2006).

The unit of analysis is firm-year; therefore I transformed the data to firm-year observations by pooling the data across all alliances formed by each focal firm in a given year. For each focal firm, between the year when it formed its first alliance and the year when it established the last one recorded in the database, I assigned a value of zero to alliance formed in a given year when it did not have alliance records. A value of zero was also assigned to the year before its first alliance and to the year after its last alliance. The final data included 4,202 firm-year observations.

2.3.3 Measures

Exploration and exploitation alliances. The dependent variables, exploration and exploitation alliances, were constructed by counting the number of exploration or exploitation alliances for each sampled firm in a given year. Following previous research (e.g., Koza & Lewin, 1998; Rothaermel & Deeds, 2004), I coded exploration and exploitation alliances by considering the nature of the alliance activity. Those focusing on basic research, drug or

biomedicine discovery and development were coded as exploration alliances. The following is an example of an alliance announcement I coded as exploration:

August 30, 1988 - Calgene and Campbell Soup Co. signed an agreement to jointly develop a genetically-engineered gene for fresh tomatoes. The two companies developed an antisense polygalacturonase gene, which suppressed the levels of polygalacturonase in tomatoes, thereby reducing pectin degradation and fruit softening. This "Flavr Savr" gene prolonged shelf life, enhanced resistance to post-harvest disease, and also allowed the tomatoes to better survive handling during shipments.

Alliances that were associated with commercialization or downstream activities on the value chain, such as clinical trials, licensing, marketing and sales, were classified as exploitation alliances. An example of exploitation alliance is as following:

December 31, 1989-Cambridge Biotech Corp and Diagnostics Pasteur signed a cross licensing agreement which granted each other access to each participant's AIDS and HTLV-1 antibody diagnostics.

Market uncertainty. The independent variable, market uncertainty, captures the industry level of environmental uncertainty. I used objective measures based on the original work of Tosi, Aldag, and Storey (1973), which has been applied frequently in previous studies (e.g., Bourgeois, 1985; Folta, 1998; Gohosh & Olsen, 2009; Sasson, 2008). This variable is measured by computing the coefficient of variation in the industry. I calculated the volatility of sales over five years in several steps, using the following formula:

$$\text{Coefficient of Variation} = \sqrt{\frac{\sum_{i=1}^5 (y_i - \bar{Y})^2}{5}} / \bar{Y} \quad (1)$$

Where

Y_i = average sales in year i in this industry;

\bar{Y} = average sales over the five year period in this industry.

The coefficient of variation of a focal year was calculated based on the five-year period prior to this year. First, the industry averages of sales per year were computed. Then I calculated the sum of the one-fifth of the squared term of the average sales for each year minus the average sales over the five-year period. And the square root of the sum was divided by the average sales over the five-year period.

Organizational slack. Previous studies have measured organizational slack in multiple ways, including accounting-based financial and non-financial measures (Bradley, Shepherd, & Wiklund, 2011; Daniel, Lohrke, Fornaciari, & Turner, 2004; Nohria & Gulati, 1996). Reliance on standard financial data to measure organizational slack can be traced back to the early work of Bourgeois (1981) and has been applied frequently in subsequent slack research (e.g., Bradley et al., 2011; Mishina, Pollock, & Porac, 2004; Nohria & Gulati, 1996; Zajac, Golden, & Shortell, 1991). Organizational financial slack allows firms to allocate the spare resources for various uses (Bradley et al., 2011). Along this line of research, I measured organizational slack using the following three items: 1) retained earnings, 2) working capital as a percent of sales, and 3) debt as a percent of equity.

Innovative capacity. Scholars have used both subjective and objective measurements to capture firms' innovative capacity (e.g., Coad & Rao, 2008; Song, Droge, Hanvanich, & Calantone, 2005; Zhou & Wu, 2010). In this study, I employed the objective measurement using the R&D intensity as an indicator for innovative capacity (Lavie & Rosenkopf, 2006). It was

operationalized as the ratio of a firm's annual R&D expenses over its assets. Prior research indicates that R&D spending is a good indicator of the firm's technological position (Hall, 2004). A firm's R&D intensity represents their innovative and technological capacity inside the firm, which may affect their external exploration activities (Lavie & Rosenkopf, 2006).

Control variables. I controlled for firm-specific factors that might influence their inclination to engage in exploration and exploitation alliances. *Firm size* has been examined in previous studies with mixed findings regarding its impact on the tendency to explore versus exploit (Beckman et al., 2004; Lavie et al., 2010; Rothaermel & Deeds, 2004). I controlled for this confounding factor measured by the logged value of a firm's assets in a focal year. *Firm performance* measured as the ratio of net income to total assets (ROA) was included to account for the possibility that financial performance might drive exploration or exploitation (Lavie & Rosenkopf, 2006; Levinthal & March, 1993). ROA is commonly used in current literature as an objective measure of organizational profitability or economic performance (Bae & Gargiulo, 2004; Lin, Yang, & Arya, 2009). Further, I controlled for prior *exploration and exploitation alliance experience*. A firm's past experience in exploration and exploitation alliances are highly likely to affect its tendencies to engage in exploration or exploitation alliances in the future (Ahuja, 2000; Lavie & Rosenkopf, 2006; Tsai, 2001). Therefore, following previous research (Anand & Khanna, 2000; Lavie & Rosenkopf, 2006), I operationalized past exploration and exploitation alliance experience as a count of all prior exploration and exploitation alliances formed by a focal firm between 1985 and the preceding year. Finally, I included the number of exploitation alliances in a given year as a control variable in the regression analysis of

exploration alliances, and the number of exploration alliances in exploitation alliances regression.

2.3.4 Analysis

I used Bayesian multilevel models to test the influence of organizational and environmental factors on firms' alliance activities. Suggested by strategy scholars in recent years (Hahn & Doh, 2006; Hansen, Perry, & Reese, 2004), Bayesian methods are especially useful in detailed examinations of strategy problems in complex business environments which are increasingly characterized by change and uncertainty. The Bayesian approach is superior to traditional methodological approaches in potentially accounting for variables and relationships that may go unobserved (Hahn & Doh, 2006). As the two dependent measures were count variables, I used the Poisson models and log link to test the hypotheses. To incorporate unobserved firm heterogeneity, I introduced a firm-specific intercept term in the multilevel Poisson models by including firm as a random effect, as follows:

$$\log (\textit{Exploration alliances}_{(ft)}) = \beta_R X_{(ft)} + K_{Rf} + e_{R(ft)} \quad (2)$$

$$\log (\textit{Exploitation alliances}_{(ft)}) = \beta_I X_{(ft)} + K_{If} + e_{R(ft)}$$

where f subscripts the firms and t subscripts time; β_R and β_I are the parameter estimates for the effect of the various explanatory variables at the Exploration alliances and Exploitation alliances respectively; K_{Rf} and K_{If} represent the firm-specific term for incorporating unobserved heterogeneity; and $e_{R(ft)}$ stands for the error term. Due to the prevalence of zero outcomes in the dependent variables, I fit a zero-inflated multilevel Poisson (ZIP) model (Gelman & Hill, 2007).

I estimated the ZIP model specified in equation (2) using Markov Chain Monte Carlo (MCMC) methods (Gilks, Richardson, & Spiegelhalter, 1998). MCMC estimation methods allow full distributions of the parameters through simulation (Hahn & Doh, 2006). An inverse Wishart prior distribution was used for the firm and residual variance components, and a multivariate normal distribution was used for other fixed effects. I allowed 20,000 iterations to elapse to give the simulation to reach its final steady state. The mode and the 95% credible interval (CI) of the simulated posterior distribution were used to estimate fixed and random effects, as is standard in Bayesian models. For model comparison purposes, I estimated five models for both dependent variables respectively: (1) a model with only the control variables as explanatory variables, (2) a model with both control variables and firm-specific factors, and (3) a model with all the firm-specific, environmental, and control variables. The deviance information criterion (DIC) was used to compare the models, where smaller values indicate better fit (Hadfield, 2010). All models were fit using the MCMCglmm R package (Version 2.13.1; Hadfield, 2010).

2.4 Results

Table 2 presents the descriptive statistics and correlations of variables. I did not observe high correlations among independent variables, and I also checked whether multicollinearity might be a threat. I examined the variance inflation factor value for each variable, all of which were far below the recommended limit of ten (Chatterjee & Price, 1991), suggesting that multicollinearity is not a threat to the validity of the findings.

Modeling results are provided in Table 3. I included the control variables and explanatory variables to test the different hypotheses in multiple models step by step. When necessary, the

variables were mean-centered to generate their interaction terms. Models M1 to M5 are regressions on exploration alliances and Models M6 to M10 use exploitation alliances as dependent variable. M1 and M6 include only control variables. Then I added firm-specific factors in Models M2 and Model M7. Models M3 and Model M8 represent models with all predicting variables. Models M4 and M9 included the interaction of innovative capacity and market uncertainty, and finally M5 and M10 included the interaction of organizational slack and market uncertainty. Based on DIC values, the model fit generally improves when I included more variables into the regression of two dependent variables respectively.

Table 2 Descriptive Statistics and Correlation Matrix

Variables	Mean	s.d.	1	2	3	4	5	6	7	8
1. No. of exploitation alliances a	.12	.36								
2. No. of exploration alliances a	.36	.69	.04**							
3. Firm size b	2.15	1.14	.11**	.23**						
4. Firm performance c	-.49	3.69	.03	.02	.23**					
5. Past exploitation experience a	.61	1.50	.10**	.24**	.52**	.06**				
6. Past exploration experience a	1.62	3.87	.05**	.30**	.51**	.05**	.71**			
7. Innovative capacity d	.32	.51	.05**	-.04*	-.40**	-.20**	-.14**	-.12**		
8. Organizational slack e	.01	.57	.03*	.15**	.26**	.03	.27**	.34**	-.09**	
9. Market uncertainty a	.07	.04	-.05**	-.02	.17**	-.01	.05**	.10**	.02	.05*

^a $N = 4,202$; ^b $N = 2,520$; ^c $N = 2,515$; ^d $N = 2,469$; ^e $N = 2,369$; * $p < .05$ ** $p < .01$ (2-tailed)

Table 3 Zero-inflated Poisson Models of Control and Independent Variables against Exploration and Exploitation Alliance Founding ^a

Predictor Variables	Exploration alliances ^b					Exploitation alliances ^b				
	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10
Firm size	.327*** [.25, .37] ^c	.272*** [.16, .41]	.133*** [.03, .23]	.203*** [.08, .34]	.261*** [.17, .36]	.319*** [.06, .50]	.378*** [.22, .53]	.094** [.03, .15]	.360*** [.23, .47]	.028 [-.05, .10]
Firm performance	-.078*** [-.09, -.06]	-.080*** [-.12, -.04]	-.044*** [-.05, -.04]	-.043 [-.09, .00]	-.071*** [-.11, -.03]	-.120*** [-.18, -.04]	.116*** [.04, .16]	.042*** [.01, .07]	-.206*** [-.23, -.15]	-.061*** [-.09, -.05]
Past exploration experience	-.013* [-.03, -.00]	-.011 [-.03, .01]	.024*** [.01, .04]	.020* [.00, .04]	.010 [-.01, .03]	.040** [.01, .06]	.038 [-.01, .10]	.020 [-.02, .04]	.008 [-.02, .04]	.028** [.01, .04]
Past exploitation experience	.111*** [.07, .15]	.078*** [.03, .13]	.019 [-.00, .04]	.026 [-.03, .08]	.013 [-.04, .08]	-.147* [-.23, -.01]	-.005 [-.12, .11]	-.049 [-.11, .02]	.013 [-.14, .12]	-.007 [-.08, .06]
Current exploitation/ exploration experience	.032 [-.14, .10]	.106 [-.03, .25]	.170*** [.09, .27]	.123 [-.04, .30]	-.006 [-.15, .11]	.116*** [.04, .24]	.032 [-.07, .12]	.066 [-.02, .17]	.020 [-.13, .25]	.183*** [.14, .23]
Innovative capacity (IC)		-.040 [-.24, .16]	-.239*** [-.38, -.11]	-.270 [-.61, .06]	.067 [-.12, .24]		.576*** [.12, .87]	.246* [.07, .40]	-1.171*** [-2.28, -.45]	-.466 [-.77, .13]
Organizational slack		.132* [.02, .26]	.171*** [.10, .27]	.010 [-.04, .23]	.548** [.23, .89]		-.892*** [-1.29, -.36]	-.293*** [-.51, -.08]	-.626** [-.88, -.11]	-.798*** [-1.03, -.52]
Market uncertainty (MKT)			-2.700*** [-4.30, -.96]	-3.614*** [-5.57, -1.89]	-2.707* [-4.55, -.65]			-2.683*** [-4.18, -1.34]	.690 [-2.31, 4.27]	-2.159 [-4.15, .79]
MKT x IC				2.551* [.15, 5.30]					8.237*** [4.65, 13.09]	
MKT x Slack					-1.766** [-3.17, -.48]					2.458*** [.99, 3.32]
DIC	3800.27	3795.25	3731.05	3791.85	3789.64	1886.65	1782.99	1817.142	1787.80	1852.64

a. Coefficients are the mode of the posterior distribution; * p < .05; ** p < .01; *** p < .001

b. Dependent variables

c. 95% CI

In Hypothesis 1, I predicted that a firm with higher level of innovative capacity will be more likely to form exploitation alliances than exploration ones. Model 2 and Model 5 in Table 2 shows that an increase in the rate of the focal firm's innovative capacity serves as a significant predictor of its number of exploitation alliances formed ($b = .576, p < .001$), and innovative capacity is negatively associated with and has non-significant effect on the number of exploration alliances. Thus, Hypothesis 1 is supported, indicating that firms with higher level of innovative capacity are more likely to form exploitation alliances than exploration alliances. Hypothesis 2 postulated that a firm with higher level of organizational slack will be inclined to form more exploration alliances than exploitation ones. As shown in Model 2 and Model 5, organizational slack was significantly and positively associated with the number of exploration alliances ($b = .132, p < .05$) as well as significantly and negatively related to the number of exploitation alliances ($b = -0.892, p < .001$), supporting Hypothesis 2. As expected, the results confirm that capable firms with abundant slack resources tend to explore new opportunities through alliances. I next turn to environmental factors in the industry. I predicted in Hypotheses 3 that market uncertainty will diminish the number of both exploitation alliances and exploration alliances. For Hypothesis 3, the results in Model 3 show that market uncertainty is negatively associated with the number of exploration alliances ($b = -2.700, p < .001$) and results in Model 8 show that it is negatively and significantly predicting the number of exploitation alliances ($b = -2.683, p < .001$), supporting Hypothesis 3. Although the focal firms may be motivated to exploit or explore in order to mitigate market uncertainty, it is difficult to evaluate the potential of uncertain markets. Unpredictable returns discourage the willingness of potential partners, decreasing the realization of both exploration and exploitation collaborations. Regardless, the

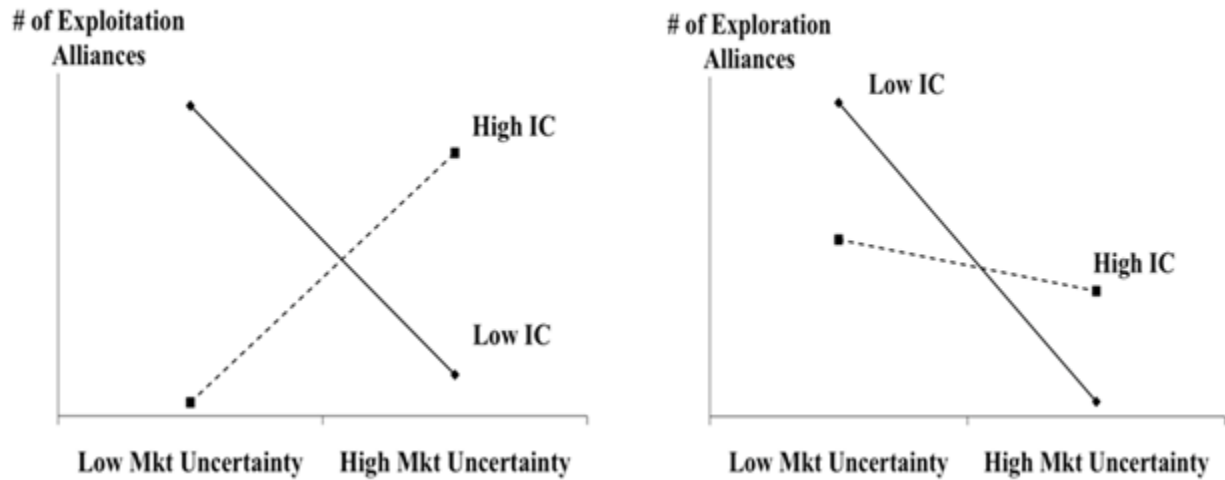
findings support the position that firms tend to respond to environmental turbulence by constructing its alliance portfolio. The ‘industry’ affects the configuration of exploitation and exploration alliances in a firm’s portfolio. Hypothesis 4 posits that innovative capacity moderates the relationship between market uncertainty and exploitation/exploration alliance formation, such that firms with higher level of innovative capacity tend to be more willing to form such alliances in uncertain markets. Model 4 and Model 9 together test this hypothesis. The coefficient of the interaction term (Market uncertainty X Innovative capacity) in both models are positive and significant ($b = 2.551, p < .05$ in Model 4; $b = 8.237, p < .001$ in Model 9), indicating a positive moderating effect. Theoretically, it shows that higher level of innovative capacity will enhance the likelihood or mitigate the unwillingness to form exploitation versus exploration alliances in uncertain markets. Figure 2 visualizes the moderating effect of innovative capacity. It shows that with respect to exploitation alliances, firms with high level of innovative capacity tend to form more exploitation alliances as market uncertainty increases; in contrast, firms with low level of innovative capacity tend to form less exploitation alliances as market uncertainty increases. Regarding exploration alliances, Figure 2 shows that firms with high level of innovative capacity tend to be less unwilling to engage in exploration alliances as market uncertainty increases, compared to firms with low level of innovative capacity. Therefore Hypothesis 4 is generally supported. Finally, Hypothesis 5 looks at the moderating effect of organizational slack. I posit a positive moderating effect of organizational slack, similar to innovative capacity. Model 5 and Model 10 together test this hypothesis. The coefficient of the interaction term in Model 10 is positive and significant ($b = 2.458, p < .001$), whereas that in Model 5 it is negative and significant ($b = -1.766, p < .01$). The results indicate that the hypothesized moderating effect is

supported with respect to exploitation alliance formation, but the reverse effect is found with respect to exploration alliance formation. As can be seen from Figure 2, firms with high level of organizational slack tend to establish more exploitation alliances as market uncertainty increases. However, such firms tend to form less exploration alliances in highly uncertain markets. Hypothesis 5 is therefore partially supported. This finding somehow affirms the risk adverse side and the complacency nature of firms when faced with uncertainty. In uncertain environment, firms may tend to avoid such risk-taking activities as exploration alliances; when they are blessed with high organizational slack, firms may be inclined to be complacent and further decline risk taking.

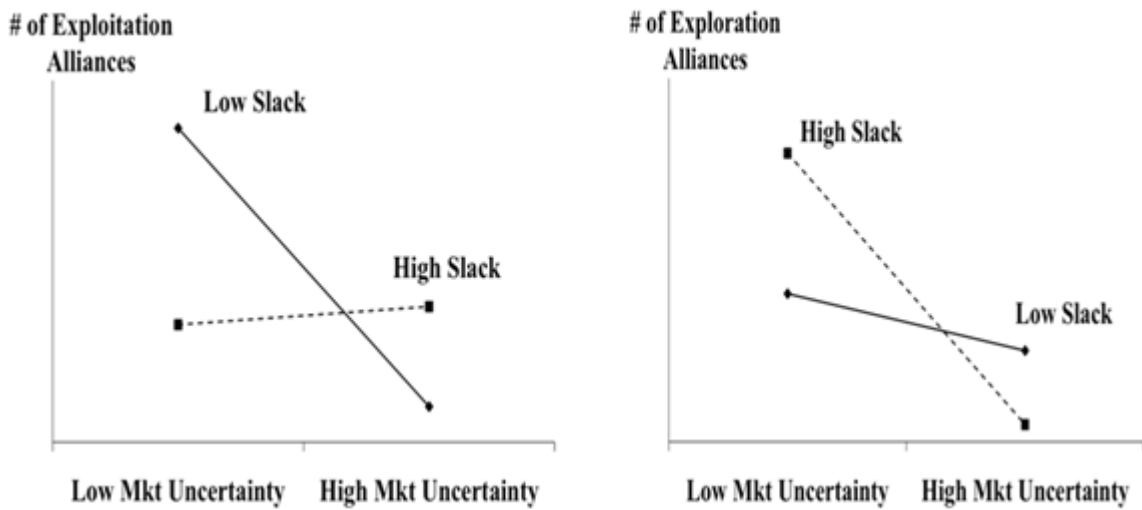
To summarize, I find support for the expected effects for the main effects of firm-specific factors and environmental factor. A firm's level of innovative capacity and that of slack resources have diverging effects on the formation of exploitation and exploration alliances. I also find that environmental conditions such as market uncertainty relate to exploitation versus exploration alliance decisions. Market uncertainty reduces the formation of both exploration and exploitation alliances. Both organizational and industrial conditions shape organizational strategic choices. In addition, organizational conditions influence the industry's impact on firms' strategic actions.

Figure 2 Interaction effects of organizational factors and market uncertainty

Interaction Effect between Innovative Capacity and Market Uncertainty



Interaction Effect between Organizational Slack and Market Uncertainty



2.5 Discussion

This paper examines the antecedents of exploration and exploitation alliances formed by firms in the U.S. biopharmaceutical industry. The findings generate insights for existing research on exploration-exploitation in strategic alliances which falls short of understanding that why organizations pursue exploration or exploitation alliances (Lavie et al., 2010).

The results showed that firms with high innovative capacity tend to seek more external exploitative collaborations as opposed to explorative collaborations. It is at first sight countering the conventional wisdom in organizational learning literature that firms with higher level of innovative capacity are able to identify and absorb external knowledge and learning opportunities through exploration activities (Lavie & Rosenkopf, 2006). However, a deeper examination could reveal that the focus of exploitation-exploration varies. Organizational learning suggests that higher level of innovative capacity tends to lead to more exploration activities, mainly pertaining to internal product/innovation exploration, whereas this study focuses on exploration alliance as a form of external collaboration. Firms with high innovative capacity could emphasize internal exploration more than external exploration collaborations, and leverage exploitation alliances. My finding is in consistency with the work of Wang and Li (2008) that suggests firms with higher technological capability make less effort in explorative search beyond the firm. This finding expands March's exploration-exploitation learning framework, which traditionally provides insights to internal activities to the context of strategic alliances. The results also tap on the tension view of exploration and exploitation activities. When firms are endowed with more slack resources, they tend to invest more on exploration alliances as opposed to exploitation alliances. It indicates that exploration and exploitation do

compete for organizational resources, as firms make resource allocation decisions (March, 1991; Sorenson & Stuart, 2000). This finding also shows that firms build their strategic choices according to their organizational features. It is consistent with prior literature that advocates the positive role of slack resources in promoting exploration activities and its function as buffering the possible downside risks (Greve, 2007; Sidhu et al., 2004). The impact of organizational factors on a firm's alliance formation decision suggests that internal features help shape a firm's strategic choices.

The results also shed light on the role of environmental dynamism in exploration and exploitation alliances. Prior research has been debating that whether firms should explore or exploit in dynamic environments (Beckman et al., 2004; Jansen et al., 2006; Kim & Rhee, 2009; Sidhu et al., 2004); the findings provide two folds of implications. First, it is important to define the boundary and context of exploration-exploitation. Although Beckman et al. (2004) suggested that market uncertainty leads to more exploitation alliances, they considered forming alliances with prior partners as a form of exploitation. In essence, it is acknowledged that 'reinforcement' and 'stability' is critical in uncertain environment. This study, in contrast, focuses on the 'function' domain of exploitation versus exploration alliances. I found that uncertain market depresses the formation of both exploitation and exploration alliances. In such a context, both exploration and exploitation alliances are characterized of high degree of uncertainty due to the uncertainty of alliances activities per se as well as the uncertainty of collaboration in turbulent market. As such, environmental dynamism will lead to less exploitation alliances and exploration alliances because firms long for uncertainty reduction through strategic actions. Second, I examined the interactions between environmental uncertainty and organizational features. The

results show that organizational specific factors influence its response to external environment. When firms have high level of innovative capacity and organizational slack, they tend to be more courageous in forming alliances in uncertain markets. To some extent, with higher capability and better endowments, organizations tend to be more proactive as opposed to passively respond to the changes in the external environment.

Some of the secondary findings from control variables are also worth highlighting. I find that increase in organizational size tends to increase the number of exploitation alliances as well as exploration alliances formed by firms. Although current literature generates conflicting findings regarding the impact of organizational size on firms' tendency to explore versus exploit (Lavie et al., 2010), my finding tend to support both sides of the story. The organizational inertia perspective argues that larger firms are more inclined to engage in exploitation alliances due to increasing inertia. The result is in consistence with the findings of prior research in similar context supporting this line of logic (Rothaermel & Deeds, 2004). The resource-based perspective asserts that larger organizations can support exploration in their alliances because they have better access to resources. My finding resonates with that of Beckman et al. (2004), whose findings show that large firms respond to external stimuli by forming more exploration and exploitation alliances. To some extent, these findings supports the conclusion made by Gupta et al. (2006) that organization context matters: as firm size increases, exploitation and exploration may tend to be orthogonal rather than competing ends of a continuum since firms are more capable of supporting both activities. In addition, the results indicate that a firm's past exploitation (exploration) experience tends to facilitate its formation of exploration (exploitation) alliances whereas reduces the formation of additional exploitation (exploration) alliances. These

results, in a sense, indicate the propensity that organizations may balance their exploration and exploitation activities over time and exploitation may reinforce exploration activities, as argued by other scholars in previous studies (Lavie & Rosenkopf, 2006).

On the aggregate, I find that a firm's strategic choice between exploration alliance versus exploitation alliance is a reflection of both organizational intention as well as an adaption to environmental turbulence. This finding is in line with the literature of organizational adaption (Brown & Eisenhardt, 1997; Raisch & Birkinshaw, 2008). Organizations are able to respond to environmental change, while those with capabilities are likely to craft its strategic choice configurations based upon its own characteristics, suggesting the possibility of organizational balance between continuity and change. This study is, of course, not free of limitations. Some of the limitations of this study could be addressed by future research efforts. First, although I simultaneously examined both organizational and environmental antecedents of exploration and exploitation alliances, I included only a limited number of factors. Future research can examine a variety of organizational and environmental factors and untangle more confounding interactions between organizational and industry conditions. For example, more environmental triggers could be investigated to answer to the claim that the multidimensionality of environment dynamism should be taken into account when scholars study its implications for organizations (McCarthy, Lawrence, Wixted, & Gordon, 2010). Besides, the combinations of more organizational conditions and environmental forces may provide richer understanding of organizations' exploration and exploitation choices (Lavie et al., 2010).

Second, I treated organizations' exploration and exploitation alliances as separate dimensions and controlled for firms' past experience in exploration-exploitation, thus leaving out

the issue of balancing exploration and exploitation. The secondary findings indicate that firms may balance between exploration and exploitation tendencies. Organizational and environmental pressures may result in conflicting demands for short-term efficiency and long-term effectiveness (Lavie et al., 2010; Smith & Tushman, 2005). Future research is encouraged to investigate the organizational factors and environmental contingencies to uncover whether and how firms balance between exploration and exploitation alliances. In this regard, a time dimension could be further introduced to longitudinally assess under what conditions firms will temporally adjust exploration and exploitation alliances.

Third, I focus on the antecedents of exploration-exploitation framework in the context of strategic alliances, which tells the first half of the story. Future research could examine the other half of the story, the consequences of exploration and exploitation alliances. The performance implication of strategic decision is an important element in the literature of strategic management research. However, research on the performance implications of exploration and exploitation alliances has been scant (Lavie et al., 2010). It is meaningful to study their consequences to provide insights and guidance for practice. For instance, when will exploration and exploitation alliances generate superior performance? How could firms balance between these two choices to achieve better performance? It is worth emphasizing that scholars need to carefully define the concepts and the applied contexts of their studies to prevent misleading prescriptions.

Finally, this study is context specific and future research could extend the study to other industries. I chose biopharmaceutical industry as the research setting for its unique characteristics, including intense resource commitment in innovation and exploration, high environmental uncertainty, and heavy regulation. Given that the findings have suggested some

consistent patterns found in prior research of similar contexts, the generalization of the findings could likely be applied in some high-tech industries with similar characteristics. More evidences from other distinctive contexts could better our understanding of organizational exploration and exploitation behavior.

3. Chapter Three: Alliance Ambidexterity and Firm Performance: Managing Exploration and Exploitation Alliances

3.1 Introduction

Rooted in the literature of organizational action, scholars have been studying exploration and exploitation as adaptive processes of organizations (Holland, 1975; Schumpeter, 1934). Both activities are considered critical elements for a firm's sustainable competitive advantage, yet are acknowledged to be two conceptually distinctive constructs in current literature. Scholars have pointed out that carrying out these two activities entails substantially different organization structures, processes, and resources (e.g., He & Wong, 2004; Lavie et al., 2011; Lavie & Rosenkopf, 2006; March, 1991). In particular, exploration is argued to be associated with organic structures, loosely coupled systems, flexibility and change. Exploitation, in contrast, is considered to be associated with mechanistic structures, tightly coupled systems, routinization, stability and inertia (Brown & Eisenhardt, 1997; Lavie et al., 2010; Lewin, Long, & Carroll, 1999). Besides, exploitation and exploration generate diverging outcomes such that exploration generates greater performance variation, whereas exploitation yields more stable outcome (March 1991). The trade-off between them indicates that exploration and exploitation compete for limited organizational resources (March 1991). Earlier research considers it a dilemma (Smith & Lewis, 2011) and splits opinions on whether exploitation or exploration is more desirable. For example, exploitative search is argued to contribute to internal accumulation of strategic knowledge and asset stocks (Dierickx & Cool, 1989) which becomes a source of firm's competitive advantage (Barney, 1991; Kogut & Zander, 1992). In contrast, exploration allows a

firm to move beyond local search and to reconfigure its knowledge base, which is critical to create sustainable competitive advantage (Rosenkopf & Nerkar, 2001; Teece et al., 1997). As such, organizations usually need to make choices between exploitation and exploration, yielding different performance implications.

The distinctive characteristics associated with exploration and exploitation posit a challenge for organizational decision making as to how to invest in different types of activities (He & Wong, 2004). However, despite that exploration and exploitation entails conflicting strategies, recent research has been increasingly emphasizing organizations' dual orientation and that the overall success depends on exploring and exploiting simultaneously (Cao et al., 2009; Gibson & Birkinshaw, 2004; He & Wong, 2004; Lavie et al., 2011; Rothaermel & Deeds, 2004; Smith & Lewis, 2011; Tushman & O'Reilly, 1996). Scholars have argued that exploration and exploitation are mutually reinforcing to facilitate a firm's long-term success through interwoven organizational learning (Andriopoulos & Lewis, 2009; He & Wong, 2004). Exploitation provides the foundational knowledge that enhances absorptive capacity and stimulates experimentation, leading to more exploration which, in turn, creates more organizational knowledge to exploit (Smith & Lewis, 2011). Consequently, an ambidextrous firm that is capable of both exploiting existing competencies and exploring new opportunities is argued to be more competitive with higher performance (Levinthal & March, 1993; March, 1991). This assertion has become a general agreement in the literature with plenty of studies examining the performance implications of organizations' dual orientation regarding exploration and exploitation (e.g., Cao et al., 2009; Gibson & Birkinshaw, 2004; He & Wong, 2004; Lavie et al., 2011; Rothaermel & Deeds, 2004; Tushman & O'Reilly, 1996). Prior research has advocated that "maintaining an

appropriate balance between exploration and exploitation is a primary factor in system survival and prosperity” (March, 1991: 71).

Although researchers have suggested that an ambidextrous approach is beneficial for firm performance, balancing exploration and exploitation has been prevalently argued to be a challenge for organizations. Prior research has proposed several approaches in an attempt to explain how organizations can successfully achieve a balance between exploration and exploitation activities (e.g., Benner & Tushman, 2003; Brown & Eisenhardt, 1997; Lavie et al., 2011; Tushman & O'Reilly, 1996). A classic approach is structural ambidexterity where organizations manage trade-offs between conflicting demands through structural separation with some business units focusing on exploitation and others on exploration (Duncan, 1976; Gibson & Birkinshaw, 2004). Another approach is temporal ambidexterity where organizations promote either exploration or exploitation temporally and sequentially (Boumgarden et al., 2012; Gulati & Puranam, 2009; Siggelkow & Levinthal, 2003). Exploitation pursuits are punctuated by periods of exploration such that organizations achieve high levels of both exploration and exploitation overtime (Burgelman, 2002; Tushman & O'Reilly, 1996; Tushman & Romanelli, 1985). In recent years, scholars have proposed a third approach, referred to as contextual ambidexterity (Gibson & Birkinshaw, 2004). Organizational ambidexterity is argued to be achieved by building a context that facilitates individual decision making to reach the optimal balance of alignment and adaptability. More recently, a fourth approach arises in the strategic alliance literature. Domain ambidexterity, proposed by Lavie, Kang and Rosenkopf (2011), advocates a balance between exploration and exploitation across different domains to bypass the conflicting routines associated with these two activities. They argue that exploration and

exploitation across different domains generate less conflicts and resource constrains.

Consequently, firms can explore in one domain while exploit in another to realize organizational ambidexterity.

There have been extensive discussions of the merits and constrains of different approaches in the literature. One common assumption held in the arguments of various approaches is that exploration and exploitation are in tension. Scholars have also been examining the different contingencies for the optimal approach. However, empirical studies have been surprisingly inadequate and inconclusive as to how the balance of exploration and exploitation influences firm performance (He & Wong, 2004; Lavie et al., 2011; Lavie et al., 2010). Among the limited amount of current research, empirical evidence of performance effects has been relatively limited to anecdotal case studies (e.g., Brown & Eisenhardt, 1997; Tushman & O'Reilly, 1996). More research based on large samples is critical to provide more evidences from different perspectives.

In the literature of strategic alliances, scholars have applied the concepts exploitation and exploration to examine alliance ambidexterity. Koza and Lewin (1998) suggested that firms establish strategic alliances to jointly exploit existing knowledge or to explore new opportunities. Alliances are formed to access markets, develop new products and services, and leverage each other's resources and capabilities (Gulati, 1998; Lavie & Rosenkopf, 2006). For example, UPS and Toshiba have collaborated to exploit existing competencies by fine-tuning global supply chain operations and streamlining freight movement on the one hand, and to explore innovations by co-developing innovative solutions such as repair-and-reverse-logistics-process for laptops on the other hand (Hesseldahl, 2004). Although scholars have suggested the importance of

understanding the challenges and consequences of exploration and exploitation in strategic alliances (Im & Rai, 2008; Koza & Lewin, 1998), ambidexterity in alliance has remained much less studied. First, there is limited understanding regarding how exploration and exploitation alliances impact firm performance (e.g., Im & Rai, 2008; Lavie & Rosenkopf, 2006). Previous studies have argued that exploration and exploitation drive out each other (Benner & Tushman, 2002, 2003), or reinforce each other (He & Wong, 2004). However, we do not know much about the performance implication of exploration and exploitation in the context of strategic alliances. Second, firms' tendencies toward exploration versus exploitation may be driven by various triggers such as industry events, leadership changes, or resource constraints (Lavie & Rosenkopf, 2006; Nickerson & Zenger, 2002; Park et al., 2002). Thus, performance implication of ambidexterity approach in alliance formation is contingent on organizational characteristics and external conditions (He & Wong, 2004; Lavie & Rosenkopf, 2006; Lin et al., 2007). Nevertheless, previous findings on alliance ambidexterity have shed little light on contingent conditions. Third, the optimal organization designs that facilitate exploration and exploitation in strategic alliances have been paid scant attention to (Im & Rai, 2008; Lavie et al., 2011). The abovementioned approaches have received scarce empirical examination in strategic alliance literature. For instance, as a recently proposed approach, domain separation has received little research attention, with the vast majority of previous research focusing on a single domain. However, as argued by Lavie and his colleagues (2011), domain separation is a noteworthy approach because "it does not entail separate organizational units with distinctive sets of conflicting routines. Instead, it offers flexibility for firms to underscore either exploration or exploitation within each domain as long as balance is maintained across domains".

In an attempt to address some of the above-mentioned research gaps, in this chapter, I investigate the balance of exploration and exploitation activities in the context of strategic alliance, by focusing on two organizational designs, i.e., temporal separation and domain separation. Previous studies have suggested a further examination on the contingencies of strategic activities. I therefore consider firm-size an important contingent condition because prior research has suggested that firm size is an indicator of a firm's available resources and capabilities, which are pivotal in the strategic choice between exploration and exploitation. In the following sections, I will present the theoretical background and hypotheses, followed by method and analysis, and conclude with a discussion.

3.2 Theoretical Background and Hypotheses

3.2.1 Balancing Exploration and Exploitation in Alliances

It has been prevalently established in the literature that firms need both exploration and exploitation to sustain longevity, despite that these two activities are in tension. An optimal level of the combination of exploration and exploitation is desirable, whereas over-exploration or over-exploitation impedes long-term performance (Wang & Li, 2008). Research has indicated that firms relying on excessive exploitation tend to have difficulty in maintaining their leadership positions in the industry (Tushman & O'Reilly, 1997), whereas excessive exploration could also hurt firm performance (Wang & Li, 2008). Maintaining an ambidexterity of exploration and exploitation allows firms to leverage the synergy of the unused potential of both activities thus increases subsequent performance (Jansen et al., 2012). For instance, when a firm regularly

makes adaptations to existing products and also develops new products, it tends to benefit from both the increasing market share of existing markets and the creation of new revenue sources generated from new product development, leading to enhanced performance (Jansen et al., 2012).

However, the joint pursuit of exploration and exploitation is inherently challenging. It is assumed in the literature that firms ought to maintain a balance between exploration and exploitation in order to achieve performance enhancement (Rothaermel & Alexandre, 2009). As pointed out by Levinthal and March (1993, p. 105), “the basic problem confronting an organization is to engage in sufficient exploitation to ensure its current viability and, at the same time, to devote enough energy to exploration to ensure its future viability.” Nevertheless, they also suggested that “the precise mix of exploitation and exploration that is optimal is hard to specify”. Hence, in this study, I do not define balance strictly as an equal split between exploration and exploitation. Instead, a balance between exploration and exploitation represents sufficient engagement in both activities which will potentially facilitate firm performance. The difficulty of finding and maintaining a balance between exploration and exploitation is acknowledged in the literature and scholars have provided guidance on how to reconcile the inherent tensions between them (Boumgarden et al., 2012; Lavie et al., 2011; Raisch & Birkinshaw, 2008). One of the approaches that have received limited empirical examination is the temporal approach, which may also be referred to as ‘organizational vacillation’ (Boumgarden et al., 2012), or ‘temporal separation’ balance (Gibson & Birkinshaw, 2004). This approach entails dynamically oscillating between exploration and exploitation over time to achieve high levels of both exploration and exploitation (Gibson & Birkinshaw, 2004; Gulati &

Puranam, 2009; Nickerson & Zenger, 2002; Siggelkow & Levinthal, 2003). It asserts that by sequentially alternating between the focus of exploration and exploitation rather than promoting both of them simultaneously through dual structures, organizations could better avoid the conflicting routines and resource constraints of a dual-structure design (Boumgarden et al., 2012). However, despite the theoretical development, few studies have empirically examined the impact of temporal balance which demands more research efforts.

Another approach, the domain balance (Lavie & Rosenkopf, 2006), arises from the literature of strategic alliance. Prior research on alliance ambidexterity mainly distinguishes between exploration alliances and exploitation alliances based on the value chain function (e.g., Park et al., 2002; Rothaermel, 2001; Rothaermel & Deeds, 2004). Firms are considered to engage in exploration alliances in the function domain if the alliances are formed with partners to collaborate on upstream activities such as R&D initiatives. In contrast, exploitation alliances are formed for performing downstream activities of the value chain, such as commercialization of existing technologies. Therefore exploration alliances are associated with joint efforts of new technology and knowledge exploration in the upstream of value chain and exploitation alliances are tied to marketing and production cooperation in the downstream of value chain to leverage and integrate existing knowledge (e.g., Lavie & Rosenkopf, 2006; Park et al., 2002; Rothaermel, 2001; Rothaermel & Deeds, 2004). However, the alliance literature has suggested more than one domain of activities. Structure domain which refers to explore new ties or exploit existing ties by discretely selecting alliance partners allows a firm to manage and leverage the structure of its alliance portfolio (e.g., Lavie & Rosenkopf, 2006; Lin et al., 2007). Exploration alliances in structure domain present new opportunities by collaborating with new partners who possess fresh

resources and knowledge bases (Lavie et al., 2011; Lavie & Rosenkopf, 2006). In contrast, exploitation alliances in structure domain allow a firm to work with already acquainted partners with accumulated trust and reliability, thus reinforcing its knowledge base (Baum, Rowley, Shipilov, & Chuang, 2005; Beckman et al., 2004; Lavie & Rosenkopf, 2006). Despite the theoretical assertion that a firm's tendencies toward exploration versus exploitation alliances can take the form in both function and structure domains, very few studies have so far examined the performance implications of a 'domain balance', i.e., balancing exploration and exploitation alliances within and across these domains (Lavie et al., 2011; Lavie & Rosenkopf, 2006).

Furthermore, current research has been studying the impact of ambidexterity of exploration and exploitation activities on firm performance in a variety of contexts using different research methods, yielding inconsistent findings (He & Wong, 2004). For example, based on several case studies, Tushman and O'Reilly (1996) suggested that firms may not be able to manage ambidexterity successfully because the inherent tensions between the two are too difficult to reconcile. They argued that, essentially, exploration and exploitation entail fundamentally different logics and require distinctive strategies and organizational structures. In contrast, Knott (2002) found that Toyota was able to leverage the complementarity of exploration and exploitation which co-existed in its product development process. Other studies (e.g., Bierly & Daly, 2001) examining the impact of ambidexterity on firm performance, however, found no significant results. Even fewer studies have formally investigated the 'balance' between exploration and exploitation and its impact on firm performance. He and Wong (2004) examined how exploration and exploitation can jointly influence firm performance and found that their interaction enhanced sale growth rate, and that relative imbalance between

explorative and exploitative innovation strategies is detrimental to sales growth. Cao, Gedajlovic, and Zhang (2009) examined these two concepts by unpacking them into two dimensions: the balance dimension and the combined dimension. They found that both a balance between exploration and exploitation, and a combination of them have positive effects. The author also suggested that concurrent high levels of a balance and a combination yield synergistic benefits. Besides, a balance is more beneficial to resource-constrained firms, whereas a combination is more beneficial to firms with more resources. Lavie, Kang and Rosenkopf (2011), however, suggested that firms did not benefit from balancing exploration and exploitation within the function domain and structure domain respectively. But those balancing exploration and exploitation across these domains gain in profits and market value. In addition, larger firms amplify the benefits of balance across domains and the costs of balance within domains.

Overall, current research in balancing exploration and exploitation activities, especially in the context of strategic alliances, has been very limited and the empirical evidences provided have been far beyond conclusive. The confounding findings could be attributed to the approaches engaged, the contexts studies, as well as the industries examined. Firm- and industry-level attributes may predict the optimal level of balance (Wang & Li, 2008). Therefore, in an attempt to provide more evidences to the existing research stream, I investigate the balance of exploration and exploitation in the context of strategic alliances by embracing two approaches, i.e., temporal balance and domain balance.

3.2.2 Performance Implications of Balance within Domains

It has been generally accepted in the literature that exploration and exploitation are both essential for organizational performance (e.g., Boumgarden et al., 2012; Im & Rai, 2008; Lavie et al., 2011; Lavie & Rosenkopf, 2006). Exploitation allows firms to leverage existing knowledge and capabilities, whereas exploration enables firms to create new knowledge and opportunities. Furthermore, exploration and exploitation activities may reinforce each other to generate synergy and to enhance firm performance (Im & Rai, 2008). In a similar vein, exploration alliances and exploitation alliances could potentially benefit firm performance by allowing a firm to discover new opportunities or leverage existing competencies beyond its boundary (Koza & Lewin, 1998). Given the distinctive merits associated with exploration and exploitation activities, prior research has suggested that a balance between exploration and exploitation activities can help organizations achieve optimal performance (He & Wong, 2004; Uotila et al., 2009). An overwhelming emphasis on either exploration or exploitation would result in undeveloped ideas and missed opportunities or existing competencies obsolete (March, 1991). A balanced mix with both sufficient exploration and sufficient exploitation is the key to short-term and long-term success (March, 1991).

Nevertheless, exploration activities and exploitation activities entail inherently conflicting routines and trade-offs (Lavie et al., 2011). Research has indicated that exploration and exploitation rely on distinctive design elements, organizational processes, and operating routines (Boumgarden et al., 2012; Lavie et al., 2011; March, 1991). Essentially, it has been commonly argued in the literature that it takes a mechanistic and centralized organizational structure to promote exploitation, whereas an organic and decentralized structure is required to

promote exploration (Boumgarden et al., 2012; O'Reilly & Tushman, 2008; Thompson, 1967). Given the inherent conflicting nature of organizational design elements demanded by exploitation and exploration respectively, organizations could encounter organizational costs and incongruities (Boumgarden et al., 2012; Lavie et al., 2011). There are three folds of interrelated reasons arising from the tension between exploitation and exploration that can impair firm performance. First, exploitation and exploration are often at odds (Lavie et al., 2011). They represent distinctive strategic choices and orientations of organizations, and demand different organizational structures, resulting in strategic contradiction. As March (1991) has argued, both exploration and exploitation are self-reinforcing. Organizations that have accumulated substantial experience in either exploitation or exploration tend to engage in more existing knowledge leverage or new opportunity discoveries. Due to the self-reinforcing nature, exploitation and exploration tend to crowd each other out (Levinthal & March, 1993; March, 1991). It is therefore challenging to reconcile the tension and conflicting routines between exploration and exploitation (Tushman & O'Reilly, 1996). Second, it is argued that organizations encounter various costs associated with the configuration and maintenance of different organizational structures and design elements simultaneously (Boumgarden et al., 2012). Setup costs, administrative costs and costs of negative externality are the typical ones faced by ambidextrous organizations. Scholars claiming that ambidexterity leads to high performance implicitly assume that these costs do not significantly impair performance, which may not be upheld in all conditions. For example, the magnitude of negative externality could be substantially high given that ambidexterity is fundamentally against the notion of internal consistency in organizational design, rendering lower levels of organizational performance (Van

Looy, Martens, & Debackere, 2005). Third, scarcity of resources within organizations imposes further constraints on ambidexterity (March, 1991). The simultaneous pursuit of exploration and exploitation requires abundant resources to support the high level performance of both activities. Organizations with limited amount of resources often experience trade-offs when they strive to balance exploration and exploitation at the same time. Competition for scarce resource can be detrimental to firm performance (Lavie et al., 2011).

Strategic alliances are formed by organizations to access resources and knowledge beyond their organizational boundaries which are usually unavailable from within. Depending on a firm's strategic intent, organizational learning, or its expected returns, a firm may choose between exploration and exploitation in alliance formation (Koza & Lewin, 1998). It is argued that in the context of alliances, firms experience similar tension when they attempt to balance exploration and exploitation activities in their alliance portfolios (Lavie et al., 2011).

Organizational conflicts, negative externality, and resource allocation constraints shift from internal organization structures to alliance organization. Despite respective merits of exploration and exploitation alliances, however, balancing exploration and exploitation within domains demands the management of trade-offs and conflicting routines (Lavie et al., 2011). Balancing exploration and exploitation in alliance portfolio takes substantial operational resources. For example, within the function domain, exploration alliance tends to require high-risk investments in uncertain new technologies, while exploitation alliance needs financial capital for product commercialization and marketing. The trade-offs of resource allocation may diminish the effectiveness of the alliances. In addition, exploration alliances and exploitation alliances entail different and even conflicting search routines and processes, leading to organizational

inconsistencies when firms seek to balance them. The lack of a dominant logic can undermine the effectiveness of both types of alliances (Prahalad & Bettis, 1986). Recent empirical studies have provided evidences supporting this line of reasoning, as opposed to the balance declaim of simultaneous ambidexterity. For example, Lavie et al. (2011) studied the alliance portfolios of software firms and found that firm performance was negatively associated with a balance between exploration and exploitation alliance formation decisions. They demonstrated that firms do not typically benefit from such a balance within the function domain (technology versus marketing alliances) and structure domain (new versus prior partners). Based on an empirical study of five U.S. industries spanning eight years, Lin, Yang and Demirkan (2007) initially proposed a positive effect of balance between exploration and exploitation alliances on firm performance, yet their empirical result suggested the opposite effect. Their findings indicated that a mere pursuit of ambidexterity in alliance formation could actually hurt firm performance. Therefore, based on the above argument, I hypothesize that:

H1. At one static point of time, performance is likely to increase when a firm focuses on either exploration alliances or exploitation alliances.

3.2.3 Performance Implications of Temporal Balance

The majority of organizational ambidexterity research views ambidexterity as the simultaneous pursuit of both exploration and exploitation by adopting certain organizational configurations at one static point of time (Gupta et al., 2006; Raisch & Birkinshaw, 2008; Raisch et al., 2009). However, some scholars have argued that achieving ambidexterity is a dynamic process rather than static configurations and suggested that firms should vacillate through

periods of exploitation and exploration temporally (e.g., Brown & Eisenhardt, 1997; Nickerson & Zenger, 2002; Puranam, Singh, & Zollo, 2006; Raisch et al., 2009; Siggelkow & Levinthal, 2003; Venkatraman, Lee, & Iyer, 2007). The temporal balance approach regards the organization as a coherent system and proposes that, due to bounded rationality and sequential attention to divergent goals (Cyert & March, 1963), organizations can achieve ambidexterity by focusing on exploration at one point of time and exploitation at another (Brown & Eisenhardt, 1997). Introducing the temporal lens to organizational ambidexterity research allows for a deeper examination of the dynamic processes (Raisch et al., 2009).

Previous research has suggested two sets of benefits associated with a temporal balance of exploration and exploitation. First, as argued before, exploitation and exploration generate resource allocation trade-offs and conflicting routines, especially when firms pursue them simultaneously. Resource allocation trade-offs between exploitation and exploration activities as well as disruptions as a result of conflicting operation routines could lead to inferior performance (e.g., Lavie et al., 2010; Piao, 2010). A simultaneous pursuit of ambidexterity translates into contemporaneous resource sharing between exploitation and exploration. The tension gets accentuated when exploitation and exploration projects compete for scarce resources to obtain sufficient resources that are needed for them to survive and thrive. Consequently, firms pay a price for attempting to balance exploitation and exploration simultaneously. In contrast, a temporal balance by gradually shifting from one learning activity to the other can mitigate the tension and conflicts (Boumgarden et al., 2012; Lavie & Rosenkopf, 2006; Piao, 2010). On the one hand, a “sequential ambidexterity” of exploitation and exploration makes it possible for firms to spare more resources for a relative focused exploitation or exploration at certain point of

time without a high degree of tension invoked; on the other hand, firms are able to focus on one activity at a time with a lesser degree of interruption imposed by the other (Piao, 2010). As a result, firms can achieve a high level of both exploitation and exploration over time. Second, a temporal balance of exploitation and exploration can reinforce each other. At a static point of time, organizational resources are fixed. However, over time, organizational resources would change such that exploitation can produce resources that can be invested in future exploration and vice versa (Lavie et al., 2010). By implementing either exploration or exploitation effectively, firms can generate and accumulate sufficient resources for the next stage of strategic focus when they diligently shift their orientation. For example, a successful commercialization of products (i.e., exploitation) can provide financial and knowledge base for future new product development (i.e., exploration). The mutual reinforcement nature of exploitation and exploration over time could potentially enhance firm performance (Lavie & Rosenkopf, 2006; Lavie et al., 2010; Piao, 2010).

Strategic alliance formation is regarded as a process of dynamic evolution (Dyer & Nobeoka, 2000). Over time, inter-organizational relationships become strengthened, weakened, or altered, as opposed to remaining static. Scholars have emphasized the importance of dynamic adaptation and evolution of inter-organizational relationships so as to avoid inertia buildup and failure of these relationships, as well as to maintain the viability of a firm's strategic networks (Doz, 1996; Madhavan, Koka, & Prescott, 1998). In accordance with this dynamic perspective of strategic alliance formation, the temporal balance serves well in shaping the dynamism of a firm's alliance portfolio. Within each domain, firms can balance exploration and exploitation over time by sequentially shifting their tendencies to explore or to exploit to avoid resource

allocation trade-offs and conflicting routines (Lavie & Rosenkopf, 2006). For example, within the function domain, firms that have primarily engaged in R&D collaboration to explore new product and opportunities may shift their focus later on to establish more commercialization and marketing alliances to exploit the already-developed new products. In turn, firms that have engaged in exploitation alliances can gradually adjust their emphasis to more exploration alliances for sustainability and longevity. In a similar vein, within the structure domain, firms that have engaged in alliances with recurrent partners may reach a point that they have fully leveraged the existing relationships and start to explore new partnering opportunities. When firms have accumulated sufficient diverse partners in their alliance portfolios, they can again begin to form recurrent alliances with selected partners to leverage the existing collaborations. Despite that some scholars have shed light on the theoretical development of temporal balance, there has been rather scarcity of empirical studies investigating its impact. Boumgarden et al. (2012) studies two approaches for achieving simultaneously high levels of exploration and exploitation: organizational ambidexterity and organizational vacillation. Based on the analysis of two canonical cases, this paper suggests that vacillation may offer higher long run performance than ambidexterity, while ambidexterity enhances performance on the margin when utilized within larger epochs of vacillation. Piao (2010) studies the temporal balance of exploration and exploitation. An analysis of 1980-1999 data from the hard disk drive industry suggests that exploitation to the exclusion of exploration generally undermines firms' long-term viability. A moderate level of temporal overlap between exploitation and exploration processes enables a firm to extend its longevity. The limited amount of empirical research tends to lend support to the merits of a temporal balance. I thus propose the following hypothesis:

H2. Over time, firm performance is likely to increase when a firm balances exploration and exploitation of alliance formation decisions temporally.

3.2.4 Performance Implications of Balance across Domains

Balance exploitation and exploration within domains simultaneously has been argued to incur inherent trade-offs, conflicting routines, and negative externality. Besides the temporal balance to separate the tendencies to explore or to exploit over time, Lavie and his colleagues (Lavie et al., 2011; Lavie & Rosenkopf, 2006) have proposed another approach, i.e., balancing both activities across domains, which is particularly applicable in the context of strategic alliances. According to the domain separation approach (Lavie et al., 2011), the inherent organizational trade-offs and impediments can be circumvented by balancing exploration and exploitation activities across domains, whereas the benefits of such a balance remains. To achieve a balance across domains, scholars have argued that, firms can explore in the function domain while exploit in the structure domain, or exploit in the function domain when explore in the structure domain (Lavie et al., 2011; Lavie & Rosenkopf, 2006). For instance, a firm can form R&D alliances (function exploration) with recurrent partners that they are familiar with (structure exploitation), or engage in marketing alliances (function exploitation) with new partners (structure exploration).

On the one hand, it is argued that balancing exploitation and exploration across domains can help firms overcome the inherent conflicts and trade-offs (Lavie et al., 2011; Lavie & Rosenkopf, 2006). The inconsistent and conflicting routines and resource allocation trade-offs associated with exploitation and exploration suggested in previous literature primarily occur

within domains. For example, attempt to conduct market research and to promote market coverage of existing products is in tension with efforts to research and develop new products. However, it is likely that firms can support exploitation in one domain and exploration in another simultaneously without incurring such tensions because exploitation and exploration in function domain and structure domain are conceptually independent (Lavie et al., 2011), therefore the routines and heuristics associated with exploitation and exploration within each domain are independent. A firm's pursuit of new technology and product development in R&D alliances does not counter its reliance on current partnering routines such as developing inter-firm trust and informal governance mechanisms. Firms can use relatively consistent routines for managing its alliance portfolio within each domain (Lavie et al., 2011). Consequently, such a balance can eliminate certain organizational conflicts and trade-offs, as well as diminish the corresponding organizational costs. On the other hand, balancing exploitation and exploration across domains still generates substantial benefits attributed to ambidexterity. In this regard, a firm can generate new knowledge as well as leverage established heuristics and effective governance mechanisms simultaneously (Lavie et al., 2011; Lavie & Rosenkopf, 2006). A combination of function exploration and structure exploitation, e.g., forming R&D alliances with recurrent partners, allows a firm to focus on innovation and new technology exploration by collaborating with familiar partners. Given the inherent uncertainty of new technology exploration, it is critical that collaboration with existing partners frees a firm from dealing with the uncertainty and frictions of working with unfamiliar or new partners. Familiarity, mutual trust fostered from previous collaborations, and established partnering routines are likely to facilitate the exploration endeavors and enhance performance. Alternatively, engaging in function exploitation and

structure exploration, e.g., forming marketing or licensing alliances with new partners, offers market variance and potentially new market penetration while allows a firm to leverage its existing product base. Exploring new partnership in the quest of market extension of existing products adds value to the function exploitation because repeated alliances with prior partners can only provide limited and perhaps saturated market access. Empirical studies have just started to investigate this approach. Lavie et al. (2011) studied U.S.-based firms in the software industry and found that balancing exploration and exploitation across domains enhanced profitability and market value. Based on the above argument, I therefore hypothesize:

H3. At one static point of time, a firm is likely to increase its performance when it balances exploration and exploitation across the function-based and structure-based domains of alliance formation decisions.

3.2.5 Moderating Effects of Firm Size

As argued before, firms generally strive to engage in both exploitation and exploration activities in order to benefit from short-term and long-term performance enhancement attributed to them respectively. However, resource allocation trade-offs and internal conflicts arise when firms seek a balance. Scholars have argued for the importance of contingency conditions that could affect the performance implications of organizational ambidexterity (Lin et al., 2007). One of the contingency factors that is of high importance is resource munificence (e.g., Jansen et al., 2012). To successfully implement and leverage both exploitation and exploration, a firm needs to be able to invest sufficient and diverse resources in a timely manner. The munificence of organizational resources could potentially impose a significant influence on the relationship

between ambidexterity and performance such that a munificent context may mitigate resource constraints and trade-offs as well as conflicting routines imposed by ambidexterity (Aiken & Hage, 1968; Jansen et al., 2012; Tushman & Nadler, 1978). Firms would be able to more effectively manage and leverage both exploitation and exploration. To the contrary, the lack of a munificent context may accentuate the tension of ambidexterity, thus pushing firms towards alternative ways to balance exploitation and exploration.

Strategic alliances serve as an alternative source for firms to access resources that may not be available internally. Firms may establish alliances with partners to collaborate on exploitative marketing activities and/or explorative R&D activities, as well as to leverage existing and new social capital (Lavie et al., 2011). Despite that alliances may provide additional resources to a firm, it will encounter similar tensions of resource allocation trade-offs and conflicting routines associated with engaging and managing multiple alliance activities. Consequently, a munificent context is necessary for successfully carrying out a variety of strategic alliances. In general, the size of a firm is positively related to the amount of resource endowment it holds internally. As a firm grows, it accumulates more organizational resources and expands in structure. Hence a large firm is relatively less resource constrained. In contrast, a small firm relies on strategic alliances to a greater extent, while facing intensified tensions of ambidexterity (Lavie et al., 2011; Lavie & Rosenkopf, 2006). With a limited resource base, a small firm is likely to experience intensified competition for resources within domains which are required to support exploitation and exploration alliance activities effectively. In order to ensure the expected performance rather than to be 'stuck in the middle', it may be forced to invest in a certain type of alliance activities as opposed to scattering the resources. Besides, a small firm's

organizational structure does not grant generous space for managing conflicting routines attributed to exploitation and exploration. It is more difficult for a small firm to digest different organizational logics and to cope with the internal inconsistency. Furthermore, a small firm tends to be less capable of mitigating negative externality arising from organizational ambidexterity bounded by their limited endowment. Therefore, at one static point of time, given the limited resource base a small firm has, it is critical for the firm to make wise decisions regarding alliance formation. It is highly likely that a small firm is not capable of supporting both exploration and exploitation alliance activities at the same time. As such, it is particularly critical for smaller firms to take on a focused strategic choice by engaging primarily in exploration alliances or exploitation alliances within domains.

Although in the above paragraph I argued that smaller firms would particularly benefit from a focused strategy in alliance formation at one static point of time, it does not suggest that smaller firms shall only focus on either exploration alliances or exploitation alliances. Both exploitation and exploration are essential for short-term and long-term performance, regardless of firm size. Therefore, in order to survive and thrive in the long run, I argue that a temporal balance or a balance across domains is particularly beneficial for smaller firms to achieve ambidexterity. A small firm is generally not well positioned to engage in both activities at the same time, given the conflicting organizational requirements entailed as well as the trade-offs between them. With limited amount of resources, it is in a small firm's best interest to invest in one type of activities at one time then shift to the other later on. A temporal balance allows it to make the best use of its resources and leverage the benefits of both exploration and exploitation alliance activities. Compared to a large firm, a small firm functions more as a coherent entity. To

avoid the liability of being ‘stuck-in-the-middle’ and to maximize returns, a small firm with constraining organizational context may pool its resources and attention on one activity at a time (Jansen et al., 2012). For example, it can focus on working with partners to develop new technology and products then shift to collaboration with partners who can help with commercialization and marketing. A small firm can also extensively explore new partnerships at one time to allow more opportunities and intensively work with familiar partners at another. The stage of exploitation alliances may provide smaller firms a period of stability and a break from exploration uncertainty, which allows them to digest technology and social capital exploration and at the same time accumulate resources to reinforce future exploration. In a similar vein, balancing exploitation alliances and exploration alliances across domains will benefit smaller firms to a greater extent. For smaller firms, it is more important to avoid resource trade-offs and incurring additional organizational costs by exploring in one domain while exploiting in another. Besides, a small firm’s condensed administrative structure better supports one set of operating and partnering routines at a given time. Engaging in R&D alliances (function exploration) with recurrent partners (structure exploitation) enables a small firm to focus its attention on exploring new technology while relying on partners with higher level of trust and smoother collaboration, diminishing uncertainty and the liability of smallness faced by smaller firms. Alternatively, forming marketing or commercialization alliances (function exploitation) with a variety of new partners (structure exploration) may offer small firms opportunities for new market exploration by exploring heterogeneous social capital, which are beyond small firms’ capability and accessibility as compared to larger firms. As a result, the above argument leads to the following hypotheses:

H4. At one static point of time, firm size affects the performance implication of exploitation-exploration balance such that it is more beneficial for a small firm to focus on either exploration alliances or exploitation alliances.

H5. Over time, firm size affects the performance implication of temporal exploitation-exploration balance such that it is more beneficial for a small firm to balance exploration and exploitation of alliance formation decisions temporally.

H6. At one static point of time, firm size affects the performance implication of exploitation-exploration balance across domains such that it is more beneficial for a small firm to balance exploration and exploitation across the function-based and structure-based domains of alliance formation decisions.

3.3 Method

3.3.1 Research Setting

This study was designed as a pooled time series analysis of alliances formed by high-technology firms in U.S., including five industries (i.e., biotechnology, computer hardware and software, telecommunication, semiconductor, and electronics). High-technology industry offers an appropriate setting because in these industries, the high level of innovative activities and the commercialization of technology are characterized by intensive alliance relations (Rothaermeli &

Boeker, 2008). The intensity of alliance also accounts for a high proportion of the observed strategic alliances in high-technology industries (Hagedoorn, 1993).

This study's time frame spanned the years 1985 to 2009. Prior work employing the same time frame suggests that a 25-year period serves well in capturing the upturns and downturns in the growth of the high-tech industries (e.g., Nadkarni & Barr, 2008). In addition, previous research studying alliances also sets 1985 as a base year or the starting year (e.g., Beckman et al., 2004; Lavie & Rosenkopf, 2006) and prior studies suggested that there were much fewer alliances formed in this industry before 1985. Alliances formed after 1985 therefore represent a sufficient and viable pool for this study. The sample included 905 publicly traded United States-based high-technology firms that have records in both Securities Data Corporation (SDC) and COMPUSTAT datasets. In total, 4,617 alliances were identified between 1985 and 2009, and the number of alliances formed by a focal firm ranged between 1 alliance to 86 alliances in a given year, with an average of 2.54 alliances per firm-year.

3.3.2 Data Collection

The bulk of the data on alliances was retrieved from the SDC database. The SDC database is one of the most commonly used and comprehensive alliance databases (Schilling, 2009). A great amount of previous studies have used the SDC database for strategic alliance research. To increase the reliability of SDC records, the alliance data was verified and corrected through crosschecking the Securities and Exchange Commission (SEC) filings, the Bloomberg database, and corporate websites. Relying on multiple sources therefore enhanced the validity of the alliance data. Overall, I identified 4,617 alliances formed by 905 focal firms within the five

high-technology industries. Firm-specific data, such as total assets, R&D expenses, net income, and retained earnings, were extracted from COMPUSTAT database.

To match the data from the SDC database and the COMPUSTAT database, I took several steps. First, I compared and matched the CUSIP codes in both databases. CUSIP code in SDC is recorded in 6 digits whereas that in COMPUSTAT is in 9 digits. I extracted all 9-digit CUSIP codes of firms and the SIC codes of all firms in the five high-technology industries from COMPUSTAT; then I identified those firms whose first 6 digits of COMPUSAT CUSIP codes were the same as SDC CUSIP codes. All matched records were then included in the sample for further analysis. The unit of analysis in this study is firm-year; therefore I transformed the data to firm-year observations by pooling the data across all alliances formed by each focal firm in a given year, yielding 2,300 firm-year observations. In the regression models, 1,961 valid firm-year observations were included for analysis due to missing data.

3.3.3 Measures

As two key constructs in this study, exploration alliance and exploitation alliance were measured following previous studies and constructed by counting the number of exploration alliances or exploitation alliances for each sampled firm in a given year.

Function exploration alliances and exploitation alliances. Following previous research (e.g., Koza & Lewin, 1998; Lavie et al., 2011; Rothaermel & Deeds, 2004), I coded exploration and exploitation alliances by considering the nature of the alliance activity. Those focusing on basic research, new product discovery and development were coded as exploration alliances. The following is an example of an alliance announcement I coded as exploration:

August 30, 1988 - Calgene and Campbell Soup Co. signed an agreement to jointly develop a genetically-engineered gene for fresh tomatoes. The two companies developed an antisense polygalacturonase gene, which suppressed the levels of polygalacturonase in tomatoes, thereby reducing pectin degradation and fruit softening. This "Flavr Savr" gene prolonged shelf life, enhanced resistance to post-harvest disease, and also allowed the tomatoes to better survive handling during shipments.

Alliances that were associated with commercialization or downstream activities on the value chain, such as clinical trials, licensing, marketing and sales, were classified as exploitation alliances. An example of exploitation alliance is as following:

December 31, 1989-Cambridge Biotech Corp and Diagnostics Pasteur signed a cross licensing agreement which granted each other access to each participant's AIDS and HTLV-1 antibody diagnostics.

Structure exploration alliance and exploitation alliances. Based on the argument of Lavie and Rosenkopf (2006), I focus on whether the partner is an old one or a new one in the year of alliance formation. An alliance is structure exploratory when it is established with a new partner that the focal firm has never formed alliances with before, and structure exploitative otherwise. I operationalized it by following the measures used in the work of Lavie, Kang, and Rosenkopf (2011). I coded each alliance formed by the focal firm such that a value of 1 was given to an indicator for exploration if the firm had no prior alliances with its partner and a value of 1 was given to another indicator for exploitation if they had prior collaboration. Then structure

exploration alliances or exploitations alliance was calculated as the total number of its indicator across all alliances formed by the focal firm in a given year.

Balance within domains. Previous research studying the balance of exploration and exploitation generally suggests two approaches to measure this construct: the absolute difference (Cao et al., 2009; He & Wong, 2004) and the curvilinear approach (Lavie et al., 2011). The curvilinear approach models the square term of exploration and tests its influence on performance. It is difficult to determine the ‘balance point’ because the inflexion point might not necessarily be 0.5. Besides, the actual value range of exploration may fall out of the interval of effective curve. Therefore, I followed the first approach and measured the balance between exploration and exploitation within function and structure domain by calculating the absolute value of the difference between exploration alliances and exploitation alliances. I first calculated the portion of function/structure exploration and exploitation through dividing the number of exploration or exploitation alliances by the total number of alliances formed by a firm in a given year. Then I calculated the absolute value of the difference between them. A higher value indicates a higher unbalance between exploration and exploitation, and that a firm is dominantly engaging in either exploration or exploitation alliances. The absolute difference of function balance ranges between 0 and 1, with an average of 0.80. The absolute difference of structure balance ranges between 0 and 1, with an average of 0.97.

Temporal balance. There have been a rather limited amount of studies that empirically examine the temporal transition between exploration and exploitation activities in previous research. Employing quantitative method to examine temporal balance has been methodologically challenging, rendering little research endeavor. Some scholars investigated this

topic qualitatively. For example, Brown and Eisenhardt (1997) employed a case-study approach to examine organizational change over time. To the best of my knowledge, no existing research has empirically investigated the temporal balance in the context of strategic alliance, leaving little reference, if not none, for measuring this construct. To account for the oscillating strategy of firms in managing their exploration versus exploitation alliance portfolios, I observed the change of a firm's balance strategy longitudinally. For example, a firm may emphasize exploration alliances in a given year and shift to focus more on exploitation alliances in a later year. If this is the case, it temporally balances its focus on exploration or exploitation over time. Accordingly, temporal balance was operationalized by calculating the absolute value of the difference between the the value of within-domain (function domain or structure domain) exploration percentage (i.e., the number of exploration alliances divided by the total number of alliances) in a given year and the corresponding value in the nearest proceeded year when the focal firm had a record of forming alliances. For instance, if a firm was engaging dominantly in exploration (or exploitation) alliances in a given year and shifted to a higher proportion of exploitation (or exploration) alliances constructed in its alliance portfolio in a later year, the absolute value of the percentage difference between these two years indicates a change of focus over time. A higher temporal balance indicates a greater shift of a firm's exploration or exploitation alliance focus over time. That is to say, for example, in a proceeded year, a firm primarily formed exploration alliances, and in a later year, it engaged in more exploitation alliances. The absolute difference of temporal function balance ranges between 0 and 1, with an average of 0.48. The absolute difference of temporal structure balance ranges between 0 and 1, with an average of 0.42.

Balance across domains. As a recently proposed approach by Lavie and Rosenkopf (2006), there has been only one study applying this approach so far (Lavie et al., 2011). In their work, Lavie and his colleagues did not operationalize it as a separate construct. Instead, they tested the interaction of within-domain balances (i.e., the interaction between function-domain balance and structure-domain balance) to investigate whether one would moderate the other's impact on performance. To avoid the potential confounding impact, I created a construct to capture the balance of exploration and exploitation alliances across domains. I operationalized across-domain balance by calculating the standard deviation of function exploration and structure exploration of a focal firm in a given year. If a firm forms a high level of both function exploration (or exploitation) alliances and structure exploration (or exploitation) alliances, the standard deviation between them will be low. In contrast, a higher standard deviation indicates that a firm is either engaging in both a high level of function exploration alliance and a high level of structure exploitation alliance, or a high level of function exploitation alliance and a high level of structure exploration alliance. In other words, a firm is relatively balancing exploitation and exploration across function and structure domains.

Firm Size. Firm size has been examined in previous studies with mixed findings regarding its impact on the tendency to explore versus exploit (Beckman et al., 2004; Lavie et al., 2010; Rothaermel & Deeds, 2004). Following previous studies, I measured firm size as the value of total assets reported in COMPUSTAT. Firm size served as a moderator of the relationship between exploration/exploitation and firm performance. I did not use the number of employees given that the industries are relatively not labor intensive. However, robustness tests using the alternative measure (i.e., the number of employees) produced consistent results.

Firm performance (ROA_{t+1}). The dependent variable was measured as the ratio of net income to total assets (ROA). ROA is commonly used in current literature as an objective measure of organizational profitability or economic performance (Bae & Gargiulo, 2004; Lin et al., 2009). The dependent variable was lagged one year after all independent variables and control variables to allow time for the possible effects to take place.

Control variables. I controlled for industry-specific and firm-specific factors that might influence their inclination to engage in exploration and exploitation alliances.

Market uncertainty. The control variable, market uncertainty, captures the industry level of environmental uncertainty. I used objective measures based on the original work of Tosi, Aldag, and Storey (1973), which has been applied frequently in previous studies (e.g., Bourgeois, 1985; Folta, 1998; Gohosh & Olsen, 2009; Sasson, 2008). This variable is measured by computing the coefficient of variation of sales in the industry. I calculated the volatility of sales over five years in several steps, using the following formula:

$$\text{Coefficient of Variation} = \sqrt{\frac{\sum_{i=1}^5 \frac{(Y_i - \bar{Y})^2}{5}}{\bar{Y}}}$$

Where

Y_i = average sales in year i in this industry;

\bar{Y} = average sales over the five year period in this industry.

The coefficient of variation of a focal year was calculated based on the five-year period prior to this year. First, the industry averages of sales per year over the previous five years were computed. Then I calculated the sum of the one-fifth of the squared term of the average sales for each year minus the average sales over the five-year period. And the square root of the sum was divided by the average sales over the five-year period.

Organizational slack. Previous studies have measured organizational slack in multiple ways, including accounting-based financial and non-financial measures (Bradley et al., 2011; Daniel et al., 2004; Nohria & Gulati, 1996; Tan & Peng, 2003). Reliance on standard financial data to measure organizational slack can be traced back to the early work of Bourgeois (1981) and has been applied frequently in subsequent slack research (e.g., Bradley et al., 2011; Mishina et al., 2004; Nohria & Gulati, 1996; Zajac et al., 1991). Organizational financial slack allows firms to allocate the spare resources for various uses (Bradley et al., 2011). Along this line of research, I measured organizational slack using the following three items: 1) retained earnings, 2) working capital as a percent of sales, and 3) debt as a percent of equity.

*Firm performance (ROA_{*t*})* in the year prior to the measured performance as the dependent variable was also included as a controlled variable in order to account for the possibility that financial performance might drive exploration or exploitation (Lavie & Rosenkopf, 2006; Levinthal & March, 1993). Some alliance-related variables are controlled in this study. I controlled for a firm's prior *alliance experience* as well as its *alliance experience in a given year*. A firm's past and current experience in alliances are highly likely to affect its capability to effectively manage its exploration or exploitation alliances (Ahuja, 2000; Lavie & Rosenkopf, 2006; Tsai, 2001). Therefore, following previous research (Anand & Khanna, 2000; Lavie & Rosenkopf, 2006), I operationalized past alliance experience as a count of all prior alliances formed by a focal firm between 1985 and the preceding year, and current alliance experience as the number of alliances formed by a focal firm in the corresponding examined year. Similarly, the *number of partners* a firm has is controlled to control its partnering experience. I also controlled for the number of *joint ventures* and the number of *international*

alliances in order to account for the inherent nature of exploration in these dimensions, given that there is a certain level of exploration involved when firms form joint ventures or international alliances. To account for industry effects, I included industry dummy variables as control variables (i.e., biotechnology, computer software-hardware, telecommunication, semiconductor, and electronics). Finally, I controlled for variation within each firm as a random effect (using the variable FirmID).

3.4 Analysis and Results

I analyzed the effects of balancing exploitation and exploration on firm profitability by using linear mixed models (LMMs) in STATA 12.0, an extension of generalized linear models (Molenberghs & Verbeke, 2006; Pinheiro & Bates, 2000; West, Welch, & Galecki, 2007). LMMs produce maximum likelihood estimates from models for fixed and random effects. These models are specifically designed to correct for correlations within subjects in multi-level or panel data. They have the additional feature of being able to model residual serial correlations as a random effect through their random effect or repeating measures features. They have advantages over GEE models in that they can handle unbalanced data. This method of analysis is particularly suited to the data, since firm-year data is characterized by correlations within firms and the number of observations per firm was unbalanced with gaps between years. The estimated models can be represented by the following equation:

$$ROA_{i(t+1)} = EV_{it} \times \beta + Firm_i + \varepsilon_{it}$$

where $ROA_{i(t+1)}$ is the ROA for firm i at time $t+1$; EV_{it} is a vector of explanatory variables of firm i at time t , including function balance, structure balance, temporal function balance, temporal structure balance, domain balance, firm size, and control variables; $Firm_i$ is a firm random effect in the random-effects models; and s_{it} is an error term.

When the correlation within firms was accounted for by using this method of analysis, there appeared to be little residual serial correlation. After the firm was specified as the 'subject', time (year) was introduced as another random effect and then as a repeated measure. When the firm variance was accounted for, the random effect intercepts and slope estimates were not significant, and introducing time as a repeated measure decreased the model fit. I therefore concluded that serial correlations were not significant in this dataset after controlling for firm variance using LMM. Also note that all models were carefully diagnosed for multicollinearity. The variance inflation factor value for each variable did not exceed four, which is far below the recommended limit of 10 (Chatterjee & Price, 1991). Therefore multicollinearity shall not be a concern in this study. I included the control variables and explanatory variables to test the different hypotheses in multiple models step by step. When necessary, the variables were mean-centered to generate their interaction terms. The descriptive statistics and correlations of the variables are provided in Table 4. Table 4 reveals generally low correlations among the independent variables. The mean values of the independent variables indicate tendencies toward function exploration/exploitation imbalance ($y = 0.80$) and structure exploration/exploitation imbalance ($y = 0.97$). Firms tend to maintain a relative balance between function/structure exploration and exploitation temporally ($y = 0.48/0.42$).

Table 4 Descriptive Statistics and Correlation Matrix

Variables	Mean	s.d.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	
1. ROA t+1	-.07	.52																				
2. Biotech	.36	.48	-.10																			
3. Computer	.43	.49	.05	-.05																		
4. Semicon	.14	.34	.07	-.02	-.09																	
5. Telecom	.24	.43	.08	-.04	-.08	-.04																
6. Electronics	.01	.11	.02	-.06	-.03	.03	-.01															
7. Alliance Experience	10.59	31.87	.09	.00	.19	.13	.21	.00														
8. No. of Alliances t	2.01	3.65	.07	.01	.20	.17	.24	.03	.61													
9. No. of Intl Alliances t	.11	.43	.02	.08	.00	.12	.10	.02	.18	.48												
10. No. of JVs t	.27	.72	.06	-.08	.05	.19	.26	.09	.27	.66	.35											
11. No. of Partners	4.61	8.88	.07	-.02	.20	.18	.27	.04	.58	.98	.48	.69										
12. ROA t	-.06	.45	.55	-.12	.07	.08	.10	.02	.09	.09	.01	.07	.09									
13. Firm Size t	6.84	2.85	.34	-.13	.09	.06	.31	.08	.32	.24	.05	.22	.25	.42								
14. Organizational Slack t	-.01	.54	.01	.16	-.07	-.00	-.00	.03	.07	.09	.03	.09	.09	.05	.18							
15. Market Uncertainty t	.12	.07	.04	-.33	.22	.16	.11	-.00	.05	.04	-.08	.01	.47	.06	.13	-.06						
16. Function Balance (FunB)	.80	.36	.07	-.05	.24	.01	.19	-.00	.01	-.00	-.11	.05	.01	.07	.08	-.08	.24					
17. Structure Balance (StrB)	.97	.12	-.04	.01	-.13	-.15	-.13	-.03	.31	-.25	-.08	-.15	-.24	-.04	-.17	-.05	-.03	.03				
18. Temporal FunB (TemFun)	.48	.47	-.07	.04	-.14	.00	-.06	-.00	.18	-.15	-.03	-.05	-.15	-.06	-.26	-.06	-.03	.10	.10			
19. Temporal StrB (TemStr)	.42	.48	-.07	-.06	-.06	.00	-.00	-.01	.16	-.11	-.06	-.02	-.01	-.08	-.34	-.07	.07	.08	-.05	.57		
20. Domain Balance	.34	.21	.06	-.62	.39	.07	.26	.03	.01	.04	-.07	.09	.05	.08	.06	-.14	.25	.66	.08	.05	.07	

Table 5 Mixed Models for Firm Performance t+1

Predictor Variables	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
Biotech	-.03	-.01	-.02	-.03	-.03	-.02	-.02
Computer	.00	.01	-.00	.00	.00	-.00	-.00
Semicon	.02	.03	.02	.02	.03	.02	.02
Telecom	-.00	-.00	-.01	-.01	-.01	-.01	-.00
Electronics	.00	.01	-.00	.00	.00	.00	.00
Alliance Experience	-.00	-.00	-.00	-.00	-.00	-.00	-.00
Alliance this year	.01	.01	.01	.01	.01	.01	.01
No of Intl Alliances	-.00	.00	.00	.00	.00	.00	.00
No of JVs	.01	.01	.01	.00	.00	.01	.01
No of Partners	-.01	-.01	-.01	-.01	-.01	-.01	-.01
Performance t	.45***	.45***	.45***	.45***	.45***	.45***	.45***
Firm Size	.03***	.02***	.02***	.03***	.03***	.03***	.02***
Organizational Slack	-.02	-.02	-.02	-.02	-.02	-.02	-.02
Market Uncertainty	-.10	-.12	-.13	-.13	-.10	-.10	-.12
Function Balance (FunB)		.05*	.03				
Structure Balance (StrB)		.03	.06				
FunB x Size			-.03***				
StrB x Size			-.01				
Temporal FunB (TemFun)				-.01	.00		
Temporal StrB (TemStr)				.04*	.03		
TemFun x Size					.01		
TemStr x Size					-.02*		
Domain Balance (DB)						.06	.05
DB x Size							-.02*
Random Effect (firm ID)	-1.19***	-1.18***	-1.17***	-1.18***	-1.19***	-1.18***	-1.17***
-2 Restricted Log Likelihood	-768.58	-766.38	-759.05	-766.16	-764.08	-767.62	-764.94

Dependent variable: Firm Performance (ROA_{t+1})

† p < .10 level **p < .01 level

* p < .05 level ***p < .001 level

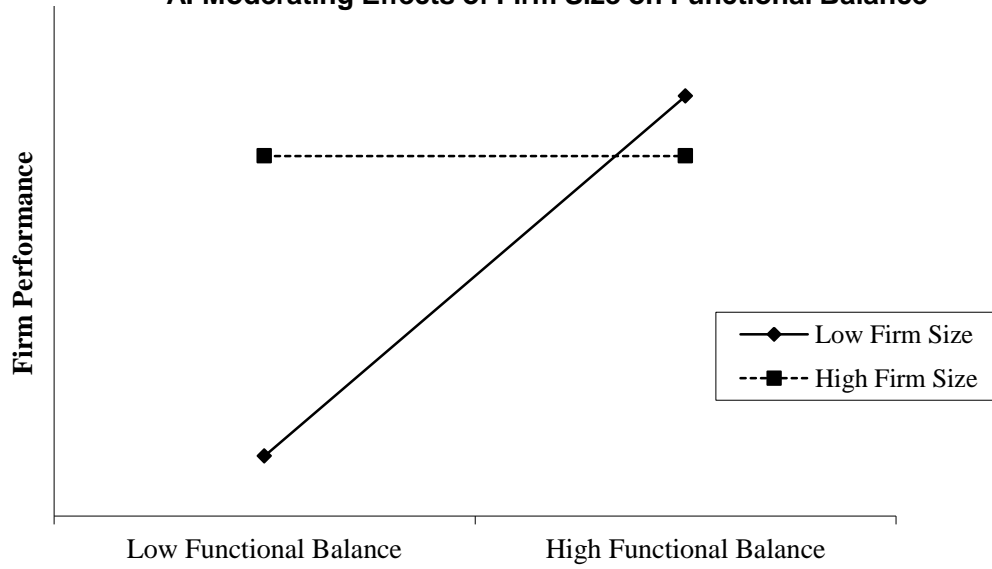
To test the hypotheses, I first included all control variables in Model 1. Model 2 included two more variables, function balance and structure balance, testing Hypothesis 1. The interaction terms of function/structure balance and firm size were entered in Model 3 which tests Hypothesis 4. Model 4 included all control variables and temporal function balance as well as temporal structure balance to test Hypothesis 2. To test Hypothesis 5, the interaction terms between temporal balances and firm size were added in Model 5. Finally, domain balance and control variables were entered in Model 6 for testing Hypothesis 3, and Model 7 included its interaction term with firm size for testing Hypothesis 6.

As can be seen from Model 2 in Table 5, the coefficient of function balance is 0.05 ($p < 0.05$), and that of structure balance is 0.03 but not significant. Therefore, the variable function balance is positively and significantly related to firm performance, whereas the variable structure balance does not have significant impact. It shows that when a firm's alliance portfolio dominantly focuses on product exploration or product exploitation at certain point of time, its performance tends to increase. Thus Hypothesis 1 is partially supported such that a focused strategy on function alliance formation at one static point of time tends to benefit firm performance. Model 3 shows the moderating effect of firm size. The coefficient of the interaction between function balance and firm size is negative and significant ($b = -0.03, p < 0.01$), whereas that of the interaction between structure balance and firm size is not significant. Figure 3 presents a visualization of the interaction effect. From Figure 3A we can see that, when firm size is smaller, a product-focused alliance formation decision tends to benefit the firm to a greater extent, structure alliance formation does not have significant impact. The finding lends partial support to Hypothesis 4. In Model 4, the coefficient of temporal function balance is not

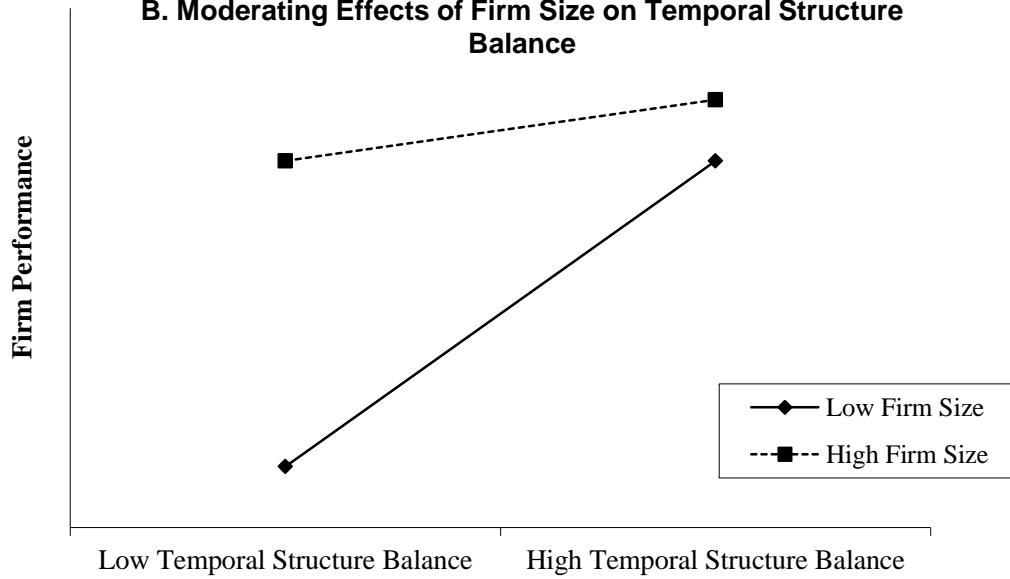
significant, while that of temporal structure balance is positive and significant ($b = 0.04, p < 0.05$). This result shows that temporal balance of structure exploration and exploitation is positively and significantly related to firm performance, suggesting that a firm can benefit from focus on structure exploration at one time and structure exploitation at the other, partially supporting Hypothesis 2. In Model 5, the coefficient of the interaction between temporal function balance and firm size is not significant. In contrast, the interaction between temporal structure balance and firm size is negative and significant ($b = -0.02, p < 0.05$), showing a significant moderating effect of firm size. From Figure 3B, we can see that the benefit of temporal structure balance is intensified when a firm's size is smaller. Therefore, Hypothesis 5 is partially supported along the structure domain. In Model 6, the effect of cross-domain balance is not significant; therefore Hypothesis 3 does not receive empirical support. However, Model 7 shows a significant moderating effect of firm size on the relationship between cross-domain balance and firm performance, with the coefficient equals -0.02 ($p < 0.05$). Figure 3C more clearly shows that a small firm benefits significantly more from balancing between exploration and exploitation across function and structure domains when making alliance formation decision. Thus Hypothesis 6 is supported.

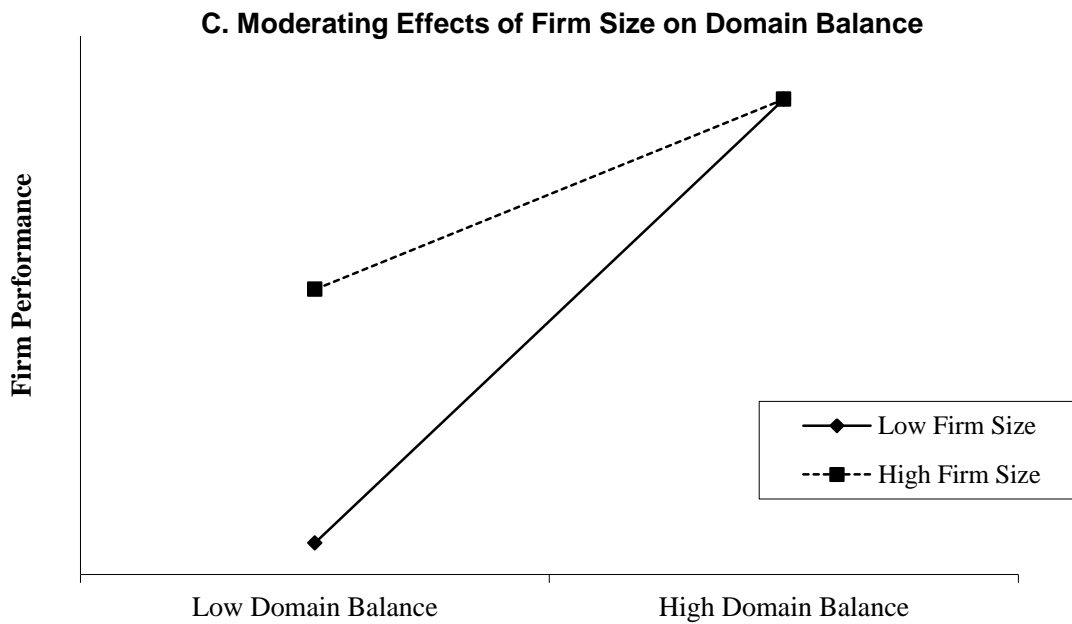
Figure 3 Moderating Effects of Firm Size

A. Moderating Effects of Firm Size on Functional Balance



B. Moderating Effects of Firm Size on Temporal Structure Balance





3.5 Discussion

There has been a significant amount of work in the existing literature devoted to the examination of the tension between exploration and exploitation, as well as the approaches to resolve this tension for firms’ survival and longevity. Nevertheless, it is still not clearly understood that how firms can achieve ambidexterity and a lasting balance between exploration and exploitation (Cantarello et al., 2012). Scholars have acknowledged that it is difficult, if not impossible, to specify a precise mix of an optimal balance (Levinthal & March, 1993). Perhaps there is no need for such a specification, since a precise mix for one firm is very likely not a good prescription for another. However, it is worthwhile to investigate the mechanisms and influencing factors that could lead to a better understanding of how to achieve such a balance. This study thus attempts to join this stream of research endeavor. Seeking to learn from an

ambidextrous perspective, in this study, I found support for the ambidextrous arguments made by previous scholars. It is generally suggested that an ambidexterity of both exploitation and exploration is critical for short-term and long-term performance. The overall findings in this study suggest that engaging in both exploration and exploitation activities may enable firms to secure a good performance. However, firms need specific tactics to achieve an effective ambidexterity. Simply carrying out both activities at the same time does not automatically translate into higher performance. I found that at one static point of time, firms tend to be better off when they focus on either product exploration alliances or product exploitation alliances (the function domain) as opposed to simultaneously pursuing two streams. Through examining other approaches of ambidexterity, the findings suggest that, to achieve ambidexterity, firms can sequentially shift between developing exploration alliance and exploitation alliance activities over time. A temporal balance within the structure domain between exploration alliance and exploitation alliance will benefit firm performance. In other words, firms benefit from focusing on working with existing and familiar partners at one time then on developing new partnering relationships for variety and novelty at another time. In addition, I examined the impact of a contingent condition, firm size, on the performance implication of ambidexterity. The findings indicate that it is particularly important for smaller firms to find the optimal approaches in order to effectively manage ambidexterity. Without a munificent context, smaller firms tend to be better off if they adopt a focused approach when it comes to exploration or exploitation alliance formation along the value chain, or temporally balance exploration and exploitation partnering experience. Although the main effect of a domain balance is not empirically supported, it is found that smaller firms can better benefit from ambidexterity by carrying out exploration and

exploitation pursuits across different domains. It is beneficial for a small firm to form exploration alliances or exploitation alliances within the function domain by exploiting existing partnering relationships or exploring new partnership (i.e., the structure domain).

I believe this study has made several contributions to the ambidexterity literature in general and ambidexterity in the context of strategic alliance in particular. First, generally speaking, the results acknowledge the significance of tension existing between exploration and exploitation, which has been a long-held theoretical lens. It resonates with previous research that effective management of the tension between exploration and exploitation is critical for firms to achieve longevity. The large amount of research embracing this theoretical lens proves a solid existence of tension. Ambidexterity in strategic alliances is not an exception. Since that there has been limited amount of research examining ambidexterity in the context of strategic alliances, this study adds insights to enrich the realm of alliance ambidexterity. To better manage exploration and exploitation alliances, firms need to give weight to the tradition wisdom that the tension between them needs to be effectively accounted for. The results shows that at certain point of time, it is better for firms to adopt a focused strategy within domain to either focus on forming exploration alliances at upstream of the value chain or exploitation alliances at downstream of the value chain to avoid such tensions as resource allocation trade-offs or conflicting routines. This finding is consistent with previous empirical results that are suggestive of a positive impact of a focused approach on firm performance (Lavie et al., 2011; Lin et al., 2007). There has been a scarcity of research investigating the balance of exploration alliances and exploitation alliances and its impact on firm performance. Existing studies (Lavie et al., 2011; Lin et al., 2007) lend support to the benefits of a focused approach, however, within the

structure domain. Their findings suggest that simultaneously investment in seeking new partners and renewing existing alliance relationships diminishes a firm's market value and net profit. My finding suggests that, within the function domain, simultaneous pursuit of product exploration alliances and exploitation alliances tends to harm firm performance as well. A firm that adopts a focused approach (an unbalanced combination) in either type of alliances at certain point of time would expect better performance. To some extent, my findings enrich the subject of balancing exploration and exploitation in alliances by providing stronger evidence that a simultaneous pursuit of both activities is likely not a wise strategic choice.

Second, this study advances our understanding of how to achieve ambidexterity in alliance formation. Despite that the findings suggest a focused approach within domains at a certain point of time, firms can make use of other approaches to manage ambidexterity when forming alliances. This study examines two approaches to circumvent the inherent tension: temporal balance and domain balance. A temporal balance approach advocates that firms sequentially balance exploration and exploitation over time (Boumgarden et al., 2012; Lavie et al., 2010; Piao, 2010; Simsek et al., 2009). Although temporal balance has been proposed as a viable solution in theory, empirical studies devoted to this line of query has been scant. The limited amount of existing research (Boumgarden et al., 2012; Piao, 2010) provides supporting evidence that balancing exploration and exploitation into different time horizons promotes longevity. My findings supply consistent evidence to the positive impact of temporal balance on firm performance, while adding insights to the alliance literature in this regard. To the best of my knowledge, this study is among the first ones to investigate a temporal balance between exploration alliances and exploitation alliances. Lavie et al. (2006) found that the behavior of

gradual adjustment of tendencies towards exploration or exploitation alliances occurs over time, without examining its performance implications. This study extends the temporal balance approach and its impact on performance to the alliance literature. My findings suggest that when firms make alliance formation decisions, it is beneficial to temporally balance exploiting existing partnering relationships and exploring new partners. Tactically modulating between exploration and exploitation in alliance formation over time should be considered by firms to enhance viability. Furthermore, this research studies another recently proposed approach, domain separation (Lavie et al., 2011; Lavie & Rosenkopf, 2006). Lavie and his colleagues' research supports the merits of balance across domains in alliance formation, whereas this study does not find a significant relationship, although the impact of balance across function and structure domains tends to be positive. However, the contingency effect is found to be significant such that for smaller firms, balancing across domains is beneficial. As a newly proposed approach, across-domain balance is worthy of further examinations.

Third, the findings echo the importance of contingent conditions in the ambidexterity research (Lin et al., 2007). Organizational characteristics may play an important role in explaining the performance implications of ambidexterity. The findings in this study demonstrate that the impediments associated with balance within domains and the merits associated with temporal balance and across domain balance exacerbate with firm size. These findings are consistent with the majority of prior research (e.g., Beckman et al., 2004; Lin et al., 2007). Overall, this study demonstrates that it is particularly important for smaller firms to circumvent such tensions. Smaller firms are suggested to make the best use of their limited resource endowment by adopting a focused strategy at certain point of time, a temporal balance approach,

and/or an across domain balance approach when managing their alliance portfolios. As a firm accumulates assets, it becomes less resource constrained. It is therefore more important for resource-lean firms to manage the tensions. The findings depart from the preliminary findings of a couple of prior studies (i.e., Cao et al., 2009; Lavie et al., 2011) that suggest smaller firms tend to be better off when they balance exploration and exploitation within domains or across domains, compared to larger firms. Built on a different logic of reasoning, they argue that smaller firms are more susceptible to the risks of over-commitment on either exploration or exploitation, hence in higher need to maintain a balance (Cao et al., 2009); or as a firm grows, it may lose its flexibility and ability to reconcile the conflicting routines (Lavie et al., 2011). In contrast, my findings of the contingent condition (firm size) accentuate the logic of tension between exploration and exploitation, on which the main hypotheses in this study were built, which is also consistent with the logic of hypotheses in the study of Lavie et al. (2011). This study thus provides different insights to current research. It is likely that the influence of contingent condition hinges on specific context characteristics, which in turn indicates the complexity of this subject and the importance of more thorough research in this field.

The performance implications of balancing exploration and exploitation alliances provide important insights for practices. The results demonstrate that a firm does not benefit from simultaneously engaging its alliances in generating new knowledge and leveraging existing knowledge. Striving to balance exploration and exploitation within a single domain may actually hurt a firm's performance, although conventional wisdom suggests such a balance. For example, if a firm tries to invest in both exploration alliances and exploitation alliances at the same time, the benefits of ambidexterity may be offset by the trade-offs and conflicts incurred. It may not be

able to leverage its specialty and expertise and end up with being stuck in the middle. However, financial performance improves when a firm explores in one domain while exploiting in another. For example, it can form R&D alliances with “old buddies” to effectively co-develop new products while relying on established partnering heuristics and routines. Or it can extend its market channels by collaborating with new partners for marketing and commercialization endeavors. The results are of particular practical importance for smaller firms. Although they are resource constrained, smaller firms can still reap the merits of ambidexterity by strategically managing its alliance portfolios. The key to successfully managing this is to effectively manage the tension by focusing on one type of alliances at a time, temporally shifting between exploration alliances and exploitation alliances, or balancing exploration and exploitation alliances across domains.

Finally, without exception, this study incurs boundary conditions and leaves room for future research. First, this study is set in the context of strategic alliance formation. The findings provide insights to the alliance literature, however, should be cautiously interpreted when extended to other settings. The function and structure domains of strategic alliances have been examined in this study. Future research may look into other domains to enrich our understanding of ambidexterity in alliances (Lavie & Rosenkopf, 2006). In addition, future research may extend the logic of across domain balance to intra-organizational context by considering corresponding domains within organizational boundaries to see how across-domain balance would facilitate ambidexterity within organizations (Lavie et al., 2011). Second, I examined the approach of temporal balance and its performance implications. Previous research calls for more attention on a temporal perspective in organizational ambidexterity research to explore its dynamic nature

(Boumgarden et al., 2012; Piao, 2010). However, it is acknowledged that there are challenges of large-scale empirical examination of this phenomenon. This study looks at the shifts between exploration and exploitation alliances by checking whether a firm's emphasis on one type of activity in a given year had changed, compared to the preceding year in which alliances were formed. Identifying and operationalizing the temporal shifts or episodes need more future research efforts which may require detailed case studies and a variety of methods to capture change (Boumgarden et al., 2012). Third, I examined the contingent effect of firm size on balancing exploration and exploitation alliances. The results depart from some prior research (e.g., Cao et al., 2009; Lavie et al., 2011), but resonate with other previous studies (e.g., Beckman et al., 2004; Lin et al., 2007). Future research may examine its contingent effect in other contexts to provide more insights into this subject. Besides, other contingent conditions such as environmental uncertainty may be investigated to uncover more underlying mechanisms that may influence the benefits of balancing exploration and exploitation within and across domains. Fourth, overall, my study supports the tension view of exploration and exploitation, which has been the long tradition of research in this area. As powerful as the tension view is, recent research has started to explore other theoretical lens, such as the paradox view, the complementarity view and the synergy view (Piao, 2010; Smith & Tushman, 2005). Future research may look into the variety of theoretical lenses and explore the interplay between multiple balancing approaches to enhance our understanding of this phenomenon.

4. Conclusion

Research interest in the exploration-exploitation framework has grown significantly in the past two decades, and the application of this framework in strategic alliances has been increasing in recent years. Although much progress has been made in multiple disciplines, many open questions remain that merit further attention (Lavie et al., 2010). In this dissertation, I reviewed the current literature, and examined various facets of this framework in the context of strategic alliances. I focused on discussing the antecedents and consequences of exploration and exploitation alliances and the balance between them. In particular, I examined how environmental force (i.e., market uncertainty) and organizational features including innovative capacity, and slack resources, as well as their interactions, drive organizations towards exploration alliance formation or exploitation alliance formation. I also investigated the performance outcome of balancing exploration and exploitation alliances, by examining the balance versus focus perspective, the temporal separation approach, and the domain separation approach. A contingent condition, firm size, was included in the examination of the relationship between balancing exploration-exploitation and firm performance. Hypotheses were proposed to test these facets and the results of the hypotheses are presented in Table 6.

Table 6 Hypotheses and Results

Hypothesis	Prediction	Result
Chapter 2: Antecedents of exploration-exploitation alliances		
H1	Firms with higher levels of innovative capacity are more likely to form exploitation alliances than exploration alliances.	Supported
H2	Firms with higher levels of organizational slack are more likely to form exploration alliances than exploitation alliances.	Supported
H3	At higher levels of market uncertainty, firms are less likely to form either exploration or exploitation alliances.	Supported
H4	Firms with higher innovative capacity tend to be more willing to form exploration and exploitation alliances in uncertain markets.	Supported
H5	Firms with more slack resources tend to be more willing to form exploration and exploitation alliances in uncertain markets.	Effect on exploitation alliances supported; reverse effect on exploration alliances.
Chapter 3: Consequences of exploration-exploitation alliances		
H1	At one static point of time, performance is likely to increase when a firm focuses on either exploration alliances or exploitation alliances.	Function domain supported Structure domain not significant
H2	Over time, firm performance is likely to increase when a firm balances exploration and exploitation of alliance formation decisions temporally.	Function domain not significant Structure domain supported
H3	At one static point of time, a firm is likely to increase its performance when it balances exploration and exploitation across the function-based and structure-based domains of alliance formation decisions.	Not significant
H4	At one static point of time, firm size affects the performance implication of exploitation-exploration balance such that it is more beneficial for a small firm to focus on either exploration alliances or exploitation alliances.	Function domain supported Structure domain not significant
H5	Over time, firm size affects the performance implication of temporal exploitation-exploration balance such that it is more beneficial for a small firm to balance exploration and exploitation of alliance formation decisions temporally.	Function domain not significant Structure domain supported
H6	At one static point of time, firm size affects the performance implication of exploitation-exploration balance across domains such that it is more beneficial for a small firm to balance exploration and exploitation across the function-based and structure-based domains of alliance formation decisions.	Supported

On the aggregate, my findings confirm that exploration and exploitation are in tension. Triggers of exploration versus exploitation tend to steer organizations toward them in different ways. I find that a firm's strategic choice between exploration alliances versus exploitation alliances is a reflection of both organizational intention as well as an adaption to environmental turbulence. Both 'Me' and the 'Industry' together craft strategic choices. In particular, firms with higher innovative capacity form more exploitation alliances and less exploration alliances; those with more slack resources form more exploration alliances and less exploitation alliances. Under market uncertainty, firms tend to be risk adverse and reduce the formation of both types of alliances. Furthermore, firms with higher innovative capacity and more slack resources generally mitigate the negative impact of market uncertainty on alliance formation. The tension also exists when exploration versus exploitation affect performance outcome. My findings suggest that balancing them simultaneously may hurt performance. Instead, balance can be executed via temporal separation, or domain separation, which is particularly important for smaller firms. Interestingly, my findings tend to show that a focused strategy worked particularly in the function domain of exploration-exploitation, whereas the temporal approach fits the structure domain of exploration-exploitation. It would be intriguing to further investigate the interaction of multiple approaches. Organizational ambidexterity does benefit firm performance, given that it is achieved tactically.

Inconsistent conclusions have been drawn regarding the antecedents of exploration and exploitation, and few studies have demonstrated how balance between exploration and exploitation generates favorable outcomes. I have examined both the antecedents and consequences of this framework in the context of strategic alliances, in hope of contributing to a

more coherent and complete body of work on this phenomenon. More research is encouraged to sort out and refine the fundamental terms and concepts of exploration-exploitation, and to further improve our understanding of their determinants and effects.

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