The Effects of Coopetition and Coopetition Capability on Firm Innovation Performance

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ABSTRACT

This dissertation is motivated by two research questions: 1) to what extent does coopetition impact firm innovation performance? and 2) to what extent does a firm's coopetition capability influence the relationship between coopetition and firm innovation performance? Despite the popularity of coopetition in both the academic and business arenas, empirical studies on the effects of coopetition on firm innovation performance are rare. With the dynamic and paradoxical nature of coopetition, the role of a firm's specific capability to manage coopetition (i.e., coopetition capability) is an important issue that has remained under-researched in the literature.

In an endeavor to contribute to the coopetition literature in the context of technological innovation, both theoretical and methodological improvements were pursued for this dissertation. From a theoretical perspective, I conceptualize coopetition as composed of three components: 1) competition between partners, 2) cooperation between partners, and 3) the interplay between competition and cooperation. It is argued that the balance between competition and cooperation is

essential to generate greater innovation performance in the paradoxical relationship. Further, I newly conceptualize coopetition-based innovation that is composed of three components: 1) joint innovation, 2) innovation through knowledge application, and 3) innovation in the partner's domains. Methodologically, I measure coopetition as a continuous variable.

Using both a longitudinal research design in the semiconductor industry and an exemplar case study of coopetition, I examine the effects of coopetition and coopetition capability on coopetition-based innovation. To represent coopetition, I employed four combinations with two types of competition (technology competition and market competition) and two types of cooperation (type strength of a focal alliance and tie strength between partners). The empirical evidence indicates that the balance between competition and cooperation at both the dyadic and portfolio levels increases the potential of firms to generate greater innovation performance from coopetition. This study demonstrates that firms with coopetition capabilities can manage coopetition and create greater common value with a partner and appropriate more value from the dynamic and paradoxical relationship. The research findings also have important managerial implications.

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I started my research journey after 14 years at the Federation of Korean Industries (FKI) and was almost 40 years old. Under such circumstances, it was not easy for me to make a career change. Since my wife started to pursue her PhD in the USA, I put my values first and decided that we could pursue the same career in the same place. This new journey was really challenging because my wife and I were always at the same stage of the program for the entire PhD process and we had to take care of two daughters. Thus, I wish to thank my family for their understanding and support during this time consuming and stressful process. Without the strong support of my mother-in-law and father-in-law, we could not have started and completed the PhD journey. My mother and father taught me the values of hard work and an optimistic view. Whenever I was struggling, I gained spiritual strength from them up in heaven. My daughters, Junghyun (Jenny) and Minjoo, have endured the lack of time to spent together. Instead, their brightness, happiness, and love gave me the courage to overcome difficulties.

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DEDICATION

I dedicate this dissertation to my loving wife, Dohee Kim; my daughters, Junghyun and Minjoo; and my mother-in law and father-in law without whose love, support, and sacrifices this monumental task could not have been completed. I would also like to dedicate this dissertation to my mother and father in heaven who are proud of their son.

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1.0 INTRODUCTION

1.1 Research Motivation

In the dynamic, complex, and global business world, firms have increasingly engaged in coopetition, i.e., simultaneous pursuit of collaboration and competition (Bengtsson & Kock, 2000; Brandenburger & Nalebuff, 1996b; Gnyawali, He, & Madhavan, 2008; Luo, 2007), to generate competitive advantage. Scholars argue that coopetition is a new lens to understand the benefits that arise from both cooperation and competition (Bengtsson, Eriksson, & Wincent, 2010). Because competing firms possess relevant resources and face similar pressures, collaboration with competitors enables firms to acquire and create new technological knowledge and use the knowledge in pursuit of innovation (Quintana-García & Benavides-Velasco, 2004; Ritala, Hurmelinna-Laukkanen, & Blomqvist, 2009). Coopetition can stimulate search for new rent-generating combinations of resources, skills, and processes (Lado, Boyd, & Hanlon, 1997; Yami, Castaldo, Dagnino, & Roy, 2010). In practice, the phenomenon of coopetition has become increasingly popular in recent years. An increasing number of new alliances are being formed between competing firms (Harbison & Pekar, 1998). Coopetition is particularly important for innovation in high-tech industries (Carayannis & Alexander, 1999; Dagnino & Rocco, 2009; Gnyawali et al., 2008; Jorde & Teece, 1990; Quintana-García & Benavides-Velasco, 2004) where firms are confronting challenges such as short product life cycles, technological convergence, and massive R&D costs (Gnyawali & Park, 2009). An exemplar case of coopetition is a joint venture between Samsung Electronics and Sony Corporation to manufacture liquid crystal display (LCD) panels for large television sets. While collaborating in LCD panel production, the two rivals compete fiercely in the LCD TV market. This on-going coopetition, which has lasted over eight years, has helped the two firms to establish their

leaderships in the TV industry, set technological standards, and develop technologies related to the panel and TV industry. That is, coopetition between Samsung and Sony had a tremendous impact on both firms, the LCD segment, and the TV industry as a whole. As a result, the case demonstrates that coopetition can play a critical role in addressing technological challenges.

Despite the popularity of coopetition from both the academic and business arenas, empirical studies on the effects of coopetition on firm performance, including innovation, are rare (Walley, 2007; Yami, Castaldo, Dagnino, & Le Roy, 2010). The majority of relevant studies are focused on conceptual developments or based on case studies. Further, limited empirical studies that examined the effects of coopetition on firm innovation performance provide inconsistent findings. While Quintana-García and Benavides-Velasco (2004) report positive effects of coopetition on innovation, Nieto and Santamaria (2007) report a negative relationship between alliances with competitors (i.e., coopetition) and innovation performance, and Knudsen (2007) finds no evidence that coopetition leads to an increase in innovation performance. Considering the importance of coopetition and innovation in high-tech industries, the inconsistent results of empirical research on the effects of coopetition on innovation should be addressed systematically. Also, although it is considered a win-win strategy, coopetition is a dynamic and paradoxical phenomenon. Firms struggle with a dilemma between the need to work together in order to create value and the temptation to be opportunistic in order to appropriate a greater share of the created value (Lavie, 2007; Gnyawali & Park, 2009; Ritala & Hurmelinna-Laukkanen, 2009). The case of coopetition between Samsung and Sony in the TV industry shows that the firms' capabilities (e.g., coopetition mindset) might play a critical role in the successful coopetitive relationship (Chang, 2008; Dvorak & Ramstad, 2006; Gnyawali & Park, 2011). However, the role of a firm's capabilities in managing coopetitive relationships is rarely

discussed in the coopetition literature. This study aims to address these critical gaps by focusing on the following questions: (a) to what extent does coopetition impact firm innovation performance? and (b) to what extent does a firm's coopetition capability influence the relationship between coopetition and firm innovation performance? In addressing these issues, I extend the conceptualization of coopetition and innovation performance, develop knowledge on coopetition tension and firm-specific coopetition capabilities, and advance methodological approach to study coopetition.

To understand the relationship between coopetition and innovation, it is necessary to clarify the distinctive features of value creation and value appropriation in coopetition. That is, coopetition means cooperating to create a bigger business "pie" (or value), while competing to divide it up (Brandenburger & Nalebuff, 1996). Although value creation and appropriation is central to coopetition, the composition of value ("innovation" in this dissertation) has not been examined systematically. I suggest that the value (i.e., firm innovation performance) a focal firm can obtain through coopetition can be conceptualized by three dimensions: 1) joint innovation (co-created value within alliance boundaries), 2) innovation through the application of partner knowledge (value created by applying the partner's knowledge, which is beyond alliance boundaries), and 3) innovation within the partner's domains (value created by the focal firm's additional efforts for competition, which is related to, but beyond, alliance boundaries). That is, value is created by both cooperation and competition and then is appropriated by collaboration arrangement and private efforts and capabilities by the firms.

In addition, to examine the relationship between coopetition and innovation, it is critical to understand the tension arising from paradoxical factors in coopetition. Coopetition is extremely challenging due to diametrically opposing forces – value creation versus value

appropriation, knowledge sharing versus knowledge protection, and mutual learning versus learning race. For example, firms need to share knowledge for mutual gain, while protecting core knowledge. These opposing forces (or the paradox) in coopetition create a great deal of tension that can either help or hurt firm innovation performance. That is, coopetition will provide both payoffs (in terms of resource potential, efficiency, and/or standard setting) and risks (in terms of dependence, opportunism, and potential competition). However, previous research has paid little attention to the role of tension in coopetition. A fundamental source of tension is a paradox that denotes "contradictory yet interrelated elements that seem logical in isolation but absurd and irrational when appearing simultaneously" (Lewis, 2000). Therefore, to understand the tension in coopetition, it is essential to examine the contradictory elements. In this regard, I note that we need to consider the cooperation side of the relationship to understand the tension in coopetition. That is, the tension from the paradoxical and dynamic nature of coopetition will clearly appear when the degrees of competition and cooperation are both high (Gnyawali et al., 2008). In addition, some scholars (e.g., Chen, 2008; Das & Teng, 2000) suggest that firms should balance the contradictory forces (i.e., competition and cooperation) in which tension from the paradox can lead to the most positive effects.[1] For example, Das and Teng (2000) suggest that the balance between competition and cooperation will increase alliance stability. Chen (2002) paid attention to the Chinese "middle way" philosophy that emphasizes the balance and integration of opposites. Integrating the paradox perspective and the Chinese "middle way" philosophy, Chen (2008) suggests the transparadox perspective in which two opposites may be interdependent in nature and together form a totality. Building on the transparadox (Chen, 2008) and balancing strategy (Das & Teng, 2000) perspectives, I argue that coopetition needs to be captured in three

[1] I note that most previous studies regarding tension in inter-firm relationships approach it from a risk perspective, such as competitive tension (the competitive dynamics literature), threat of opportunism (the alliance literature), and role conflicts (the coopetition literature).

dimensions: 1) competition between partners, 2) cooperation between partners, and 3) the interplay between competition and cooperation. Further, I suggest that the balance between competition and cooperation may generate positive effects on innovation.

The dynamic and paradoxical nature of coopetition raises an important issue – the role of a firm's specific capability to manage coopetition, which I will term as "coopetition capability" that has remained an under-researched topic in the literature. As coopetition is dynamic in nature (Luo, 2007b), tension also stems from coordination problems that coopetitors often overlook (Bonel & Rocco, 2007). "Companies may succeed or fail based on differences in their capability to manage paradox" (Lado, Boyd, Wright, & Kroll, 2006, p.115). While tension is inherent in all collaborative relationships (Das & Teng, 2000), it may be much more critical in coopetition because of the paradoxical (Chen, 2008) and dynamic (Luo, 2007b) nature and unstable tendency (Das & Teng, 2000) of coopetition. Thus, a firm's specific capability for managing coopetition at both *ex ante* and *ex post* stages may be critical for generating superior firm innovation performance.

From empirical standpoints, scholars (e.g., Yami et al., 2010) call for developing appropriate operational measures for coopetition, in order to facilitate more quantitative research. The coopetition measures used in previous studies have several limitations. First, previous studies typically used categorical variables, such as alliances with suppliers, clients, or competitors (e.g., Quintana-García & Benavides-Velasco, 2004; Nieto & Santamaria, 2007). Although those studies provided a valuable foundation to understand the effects of coopetition on innovation, little is known about the effects across various types of coopetition, such as competition-dominant, cooperation-dominant, and equal coopetition (Bengtsson & Kock, 2000). Although the effects of various types of coopetition may be different, they have not been

operationalized and examined in empirical studies. Second and related to the above, previous studies measure coopetition based only on competition, while implicitly assuming that each alliance has a constant strength of cooperation. As coopetition is the interplay between collaboration and competition, I suggest that coopetition needs to be measured by both the degree of competition and the degree of collaboration. The degree of cooperation that captures both the type-strength of a focal alliance and the strength of ties between two firms will significantly influence the transfer of knowledge between partners. That is, the type of collaboration of a focal alliance (e.g., R&D, marketing, or licensing) offers different strength from the strategic linkages and/or interorganizational dependencies (Contractor & Lorange, 1988; Nohria & Garcia-Point, 1991) and different levels of practice (e.g., co-location) that influence knowledge transfer between partners especially when the knowledge is tacit in nature. Further, the strength of ties between two firms, i.e., the quality of overall cooperative relationship, plays an informal safeguarding mechanism that reduces the threat of opportunism (Parkhe, 1993; Rowley et al., 2000), which will facilitate knowledge sharing. Further, the tension in coopetition will clearly appear when we consider both competition and cooperation. Some scholars (Bengtsson et al., 2010; Gnyawali et al., 2008) suggest that it is necessary to examine coopetition where both competition and cooperation are simultaneously present and high. However, the strength of cooperation in individual alliances still has not been operationalized in empirical research. Finally, previous studies typically categorized coopetition based on the partners industry (SIC code), which seems too broad to capture firms' competitors in a certain product or geographical market. From a cognitive perspective, not all firms operating in the same industry are necessarily perceived as competitors by a certain actor (Porac, Thomas, Wilson, Paton, & Kanfer, 1995; Ritala, Hallikas, & Sissonen, 2008). Further, previous studies focused on

competition in the product markets, but ignored the competition surrounding technology (i.e., technology competition) that may more directly impact innovation. In sum, to better understand the concept of coopetition and its implications, it is necessary to develop measures of varying degrees (or different types) of coopetition that consider both competition and cooperation.

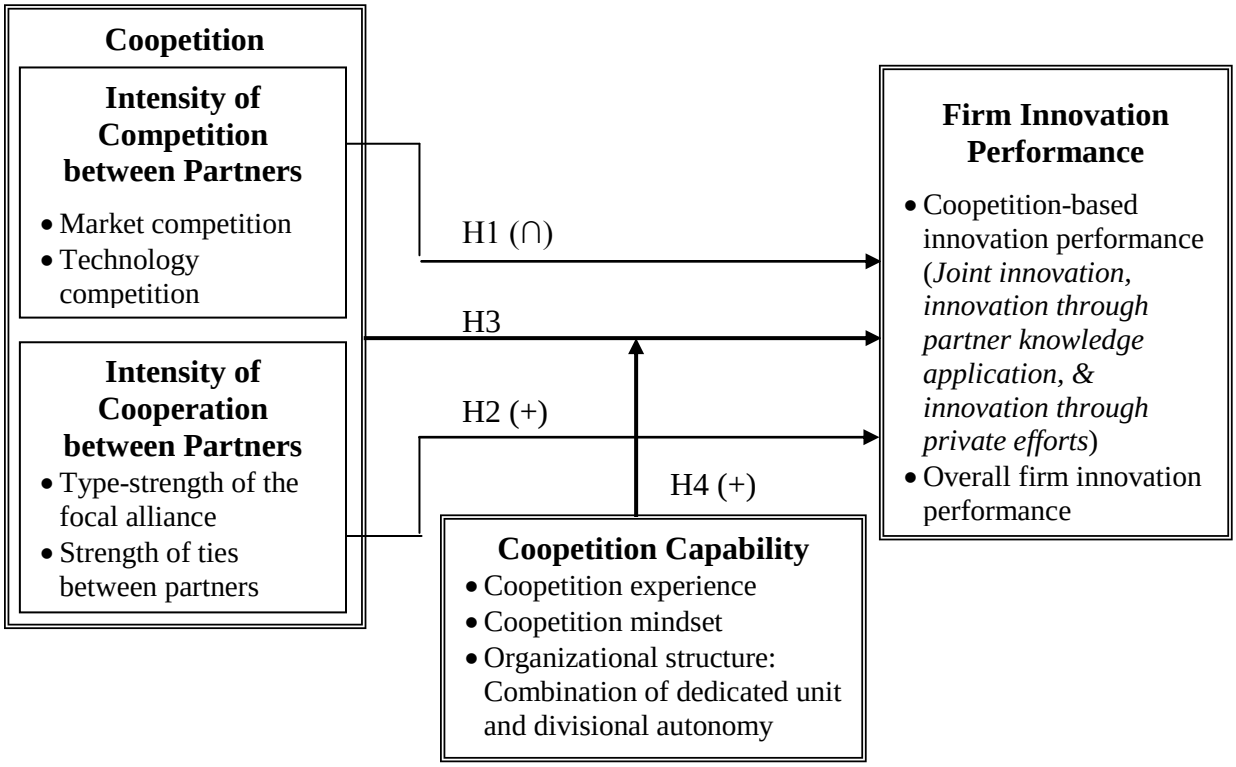
1.2 Conceptual Overview

I develop a conceptual framework of the relationship between coopetition and innovation performance that includes a moderating role of the firm's coopetition capability. I argue that coopetition, which should be captured by both the degree of competition and the degree of collaboration as well as the balance between competition and cooperation, influences a firm's ability to generate technological innovation. Also, based on the balancing strategy and transparadox perspectives, I examine if the balance between competition and cooperation generates superior innovation performance. Further, I examine the moderating role of firm-specific coopetition capability on the relationship between coopetition and firm innovation. This study also attempts to separate coopetition-based innovation from the overall firm innovation performance.

Scholars have used a wide variety of definitions and perspectives in examining coopetition (Yami et al., 2010). Gnyawali et al. (2008) provide a framework that explains how coopetition occurs very intensely (when a dyad engages in simultaneous collaboration and competition) and much less intensely (when several firms engage in some forms of collaboration and competition at different time). Bengtsson et al. (2010) suggest that coopetition has been defined in at least two different ways and the definitions are related to the levels of analysis. According to Bengtsson et al. (2010), in some studies, the authors (e.g., Brandenburger & Nalebuff, 1996; Lado et al., 1997) view coopetition as the sum of many different relationships and the cooperative and competitive parts are divided between different actors, which is relevant

to network (or portfolio) level analysis. In other studies, the authors (e.g., Bengtsson & Kock, 1999, 2000) view collaboration and competition as two interrelated parts of one dyadic relationship and argue that the different parts of the relationship are divided between activities, which is relevant to dyadic level analysis (Bengtsson et al., 2010). Bengtsson and Kock (1999, 2000) and Bengtsson et al. (2010) suggest that coopetition should be defined more narrowly to better grasp the tension and complexity in coopetition. As this study focuses on understanding the tension in coopetition, I test the model at the dyadic level.

FIGURE 1.1
Conceptual Model



Although my primary concern is about coopetition in which the degrees of competition and cooperation are both high, my model includes all alliances by capturing various combinations of degrees of competition and cooperation. The tension in coopetition clearly occurs in the context in which the degrees of competition and cooperation are both high, but the

logic can be applied to all alliances. In fact, tension is inherent in all collaborative relationships (Das & Teng, 2000) and all alliances have a certain degree of competition between partners. Further, examining coopetition in all alliances enables us to compare narrowly defined coopetition (i.e., the degree of competition and that of cooperation are both high) with different types of coopetition, by categorizing the observations into various types of coopetition. This conceptualization is similar to Bengtsson et al's (2010) arguments because they view coopetition in which collaboration and competition are divided between activities at one dyadic relationship but do not limit it to only cooperation with key competitors. As a result, this study will show not only the extent to which coopetition has an effect on innovation, but also the extent to which the balance of cooperation and competition between partners produces superior innovation performance.

1.3 Contributions

This dissertation makes four important contributions to the coopetition and innovation literatures. First, it extends our understanding of coopetition through a conceptualization and operationalization of coopetition. Building on previous works (Bengtsson et al., 2010; Chen, 2008; Das & Teng, 2000; Luo, 2007a), I conceptualize coopetition as being composed of three components: 1) competition between partners, 2) cooperation between partners, and 3) the interplay between competition and cooperation. Such conceptualization is essential for exploring the role of tension in coopetition. The tension in coopetition stems from the paradoxical factors, such as value creation versus value appropriation, knowledge sharing versus knowledge protection, and so on. The role of tension is critical for understanding the relationship between coopetition and innovation (Gnyawali, 2010) but tension is an unresolved issue in the coopetition literature. By adopting the transparadox approach (Chen, 2008; Lewis, 2000) based on the

Chinese Middle Way perspective (Chen, 2002), this study extends the notion of the balance of opposites (Das & Teng, 2000).

Second, this study advances our understanding of the role of coopetition on firm innovation performance by shifting the focus of the discussion from whether coopetition is beneficial for innovation to how, when, and to what extent firms can reap the benefits of coopetition. Based on the above conceptualizations of coopetition, this study examines the relationship between coopetition and firm innovation through methodological advancement. The lack of appropriate measures for coopetition is one of the most critical obstacles to large scale empirical studies (Yami et al., 2010). Previous studies have measured coopetition by establishing categorical variables, based on partners' industries, which limits researchers' ability to capture varying degrees of competition and cooperation. By measuring coopetition as a continuous variable, this dissertation demonstrates that coopetition based on market competition has an inverted-U relationship with innovation. Further, by capturing coopetition based both on the intensity of competition and the intensity of cooperation between partners, this study shows that the balance between competition and cooperation generates superior innovation performance.

Third, and related to the above, this study shows that a firm's coopetition capability, i.e., accumulated managerial competencies regarding how to manage a firm's coopetitive ties, plays a critical role in moderating the relationship between coopetition and innovation performance. Coopetition is considered as a paradoxical (Chen, 2008), dynamic (Luo, 2007b), and unstable (Das & Teng, 2000) relationship. Thus, managing coopetition is a much more challenging task than managing general alliances and requires unique managerial capabilities. From a managerial standpoint, how to understand and manage the tension from paradoxical factors is critical for selecting partners and managing (or coordinating) the paradoxical factors and conflicts within

and between firms. Through both the case study and the quantitatitive study, this dissertation demonstrates that a firm's coopetition capability plays a critical role in coopetition.

Finally, this dissertation contributes to the innovation literature as well. Building on the rationale of value creation and appropriation, which is a central part of coopetition, I conceptualize the composition of value ("innovation" in this study) that a focal firm can create and appropriate through coopetition as follows: 1) value co-creation, 2) value creation through knowledge application, and 3) value creation through competition with partners (refer to Figure 3.3). Based on such a conceptualization, I isolated innovation performance through coopetition, which is composed of three components: 1) joint innovation, 2) innovation through the application of partner knowledge, and 3) innovation in the partner's domains. Ahuja, Lampert, and Tandon (2008) raised an issue in alliance research on innovation – the difficulty in matching innovations directly to alliances. In this dissertation, I provide a new measure (i.e., coopetition-based innovation), which captures only the value (innovation performance) related to coopetition. Thus, this dissertation helps resolve an important challenge in the coopetition (or general alliance) research on innovation.

2. LITERATURE REVIEW

This chapter is composed of four parts. The first part presents a review of the evolution of coopetition literature. This part begins with the existing literature on the competitive perspective, the cooperative perspective, and collaboration with competitors, providing a basis to understand how such an increasing phenomenon – collaborating with competitors – has been approached from the competition and cooperation perspectives. Then, I address the different definitions (focused vs. broad) and recent trends of coopetition. The second part presents the role of inter-firm dynamics (competition, cooperation, and coopetition) in innovation. The third part addresses the tension and paradox in coopetition as the theoretical foundation of this study. The fourth part reviews the role of dynamic capabilities.

2.1 The Evolution of Coopetition Literature

In recent decades, competitive advantage and firm performance have been heavily emphasized in strategic management research and practice. The focus in this stream has shifted from the competitive perspective, based on organizational economics and resource-based view (RBV), to the cooperative perspective, based on the collaborative or relational benefits from inter-organizational alliances and networks (RBV is extended to beyond the firm boundary), and more recently to the interplay of the two perspectives. In the section below, I briefly review the competition and collaboration literatures that helped to develop coopetition studies. Then I review the coopetition literature.

2.1.1 Competition-cooperation research

2.1.1.1 The competitive perspective

To accomplish their performance goals (i.e., achieving and sustaining competitive advantage), firms formulate competitive strategies on how to compete with their rivals.

Competitive strategy is concerned with the question of how a firm can gain advantage over its competitors (Bowman & Faulkner, 1997; Porter, 1985). There are two broad traditions of thinking about competitive strategy from either external or internal aspects of the firm. Hoskisson and colleagues note that the field of strategic management has shifted its focus from one to the other like the swing of a pendulum (Hoskisson, Hitt, Wan, & Yiu, 1999). On the one hand, competitive strategy is based on the structure-conduct-performance (S-C-P) paradigm of industrial-organization (IO) economics. Contributing to this paradigm, Porter (1980) provides a model in which the structure of an industry determines the state of competition within that industry and structural forces, the so called five forces, determine the average profitability of the industry. On the other hand, the development of the resource-based view (RBV) of the firm (e.g., Barney, 1986, 1991; Penrose, 1959; Wernerfelt, 1984) has increased emphasis on firms' internal attributes such as resources, capabilities, and knowledge. Different from IO economics, the RBV sees resources and capabilities as the heart of a company's competitiveness. Based on the assumption of resource heterogeneity, researchers try to explain how firms' different resources influence firm performance.

Meanwhile, another stream of research explicitly focuses on the interactive, dynamic nature of firm competition. Although the dynamic competition may be discussed from multiple perspectives,[2] I focus on competitive dynamics research in this chapter and dynamic capabilities in section 2.4. Competitive dynamics research (Chen, 1996; Chen, Su & Tsai, 2007; Ferrier, Smith & Grimm, 1999) has examined the dynamics of how firms compete with one another and how they make use of strategy to build competitive advantages over competitors (Hoskisson et al., 1999). Grounded in Schumpeter's (1942) theory of creative destruction and Austrian

[2] Elling and Lin (2001) introduced the term "dynamic competition" and argue that dynamic theories include 1) Schumpeterian, 2) revolutionary, 3) Austrian, 4) path dependence, and 5) resource-based view (RBV).

Economics, competitive dynamics research emphasizes the dynamic process of how firms act and react to the competitive environment in order to achieve competitiveness (Smith, Ferrier, & Ndofor, 2001). Emphasizing a dyadic, pair-wise analysis, Chen (1996) introduced two firm-specific concepts – market commonality and resource similarity – to help elucidate the pre-battle competitive tension between two firms and to predict how firms may interact with each other as competitors. There are three elements – awareness, motivation and capability (AMC) – that provide the theoretical foundation for analyzing factors that can influence the characteristics of competitive reaction at various levels. Chen et al. (2007) argue that competitors can offer responses to a competitive move only if they are aware of the move, motivated to respond to the move, and capable of responding to the move. Accordingly, they argue that AMC will influence the competitive tension.

In competition-dominated relationships, firms show competitive rent-seeking behavior (Lado et al., 1997). According to Lado et al. (1997), competition arguably generates economic efficiency in the following ways: a) it encourages firms to optimally allocate scarce resources and b) it provides the impetus for innovation and entrepreneurship (Nelson, 1991; Schumpeter, 1942). However, this approach is based on the theoretical assumption that the creation of economic value occurs within the firm whereas inter-firm interactions influence the distribution of that value (Dagnino, 2009). Thus, firms may be blinded to opportunities to realize positive-sum benefits through effective collaboration (Kanter, 1994). Also, this approach encompasses a zero-sum orientation toward the firm's stakeholders (Lado et al., 1997; Dagnino, 2009). Lado et al. (1997) point out that by perceiving and structuring relationships with their stakeholders as zero-sum games where one firm's gain is another firm's loss, competitive behavior may encourage firms either to erect barriers around their distinctive competencies and then make

cooperation difficult or to behave opportunistically toward others (Williamson, 1985). In the case of a company adopting competitive behavior, the risk of a 'learning race' emerges (Quintana-García & Benavides-Velasco, 2004), where firms simultaneously look for a maximum absorption of distinctive competencies from its partner and try to protect their own core resources and capabilities (Kale, Singh & Perlmutter, 2000). Consequently, although competitive behavior helps earn temporary rents, it may be difficult for firms with such behavior to maintain a competitive advantage for a long time.

2.1.1.2 The cooperative perspective

More recently, scholars have paid increasing attention to "cooperative strategy" that "is the attempt by organizations to realize their objectives through cooperation with other organizations rather than in competition with them" (Child, Faulkner, & Tallman, 2005: 1). This strategic perspective emphasizes the development and nurturing of "collaborative" or "relational" advantage. Few firms have all the resources needed to compete effectively in the current dynamic business environment (Ireland, Hitt, & Vaidyanath, 2002). Companies that are lacking in particular competencies or resources can secure these through links (i.e., establishing alliances or joint ventures) with other organizations possessing complementary resources or capabilities (Child et al., 2005). Within the collaborative paradigm, the business world is composed of networks of interdependent relationships and firms are intertwined in complex networks of interactions with other organizations (Dyer & Singh, 1998; Gulati, 1998; Gulati, Nohria, & Zaheer, 2000). According to the research on inter-organizational alliances and networks, a cooperative strategy can offer significant advantages for companies to pool and utilize valuable resources and capabilities, offer easier access to new markets, and obtain opportunities for mutual synergies and learning (Dyer & Singh, 1998; Ireland et al., 2002).

In cooperation-dominated relationships, firms show collaborative rent-seeking behavior (Lado et al., 1997). Dagnino (2009) argues that the sources of economic value creation in cooperative relationships are located within the structure of firms' interdependence, which is based on a positive-sum game with the goal of deriving mutual benefits. In the same vein, Lado et al. (1997) echoed Kanter's (1994) argument that collaborative advantage is generated when companies develop a behavior that emphasizes altruism, trust, and reciprocity among the partners. "Trust generates economic rents in several ways such as serving as a mechanism for social control and reducing the transaction costs that would otherwise be incurred in building governance mechanisms to safeguard against the hazards of partner opportunism (Lado et al., 1997: 121)." Axelrod (1984) noted that for cooperation to succeed, it must be based on reciprocity and on mutual expectations that economic exchanges between the parties will continue in the future. Vis-à-vis the competitive approach, the cooperative perspective significantly reduces the threat of opportunistic behaviors (Dagnino, 2009).

However, cooperative rent-seeking behavior has several limitations. Lado et al. (1997) noted that habitually cooperative firms, which tend to perceive and structure inter-firm relationships as positive-sum games, might fail to differentiate between genuinely cooperative and trustworthy partners and opportunistic ones (Frank, 1988). Also, cooperative rent-seeking behavior might generate strategic inflexibility. While inter-firm relationships may help firms enhance their strategic flexibility and learning capability (Volberda, 1996), Bresser and Harl (1986) noted that greater cooperation heightens reciprocal commitments of idiosyncratic and specialized resources to the cooperative efforts, which, in turn, exacerbates strategic inflexibility. In a similar vein, Uzzi (1997) reports that, beyond a threshold, embeddedness can hurt performance by making firms vulnerable to exogenous shocks or insulating them from

information that exists outside their network. Consequently, although cooperative behavior is necessary to generate collaborative benefits, it may be not sufficient for achieving sustained superior performance and viability.

2.1.1.3 Collective competition versus competitive collaboration

Until recently, researchers have tended to view competition and cooperation as opposite ends of a single continuum (Quintana-García & Benavides-Velasco, 2004). From two different perspectives, existing theory and research on relationships among competitors have focused either on competitive or on cooperative relationships between them, with one relationship to arguably harm or threaten the other (Bengtsson & Kock, 2000).

However, recently the phenomenon of collaboration with competitors has been studied from the viewpoints of cooperation theory and competition theory. As collaboration between competitors becomes more common, scholars in alliance or competitive dynamics pay attention to the phenomena, even though they use different terms, such as "competitive collaboration," "collective competition" as well as "cooperation with rivals," depending on their approach or focus (competition-oriented or cooperation-oriented) (see Chen, 2008; Gomes-Casseres, 1994; Hamel, Doz & Prahalad, 1989). With regard to collaboration with competitors, the alliance literature takes a zero-sum approach and adopts an opportunistic perspective, based on the TCE framework. Hamel et al. (1989) analyze the phenomenon of collaborating with competitors, what they call "competitive collaboration," focusing on how to win (or get more value) over competitor-partners in the relationship. Hamel (1991) argues that collaboration between competitors often leads to a "learning race" in which firms compete over who can acquire more knowledge from the relationship before its termination. Such a setting implies a zero-sum (or negative-sum) game between the collaborating partners. In the similar vein, Park and Russo

(1996: 878) show that 'the potential for appropriability in a joint venture setting is higher when the partners are direct competitors.' Meanwhile, competition literature also studied collaboration with competitors. Ketchen and Snow (2004) include coopetition as one of six streams in competitive dynamics research. Chen (2008) summarizes that competition-oriented cooperation studies use various competitive attributes (such as industry structure and inter-firm competitive relationships) to predict outcomes (such as duration, intensity, organizational learning between partners) of cooperative arrangements (such as joint ventures, alliances).

A critical issue is that these research streams continue to use different terms even after the term 'coopetition' was introduced into the academic literature by Brandenburger and Nalebuff (1996). Thus, scholars can be confused in regard to the difference between coopetition and certain types of alliance (e.g., horizontal alliance, scale alliance, or competitor alliance) or certain types of competition (e.g., collective competition). The alliance literature has developed the categorizations for collaboration with competitors, such as "horizontal alliances," "scale alliances," and "competitor alliances." First, alliances between competitors within an industry are referred to as "horizontal alliances" (Burgers, Hill & Kim, 1993). They can be distinguished from vertical alliances between firms operating in adjacent stages of a value chain (Harrigan, 1988). Based on the venture relatedness, Harrigan (1988) divided the types of ventures into two categories – vertical and horizontal. She argues that joint ventures are vertically related to owners if buyer-seller relationships are created between owner and venture, as in the example of Reserve Mining (owned by Republic Steel and Armco Steel); horizontally related joint ventures link owner and venture in the same strategic activities, as in the example of New United Motor Manufacturing Inc. (NUMMI) owned by GM and Toyota. Second, Dussauge, Garrette, and Mitchell (2000) provide another useful classification (i.e., scale vs. link alliances) of alliances

that supports the theory relating to coopetition, albeit implicitly (Walley, 2007). Where firms contribute similar resources to achieve scale advantages, the relationship is referred to as a "scale alliance," while a "link alliance" refers to the relationship where firms contribute complimentary resources to achieve a differential advantage (Dussauge, Garrette & Mitchell, 2004). Finally, Luo, Rindfleisch, and Tse (2007) suggest that firms can form alliances with rivals (which they term "competitor alliances") to accomplish both competitive and cooperative goals and boost profits in a "win-win" manner.

In sum, the phenomenon of collaboration with competitors has been studied from the viewpoints of cooperation theory and competition theory as well as the coopetition literature. Such studies have advanced our understanding of the phenomenon (collaboration with competitors), and coopetition research can draw extensively from these studies. Therefore, it is necessary to examine the similarities/differences between coopetition and related research streams, which will show the uniqueness of coopetition.

2.1.2 The Coopetitive Perspective

2.1.2.1 Why do we need the term coopetition?

The term coopetition was coined by Ray Noorda, CEO of the technology company Novell, but it was popularized by the bestselling book titled *Co-Opetition* by Brandenburger and Nalebuff published in 1996 (Gnyawali et al., 2008). The discussion above raises a natural question: "Why do we need the term (or concept) of coopetition?" Scholars who support coopetition argue that the research from either the cooperation or the competition perspective is limited when capturing the business reality, which is much more complex in terms of separating between competing and collaborating actors. Coopetition strategies are by nature non-conventional, paradoxical, or heterodox because they link two concepts that are contradictory by

definition and nature – competition and cooperation (Yami et al., 2010). Brandenburger and Nalebuff (1996) and their followers considered the concept of coopetition to be a new strategic perspective that is capable of overcoming the limits of the old strategic dichotomy (cooperation or competition) and suggested that firms should seek the advantages arising from both competition and cooperation. More scholars have recognized the benefits of a blended approach that includes both the competitive and cooperative perspectives. For example, Chen (2008) observed that although competition and cooperation individually have received much consideration in the strategy field, there seems to be clear and unsolved contradiction between the competitive paradigm and the cooperative paradigm. Therefore, Chen (2008) points out that, even though both competitive and cooperative strategies are integral parts of a firm's overall strategy, researchers have given little attention to the fundamental issue of interplay between the two concepts.

2.1.2.2 Different views of coopetition

While the elements of competition and collaboration are essential for the conceptualization of coopetition, scholars have used a wide variety of definitions and perspectives to examine it (Yami et al., 2010). While some definitions are focused, others are rather broad. Scholars capture the concept of coopetition based on the three most cited seminal works: Brandenburg and Nalebuff (1996), Lado et al. (1997), and Bengtsson and Kock (2000). In the book *Co-Opetition*, Brandenburg and Nalebuff (1996) provide a theoretical background of coopetition, based on the "value-net" model, which focuses on the presence of a "complementor." From this viewpoint, coopetition includes indirect collaboration among competitors. For example, two competitors (e.g., computer manufacturers) can be complementors through their collaboration with a third firm (e.g., software producers). Lado et

al. (1997) make another contribution to the notion of coopetition, even though they did not use the term. Using game theory, RBV, and social network theory, they argued that a combination of competitive and cooperative strategies will create a higher overall rent for a firm (so called "syncretic rent"). Brandenburger and Nalebuff (1996) and their followers consequently view coopetition as the sum of many different relationships and the cooperative and competitive part is divided between different actors (Bengtsson et al., 2010), which results in a very broad definition of coopetition.

In contrast to the broad approach, Bengtsson and Kock (1999, 2000) are more focused in defining coopetition as a "dyadic and paradoxical relationship emerging when two firms are cooperating in some activities, while competing with each other in the remaining activities." That is, the authors view collaboration and competition as two interrelated parts of one dyadic relationship and argue that the different parts of the relationship are divided between activities. In this regard, Bengtsson and Kock (2000) identified two different patterns of division between the two parts of the coopetitive relationship: the value chain and the market (business units or product area). In such cases, coopetition should be defined as a relationship between two actors (Bengtsson & Kock, 1999, 2000) and the actors could be individuals, units, organizations, alliances, or formalized networks (Bengtsson et al., 2010).

The definitions are also related to the levels of analysis (Bentsson et al., 2010). While broad approaches are related to the network or portfolio level, focused approaches are related to the dyadic level research. Until now, for quantitative research, scholars take a broad approach. However, several scholars (e.g., Bentsson et al., 2010; Bengtsson & Kock, 2000; Gnyawali et al., 2008) point out that coopetition should be defined more narrowly to better grasp the tension and complexity that follows when two firms simultaneously cooperate and compete with each other.

As the focus of this research is on tension in coopetition, the focused definition of coopetition and a dyadic level approach seem appropriate to this study.

2.1.2.3 Trends in the coopetition literature

Based on the foundation works (Brandenburg & Nalebuff, 1996; Bengtsson & Kock, 2000), the concept of coopetition has been increasingly adopted by scholars in various fields. The coopetition literature offers several characteristics. First, as coopetition is a multi-level phenomenon, coopetition research includes at least three levels of analysis: 1) intra-firm, 2) inter-firm (or dyad), and 3) network (or portfolio) level research. As Table 2.1 and Table 2.2 present, research has been the most fruitful at the level of inter-firm relationships, while network level research (e.g., Gnyawali, He & Madhavan, 2006; Peng & Bourne, 2009) and intra-firm level studies (e.g., Tsai, 2002; Luo, 2005) have received far less academic attention. Second, research on coopetition has developed in terms of conceptual advancement. Some scholars have proposed theoretical extensions on the nature or typology of coopetition, which enables a better understanding of the phenomenon. Dagnino and Padula (2002) differentiate among four forms of coopetition, which depend on the number of rival firms and number of value activities involved in coopetition relationships. Luo (2007a) offers the typology of the intensity of coopetition and identifies four situations: contending (high competition, low cooperation), isolating (low-low), partnering (high cooperation, low competition), and adapting (high-high). Gnyawali et al. (2008) provide a framework that explains how coopetition occurs very intensely (when a dyad engages in simultaneous collaboration and competition) and much less intensely (when several firms engage in some forms of collaboration and competition at different time periods). Finally, with a few exceptions, empirical research on coopetition has focused on explorative single-industry case studies (Yami et al., 2010).

The subjects that the literature has examined can be divided into three categories: 1) drivers, 2) processes/contexts, and 3) outcomes of coopetition (Gnyawali et al., 2008). First, scholars identified various drivers (or motivations) of coopetition, such as changes in market conditions, institutional or regulatory change, complementary resource or knowledge profiles (Padula & Dagnino, 2007), or the need for advantages of scale (Walley, 2007). However, there have been limited studies that extensively examine drivers of coopetition, the exception being Gnyawali and Park's (2009) multi-level model of drivers and outcomes of coopetition. They identified three drivers (short product life cycles, technological convergence, and massive R&D investment), which will increase the likelihood of coopetition in the high-tech industry. In addition, they argue that firm-level factors (firms' prospecting strategy and venerability) and dyadic factors (technological competence, resource complementarity, and resource similarity) interplay with industry-level factors, which will determine actual coopetition. Second, in terms of the coopetition process, recent trends in coopetition research show a proliferation in the use of the term "coopetition" in various contexts and many studies broadly defined coopetitive relationships. As Brandenburg and Nalebuff (1996) thought of coopetition as a revolutionary mind-set, coopetition has been viewed as a broad philosophy. Therefore, coopetition has been applied to explain various relationships and phenomena, including supply chain relationships, firm-government (or broad stakeholders) relationships, and collaboration with direct/indirect competitors. For example, Eriksson (2008) investigated coopetition in buyer-supplier relationships. Luo (2007a) suggests that coopetition can be applied to various contexts, such as MNC-host government relationships. Walley (2007) also suggested studying broad topics, including coopetition with consumers.

Finally, regarding the outcomes of coopetition, even though some studies (e.g., Lado et al., 1997) conceptually address the performance implications of coopetition, empirical studies focusing on this link are rare (Walley, 2007). Only a few studies have dealt with financial performance (Luo, Rindfleisch, & Tse, 2007; Ritala et al., 2008), innovation performance (Quintana-García & Benavides-Velasco, 2004), JV stability (Park & Russo, 1996), and competitive behavior (Gnyawali et al., 2006). With the limited empirical studies and some inconsistent results, however, there is a great deal of ambiguity concerning the effects of coopetition on firm performance. In terms of firm financial performance, Luo et al. (2007) reported that competitor alliance intensity has an inverted U-shaped relationship with firm profitability. However, Ritala et al. (2008) failed to find a significant relationship between coopetition (in terms of the relative number of key competitors among the group of firm's strategic alliances) and firm financial performance. Regarding joint venture stability, Park and Russo (1996), using the perspectives of TCE, reported that a joint venture between competitors is significantly more likely to fail. Innovation performance will be discussed in the next section.

2.1.3 Research gaps in the coopetition literature

Research on coopetition is still at a very early and conceptual phase (Padula & Dagnino, 2007) and is relatively small, fragmented, and sparse (Yami et al., 2010). Most empirical studies are explorative single-industry case studies. The first gap in the literature addressed in this study concerns the lack of studies and inconsistent results on the relationship between coopetition and firm performance. There is a great deal of ambiguity concerning the effects of coopetition on firm-level performance (Ritala, in press). As a key objective of strategy is to generate competitive advantage, a fundamental issue to examine is the role of coopetition in firm performance, including innovation. Second, tension in coopetition is under-researched. Tension

is inherent in coopetition due to the paradoxical relationship between competition and cooperation. However, dynamic tension and its implications for firm performance have not been systematically examined in the coopetition literature. Third, research has paid less attention to the dynamics of coopetition. If the effects of coopetition on firm performance are significant, how do a firm's specific capabilities related to coopetition affect its success? As coopetition is considered a dynamic and paradoxical relationship, it is necessary to examine which factors are necessary to manage coopetition in order to avoid the risks and maximize the benefits. Finally, case studies are important especially for extending our understanding the tension and dynamics of coopetition. With a few exceptions, most of the case studies focus on describing the phenomenon of coopetition in various contexts. Therefore, we still know little about how firms could simultaneously collaborate and compete, how the relationship evolves over time, and how firms could manage tension from paradoxical factors in coopetition.

TABLE 2.1: Key Empirical Research on Coopetition

	Author(s)	Research objectives	Research setting	Unit of analysis	Measures	Key Findings
Financial Performance						
1	Ritala et al. (2008)	What is the relationship b/w firm performance and the amount of strategic alliances with firm's key competitors?	• The global ICT sector (56 large companies-10 largest firms from each group) • N=36 (having at least one or more coopetitive relationships)	Firm-Portfolio	• Coopetition: - The relative number of key competitors among the firm's strategic alliance partners - The relative number of strategic alliances among the firm's key competitors • Performance: ROA, Sales	• A high relative number of strategic alliances among a group of firm's key competitors contributes negatively to firm performance. • Mixed results: statistical sign is negative and significant ($p<.05$); correlation(r) is 0.42 (positive).
2	Luo, Rindfleisch, & Tse (2007)	The impact of competitor alliances on financial performance.	• Industries: electronics, pharmaceuticals, machinery, chemicals, paper & forest, apparel, rubber & plastic, computer industry.	Firm	• Coopetition: Survey - Competitor alliances (CA) intensity: five items - Competitor-oriented strategies (COS): six items - Competitor-oriented objectives (COO): four items • Performance: ROE	• Competitor alliances intensity has an inverted U-shaped relationship to firm profitability ($p<.01$; $r=.27$). • Competitor-oriented strategies are positively related to firm profitability ($p<.01$; $r=.17$). • Competitor-oriented objectives are negatively related to firm profitability ($p<.01$; $r=-.12$).
Innovation Performance						
3	Ritala & Hurmelinna-Laukkanen (2009)	Firm-specific success factors in coopetition.	• A cross-industry survey to 213 Finnish companies	Firm	• Survey • DV: Level of incremental and radical innovation • IVs: Potential absorptive capacity (5 items); Appropriability regime (7 factors)	• In coopetition, both potential absorptive capacity ($p<.05$; $r=.11$) and appropriability regime ($p<.01$; $r=.18$) have a positive effect on incremental innovation. • In the case of radical innovations, appropriability regime has a positive effect ($p<.001$; $r=.24$), while the effect of absorptive capacity is not statistically significant ($r=.08$).
4	Nieto & Santamaria (2007)	The effects of different type of partners on the degree of novelty of product innovation.	• Survey by Spanish Ministry of Science and Technology from 1998 to 2002 • 6500 observations from 1300 firms	Firm-Portfolio	• Coopetition: Collaboration with competitors exclusively • Innovation: survey - the characteristics (high or low novelty) of product innovation	• Collaboration with competitors exclusively has a negative impact on the novelty of innovation and produces the least level of novel innovations ($p<.01$); $r=-.00$). • Collaboration with multiple partners produces positive effects on innovation ($p<.01$; $r=.29$)

	Author(s)	Research objectives	Research setting	Unit of analysis	Measures	Key Findings
5	Quintana-Garcia & Benavides-Velasco (2004)	The role of coopetition on innovation performance.	• European biotechnology industry. • Small and medium sized dedicated biotechnology firms.	Alliance	• Coopetition: alliance with direct competitors - other small and medium sized dedicated biotechnology firms. • Innovation: technology diversity (number of technologies), product lines (number of products on the market)	• Coopetition (alliance with direct competitors) generates positive effects on innovation ($p<.001$; $r=.65$). • Downstream alliance (with pharmaceutical or chemical firms) and compete through subsidiary: positive effects on innovation ($p<.001$; $r=.55$). • Other types: insignificant or negative effects on innovation.
Consequences: competitive behavior or JV stability						
6	Gnyawali et al. (2006)	How does coopetition affect firms' competitive behavior?	• Global steel industry network in 1995, comprising of 45 major firms.	Firm-Network	• Coopetition: simultaneous cooperation and competition.	• A firm's centrality is positively related to its volume of competition actions. • A firm's structural autonomy is positively related to the diversity of its competitive actions. • Market diversity moderates the impact of centrality and structural autonomy on competitive behavior.
7	Park & Russo (1996)	The predictors of JV failure (whether a JV between direct competitors is more likely to fail).	• 204 JVs in the electronics industry b/w 1979 and 1988	Joint Venture	• Coopetition: JVs between direct competitors (same SIC code)	• Coopetition with competitor in a JV is significantly more likely to fail.
Coopetition Management						
8	Chin, Chan, Lam (2008)	Success factors critical to coopetition strategy management.	• Hong Kong manufacturing industries • Survey: 149 responses • 6 interviews	Firm	• Coopetition: a revolutionary mindset that combines competition and cooperation. • Survey: Hierarchical model consisted of four levels and three categories	• Identified seven critical success factors and 17 critical success sub-factors comprising three categories: management commitment, relationship development, and communication management. • Management leadership and development of trust are the most important success factors.

TABLE 2.2: Key Case-Based Empirical Research on Coopetition

	Author(s)	Research objectives	Research setting	Unit of analysis	Measures	Key Findings
Coopetition Management						
1	Watanabe et al. (2009)	The effects of the fusion of Canon's indigenous strength in printer technology and market learning effects.	• Case study of Canon printer	Firm	• A co-evolutionary trajectory b/w printers and PCs	• Canon accomplished in sustainable functionality development by fusing its indigenous strength and effective external market learning. • While Canon and PC makers cooperate to expand the PC market, they compete in the market of computer peripheral equipment.
2	Oshri & Weeber (2006)	Whether is a standardization battle taking a hybrid mode (not either pure competition or cooperation activities)?	• Case study of the Wireless Information Devices Operating System (WID-OS) battle	Firm-dyad	• Coopetition: hybrid mode between pure competition and cooperation	• Standard-setting activities are taking place in a hybrid mode. • Members of a network undertake to 1) coordinate standard-setting activities as a cooperative unit, and 2) ensure that their competitive position in their respective market is secured as individual competitors.
3	Bengtsson & Kock (2000)	The trade-off between cooperation and competition in relationships among competitors.	• Case study of the two Swedish and one Finnish industries (the lining, brewery, and diary industries) • Interview 21 persons.	Firm-dyad	• Coopetition: simultaneous collaboration and competition	• Competitors cooperate with activities far from the customer and compete in activities close to the customer. • Driving factors influence coopetition: heterogeneity in resources, competitors' position and the connectedness b/w them, conflict and consensus about organizational goals.
4	Tsai (2002)	How does interunit competition moderate the relationship b/w coordination mechanism and interunit knowledge sharing?	• A large multiunit company with 24 business units. • Surveys were conducted in 1996 and 1998.	Intra firm (Business unit)	• Coopetition: simultaneously collaborative and competitive behavior	• Social interaction has a significant positive effect on knowledge sharing among units that compete with each other for market share, but not among units that compete for internal resources.
5	Cassiman et al. (2009)	Which factors are relevant at the project level to profit from R&D projects?	• Case study of STMcroelectronics • 52 projects between 1998 to 2003 • Interviews	R&D Project	• Partners: universities vs. firms • Governance structure: internal development, cooperation, or contracting	• The balance of cooperative and competitive forces in the organization of R&D projects is made through the alignment of three variables: project knowledge attributes, project governance structure, and project partner selection.

	Author(s)	Research objectives	Research setting	Unit of analysis	Measures	Key Findings
Contexts in Coopetition						
6	Ritala et al. (2009)	How does coopetition manifest in the context of collaborative service development and how can it be managed?	• Case study of Finnish mobile TV service development • Interview: 14 persons representing 12 organizations	Firm	• Coopetition: simultaneous competition and cooperation.	• As the business model is closer to commercialization, competition intensifies and cooperation diminishes. • Both complementary/heterogeneous resources and homogeneous resources create value in cooperative service development. • Coopetition management: flexible use of different governance structure is beneficial; trust is needed to complement the contractual framework.
7	Eriksson (2009)	How can a suitable balance b/w c ooperation and competition be identified in coopetitive buyer-supplier relationship?	• Case study of AstraZeneca in the construction industry	Firm	• Coopetition: coexistence of cooperation and competition	• A total focus on cooperation is only suitable when the characteristics (asset specificity, frequency/duration, and uncertainty) reach very high levels, while a total focus on competition is suitable for very low levels. In between these end points, a simultaneous mix of competition and cooperation is more suitable.
8	Wang & Krakover (2008)	The coopetitive relationship in the context of destination marketing	• Case study of the tourism industry (Elkhart County, Indiana)	Firm	• Coopetition: competitors have both a competitive and a cooperative relationship with one another at the same time.	• Different relationships of cooperation, competition, and coopetition coexist among the tourism stakeholders • Coopetition emerges when tourism businesses cooperate in some activities in a collaborative destination-marketing context, while competing with each other in other activities.
9	Mariani (2007)	The emergent (unintended) dimension of coopetition strategy.	• Case study of the consortium of Italian opera houses.	Firm	• Coopetition: co-existence of cooperation and competition (*The paper doesn't define the term)	• Coopetition originates as an emergent strategy that only afterwards becomes a deliberate strategy. • Induced coopetition is the transitory initiation stage of a coopetitive strategy life cycle where coopetition is imposed on competing organizations.

	Author(s)	Research objectives	Research setting	Unit of analysis	Measures	Key Findings
Coopetition Evolution / Interaction between Partners						
10	Peng & Bourne (2009)	How do networks with different structures interact with each other?	• Case study of two Taiwanese healthcare networks	Network	• Coopetition: coexistence of competition and cooperation b/w networks. • Cooperation: patient referrals, joint training and education, use of the burns-care unit and the central laboratory. • Competition: technology, cost efficiency, and public influence in the market.	• Firms or networks first initiated competition, followed by cooperation and then coopetition. • Two organizations will compete and cooperate simultaneously when two conditions hold: a) where each organization has complementary but distinctly different sets of resources; and b) where the field of competition is distinctly separate from the field of cooperation.

2.2 Role of Inter-firm Dynamics in Innovation

Innovation has long been seen as a source of competitive advantage (Abernathy & Clark, 1985; Ahuja & Katila, 2001; Schumpeter, 1942; Teece, 1996; Utterback & Suarez, 1993). Thus, understanding the determinants of technological innovation has been an important area of inquiry in the management and economics literatures. Although the innovation literature has examined various levels of analysis (such as industry, firm, inter-firm, and intra-firm levels), the role of inter-firm dynamics on innovation is an important but under-researched subject. The relationship between competition and innovation is an ongoing subject (Tang, 2006). Some competition studies, such as the patent race research, provide valuable insights on innovation from the inter-firm dynamics perspective. In the last two decades, the management literature on innovation has paid significant attention to inter-firm collaboration as a determinant of firm innovativeness (Ahuja, 2000; Ahuja, Lampert, & Tandon, 2008; Lei, 2003; Powell, Koput, & SmithDoerr, 1996; Sampson, 2007). However, the role of the interplay between competition and cooperation for innovation performance has not been examined systematically. In the section below, I review the role of coopetition on innovation and some studies from the competition and collaboration literatures that help to develop coopetition studies.

2.2.1 Role of competition in innovation

The relationship between competition and innovation has been examined mainly at the industry level by economists[3]. For example, Aghion, Bloom, Blundell, Griffith, and Howitt's

[3] The Schumpeterian view predicts that innovation declines with competition. That is, an increase in product market competition has a negative effect on productivity growth by reducing the monopoly rents that reward new innovation. However, several studies predict the opposite results. For example, Gonzalex-Maestre and Penarrubia (2005) argue that cooperation is recommended only when positive externalities are important. Combining the opposite predictions, Aghion et al. (2005) propose and test a model that predicts an inverted-U pattern between product market competition and innovation. In this model, competition discourages laggard firms from innovating but encourages neck-and-neck firms to innovate. Further, the average technological distance between leaders and followers increases with competition.

(2005) model predicts an inverted-U pattern between product market competition and innovation. But, the patent race literature, which is more related to technology competition, examines the relationship between competition and innovation from inter-firm dynamics perspective and provides some important implications to the coopetition research. First, firms in the same position (or close followers) in a patent race compete fiercely in R&D, but they can also be potential partners for R&D. Fudenberg, Gilbert, Stiglitz, and Tirole (1983) studied the main features of a patent race when firms compete in R&D, showing that firms in the same position compete fiercely, dissipating the rent from innovation. Building on the dynamic model of the patent race, Silipo (2005) analyzed the formation and breakup of joint ventures in relation to: 1) the relative as well as absolute position of the firms in the race; and 2) the degree of competition in the ex-post market. The results of the study imply that firms cooperate with competitors in the same position or colse followers. Also, market competition affects their collaboration: 1) if firms can collude in the product (or ex-post) market, they cooperate from the outset and innovate jointly; and 2) if they will be serious competitors in the downstream market, they cooperate at the outset but break their agreement in the last stage. Second, regarding the role of a firm's position, the literature reports that the follower devotes more resources to R&D than the leader (Doraszelski, 2003; Lerner, 1997), which gives rise to a pattern of action-reaction (Doraszelski, 2003). Finally, related to the racing behavior, Khanna, Gulati, and Nohria (1998) showed how the tension between cooperation and competition (or common benefits versus private benefits) affects the dynamics of learning alliances. That is, a situation of pure private benefits causes firms to race for learning against each other. And, "starting from a situation of pure private benefits, as the ratio of common to private benefit rises, the incentive to race is attenuated (Khanna et al., 1998: 200)."

Regarding technology competition, some scholars pay attention to intellectual property (IP) litigation, which reflects competition and conflicts. For example, Lanjouw and Schankerman (2001) imply that patent litigation is more likely when competitors (who are active in closely related technology fields) are engaged in patent infringement (regardless that the competitors are alliance partners or not) and it is important for patentees to defend the patent. That is, patentees are more likely go to court to protect patents that form the base of a cumulative chain, or technological trajectory (Lanjouw & Schankerman, 2001). Also, reputation building plays a role in the decision to litigate: 1) firms are more likely to prosecute the infringement of a patent when subsequent citations to that patent come from firms active in closely related technology fields; and 2) litigation itself conveys information to competitors about the willingness to defend the patent. However, previous studies focus on when and why patentees go to court to defend their patents. And there were limited efforts to understand the effects when alliance partners are engaged in patent infringements. In this regard, it is necessary to examine whether and how partners' engagement in IP litigations increases tension and the threat of opportunism and, in turn, firm innovation performance.

2.2.2 Role of cooperation in innovation

Research shows that collaborations (alliances or network) have a positive impact on innovative output (Ahuja, 2000; Lei, 2003; Powell et al., 1996; Srivastava & Gnyawali, in press). Collaborations provide timely access to knowledge and resources that are otherwise unavailable, and firms can combine each other's resources in pursuing innovation projects that involve high risks and require heavy investments (Gnyawali & Park, 2011). The impact of inter-firm cooperative relationships on firm innovation has been studied at various levels: the role of inter-firm cooperative relationships in the dyadic fashion (Mowery, Oxley, & Silverman, 1996;

Sampson, 2007), the role of a firm's position in the network (Ahuja, 2000; Zaheer & Bell, 2005), alliance portfolio (Srivastava & Gnyawali, in press), and the impact of the structural features of inter-firm network as a whole (Baum, Calabrese, & Silverman, 2000). In this study I focus on cooperation at the dyadic level. The potential benefits of interorganizational collaboration are facilitated by knowledge sharing and interactive learning processes among partners. This potential is claimed to be considerably dependent on the strength of ties. Therefore, in this section below, I review the strength-of-ties literature.

Strength of ties. The strength of ties is a "combination of the amount of time, the emotional intensity, the intimacy, and the reciprocal services which characterize the tie" (Granovetter, 1973:1361). Regarding the tie-strength, the interorganizational network literature has two research streams that deal with 1) the structural embeddedness, i.e., the position of a given organization in a broader network structure, and 2) the relational embeddedness, i.e., the dyadic relationships or ties between the actor and each of its partners (Gulati, 1998; Uzzi, 1999). Although structural embeddedness is important at the portfolio or network levels, I will focus on the relational embeddedness because this study mainly deals with dyadic relationships. The social network literature has suggested that strength-of-ties is the most dominant antecedent of knowledge transfer at the dyadic level because strong ties reduce both motivational and cognitive problems of knowledge transfer (Szulanski, 1996). The tie-strength research typically classifies both interpersonal and interorganizational relationships as being either strong or weak. However, the literature on both interpersonal and interorganizational levels "provides considerable evidence that partners involved in dyads holding the same kind of relationship (strong or weak) behave homogeneously" (Capaldo, 2007: 588). Therefore, at the interorganizational level,

scholars draw the same rationale of interpersonal level to explain the same dimensions in Granovetter's (1973) work.

At the inter-organizational level, strength-of-ties between partners, based on the notion of relational embeddedness, is typically operationalized using frequency, duration, and resource commitment. That is, strength-of-ties is indicated by "the frequency of interaction between partners and their level of resource commitment to the relationship" (Rowley, Behrens, & Krackhardt, 2000:371). For them, some dimensions in Granovetter's (1973) work, such as the emotional intensity and intimacy, are pertinent for the individual-level relationships, but are not as applicable to the inter-firm alliances (Rowley et al., 2000). Regarding the frequency of interaction between partners and their level of resource commitment to the relationship, the types of collaborative arrangements and the safeguarding mechanism seem to be relevant.

There has been a considerable debate within the network literature regarding the relative benefits of strong ties and weak ties (Hansen, 1999; Levin & Cross, 2004; Nelson, 1989). Knowledge transfer or knowledge sharing is on a central part of the effects of strength-of-ties. That is, embedded ties perform unique functions and are characterized by trust, fine-grained information transfer, and joint problem solving arrangements (Uzzi, 1996). Meanwhile, the literature provides considerable evidence that the behavior of partners in strong ties is different from that of partners in weak ties. At the network level, weak ties (when they are also bridge ties) may be more effective and useful in bringing in novel information (new but not complex) to a network, while strong ties (when they are connected with a closure) may be more effective in sharing complex knowledge (Hansen, 1999). Rowley et al. (2000) found that strong ties have positive effects on firm performance in a rather stable environment, while weak ties have greater effects in a rather dynamic environment.

2.2.3 Role of coopetition in innovation

Gnyawali and Park (2011) noted that, based on the core idea of the dynamic interplay between collaboration and competition (Chen, 2008; Gnyawali & Madhavan, 2001), coopetition is considered as a unique strategy that capitalizes on the benefits of collaboration and competition (Brandenburger & Nalebuff, 1996a; Lado et al., 1997). While cooperation allows firms access to rare and complementary resources, competition stimulates the search for new rent-generating combinations of resources, skills, and processes. Therefore, most conceptual research on coopetition suggested advantageous outcomes. However, there are also potential drawbacks. The alliance literature suggests that firms may feel a higher level of threat of opportunism in coopetitive relationships, which will cause negative effects in terms of transaction costs and stability of the relationships. Further, Bengtsson and Kock (2001, 2008) argue that coopetition causes the role conflicts at the individual level.

An important inquiry, which is related to the outcomes of coopetition, is how coopetition could impact innovation in high-tech industries (Dagnino & Rocco, 2009; Gnyawali & Park, 2009) where innovation is critical. Jorde and Teece (1990) argue that cooperation among competitors is essential if innovating firms are to compete in today's global markets. Despite the importance of the issue, scholars have paid limited attention to empirical examinations of the impact of coopetition on innovation. Further, the limited empirical studies reported inconsistent results. Quintana-García and Benavides-Velasco (2004) empirically showed that collaboration with direct competitors is important not only to acquire new technological knowledge and skills from the partner, but also to create and access other capabilities based on intensive exploitation of the existing ones (Gnyawali & Park, 2009). However, a few studies on innovation performance, approached from general alliances, reported contradictory conclusions. For

example, Nieto and Santamaria (2007) reported that firms that established alliances with competitors (i.e., coopetition) produced the least level of novel innovations, while collaboration with multiple partners produced the highest level of novel innovations. That is, the authors categorized the types of partners into the following: 1) collaboration with research organizations (i.e., universities and technological institutes) exclusively, 2) collaboration with clients exclusively, 3) collaboration with suppliers exclusively, 4) collaboration with competitors exclusively, and 5) collaboration with multiple partners. Although this categorization is necessary for research, it limits our ability to understand the effects of coopetition. That is, if we consider that the research focus in strategic management has developed from competition to collaboration (alliance/network) to coopetition, we can assume that many firms establish alliances with suppliers and/or clients first, before adding competitor partners in their alliance portfolio. Many firms that are engaged in alliances with competitors may not be involved in alliances with competitors exclusively, but instead may be also engaged in alliances with other type (or types) of partners. Therefore, the results should be interpreted cautiously. Recently, some scholars (e.g., Ritala & Hurmelinna-Laukkanen, 2009) have addressed firm specific factors (e.g., absorptive capacity) that increase innovation. Even though such studies are necessary, research on the fundamental relationship between coopetition and innovation should be further explored first. After that, we may need to explore under what conditions firms might generate greater innovation performance in coopetitive relationships.

2.2.4 Research gaps in the role of coopetition in innovation

The first gap in the literature addressed in this study concerns the lack of studies and inconsistent results on the relationship between coopetition and firm innovation performance. The second gap, which is related to the one above, is the role a firm's specific capabilities play in

managing coopetition and thus generating superior firm innovation performance. In regard to these gaps, several measurements are important. First, measures need to be developed to capture varying degrees of coopetition. Previous empirical research used categorical variables to examine the effects of coopetition on innovation. Categorical variables are limited if the relationship between coopetition and innovation is non-linear. As scholars argue that coopetition has both positive and negative consequences, the relationship between coopetition and innovation may not be linear. Second, measures of coopetition need to capture the degree of cooperation. Previous studies used the categorizations of coopetition based only on competition between partners, ignoring cooperation. We can better understand tension in coopetition when we consider both competition and cooperation. Third, a critical empirical hurdle in alliance studies on innovation is that it is really difficult to match innovations directly to the alliances. Separation of alliance related and non-alliance related innovation is extremely difficult (or impossible) (Ahuja et al., 2008).

Additional issues are important to better understand the relationship between coopetition and innovation. As coopetition is a multi-level phenomenon, cross-level research will be valuable. Also, the effects of coopetition on firm innovation may vary across industries. Thus, large-scale cross-sectional studies will be valuable for understanding the different effects of coopetition on firm innovation in different industry contexts. Further, a public policy concern with coopetition has been the potential for collaborating competitors to engage in collusion that may hurt innovation as well as consumers' welfare (Gnyawali & Park, 2011). To reduce concerns raised by some economists and policy makers, it is also important to examine coopetition's impact on innovation performance at the industry level.

2.3 The Role of Coopetition Tension in Firm Innovation

Coopetition tension refers to the strain that managers or firms feel in coopetitive relationships. Although coopetition is considered to be a win-win strategy, firms struggle with the dilemma between the need to work together in order to create value and the temptation to be opportunistic in order to appropriate a greater share of the created value (Lavie, 2007; Gnyawali & Park, 2009; Ritala & Hurmelinna-Laukkanen, 2009). Coopetitive relationships thus involve a high degree of interdependence with each other and are full of conflicts, yet the potential for payoff is also high (Gnyawali & Park, 2011). Therefore, an important issue in the coopetition literature is to understand and examine the nature, sources, and roles of tension in coopetition and how firms can manage the tension to achieve positive outcomes.

The most widely used English dictionaries, including the Oxford and Merriam-Webster, and online reference, such as Thesaurus, define "tension" in a variety of ways[4]. Consistent with them, WordNet Online provides various meanings of "tension," which are used in various fields, such as psychology, foreign policy, physics, and art as well as management. In psychology, tension (the synonym of stress) is "a state of mental or emotional strain or suspense." Further, suspense is a feeling of uncertainty and anxiety about the outcome of certain actions, most often referring to an audience's perceptions in a dramatic work. In military or foreign policy, tension (the synonym of latent hostility) refers to "feelings of hostility that are not manifest." In art or literature, tension refers to "a balance between and interplay of opposing elements or tendencies." In sum, tension is based on the assumptions of uncertainty and anticipation (or anxiety), while "a balance between opposing elements" is critical to maintain and control the

[4] Consider the following definitions of tension according to these online and offline sources: a) mental or emotional strain; b) a situation in which there is conflict or strain because of differing views, aims, or elements; c) inner striving, unrest, or imbalance often with physiological indication of emotion; d) a state of latent hostility or opposition between individuals or groups; e) barely controlled hostility or a strained relationship between people or groups; f) a balanced relation between strongly opposing elements.

relationship. In the section below, I explain how tension has been studied in the strategic management literature.

2.3.1 Tension from the risk perspective

Most previous studies regarding tension in management focus on the risks of coopetition, such as potential competition (feelings of hostility), threat of opportunism (uncertainty), and role conflicts. In the competition literature, the concept of tension is related to 'feelings of hostility' between and/or toward competitors. The literature discusses different levels of tension, such as industry- or market-level tension (Porter, 1980), organizational level tension ("competitive intensity" by Ang, 2008; Barnett, 1997), and dyadic level tension ("competitive tension" by Chen et al., 2007). As I focus on competition between partners, "competitive tension," which is a firm-dyad-level construct, will be more appropriate in this study. Chen, Su, and Tsai (2007) define competitive tension as the strain between a focal firm and a given rival that is likely to result in the firm taking action against the rival. Chen et al. (2007) used the term "tension" rather than "threat," "intensity," or another term because tension describes the state of latent strain that precipitates the "breaking point" when strain becomes manifest through competitive actions. Second, tension in the alliance literature is related to the "threat of opportunism." Although the TCE literature does not mention explicitly the term "tension," the "threat of opportunism" is based on uncertainty as well as asset specificity and frequency (Williamson, 1985). When the degree of uncertainty is high, firms feel a higher threat from a partner's opportunistic behavior. Finally, such a focus on the risks continues in studying tension in coopetition. Bengtsson and Kock (2001, 2008) are the only studies that explicitly examine tension in coopetition. Using role theory, they analyze the tension created as a result of the conflicts. They concentrate on the role conflicts creating the tension in the relationship that affects the interaction within and between

firms. That is, tension develops when individuals within two interacting firms have to simultaneously play different and conflicting roles or act in accordance with different logics of interaction (Bengtsson & Kock, 2001). For example, top managers who occupy boundary positions (e.g., Floyd & Lane, 2000) need to work with individuals and units that cooperate with the partner firms, with individuals and units that actively compete with the same firm, and with other actors in the network.

2.3.2 Tension from a balance approach

Studies from the risk (or threat) perspective provide valuable implications, especially for managing the negative effects of tension. For example, firms take a stronger governance mode when the threat of opportunism is high than they do when the threat of opportunism is low. However, the risk-focus approach cannot reflect the positive side of tension. In this regard, some scholars (e.g., Das & Teng, 2000) in alliance literature adopt the notion of tension as a balance between opposing elements, which can lead to the most positive results. That is, partners should balance the contradictory forces to secure the original arrangement and prevent the alliance from an unplanned dissolution. Miles and Snow (1992) suggest that one key reason many network organizations fail is that the firms tend toward unbalanced relationships, usually by leaning toward too much control or modification. Ring and Van de Ven (1994) propose a framework of alliance making that consists of successive stages propelled by interactive components such as efficiency and equity. By integrating previous works, Das and Teng (2000) provide a theoretical foundation on the role of tension in an alliance. Das and Teng (2000) suggest an internal tension perspective of strategic alliances comprised of three pairs of competing forces – cooperation vs. competition, rigidity vs. flexibility, and short-term vs. long-term. Although the authors argue that the tension from the simultaneous existence of cooperation and competition between the partners

is an important characteristic of strategic alliances, the rationale of internal tension was not empirically examined.

2.3.3 Tension from a paradox perspective

In addition to the balancing strategy discussed above, a new approach toward tension in coopetition is based on the paradox perspective, and, specifically, the "transparadox" (or the Chinese "middle way" perspective). Paradox is an important concept in understanding the tension in coopetition because paradox is argued as a fundamental source of tension. Further, a "paradoxical" relationship seems to be the term that scholars most often use to describe coopetition (e.g., Chen, 2008). "Paradox denotes contradictory yet interrelated elements ⋯ that seem logical in isolation but absurd and irrational when appearing simultaneously" (Lewis, 2000: 760). According to this definition, the most salient characteristic of a paradox is its contradictory nature. The paradox approach has been emphasized to understand the complex and often juxtaposed firm behavior (Quinn & Cameron, 1988). Thus, how to manage paradox has long been the subject of philosophical and organizational inquiry (Chen, 2008).

Integrating the paradox perspective and the balancing strategy, scholars (e.g., Chen, 2008; Lewis, 2000) suggest the transparadox perspective, based on the Chinese "middle way" philosophy, to understand the tension in a paradoxical relationship. Lewis (2000) addresses the limitation of paradox within an either/or (or independent opposites) framework by encouraging researchers to "transcend" paradox. Building on Lewis (2000), Chen (2008) proposes a new concept, transparadox, a hybrid of the either/or and both/and perspectives that characterize, respectively, Western and Eastern thought. The Chinese "middle way" philosophy, with its emphasis on balance and the integration of opposites, offers promise for enriching the conventional Western conceptions of paradox (Chen, 2002, 2008). Thus, "middle way" thinking

allows opposites to be viewed as interdependent entities that together form a totality and thus offers a "transcending" conceptualization of the relationship between two seemingly conflicting entities. Chen (2002, 2008) identified two principal tenets of the "middle way" perspective. The first tenet is holism – the idea of self-other integration in which 'self' and 'other' are interdependent opposites that can only be defined as a pair. The other pillar of the middle way is paradox, which is best symbolized by the well-known yin/yang image in which opposites are contained within it and together form a dynamic unity. In the transparadox perspective, based on the "Chinese middle way" philosophy, two opposites may be interdependent in nature and together form a totality (Chen, 2002). Interdependent opposites refer to the concepts/entities that exist only within the context of each other, or which find their definition only in terms of that of their opposites (Chen, 2008).

2.3.4 Research gaps in the role of coopetition tension in firm innovation

While tension is paramount in coopetition, there is no empirical study on tension in coopetition. Further, most previous studies that studied tension did so from a risk perspective. Some scholars suggest that the balancing strategy and transparadox perspective are necessary to understand and manage coopetition. However, there was no empirical study to support their arguments. Building on the balancing strategy and transparadox perspective, it will be valuable to develop and test how the balance of paradoxical factors in coopetition can influence firm innovation.

TABLE 2.3: Key Intellectual Foundations on Tension

Studies	Domain/Theories	Core Arguments
Bengtsson & Kock (2000, 2001)	Coopetition/ Role Theory	Tension develops when individuals within two interacting firms have to simultaneously play different and conflicting roles or act in accordance with different logics of interaction
Chen et al. (2007)	Dyadic relationship/ Competitive dynamics	Perceived competitive tension is influenced by the independent and interactive effects of three factors: relative scale, rival's attack volume, and rival's capability to contest.
Park & Russo (1996)	Alliance/ Threat of Opportunism (TCE)	Uncertainty, asset specificity, and frequency will determine the threat of opportunism (Williamson, 1985).
Miles & Snow (1992)	Alliance/ Balance Theory	One key reason many network organizations fail is that the firms tend to unbalance their relationship, usually by leaning toward too much control or modification
Das & Teng (2000)	Alliance/ Balance Theory	An internal tension in strategic alliances is comprised of three pairs of competing forces – cooperation vs. competition, rigidity vs. flexibility, and short-term vs. long-term.
Poole & Van de Ven (1989)	Paradox Approach	Use of paradox can deepen our understanding by enabling scholars to address logical contradiction in a theory and to identify tensions and oppositions in order to develop more encompassing theories.
Lewis (2000)	Paradox Approach/ "Transcend" paradox	"Transcend" paradox can address the limitation of paradox within an either/or (or independent opposites) framework.
Chen (2001, 2002, 2008)	Paradox Approach/ Chinese "middle way" philosophy	The Chinese "middle way" philosophy, with its emphasis on balance and the integration of opposites, offers promise for enriching the conventional Western conceptions of paradox.

2.4 The Role of a Firm's Dynamic Capabilities in Firm Innovation

2.4.1 Dynamic capabilities

Dynamic capabilities refer to the firm's ability to integrate, build, and reconfigure internal and external competences – to address rapidly changing environments (Teece, Pisano, & Shuan 1997). The literature distinguishes dynamic capabilities from operational capabilities in two ways. First, while operational capabilities enable an organization to earn a living in the present (Winter, 2003), dynamic capabilities concern change (Helfat, Finkelstein, Mitchell, Peteraf, Singh, Teece, & Winter, 2007). To survive and prosper under conditions of change, firms must develop the "dynamic capabilities" to create, extend, and modify the ways in which they make their living (Helfat et al., 2007). Second, scholars (e.g., Helfat & Peteraf, 2003; Winter, 2003) make a distinction between first-order operational capabilities (e.g., market and technological capabilities) that a firm needs for its operations and the second-order dynamic capabilities that a firm needs for changing operational routines. Dynamic capabilities are second- or higher-order capabilities that make it possible to learn about new domains, create new asset combinations and build new capabilities (Ellonen, Wikström & Jantunen, 2009; Wang & Ahmed, 2007).

The concept of dynamic capabilities has been extended by several scholars. Teece et al. (1997) propose three organizational and managerial processes – coordination/integrating, learning, and reconfiguring – as core elements of dynamic capabilities. According to Teece (2009), dynamic capabilities refer to the firm's ability to sense, seize, and adapt to generate and exploit internal and external firm-specific competencies, and to address the firm's changing environment. "Sensing" capabilities denote the firm's activities in scanning and monitoring changes in operating environments and identifying new opportunities and threats. "Seizing"

capabilities are needed in activities such as selecting technologies and product attributes, designing business models, committing resources to investment opportunities, and building an organization that reinforces creativity and innovativeness. "Reconfiguring" capabilities are the ability to recombine and to reconfigure assets and organizational structures as the enterprise grows, and as markets and technologies change. Wang and Ahmed (2007) also identified three component factors: 1) the ability to adapt and align resources and capabilities (adaptive capability), 2) the acquisition of external knowledge (absorptive capability), and 3) the firm's ability to translate innovativeness into its products and markets (innovative capability).

2.4.2 Alliance capabilities

From the perspective of dynamic capabilities, alliance capabilities (or relational capabilities) can be viewed as a type of dynamic capability with the capacity to purposefully create, extend, or modify the firm's resource base, augmented to include the resources of its alliance partner (Dyer & Kale, 2007). That is, alliance capabilities (or relational capabilities) can enable firms to access the resources and capabilities of others through alliances (Dyer & Kale, 2007). Alliances are difficult to manage because of the various risks inherent in the inter-firm relationships, such as loss of technological know-how, management complexity, inter-firm cultural clash, and partial loss of autonomy (Barringer & Harrison, 2000). Firms exhibit significant heterogeneity in terms of their overall alliance success, and some firms are much more successful at managing alliances or creating value from them than are other firms (Anand & Khanna, 2000; Kale, Dyer, & Singh, 2002; Kale & Singh, 2007).

Alliance capability has been frequently referred as a driver of alliance success. Yet, the majority of the empirical studies are qualitative case studies (Wang & Ahmed, 2007). Thus, there has been limited quantitative work on the actual components of alliance capability (Dyer & Kale,

2007). Alliance capabilities that scholars have examined include alliance experience, a dedicated alliance function, and an alliance learning process. First, much of the work on alliance capability focuses on alliance experience as a key source of alliance management capability. For example, Anand and Khanna (2000) show that firms having greater alliance experience can develop alliance capabilities and have greater overall alliance success. This line of research suggests that alliance management capability is a path-dependent capability accumulated from a firm's previous alliance experience (Rothaermel & Deeds, 2006). Hoang and Rothaermel (2005) found that the general alliance experience of the biotechnology partners is positively related to alliance project performance, while relation-specific experience has a negative effect on alliance project performance. Second, another focus was on a dedicated alliance function. Firms with a dedicated alliance function, which oversees and coordinates a firm's overall alliance activity, have greater alliance success (Kale et al., 2002). Finally, learning is a key part of alliance capability. Kale and Singh (2007) show that an alliance learning process that involves articulation, codification, sharing, and internalization of alliance management know-how is positively related to a firm's overall alliance success.

2.4.3 Research gaps in the role of dynamic capabilities in firm innovation

Although coopetition is considered a dynamic relationship, there has been a lack of attention to dynamic capabilities in the coopetition literature. In the alliance capability literature, scholars found that firms with greater alliance experience and those that create a dedicated alliance function realize greater success with alliances (Anand & Khanna, 2000; Kale et al., 2002). As coopetition is unique and more challenging than are general alliances, a dedicated unit seems more critical. However, it is necessary to examine the effects of those factors in the coopetitive relationships. Further, there was no attempt to examine the moderating role of

alliance experience on the relationship between coopetition and innovation. Regarding the organizational structure perspective, dynamic capability literature (e.g., Teece, 2009) suggests that decentralization or considerable autonomy is necessary to adapt to rapidly changing environments. Thus, it is necessary to link a dedicated alliance function for integration/coordination with individual units having high autonomy for flexibility/adaptation.

While the importance of coopetition capability was acknowledged (e.g., Gnyawali & Park, 2011), the concept was not fully developed and its effect on firm outcome was not examined. Thus, it is necessary to develop the concept and measures of coopetition capability and conduct an empirical examination.

TABLE 2.4: Key Empirical Research on Alliance Capabilities and Firm Performance

	Author(s)	Research objectives	Research setting	Unit of analysis	Measures	Key Findings
Alliance experience						
1	Anand & Khanna (2000)	Whether firms learn to manage interfirm alliances as experience accumulates?	• SIC codes 20 through 39 • Period: between 1990 and 1993. • 870 joint ventures, 1106 licensing agreements	Alliance	• Value creation: the abnormal stock returns surrounding alliance announcements • JV experience: the number of past JVs • Licensing experience: the number of past licensing contracts	• Firms with greater prior alliance experience generate higher stock market returns • Significant learning (to manage alliances) effects in managing joint ventures are found ($p<.01$), but no such evidence for licensing contracts. • The effects of learning on value creation are strongest for research joint ventures ($p<.01$), and weakest (and insignificant) for marketing joint ventures.
2	Hoang & Rothaermel (2005)	The impact of alliance experience on alliance performance.	• Alliances between pharmaceutical companies and their biotechnology partners	Alliance	• Alliance success: Successful completion of a new drug development project • General alliance experience: the number of R&D alliances to the year prior to the start of the focal alliance • Dyad alliance experience: the number of prior R&D alliances between the pair of firms	• The general alliance experience of the biotechnology partners positively affected joint project performance ($p<.05$; $r=.16$). • Partner-specific experience had a negative effect on joint project performance ($p<.10$; $r= -.12$)
The alliance function						
3	Kale, Dyer, & Singh (2002)	Factors that influence firm's ability to build alliance capability and greater alliance success	• 1572 alliances, established during 1993-1997, from 78 companies in various industries	Alliance	• Alliance success: 1) abnormal stock market gains following alliance announcements, 2) managerial assessments of long term alliance performance	• Firms with greater alliance experience and those that create a dedicated alliance function realize greater success with alliances • A firm's investment in a dedicated alliance function is a more significant predictor of the firm's overall alliance success than a firm's alliance experience ($p<.01$ and $p<.05$; $r=.30$ and $r=.19$ respectively).

	Author(s)	Research objectives	Research setting	Unit of analysis	Measures	Key Findings
The alliance learning process						
4	Kale & Singh (2007)	How do firms develop alliance capability through learning?	• 175 firms with alliances established from 1994 to 1998. • Industries: computer, telecommunications, pharmaceutical, chemical and electronics industries	Firm	• Overall, firm-level alliance success: aggregated assessments of each alliance performance • Alliance learning process: survey-based, multi-item scales to measure articulation, codification, sharing, and internalization of alliance management knowhow.	• An alliance learning process is positively related to a firm's overall alliance success ($p<.05$; $r=.42$).

3. CONCEPTUAL DEVELOPMENT AND HYPOTHESES

In this chapter, I develop the conceptual framework that provides the foundation of the model's empirical testing. First, I identify the typology of coopetition based on the intensities of competition and cooperation between partners. Following Luo (2007a), I create a 2 x 2 matrix that provides concrete factors to determine the intensity of coopetition. Second, I discuss the composition of the value that a firm creates and appropriates in a coopetition relationship. Further, I discuss a key locus of tension in coopetition – knowledge sharing versus knowledge protection. In the following section, I discuss the conceptual model. Last, I develop the testable hypotheses related to coopetition and its effects on innovation, and the moderating role of coopetition capabilities.

3.1 Coopetition, Coopetition Tension, and Their Roles in Firm Innovation

In this section, I attempt to advance our understanding of the effects of the varying degrees of coopetition and the tension in coopetition on firm innovation performance.

3.1.1 Typology of coopetition

The impact of coopetition on firm innovation has remained largely unexplored and the research reports mixed results, which may partly stem from the limitation of previous studies that operationalized coopetition. While the measures of the degree of competition are too broad (e.g., 4-digit SIC codes) or too narrow (e.g., identified as key competitors in annual reports), the degree of collaboration has been ignored. To address this issue, I note that some scholars (e.g., Luo, 2007a) provide the typologies that consider both competition and cooperation even though the typologies have not been operationalized in empirical research. Luo (2007a) notes that using typologies allows us to further discuss strategic responses in different coopetition situations and provides a valuable approach for understanding the intensity of coopetition in order to describe

the varying degrees of collaboration and competition between a pair rivals. Building on Luo's (2007a) typology, I develop a 2x2 matrix (Figure 3.1) that is composed of cooperation-dominant coopetition (Type A), balanced strong coopetition (Type B), weak coopetition (Type C), and competition-dominant coopetition (Type D).

FIGURE 3.1
Typology of the Intensity of Coopetition

COOPERATION		
Strong	Type A Cooperation-dominant coopetition Low degree of competition: Low market commonality (different industry or different value chain), low technology similarity, multilateral relationship, different location, different time, indirect competition. High degree of cooperation: High strength cooperation (e.g., R&D, manufacturing) across a wide scope, strong safeguarding mechanisms (governance mode (JVC) or repeated ties or concurrent multiple linkage). Example: Toyota's relationship with suppliers; R&D consortium among firms from various industries	Type B Balanced strong coopetition High degree of competition: High market commonality (same industry, same products, same value chain), high technology similarity, bilateral, same location. High degree of cooperation: High strength cooperation (R&D, manufacturing) across a wide scope, strong safeguarding mechanisms (governance mode (JVC), repeated ties, or concurrent multiple linkages). Example: S-LCD (Samsung-Sony LCD JV)
Weak	Type C Weak coopetition Low degree of competition: Low market commonality (different industry or different value chain), low technology similarity, multilateral relationship, different location, different time, indirect competition. Low degree of cooperation: Low strength cooperation (licensing) within a narrow scope, weak safeguarding mechanisms (governance mode (contracts) and no repeated ties and no concurrent multiple linkage). Example: Sub-contracts (cooperation) with competitors after bidding (competition), like construction companies; Licensing to multiple partners	Type D Competition-dominant coopetition High degree of competition: High market commonality (same industry, same products, same value chain), high technology similarity, bilateral, same location. Low degree of cooperation: Low strength cooperation (e.g., licensing) within a narrow scope, weak safeguarding mechanisms (governance mode (contracts) and no repeated ties and no concurrent multiple linkage). Example: Large firm-SMEs competitive collaboration
	Weak	Strong
	COMPETITION	

3.1.2 Coopetition-based innovation performance

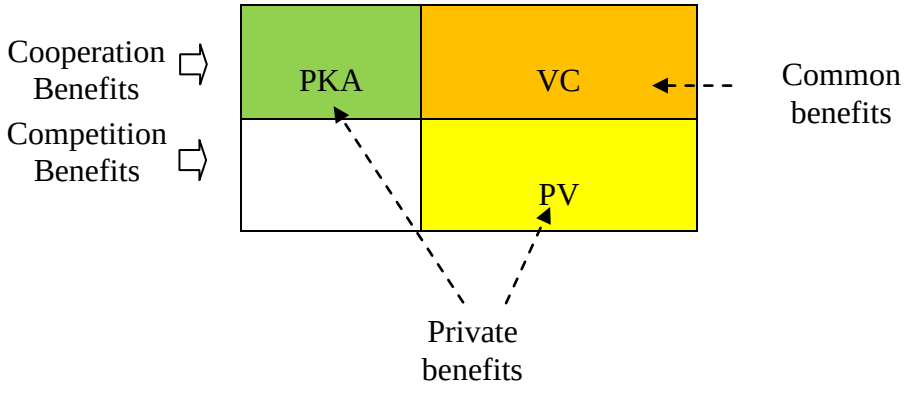
Value creation and value appropriation are central to coopetition. That is, coopetition means cooperating to create a bigger business "pie" while competing to divide it up (Brandenburger & Nalebuff, 1996). Although Lavie (2007) argues that knowledge of the logic of both value creation and value appropriation is necessary to understand how a firm can benefit and gain competitive advantage from inter-firm collaboration, Gnyawali et al. (2008) point out that the separation of these processes is even more pronounced in the case of coopetition. Despite the importance of the logic of value creation and value appropriation in coopetition, the value composition that is created and appropriated in coopetition has not been systematically examined. In regard to this topic, Khanna et al. (1998) introduced the valuable logic of "common benefits vs. private benefits." Luo (2007a) points out that "establishing an alliance with competitors emphasizes cooperation only, and its unit of analysis is the alliance itself rather than the parent organizations. Therefore, they cannot reflect the effects of comprehensive competition on a diverse list of products between rivals" (p.130). His argument implies that the effects of coopetition can happen not only within the alliance boundaries but also beyond them. Kumar (2010) explores the effects of common benefits (including synergies) based on cooperative behavior versus private benefits based on non-cooperative behavior. He reports that the stock market perceives JVs to be positive sum games (common benefits are dominant in JVs) rather than zero sum games (private benefits are dominant in JVs).

Building on their arguments, I contend that the value creation and appropriation in coopetition can be derived from a more complex process. The difference lies in that, while they consider private benefits to be based on non-cooperative behavior, I suggest that private benefits can be from both cooperation and competition. On the one hand, private benefits can be based on

learning and knowledge transfer. Kumar (2010) argues that private benefits arise as parent firms appropriate resources from each other and exploit them outside the JV. Yet, this type of private benefits is based on cooperation. According to Lavie (2006), when firms engage in alliances, they can obtain benefits from both knowledge sharing (from the shared part) and knowledge spillover (from the non-shared part). From the shared part, based on the contracts, partners will generate common benefits. Also, firms can get benefits from knowledge in the non-shared part that flows to partners through their collaboration processes. The latter are private benefits beyond the alliance boundaries but this type of private benefits may move in the same direction with common benefits. That is, high learning potential (based on a high intensity of cooperation) increases both common benefits and private benefits (through the application of partner knowledge), while greater competitive tension (based on a high intensity of competition) that limits knowledge sharing and knowledge spillover will decrease both common benefits and private benefits (through the application of partner knowledge). On the other hand, private benefits can be based on competition (competition benefits). That is, competitive tension (based on the intensity of competition) plays not only a negative role (decreasing knowledge transfer) but also a positive role (additional efforts). When firms feel high competitive tension, firms will make additional private efforts to outperform competitor-partners. This type of private benefits may move in the opposite direction with common benefits. The argument I discussed above aligns with Khanna et al's (1998) logic of common benefits versus private benefits. However, scholars (e.g., Khanna et al., 1998; Kumar, 2010) focus only on cooperation benefits, while I consider both cooperation benefits and competition benefits. I argue that adding competition benefits is the value logic of coopetition that is different from that of an alliance that focuses

only on common benefits and private benefits (partner knowledge application). Figure 3.2 shows the value creation logic and the categorization of the benefits through coopetition.

FIGURE 3.2
Value Creation Logic and Categorization of the Benefits in Coopetition



Value co-creation (VC); partner knowledge application (PKA); private value creation (PV).

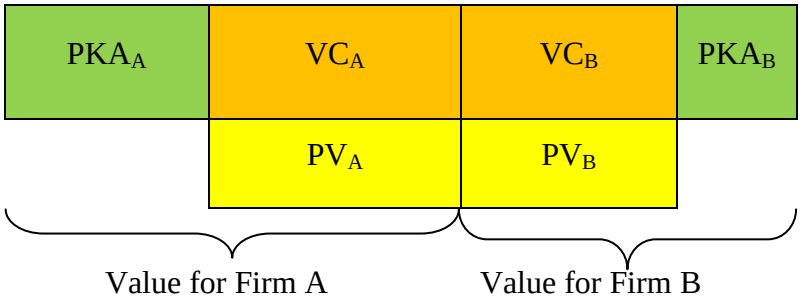
Based on the discussion above, I suggest that value creation in coopetition may result from the following three activities: 1) value co-created with partners in a focal alliance, 2) value accrued from the application of knowledge learned from the partners or focal alliance projects, and 3) private value created by the focal firm itself. While the first type of value happens within the alliance boundaries (*common benefits*), the other two may happen beyond those boundaries *(private benefits*). First, firms can co-create value with partners through collaboration with competitors. They can access partners' resources, share costs or risks, or establish joint technological standards (*cooperative advantage*s). Then, the created value will be appropriated by all partners based on 1) their contribution and bargaining power (*collaboration logic*), and 2) competition in the market (*competition logic*). While the collaboration arrangement is fixed by contracts (reflecting their contribution and *ex ante* bargaining power), the competition in the

market is dynamic and uncertain (Luo, 2007b). Second, beyond the alliance boundaries, firms can create value for their own businesses by applying knowledge learned from their partners and alliance projects, which increases private value (*cooperative advantages*). The value will be influenced by the focal firm's absorptive capacity and complementarity of its different businesses. Finally, value can be created by the focal firm's private efforts to outperform partners outside the alliance boundaries. These private efforts may be more important when the alliance partners compete with each other in the markets or need to renegotiate their contracts to adapt to rapidly changing environments. When the competition between partners in the market becomes severe, such competition will be a key determinant of value appropriation. Thus, firms that are engaged in coopetition are likely to make greater efforts to create additional value related to but beyond the alliance boundaries in order to increase their own competitiveness and outperform partners in the market (*competitive advantage*). It is important to note that competition benefits (or competitive advantages) in this paper refer to additional gains accrued due to the coopetitive relationship, which is limited to value (or innovation) related to the alliance activities but beyond the alliance boundaries. For example, when a firm cooperates with competitors to develop a key part of new products and also competes with those partners in the market, the focal firm may need to develop additional components in order to make better final products than its partners'. In this case, competition benefits are from the focal firm's additional efforts to develop other components.

As a result, the value that a firm can appropriate from coopetition is composed of three parts: 1) the share of value co-created with partners, 2) the value gained from the application of partner knowledge and learning beyond the alliance boundaries, and 3) the value created from private efforts related to but beyond the alliance boundaries. In sum, the value from coopetitive

relationships depends on the benefits of both cooperation and competition, and a firm's learning capability and knowledge management. The value creation and value appropriation through coopetition can be summarized as follows:

FIGURE 3.3
Composition of Value Created and Appropriated in Coopetition



- Value Creation = value co-creation (VC) + partner knowledge application (PKA) + private value creation (PV)
  - Value co-creation (within the alliance boundaries) = $VC_A + VC_B$
  - Partner knowledge application (beyond the alliance boundaries) = $PKA_A + PKA_B$
  - Private value creation (related to but beyond the alliance boundaries) = $PV_A + PV_B$
- Value appropriation (individual partner) = share of co-created value (within the alliance boundaries) + value from partner knowledge application (beyond the alliance boundaries) + value created from private efforts (related to but beyond the alliance boundaries)
  - Value appropriation (Firm A) = $VC_A + PKA_A + PV_A$
  - Value appropriation (Firm B) = $VC_B + PKA_B + PV_B$

3.1.3 Locus of tension – Knowledge sharing versus knowledge protection

A key locus of tension in coopetition is the dilemma between knowledge sharing and knowledge protection. That is, the fundamental dilemma of alliances, including coopetition, is that firms need to adopt various practices to facilitate knowledge transfer in order to create value

(Heiman & Nickerson, 2004). The paradox is that the knowledge that is shared in the course of collaboration can be used in both cooperation and competition (Baumard, 2009; Ritala & Hurmelinna-Laukkanen, 2009). Deploying practices to facilitate knowledge transfer may increase the likelihood that economically valuable knowledge, which is beyond the scope of the collaboration and difficult to protect legally, is expropriated (Heiman & Nickerson, 2004).

The tension in knowledge sharing and protection will be affected by the types of collaborative arrangements and by the safeguarding mechanisms. That is, when coopetition is involved in stronger types of collaboration (e.g., manufacturing or R&D), firms are more likely to adapt practices, such as co-location, that promote the transfer of knowledge. Further, working together with the employees from partner firms on a regular basis makes possible the transfer of knowledge not directly relevant to the stated goals of the collaboration. Although some knowledge may be legally protected (e.g., patents or contracts), much knowledge remains unprotectable and thus is subject to potential expropriation by collaborators (Heiman & Nickerson, 2004). Heiman and Nickerson (2004) argue that increasing knowledge transparency via knowledge management practices (e.g., the use of high-bandwidth communication channels and co-specialized communication codes) may give rise to opportunistic hazards. Thus, it is critical for firms to understand how to manage the transfer of agreed-upon knowledge in their collaborations while avoiding the expropriation of other, not-agreed-upon, yet economically valuable knowledge (Heiman & Nickerson, 2004).

Meanwhile, such dilemmas tend to be of great concern when partners are direct competitors; their markets are common and their resources are very similar (the intensity of competition is high). Resource similarity offers two countervailing effects. On the one hand, resource similarity increases the likelihood of scanning and monitoring for external resources,

accessing and acquiring external resources, and leveraging these resources for competitive advantage (Cohen & Levinthal, 1990; Lane & Lubatkin, 1998; Mowery et al., 1996). If the focal firm and its partners have high technological overlap, they are more likely to be aware of the value of a partner's knowledge and have greater motivation to learn from them. Emden, Calantone, and Droge (2006) argue that overlapping knowledge provides the necessary common ground among partners to realize a technology's potential and to communicate with each other. Further, the more experience the firms have in solving similar types of problems, the easier it will be for the focal firm to find ways to apply the newly assimilated knowledge (Lane & Lubatkin, 1998). As the relative absorptive capacity between competitors tends to be high, partners in coopetition can quickly acquire knowledge from each other, and quickly apply it to their projects or markets (Gnyawali & Park, 2009; Ritala & Hurmelinna-Laukkanen, 2009). In addition, scholars suggest that similarity in partner firms' knowledge and knowledge-processing systems enhances new learning and learning abilities (Lane & Lubatkin, 1998; Mowery et al., 1996). On the other hand, high resource similarity between the focal firm and its partners suggests that the firms feel high competitive tension (Chen et al., 2007) because competition will eventually follow the joint creation of innovation. Then, firms' motivation or willingness to transfer knowledge will be decreased because the firms will become more concerned about partners' opportunistic behavior and unintended knowledge leakage. Firms may make extra efforts to protect the knowledge. Therefore, the focal firm is less likely to access, acquire, and leverage knowledge from its alliance partners.

As a result, when the degrees of both competition and collaboration are high, firms have higher capabilities and greater motivation to learn from partners. In such a context, however, willingness to transfer knowledge to partners may not be high and firms often make extra efforts

to protect against knowledge leakage. If a firm does not understand the dilemma or the dilemma is not well managed, the value created from the collaboration through knowledge transfer may possibly be eclipsed by the value of the knowledge expropriated – a loss in competitive advantage may result. However, when willingness and ability are conflicting, the willingness becomes more critical than the ability (Srivastava & Gnyawali, in press). Since reciprocity is expected in alliances (Hansen, 1999), if a firm protects their knowledge, partners will respond by instituting their own safeguards and barriers to protect their core resources. With the barriers on both sides and intensified value tension, the resource flows get adversely affected (Heiman & Nickerson, 2004; Norman, 2002; Srivastava & Gnyawali, in press). Thus, a real possibility is that participating firms may tightly control knowledge to protect their core knowledge, which will adversely affect knowledge flow that is critical for creating value, including innovation. Another possible outcome is that an adversarial partner firm can at any moment disrupt a coopetition relationship.

3.1.4 Coopetition capability

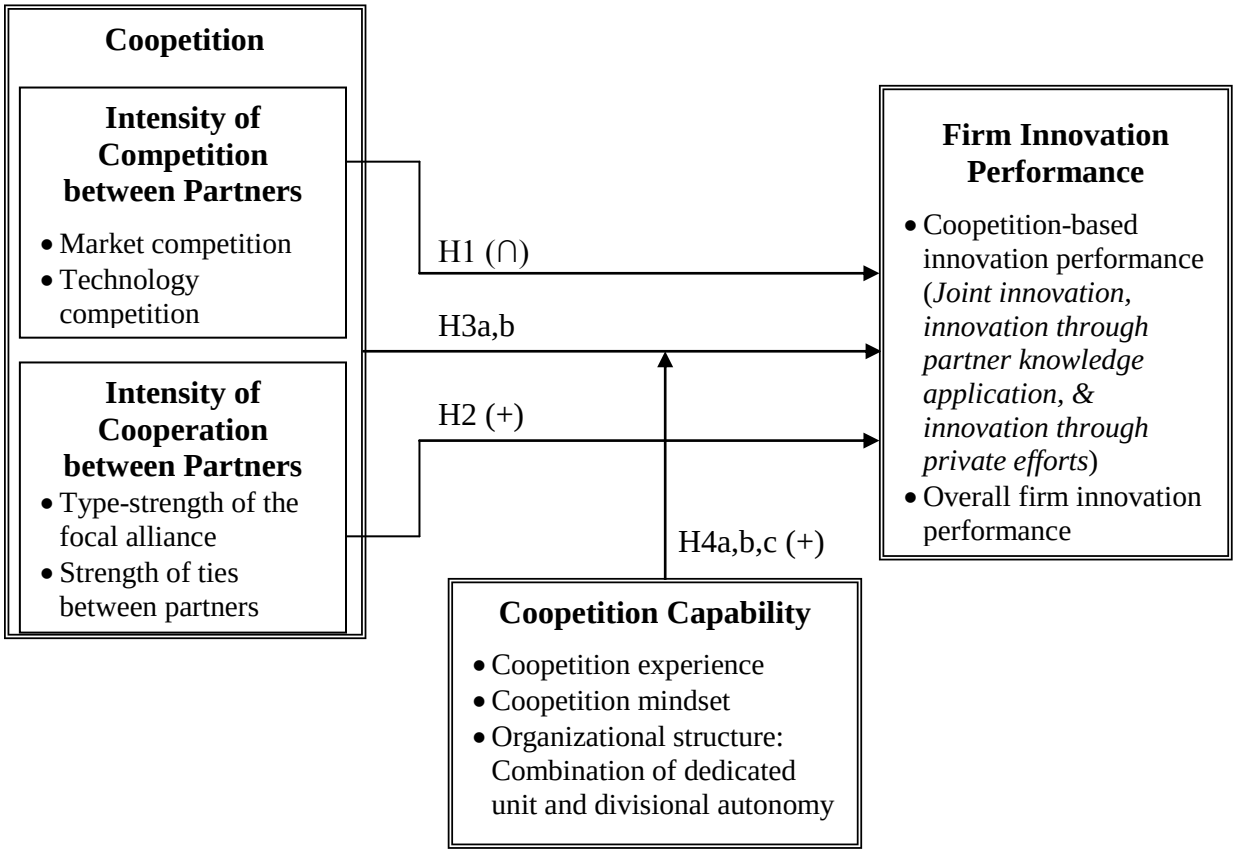
Teece et al. (1997) emphasize the importance of dynamic capabilities, i.e., a firm's ability to integrate, build, and reconfigure internal and external competencies, to address rapidly changing environments. Based on the notion of dynamic capability, I define coopetition capability as "accumulated managerial competencies regarding how to manage a firm's coopetitive ties." I define coopetition capability separately from general dynamic capability because managing coopetition is a much more challenging task than managing general alliances. Coopetition is dynamic in nature (Luo, 2007b) and is highly uncertain in terms of both environment and a partner's behavior. Further, the ratio between competition and cooperation changes across the stages of technological development. Thus, to generate greater innovation

performance in a coopetitive relationship, it is not enough to simply balance competition and cooperation at the beginning of the alliance, but the firm must also have the capabilities to manage a balanced relationship throughout the alliance lifecycle. Specifically, success in coopetition requires many abilities – 1) to scan the environment for coopetition opportunities, 2) to select partners with caution, 3) to coordinate conflicts within the firm and between partners, 4) to estimate the evolving costs and benefits of coopetition, 5) to make necessary adjustments to the cooperation-competition ratio, and 6) to maintain the bargaining power balance. The capabilities to achieve these tasks are related not only to the logic of dynamic capabilities but also to the unique characteristics of coopetition. As a result, although the fundamental dynamic capabilities will apply to coopetition, firms may need more and unique capabilities to manage tension from the dynamic and paradoxical factors inherent in coopetition.

3.2 Conceptual Model

The conceptual model below provides the theoretical foundations for this study. The model describes the key factors for determining the intensity of coopetition and how they relate to firm innovation output. Further, I suggest that a firm's coopetition capability will moderate the relationship between coopetition and firm innovation performance.

FIGURE 3.4
Conceptual Model of Coopetition, Coopetition Capability, and Firm Innovation



***This model is identical to Figure 1.1.**

3.3 Hypotheses Development

In this section, I develop the hypotheses to be tested. I outline the rationale for tension in coopetition that supports the development of the hypotheses. While I develop hypotheses at dyadic level, I develop hypotheses regarding the balance between competition and cooperation at both the dyadic and portfolio levels because the balance between competition and cooperation can be interpreted in multiple ways[5].

3.3.1 Innovation and the intensity of competition between partners

The intensity of competition between partners in a coopetitive relationship refers to the extent of competition between a focal firm and its partner in the product and geographical markets in which they operate or in the process of technological development. Previous studies have operationalized coopetition based on the competition between partners. Therefore, this hypothesis is about the relationship between traditional coopetition and innovation. In this study I operationalize the construct of "competition between partners" by measuring two of its dimensions: product market competition and technology competition. Following Chen (1996), I will capture the intensity of product market competition by market commonality, i.e., the degree of presence that a partner manifests in the markets where it overlaps with the focal firm. I will capture the intensity of technology competition by technological resource similarity, i.e., the relative overlap between the technological resources of the focal firm and those of a partner.

There are two countervailing arguments and empirical reports on the effects of the current or potential competition between partners on innovation performance. On one hand, a higher intensity of competition between partners, based on the higher degree of market

[5] I suggest that the balance in coopetition can be interpreted in multiple ways: 1) a medium degree of competition, 2) a balance between competition and cooperation at the dyadic level, and 3) a balance between competition and cooperation at the portfolio level.

commonality or resource similarity, may provide greater positive effects on innovation. First, from the perspective of learning potential, the more similar knowledge and technological resources that competitor-partners typically possess will enlarge the amount of value created from the partners' resources. Scholars suggest that similarities in partner firms' knowledge and knowledge-processing systems enhance new learning and learning abilities (Lane & Lubatkin, 1998; Mowery et al., 1996). If the focal firm and its partners overlap technologically to a high degree, they are more likely to be aware of the value of a partner's knowledge. Emden et al. (2006) argue that overlapping knowledge provides the necessary common ground to realize the technology's potential and to communicate with each other. Further, from a learner (or student) perspective, coopetition increases a focal firm's motivation to learn from partners because partners' knowledge may be more relevant to the focal firm's interests. In addition, in terms of capability, the more experience the firms have in solving similar types of problems, the easier it will be for the focal firm to find ways to apply newly assimilated knowledge (Lane & Lubatkin, 1998). In the same vein, technological resource similarity increases innovation potential through the organizational search process. The idea of recombinatory search suggests that new inventions emerge from the recombination or "mixing and matching" of existing elements of knowledge (Grant, 1996; Kogut & Zander, 1992). Kogut and Zander (1992) argue that the knowledge of the firm evolves in a path-dependent way, through the replication and recombination of existing knowledge (see Ahuja et al., 2008; Gupta, Smith, & Shalley, 2006). Second, firms can obtain competition benefits in a coopetitive relationship. The focal firm may have greater motivation to increase its own competitiveness in order to outperform its competitor-partners in the market and/or technological competitions. As the value appropriation in coopetition is decided by market competition as well as the contracts between partners, firms participating in coopetitive

relationships make more private efforts to innovate. From the competition perspective, it is natural for firms to make private efforts to innovate in order to increase their own competitiveness in the market, which will allow the firms to be in more favorable positions when they renegotiate their relationships to adjust to new environments.

On the other hand, competition between partners may provide negative effects on firm innovation. Kim and Parkhe (2009) suggest that competing similarity has a negative effect on alliance outcomes[6]. First, from a teacher perspective, the presence of competition with partners may discourage firms from sharing their knowledge, which will hurt innovation performance. When the degree of competition between partners is high, competitive tension between the focal firm and its partners will increase because knowledge gained from the partner through a collaborative relationship could be used against the same partner in order to more effectively compete in the markets (Gnyawali & Park, 2009). This high competitive tension will cause a low level of knowledge sharing and a narrow scope of cooperation, which in turn, will result in a low level of innovation output. Schuler, Jackson, and Luo (2004) suggest that unwillingness is one of the main reasons that learning between partners fails. Sampson (2007) also argues that firms may be able but not willing to share their knowledge-based capabilities. Firms may tightly control knowledge flow into partners to avoid unintended knowledge leakage. This knowledge control reduces the degree of freedom available to employees who are collaborating with partner firms. Second, in terms of learning, scholars suggest that a high level of knowledge redundancy between competitor partners may hurt innovation. Innovation arises out of new combinations of existing capabilities (Schumpeter, 1942). Therefore, the addition of similar capabilities from partners is unlikely to significantly help innovation (or may even hurt it beyond a critical level),

[6] They use two variables, competing similarity and cooperating similarity, suggesting that competing similarity has a negative effect and cooperating similarity has a positive effect on alliance outcomes.

especially when all possible new combinations of existing capabilities have been exhausted or a high level of resource redundancies occur.

Taking the factors discussed above together, competition between partners in coopetitive relationships may include factors that can help or hurt firm innovation performance. A critical issue is whether a firm's innovation performance will be more influenced by the positive effects of learning or the negative effects of competitive tension. Competitive tension describes the level of strain between a focal firm and a given rival (a partner) that is likely to result in the firm taking action against its rival and the strain of competitive tension becomes manifest through competitive actions at a certain "breaking point" (Chen et al., 2007). Their arguments imply that the negative effects of competitive tension on firm performance are minimal at first and increase slowly, but at a certain point the negative effects of competitive tension increase rapidly and surpass the positive effects of learning. Further, when the tension between willingness (or motivation) and capability of learning (or knowledge transfer) is high, willingness becomes more critical (Srivastava & Gnyawali, in press). Therefore, I suggest that as the intensity of competition between partners increases, the positive effects of learning potential are dominant up to a certain point but beyond that point the negative effects of competitive tension surpass the positive effects of learning potential. Therefore, I hypothesize that,

H1: *The intensity of competition between partners, in terms of both market competition and technology competition, will have an inverted U-shaped relationship with a focal firm's coopetition-based innovation performance. Specifically, a moderate level of competition between a focal firm and its partner contributes more to the focal firm's innovation output than do very low or very high levels of competition between partners.*

3.3.2 Innovation and the intensity of cooperation between partners

The intensity of cooperation between partners captures the extent to which a focal firm can learn from a certain partner and share and acquire valuable knowledge from that partner through a dyadic relationship. While the notion of relational embeddedness, i.e., the dyadic relationships or ties between the actor and each of its partners (Gulati, 1998; Uzzi, 1999), takes a network or portfolio approach, I focus on dyadic relationships between two firms that are based both on a focal alliance and overall relationships. That is, cooperation between partners is captured by two separate dimensions: 1) the type-strength (or the nature of the strength) of a focal alliance (applying a weighing scheme) and 2) the strength of ties between two firms, i.e., the quality of the overall relationship between a focal firm and a particular partner.

The type-strength of a focal alliance. The type of collaboration (e.g., R&D, manufacturing, marketing, and licensing) will provide potential benefits (e.g., the likelihood of knowledge transfer) to a focal firm that can be obtained from the relationship. Srivastava (2007) argues that the likelihood of knowledge transfer in an alliance depends on the types of collaboration. Manufacturing and R&D have stronger strategic linkages and/or interorganizational dependencies than marketing or licensing (Contractor & Lorange, 1988; Nohria & Garcia-Point, 1991). In the semiconductor industry, manufacturing and cross-licensing alliances play very important roles in the transfer of knowledge between partners (Grindley & Teece, 1997). When coopetition is involved in manufacturing or R&D, firms are more likely to co-locate employees and/or increase knowledge transparency. Heiman and Nickerson (2004) echoed von Hippel's (1994) argument that technical collaboration often involves the transfer of tacit knowledge to solve complex problems, which requires the adaptation of practices, such as co-location, that promote the transfer of knowledge. Such conditions allow employees from

partner firms to work together closely on a regular basis, making possible the transfer of knowledge not directly relevant to the stated goals of the collaboration (Heiman & Nickerson, 2004). That is, cooperation benefits are from both knowledge sharing (shared parts) and knowledge spillover (non-shared parts) (Lavie, 2006). In sum, compared to marketing and licensing, R&D and manufacturing offer greater level of knowledge transfer between partners. In turn, the transferred knowledge will help the focal firm to generate innovations jointly with the partner and innovations by applying the partner's knowledge to projects beyond the alliance boundaries.

The strength of ties between two firms. The strength of the ties between two firms, which is based on the overall cooperative relationship between the firms that is beyond the focal alliance, will influence the extent to which the focal firm can realize the potential benefits provided by the particular type of collaboration. The strength of the ties between two firms can be captured by the notion of relational embeddedness at the dyadic level. From the relational embeddedness perspective, strength-of-ties have been typically operationalized by frequency, duration, and resource commitment. I suggest that those dimensions at the interorganizational level can be captured by informal safeguards, such as previous ties and concurrent multiple linkages between the same partners. Previous linkages and concurrent multiple linkages, which capture both previous and current relationships between two firms, may show the frequency and duration of the relationship and affect the reciprocity of the relationship. The strength-of-ties literature suggests that strong ties have various benefits favorable for creating firm innovation.

First, strong ties (i.e., high quality of cooperation) serve as a trust-based governance mechanism (Rowley et al., 2000), which enhances knowledge transfer and innovation. Since contracts are incomplete and cannot specify all future developments (Williamson, 1985),

researchers have emphasized the important role that informal safeguards and trust-building initiatives play in deterring the potential opportunistic behavior of alliance partners (Dyer & Singh, 1998). Repeated ties and long-lasting relationships will encourage reciprocity, a long-term perspective, and joint problem-solving arrangements (Uzzi, 1997). Also, concurrent multiple linkages, i.e., multiple ties with the same partners over a specific period, will reduce the hazard of opportunistic behavior. Parkhe (1993) argues that a firm may be judged as less opportunistic when it and its partners have other ongoing agreements. Kogut (1989) found that continued viability is enhanced by the presence of concurrent ties among partners, which facilitates reciprocity. Supporting such a perspective, Park and Russo (1996) found that a joint venture whose partners are connected through multiple concurrent linkages is less likely to fail. As relationships deepen through repeated ties and/or concurrent multiple linkages, trust lessens concerns over opportunism, and firms are able to share more finely grained information and tacit knowledge (Suarez-Villa, 1998).

Second, when a focal firm has a strong tie to a certain partner, the two firms can create effective knowledge sharing routines with each other, which will increase the focal firm's innovativeness. The frequent and richer interactions between partners allow the participants to develop a shared understanding (Srivastava, 2007). Therefore, strong ties have been found to stimulate knowledge transfer in interorganizational settings (Dyer & Nobeoka, 2000; Kale, Singh, & Perlmutter, 2000). Finally, strong ties promote adaptation to environmental changes (Kraatz, 1998). I note that strong ties based on informal governance mechanisms (previous linkages and concurrent multiple linkages) may promote adaptation, while formal governance modes (joint ventures or equity investment) may not. Under rapidly changing business environments, firms cannot anticipate changes in advance and build them into contracts. Therefore, "rapid

technological changes often require partners to modify the nature of their resource commitments, expectations, and obligations in order to adjust to new environments" (Srivastava, 2007: 47). Strong ties between partners allow firms to view these changes as opportunities for a win-win situation in the long run, instead of creating a zero-sum game. The more two firms can adapt their relationship to environmental changes, the more they will be able to solve problems (Uzzi, 1996).

I note that the benefits of the strong ties discussed above are relevant at the dyadic level, but the benefits may or may not occur at the network level. At the network level, Uzzi's (1997) notion of 'overembeddedness' suggests that strategic networks composed mostly of strong ties may threaten innovation, rather than enhance it (Capaldo, 2007). From the structural embeddedness perspective, weak ties (when they are also bridge ties) may be more effective and useful in bringing novel information (new but not complex) to a network, while strong ties (when they are connected with a closure) may be more effective in sharing complex knowledge (Hansen, 1999). However, weak ties may not be helpful for innovation at the dyadic level because weak ties are likely to be thinner and less durable, and involve less commitment. Therefore, if we consider only dyadic level interactions, strong ties provide more benefits to knowledge transfer and, in turn, innovation.

In sum, the effects of an alliance on firm performance will be affected by both the type of the focal alliance and the strength of the overall cooperative relationship between partners. While the type-strength of a focal alliance is related to the potential benefits that a focal firm can obtain from the alliance, the strength of ties between two firms is related to informal safeguarding mechanisms and influences the partner firm's willingness to share knowledge. Therefore, by changing the degree of knowledge sharing and transfer, the intensity of cooperation between

partners will mainly influence the joint innovation and innovation through the application of partner knowledge. Therefore, I hypothesize that,

H2: *The intensity of cooperation between partners, in terms of both the type-strength of a focal alliance and the strength of ties between two firms, will positively affect the focal firm's coopetition-based innovation performance, mainly in the dimensions of joint innovation and innovation through the application of partner knowledge, ceteris paribus.*

3.3.3 Innovation and the balance between competition and cooperation

The tension in coopetition has been under-researched but seems to be a central issue in understanding the role of coopetition in firm innovation performance. That is, as coopetition provides both high potential benefits and high risks, the key to generate superior performance lies in how to resolve the tension from paradoxical factors, such as value creation versus appropriation and knowledge sharing versus protection.

Scholars (e.g., Chen, 2008; Das & Teng, 2000) suggest that a balancing strategy may be the best condition to manage the tension in coopetition. Based on their arguments, I suggest that firm innovation performance will be influenced by combinations of different degrees of cooperation and competition and their balancing statuses. Although measuring the balance of cooperation and competition will generate continuous data, typologies will be useful to explain the effects of coopetition on innovation. Thus, I will use the typologies of four combinations: Type A (cooperation-dominant coopetition: strong cooperation and weak competition), Type B (balanced-strong coopetition: strong cooperation and strong competition), Type C (weak coopetition: weak cooperation and weak competition), and Type D (competition-dominant coopetition: weak cooperation and strong competition). The balance may be important both at the dyadic level and at the portfolio level. Therefore, in the section below, I explore the effects of the balance between competition and cooperation at both the dyadic level and the portfolio level.

3.3.3.1 Balance between the intensities of competition and cooperation at the dyadic level

At the dyadic level, I suggest that a balanced-strong coopetition (Type B) produces superior innovation performance than other types of coopetition. As Figure 3.5 presents, value creation and appropriation in coopetition depend on both cooperation and competition benefits as well as learning potential within and beyond the alliance boundaries. In a balanced-strong coopetition (Type B), partners are direct competitors (high intensity of competition between partners) and the partners have strong ties between them and/or the focal alliance is strong based on the type of alliance (e.g., R&D, manufacturing). In this context, firms focus both on value creation and value appropriation. First, firms will make efforts to create greater value (value co-creation). Even though they are competing in the same market, the partners need to cooperate in order to achieve mutual gains, such as technological development, market creation, winning at a battle for technological standards, and so on. Second, knowledge transfer or learning potential should be high. In terms of motivation, competitor-partners may have high motivation to learn from each other (competitor intelligence) and their knowledge is more relevant. Also, as discussed in section 3.3.2, a stronger type of focal alliance, such as R&D and manufacturing, offers greater potential for participating firms to generate innovation through co-location or the levels of interaction that are critical for transferring tacit knowledge. Further, the risk of coopetition will be reduced by informal safeguards, such as repeated ties (which increase trust between partners) and concurrent multiple linkages (which reduce the threat of opportunism due to reciprocity and mutual forbearance). As a result, firms will be able to share or leverage partners' knowledge and resources and, in turn, will enlarge the co-created value within the alliance (*joint innovation*) and can apply the knowledge to their own projects beyond the alliance boundaries (*innovation through partner knowledge application*). Finally, while cooperating to

create greater value, the firms are also concerned with their own competitiveness in order to appropriate more value. As the co-created value is appropriated by competition in the market, firms will make more individual efforts to create value beyond the alliance boundaries (*private innovation*). That is, the competitive pressure will result in increased efficiency and competitiveness (competition benefits).

Other combinations may generate performance inferior to that of balanced-strong coopetition (refer to Figure 3.5). In a cooperation-dominant coopetition (Type A), partners are not direct competitors (low intensity of competition between partners) but the partners have strong ties between them and/or the focal alliance is of a strong type (e.g., R&D, manufacturing). In this context, value will be mainly created by collaborative benefits manifested in joint innovation and innovation through the application of partner knowledge. When their markets are different and resources are complementary, partners may share common goals in technology development and have more chances to achieve mutual gains. As competitive tension is low, partners may not control knowledge flow as tightly and firms can share the partners' resource potential. However, this context may cause some negative effects on firm performance. First, firms will not make additional individual efforts to create value beyond the alliance boundaries (*low private innovation in the partner's domain*) because the co-created value is mainly appropriated by a cooperative arrangement. Scholars agree that an appropriate level of competition facilitates efficiency and innovation. Therefore, a lack of competition may reduce firms' efficiency and innovativeness in the long run. Second, if partners' resource profiles are very different, firms may have limitations in leveraging partners' knowledge due to a lack of an overlapping knowledge base, which is critical to understand the knowledge (Lane & Lubatkin, 1998; Mowery et al., 1996). In sum, in a cooperation-dominant coopetition, the collaboration

benefits (*joint innovation and innovation through the application of partner knowledge*) will be greatest but competition benefits (*private innovation in the partner's domain*) will be small, which may limit the firm's overall competition-based innovation potential.

Meanwhile, in a competition-dominant coopetition, partners are direct competitors (high intensity of competition between partners) but the partners have weak ties between them and/or the focal alliance is of a weak type (e.g., licensing, marketing). In this context, value creation most depends on each firm's individual efforts to create value beyond the alliance boundaries. When the most value a focal firm can obtain depends on market competition, firms will concern their own competitiveness and create private innovation in the partner's domains. But the cooperation benefits will be limited because partners may tightly control knowledge transfer. When partners are direct competitors, firms are very concerned with market competition and feel high competitive tension. Therefore, firms may not share knowledge that is potentially related to competition even though the knowledge is helpful to the alliance's success. Moreover, partners may use strong knowledge protection mechanisms. Khanna et al. (1998) suggest that a learning race may occur that is close to pure competition. Thus, if knowledge protection is weak, there is a high potential for a "learning race" in competition-dominant coopetition. In sum, in a competition-dominant coopetition, the collaboration benefits will be small and learning potential and knowledge sharing will be limited, which will limit the firm's innovation potential. Finally, in a weak coopetition relationship, partners are not direct competitors (low intensity of competition between partners) and the partners have weak ties between them and/or the focal alliance is of a weak type (e.g., licensing, marketing). In this context, partners cannot gain much benefit from either cooperation or competition. Even though the costs of this type of relationship are the lowest, the learning potential will be also low because partners have low motivation to

learn from partners and low capability to understand their partners' knowledge. Taken together, balanced-strong coopetition will generate the highest positive effects on firm innovation. Considered in its entirety, I hypothesize that,

H3a: *The greater intensity of competition between partners that is balanced with the greater intensity of cooperation between them, the greater the focal firm's coopetition-based innovation performance. Specifically, balanced-strong coopetition, based on a high degree of cooperation and a high degree of competition, contributes more to firm innovation than does cooperation-dominant, competition-dominant, or weak coopetition.*

FIGURE 3.5
Innovation and the Balance between Cooperation and Competition

COOPERATION		

Strong	Type A
	Cooperation-dominant Coopetition
	• Tension based on threat of opportunism
	  ○ Focus on value creation
	• Value co-creation: cooperative advantage through access to partner resources
	• Partner knowledge application: Medium.
	  ○ Focus on knowledge sharing
	  ○ Learning potential: Different knowledge bases prevented from recognizing, acquiring, and applying partners' knowledge. Unilateral learning (only one partner can learn) is possible due to not-invented-here (NIH) syndrome.
	• Private value creation: limited efforts to win over partners besides alliance scope
	⇨ **Aspect of Innovation: Joint innovation and innovation through the application of partner knowledge**
		Type B
		Balanced-strong Coopetition
		• Tension based on the balance between competition and cooperation (role conflicts)
		  ○ Focus on both value creation and value appropriation
		• Value co-creation: cooperative advantage through access to partner resources
		• Partner knowledge application:
		  ○ Balance knowledge sharing and knowledge protection.
		  ○ Learning potential: high motivation to learn from each other. Overlapping knowledge bases help firms recognize, acquire, and apply partners' knowledge. Balanced learning will increase interdependence.
		• Private value creation: more efforts to increase efficiency and competitive advantage
		⇨ **Aspect of Innovation: Innovation in all dimensions - joint innovation, innovation through the application of partner knowledge, and innovation in partner's domains**

Weak	Type C
	Weak Coopetition
	• Weak tension based on threat of opportunism
	  ○ Simple transaction
	• Value co-creation: limited effects
	• Partner knowledge application: minimal.
	  ○ Lack of knowledge sharing
	  ○ Learning potential is lowest
	• Private value creation: no effects for increasing competitive advantage
	⇨ **Aspect of Innovation: Little innovation in all dimensions**
		Type D
		Competition-dominant Coopetition
		• Tension based on competition (competitive tension)
		  ○ Focus on value appropriation
		• Value co-creation: limited value creation due to narrow scope and/or weak intensity of cooperation
		• Partner knowledge application: limited.
		  ○ Focus on knowledge protection.
		  ○ Learning potential: high motivation to learn from partners but limited learning due to strong protection. If knowledge protection is weak, there is high potential of "learning race."
		• Private value creation: more efforts to increase efficiency and competitive advantage
		⇨ **Aspect of Innovation: Innovation in the partner's domains**

	Weak	Strong
	COMPETITION	

3.3.3.2 Balance between competition and cooperation at the portfolio level

Regarding the balancing strategy and tension in coopetition, another possible operationalization is the balance between cooperation and competition at the portfolio level. The balance between competition and cooperation in a focal firm's alliance portfolio, i.e., the complete set of a focal firm's collaborative relationships (Lavie, 2007), may be achieved by including more balanced-strong coopetitive relationships[7].

A balancing strategy suggests that the balance between competition and cooperation at the portfolio level will help a focal firm generate greater innovation performance. First, the logic of the balance between competition and cooperation at the dyadic level will be applied at the portfolio level. If we agree that balanced-strong coopetition generates greater innovation performance than other types of coopetition, a focal firm with an alliance portfolio (an aggregation of individual alliances) that includes a greater number of balanced-strong coopetition should produce greater coopetition-based innovation performance. Second, the effects of the balance between competition and cooperation at the portfolio level may go beyond simple aggregation of individual alliances by generating some synergy effects. Through the inclusion of more balanced-strong coopetitions in their alliance portfolios, firms may create a corporate culture that will influence the firm's overall innovation performance. Through balanced-strong coopetition, executives may be able to develop a coopetition mindset and pursue a win-win strategy with partners. Recognizing that coopetition can be positive-sum games, firms will make efforts to create greater value (value co-creation). Also, balanced-strong coopetition will make managers more alert as compared to cooperation-dominant coopetition. Firms

[7] I note that another possible balancing strategy at the portfolio level can be achieved by developing an alliance portfolio with multiple types of coopetition, such as competition-dominant, cooperation-dominant, and balanced-strong coopetition. While a balanced-strong coopetition is balanced by itself, a competition-dominant coopetition can be balanced by a cooperation-dominant coopetition. However, I focus on balanced-strong coopetition because it offers higher tension.

sometimes do not recognize the risk of knowledge sharing and therefore carelessly share their knowledge with partners. If some partners are opportunistic and outlearn others in the relationship, the opportunistic partners could terminate the alliances earlier than original scheduled (Khanna et al., 1998). Further, a lack of competition may reduce firms' efficiency in the long run. Finally, when firms engage in multiple balanced-strong coopetitions, firms can apply knowledge learned from a specific alliance to other alliances as well as their own projects. Firms engaged in balanced-strong coopetition are direct competitors that possess similar resources. As discussed in section 3.3.1, the organizational search literature (e.g., Kogut & Zander, 1992) suggests that the knowledge of the firm evolves in a path-dependent way through the replication and recombination of existing knowledge. Therefore, firms with an alliance portfolio that includes more balanced-strong coopetition will gain more relevant knowledge and resources from the partners and can use the resources for multiple projects.

On the other hand, including balanced-strong coopetition in an alliance portfolio may have some negative effects. In terms of organizational search, beyond a critical level, the addition of similar capabilities of the partners is unlikely to help (or may even hurt) innovation especially when a high level of resource redundancies occurs because innovation arises out of new combinations of existing capabilities. In a similar vein, strong ties at the portfolio level cause the risk of "overembeddedness" (Uzzi, 1997). That is, beyond a threshold, embeddedness can hurt performance by insulating firms from information that exists outside their network. Ritala et al. (2008) also suggest that firms should be aware of the risks that are included in cooperating with too many of their most direct competitors by reporting that a high relative number of strategic alliances among a firm's key competitors contributes negatively to firm performance. However, they did not consider the intensity of cooperation and the balance between competition and

cooperation in a focal alliance. Overall, although there are some negative effects, I suggest that, including more balanced-strong coopetition, which will increase the balance between competition and cooperation at the portfolio level, will positively affect firm innovation performance. Therefore, I hypothesize that,

H3b: *The higher the ratio of balanced-strong coopetition a firm has in its alliance portfolio, the greater the overall firm innovation performance, ceteris paribus*.

3.3.4 The moderating role of coopetition capability

As discussed in section 3.1.4, I conceptualize coopetition capabilities based on the notion of dynamic capabilities. According to Teece (2009), dynamic capabilities refer to the firm's ability to sense, seize, and adapt in order to generate and exploit internal and external firm-specific competencies, and to address the firm's changing environment. To capture the balance strategy and the dimensions of dynamic capabilities, I explore three different coopetition capabilities: coopetition experience, coopetition mindset, and organizational structure with a combination of dedicated unit and divisional autonomy. "Sensing" and "seizing" coopetition opportunities requires recognizing the importance of coopetition and coopetition opportunities. Brandenburger and Nalebuff (1996) suggest that coopetition requires a new mental model, namely a "coopetition mindset." "Adapting (or managing)" coopetition may require coordinating conflicts (e.g., role conflicts), which are related to not only a managerial mindset but also organizational structure and incentive systems. Finally, previous coopetition experience, which is related to entire processes of coopetition, will be helpful in all dimensions.

In this study, I focus on the moderating role of coopetition capabilities in the context with both high intensity of competition between partners and high intensity of cooperation in terms of the type-strength of a focal alliance. The first reason is that coopetition capabilities seem to be more essential in contexts with a high intensity of competition. The fundamental challenge of

coopetition stems from the dynamic nature of the relationships with competitor-partners. Luo (2007a) points out that the cooperative and competitive element mix is not static, but rather dynamic in response to changing parameters in both their external and internal environments. Therefore, although cooperation is subject to some formal governance, competition can change without any formal governance (Luo, 2007a). The matter, therefore, is how to deal with conflicts and tension related to competition with partners. Another reason is that as discussed in section 3.3.2, type-strength of a focal alliance may offer only the potential of value creation and high intensity of competition between partners will limit the potential. In the section below, I explore three coopetition capabilities in detail and suggest that firms with greater coopetition capabilities may better understand the dynamics of coopetition and manage various conflicts in the lifecycle of coopetition, which will weaken the negative effects of competitive tension and strengthen positive effects of learning.

Coopetition experience. At the heart of organizational learning resides experience (Levitt & March, 1988). Inkpen and Tsang (2007) echoed Varadarajan and Cunningham's (1995) argument that a firm's accumulated learning from its past involvement in strategic alliances is likely to have an impact on the effectiveness of its future alliances. Alliance-experienced firms learn to manage alliances more effectively over time (Anand & Khanna, 2000; Barkema, Shenkar, Vermeulen, & Bell, 1997; Tsang, 2002). Based on the same logic, prior coopetition experience will contribute to coopetition success.

Regarding experiences with inter-firm collaboration, I note that the capability accumulated from alliance experiences may be helpful for managing coopetition because there are overlaps with general alliances, such as the general procedures. As discussed previously, however, coopetition has unique characteristics and challenges to manage. Compared to inexperienced

firms, firms with more coopetition experience may understand the dynamics of coopetition, know how to coordinate conflicts, and have the skills to communicate with multiple parties within the firm and with partners. Therefore, the experience with coopetition (cooperation with competing firms) will be more critical than the experience from general alliances for managing future coopetitions. Another reason that coopetition experience is important is related to tension. If firms are repeatedly involved in coopetitive relationships, we can assume that the firms are confident in their ability to generate benefits from coopetitive relationships and may have more capability to manage the relationships. As a result, firms with more experience with coopetition may be better able to manage the tension from the paradoxical factors in coopetition than less experienced firms in the same situation. As explained above, I focus on the intensity of competition between partners and balanced-strong coopetition. Therefore, I hypothesize that,

H4a*: A focal firm's coopetition experience will positively moderate the relationship between balanced-strong coopetition and the focal firm's coopetition-based innovation performance.*

Coopetition mindset. Brandenburger and Nalebuff (1996) argue that coopetition requires a new mindset – the management mental model with a win-win approach based on value creation and value appropriation. Elements of a coopetition mental model might include recognizing the importance of coopetition, scanning the environment for coopetition opportunities, developing ways to effectively engage in actual collaborative relationships with competitors (Gnyawali & Park, 2009), and continuously seeking a win-win method with competitor-partners during the period of the partnership. The coopetition mindset may affect both *ex ante* formation and *ex post* dynamics of coopetition. In this study, however, I mainly discuss the role of the coopetition mindset as the coopetition capability that manages the tension in the dynamic evolution of the

relationship. I suggest that the key to coopetition success rests with executives who develop a coopetition mindset.

Firms led by executives with a coopetition mindset are more likely not only to perceive coopetition opportunities but also to effectively manage the dynamics of coopetition (Gnyawali & Park, 2009). First, a win-win approach is the most effective way to create significant value and, in turn, obtain a bigger share of the value (Brandenburger & Nalebuff, 1996; Cairo, 2006). Even though a firm's partners are direct competitors or larger than the focal firm, management will continually pursue a win-win approach and positive sum game instead of worrying about its partner's opportunism. Second, executives with a coopetition mindset will view a bigger picture with long-term goals. From the SME context, Gnyawali and Park (2009) argue that firms will be motivated to collaborate with some competitors to increase their bargaining power against others. If a small firm can effectively learn through coopetitive ties, it can become a better partner and avail itself of more attractive opportunities in the long run (Gnyawali & Park, 2009). Viewing the bigger picture with a long-term goal keeps coopetitive relationships from being shaken by a short-term change in the partners' relative positions. Meanwhile, if management has strong competitor-oriented objectives, the degree to which the organization's primary goal is to defeat competitors in the marketplace (Luo et al., 2007), they will view their industry as a zero-sum game in which their gains must come at the expense of competitors. Also, Luo et al. (2007) echoed Campbell and Furrer's (1995) argument that zero-sum goals are harmful to learning, shift priorities away from value creation, and fuel mutually harmful price wars. In sum, management with a coopetition mindset is more likely to manage the competitive tension and the threat of opportunism from coopetition better than management with a zero-sum mindset. As a result,

learning and knowledge transfer will be facilitated by a coopetition mindset, increasing the likelihood of innovation performance. Therefore, I hypothesize that,

***H4b**: Firms with executives that have a coopetition mindset will positively moderate the relationship between balanced-strong coopetition and the focal firm's coopetition-based innovation performance*[8].

Organizational structure: Combination of dedicated unit and divisional autonomy. With respect to the organizational structure, I suggest that divisional autonomy, i.e., the degree of autonomy of each individual division in multidivisional firms, may be useful for managing coopetition. Focusing on the issue of role conflict in coopetition, Bengtsson and Kock (2008) suggest that while organizations can engage in both cooperation and competition simultaneously, individuals cannot cooperate and compete directly with each other simultaneously. Their arguments imply that even though top management makes strategic decisions about cooperating with direct competitors, employees who have been accustomed to pure competition or pure cooperative relationships may be confronted with various challenges in day-to-day operation in terms of balancing competition and cooperation. To reduce or resolve the conflicts, I suggest that divisions with a high degree of autonomy can simplify their relationships. Specifically, higher divisional autonomy may reduce the negative effects of tension from role conflicts. Let us assume that division A in firm X is cooperating with firm Y, while division B in firm X is competing with the same firm Y. Division A may feel lower competitive tension because they do not compete directly with the partner. Therefore, the partners may have common goals and they closely cooperate and transfer knowledge, which will create greater common benefits (co-created value). Meanwhile, division B is directly competing with firm Y. If they use the same products/technologies developed in the alliance between the two firms, the division may make

[8] This hypothesis will not be statistically tested but supported by case description.

more effort to surpass and differentiate itself from firm Y in the market (private value from competitive benefits). Therefore, firm X can effectively manage tension in coopetition and generate superior performance.

The literature on dynamic capability has emphasized the role of 'dedicated alliance function.' For example, Kale et al. (2002) suggest that firms need to create, so-called, 'dedicated alliance function' – a separate, dedicated organizational unit charged with the responsibility to capture, share, and disseminate the alliance management know-how associated with prior experience. Considering both a dedicated unit and divisional autonomy, I suggest that the role of such a separate unit will be critical to managing coopetition. The unit dedicated to interorganizational relationships will be able to capture the differences between coopetition and general alliances and the unique challenges of coopetition more systematically than would a more generalized measure. Also, the unit can efficiently store, share, and disseminate the coopetition management know-how. Further, when divisional autonomy is high and competition among individual divisions is severe, a dedicated alliance function can coordinate the conflicts among individual divisions and generate synergies out of multiple relationships. Considering divisional autonomy, I note that a new challenge facing management is that it must balance divisional autonomy and the coordination of the conflicted interests of divisions involved within the firm. When each division has a high degree of autonomy and individual divisions compete with each other to generate better contributions to the firm, the severe competition among individual divisions within the firm can hurt firm performance. Therefore, I note that a dedicated unit is vital when divisional autonomy is high. In sum, firms with a structure of a "combination of a dedicated unit and divisional autonomy" can better manage complex issues in coopetition. Therefore, I hypothesize that,

***H4c**: A focal firm's organizational structure with the combination of dedicated unit and divisional autonomy will positively moderate the relationship between balanced-strong coopetition and the focal firm's coopetition-based innovation performance*[9].

[9] This hypothesis is not statistically tested but supported by case description.

4. RESEARCH METHODOLOGY

I tested the hypotheses using both a case study and a quantitative study to understand paradoxical and multi-faceted factors in coopetition. Through a case study, I could explore how two rivals engaged in a balanced-strong coopetition (high competition and high cooperation) developed their relationship and managed tension to generate greater value, and how the firms' coopetition capabilities played a critical role in the success of the coopetition. However, a case study is limited in revealing the differences among different contexts within different intensities of coopetition. So, I employed a large-scale longitudinal analysis using a sample of firms in the U.S. semiconductor industry to test the hypotheses. Through both qualitative and quantitative methods, I compared the effects of different coopetition contexts and worked to understand the deeper level of coopetition dynamics and firm capabilities to manage the tension in coopetition. Table 4.1 shows which method is used to test specific hypotheses.

TABLE 4.1: Methods Used in Hypothesis Testing

Hypothesis	Qualitative method	Quantitative method
H1		◎
H2		◎
H3a		◎
H3b		◎
H4a	◎	◎
H4b	◎	
H4c	◎	

4.1 Qualitative Research: An In-Depth Case Study[10]

4.1.1 Research setting

The research design employed an exploratory approach in order to provide meaningful insights into the effects of coopetition on the tension between competitors, technological development, and participants' performance. Gnyawali and Park (2011) argue that case-based exploratory methods are best suited for investigating new and poorly understood phenomena (Eisenhardt, 1989) that have multiple and complex elements (Dodgson, Mathews, Kastelle, & Hu, 2008) and that evolve over time (Langley, 1999). An in-depth case study is a reasonably good approach to examine complex phenomena (Yin, 1984). Since coopetition is a multi-faceted and paradoxical phenomenon, an in-depth case study over a long period provides insight into the drivers, processes, and consequences of coopetition (Gnyawali & Park, 2011). With the goal of an exemplar case to advance our understanding of the tension in coopetition and the role of a firm's coopetition capabilities in managing the paradoxical and dynamic relationship, I selected a balanced-strong coopetition (high competition and high cooperation), a joint venture between two major rivals in the high tech industry.

Established by Samsung Electronics and Sony Corporation in April 2004, S-LCD is a joint venture to develop and produce seventh generation (1,870 x 2,200mm motherglass) liquid crystal display (LCD) panels for flat screen TVs. Each party owns 50 percent of the venture, with the chief executive officer (CEO) from Samsung and the chief financial officer (CFO) from Sony. Samsung contributes its technological strengths in LCD technology, while Sony contributes its technological strengths in television, brand recognition, and market leadership in the television market (Gnyawali & Park, 2011).

[10] In this section, I build on the case description in Gnyawali and Park (2011).

S-LCD provides an ideal setting to examine hypotheses regarding coopetition capability and the balance between competition and cooperation. First, the firms operate in a high-tech industry sector in which alliance activity has been dynamic and intensive (Hagedoorn, 1993). In the TV industry, the relationships among major players have dramatically changed as TV technology has transitioned from analog (cathode-ray tube (CRT)) to digital, including liquid crystal display (LCD), plasma display panel (PDP), and organic light-emitting diode (OLED). Sony, which was a distinct leader in the traditional CRT TV market, was lagging behind in the technological development of flat screen TV. During the transition from analog to digital, the competition surrounding the technological standards became severe. Examining cooperation between the incumbent leader (Sony Corporation) and an emerging leader (Samsung Electronics) in the technology transition context can give more exciting and valuable implications.

Second, the case provides the most paradoxical situation of coopetition in which firms are involved in simultaneous strong collaboration and strong competition (Gnyawali et al., 2008). Further, the two firms are approximately equal in size and overlap significantly in the marketplace so the paradoxical nature of the relationship would be most intense. In 2003, when the two firms agreed to establish S-LCD, the annual revenue of Samsung Electronics was US$54.1 billion and that of Sony was US$67.2 billion, while their global brand rankings were 25th and 20th, respectively. The firms have competed in various product markets, such as TV, computer, video, audio, and handsets, as well as in various geographic markets in the US, Europe, and Asia. In such extreme situations, the tension between competitor-partners and its impact may be readily observed. Further, the joint venture, which still exists at the time of this study in 2011. has a sufficiently long history (eight years from 2004 to 2011) to allow a longitudinal analysis. Finally, the firms are public firms for which archival data are available.

4.1.2 Data collection

This study relied mainly on secondary data. First, I collected data from the two firms' annual reports for their businesses and strategy, industry research firms (e.g., DisplaySearch) for market share, and public financial databases (e.g., COMPUSTAT). Records of alliances (data for investigating coopetition experience to support hypothesis 4a) formed by Samsung Electronics and Sony Corporation between 1994 (10 years before the JV) and 2003 were compiled from the SDC Platinum database. Each alliance announcement was verified by tracking corresponding information from multiple sources, such as the SDC database, annual report, and Factiva news.

Second, I employed news report analysis to develop a better understanding of the situation, evolution, and effects of coopetition. As the joint venture between two industry leaders has received a great deal of attention from the media, there are ample news reports even though the focuses are different. I downloaded news reports from the Factiva database through key word searches and extracted key statements/quotes from news reports that relate to the conceptual arguments developed above. By analyzing the news reports from 2003 (to understand the situation right before Samsung and Sony decided to establish the alliance) to 2010, I attempted to understand industry and dyadic forces related to the formation of this coopetitive venture, the evolution of coopetition between two competitor-partners, and firm and industry-level outcomes. I focused on major newspapers and reports in Korea, Japan, and the United States. Cross-checking information through newspapers in three countries enabled me to overcome possible bias and gain access to the materiality of the S-LCD JV, as well as to its evolution and impact.

4.1.3 Analysis

This qualitative research is appropriate for exploring new facets that have not been thoroughly addressed in the literature about the emerging phenomenon of coopetition. Further, hypotheses 4b and 4c were not statistically tested but supported by case description (qualitative methods) due to the limitations of collecting data for large scale quantitative research. That is, I provided illustrative support for the relevant hypotheses by describing the factors that occurred in the case. To make sure that this case is a balanced-strong coopetition, I reported the two firms' businesses, their positions in the businesses, and the strength of ties between the two firms. In terms of coopetition capabilities, I analyzed their coopetition experience, coopetition mindset, and organizational structure. Regarding coopetition mindset, I used relevant quotes from news articles and corporate annual reports. Regarding organizational structure, I analyzed the two firms' organizational charts and expanded relationships with affiliates. Also, quantitative data (i.e., alliance data) were used to examine the role of coopetition experience.

4.2 Quantitative Research: The Semiconductor Industry

4.2.1 Research setting

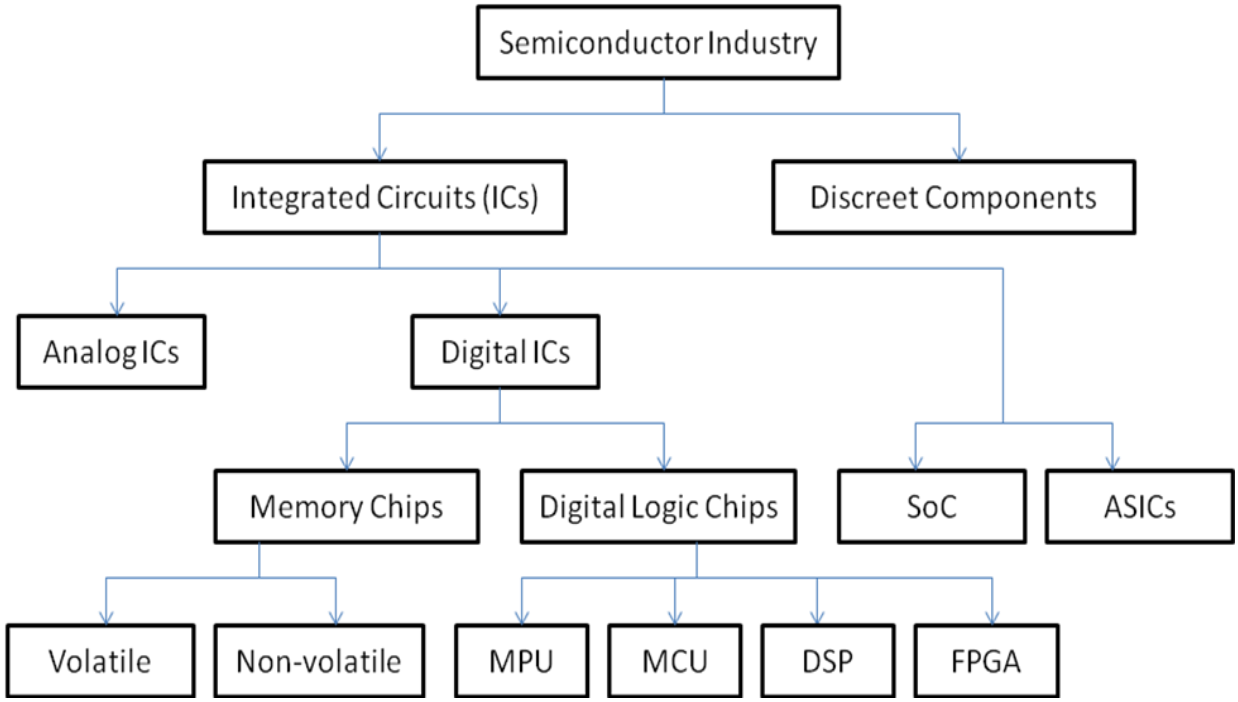
I tested the hypotheses with a large-scale longitudinal analysis using comprehensive panel data on the alliances (or alliance portfolios) of sample firms operating in the semiconductor industry (SIC 3674). Following prior research (Srivastava & Gnyawali, in press; Stuart, 2000), I selected the semiconductor industry for several reasons. First, the semiconductor industry provides an ideal setting for testing the hypotheses as the industry is characterized by a prevalence of alliances and patenting within the industry. Such practices in this industry enhance the meaningfulness, reliability, and variance of alliance (or alliance portfolio) variables and the measurement of the dependent variable, innovation output (Srivastava, 2007). Second, as industries vary in their patenting tendencies, the single industry setting is appropriate to examine a contingency relationship in a single industry context prior to making generalizations across industries (Ginsberg & Venkatraman, 1985). Finally, to create highly representative samples, I included some representative global semiconductor firms on top of the US semiconductor industry, which was the sample baseline. As Srivastava and Gnyawali (in press) argue, a sample of the US semiconductor industry is highly representative, since the US semiconductor market is the biggest and most strategically important to most firms, so they try to secure their intellectual property rights in this market (Sorensen & Stuart, 2000). However, the samples do not include all major semiconductor firms. To overcome this limitation, the samples in this research included top vendors and/or segment leaders in the global semiconductor industry.

4.2.2 Overview of the semiconductor industry

The semiconductor industry consists of different segments as indicated in Figure 4.1 and Table 4.2. It has two broad segments – integrated circuit devices and discrete devices. The

integrated circuit (IC) is the dominant segment in the industry and has two types – digital and analog. Digital ICs are further divided into two groups – memory chips and digital logic chips. Below, I provide further details about these segments based on the technological characteristics. The following section has been developed based on information by the Semiconductor Industry Association (www.sia.org), dissertations (e.g., Srivastava, 2007), books (e.g., Brown & Linden, 2009; Mathews & Cho, 2000), and expert interviews.

FIGURE 4.1
Semiconductor Industry Product Market Segments



ASICs: Application Specific Integrated Circuits ; DSP: Digital Signal Processors; FPGA: Field-progrmamable Gate Array; MPU: Microprocessors; MCU: Microcontrollers; SoC: System on a Chip

TABLE 4.2: Semiconductor Industry Product Market Segments

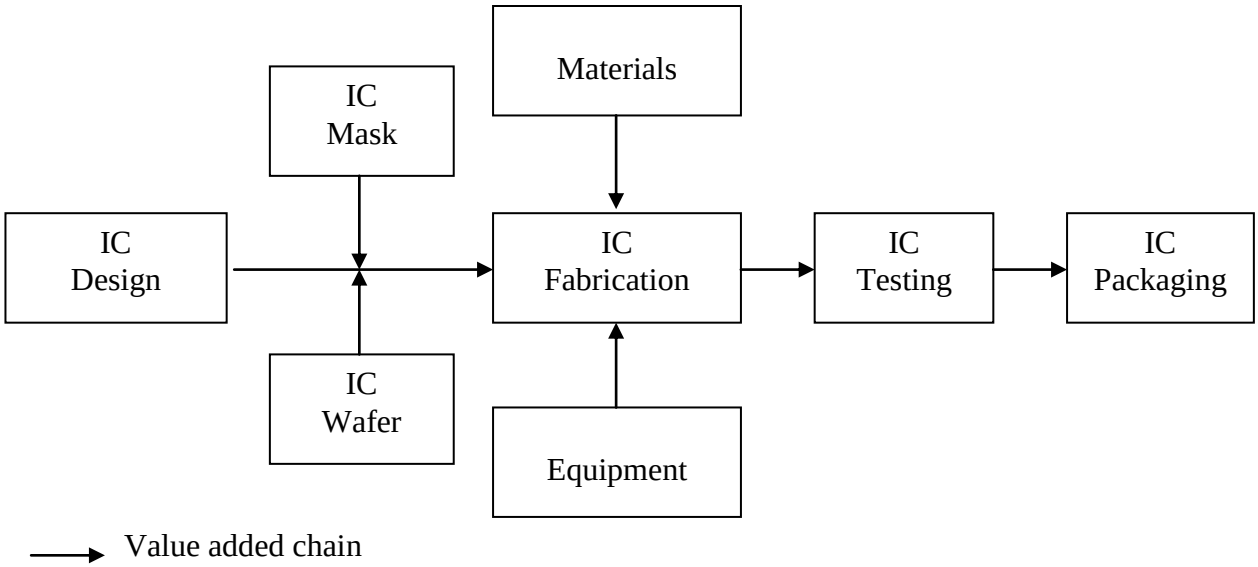
Segments				Key Products and Major Firms
Discrete devices				Individual components connected on a circuit board (e.g., transistors, rectifiers, and diodes)
Integrated circuits devices	Analog			Texas Instruments, National Semiconductors, and Analog Devices
	Digital	Memory chips	Volatile	DRAMs and SRAMs: Samsung, NEC, Hynix, Toshiba, Fujitsu, Micron Technology
			Non-volatile	Flash memory: Samsung, Intel EEPROM (Electronically Erasable Programmable Memory): Atmel, Microchip and Xicor
		Digital logic chips	Micro Processors	A "minicomputer" on a chip: Intel and AMD
			Micro Controllers	RAM and ROM: Motorola, Siemens, Hitachi, NEC, Microchip Technology
			ASICs	Application Specific Integrated Circuit: Agere Systems, LSI Logic, Xilinx, Altera and Atmel

Source: Srivastava (2007, pp.79-81)

Figure 4.2 shows the semiconductor industry value chain (Mathews & Cho, 2000). The semiconductor industry that started as a highly vertically integrated industry, when the firms conducted most of their activities in-house, has become quite horizontal over time (Uallacháin, 1997). Different groups of firms specializing in different aspects of the industry have emerged (Macher & Mowery, 2004). The firms operating in the semiconductor industry can be divided into six groups based upon the value-chain activities they perform: 1) integrated device manufacturers (IDM) – firms that design, development, and manufacture semiconductor chips, 2) fabless firms that only design semiconductor chips, but do not manufacture them, 3) foundries that only manufacture semiconductor chips designed by other firms, 4) firms offering packaging

and testing services to other firms, 5) large diversified firms, and 6) firms providing equipment for manufacturing the chips[11].

FIGURE 4.2
The Semiconductor Industry Value Chain



Source: Mathews & Cho (2000, p.39)

4.2.3 Sample and data collection

I conducted this study as an unbalanced panel analysis spanning the years 1990 to 2003. Historical patents were tracked back to 1986 and post-alliance patents were tracked through 2006. I used multiple databases (COMPUSTAT, SDC, NBER, USPTO, and Google patent databases), industry reports, and firms' 10Ks. Further, I interviewed an expert to understand the semiconductor product categories. Figure 4.3 outlines the data collection procedures.

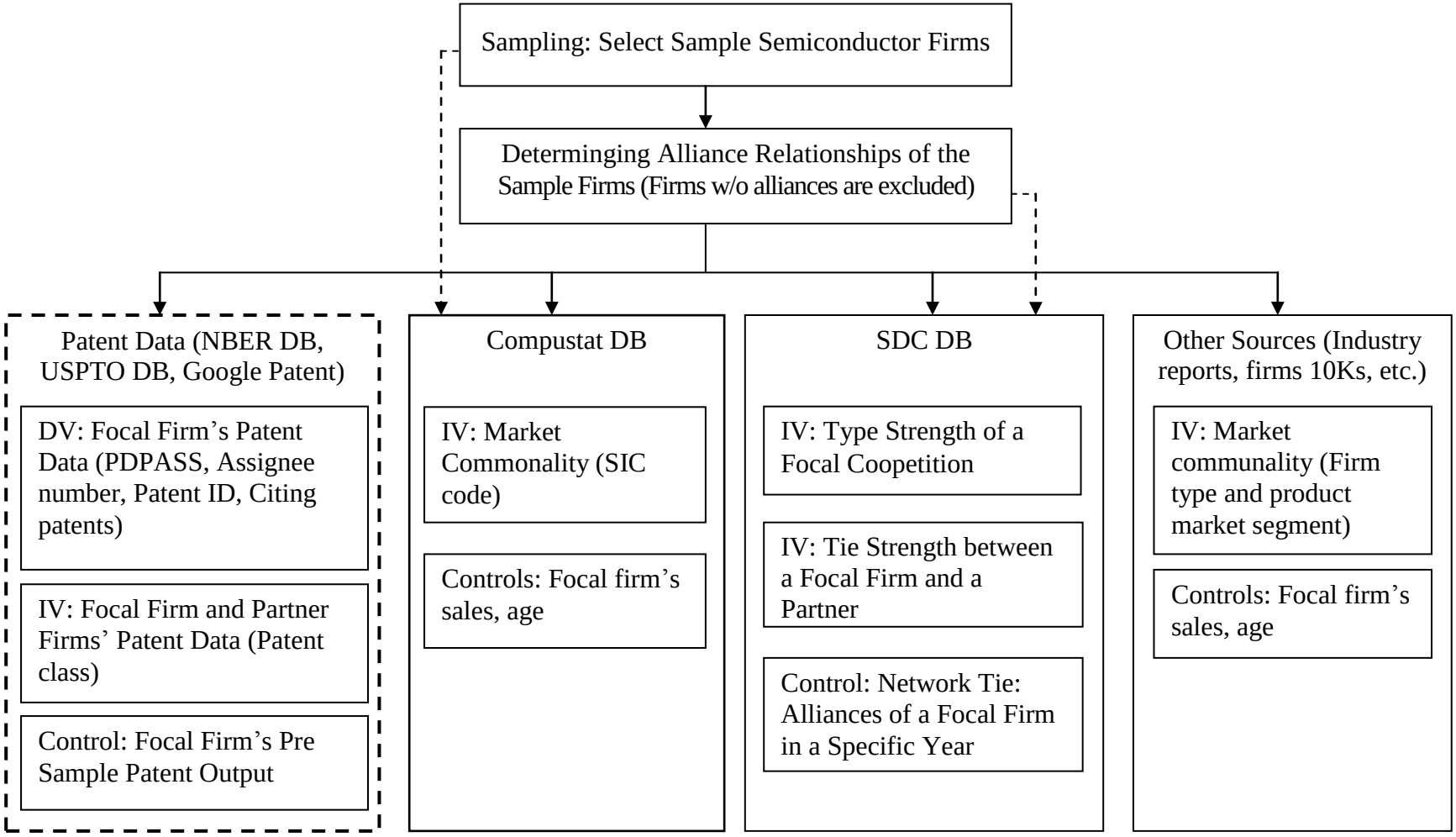
The first step of data collection was to determine the sample of semiconductor firms. Following Srivastava (2007), firms were selected based on two criteria: 1) sample firms were required to be listed in S&P's COMPUSTAT database under the SIC code 3674 and 2) firms had

[11] This categorization is mainly based on Srivastava (2007). While he considered only five groups, I considered equipment providers as the sixth group, because they are included in SIC 3674. Large diversified firms were excluded in main analysis.

to be publicly traded in 2003. Due to non-availability of financial data about private firms, they were not included in the sample. On top of that, I included representative global firms. The representative globals firms were selected based on three criteria: 1) sample firms were required to be listed in the top 20 vendors or top 10 segment leaders list at least once during the research period (1990 to 2003), 2) firms had to be publicly traded, and 3) firms' primary SIC codes had to be SIC 3674.

Alliance data. The second step of data collection was to collect data on sample semiconductor firms' alliance relationships and determine their alliance relationships. As the unit of analysis is individual alliances, firms without any alliances were excluded from the main analysis. I collected the alliance data about semiconductor firms using the Securities Data Company (SDC) database. Although this database is the most comprehensive database available, it has some limitations. First, for years prior to 1989, SDC does not provide reliable data (Anand & Khanna, 2000; Sampson, 2007; Srivastava & Gnyawali, in press). Therefore, I restricted the observation period to post-1989. Another limitation is that the SDC database includes information about alliances that were announced but not actually formed (Phelps, 2003). Following Srivastava (2007), to verify the alliance information, I used *Factiva* to trace the alliances using a key word search approach.

FIGURE 4.3
Procedures of Data Collection



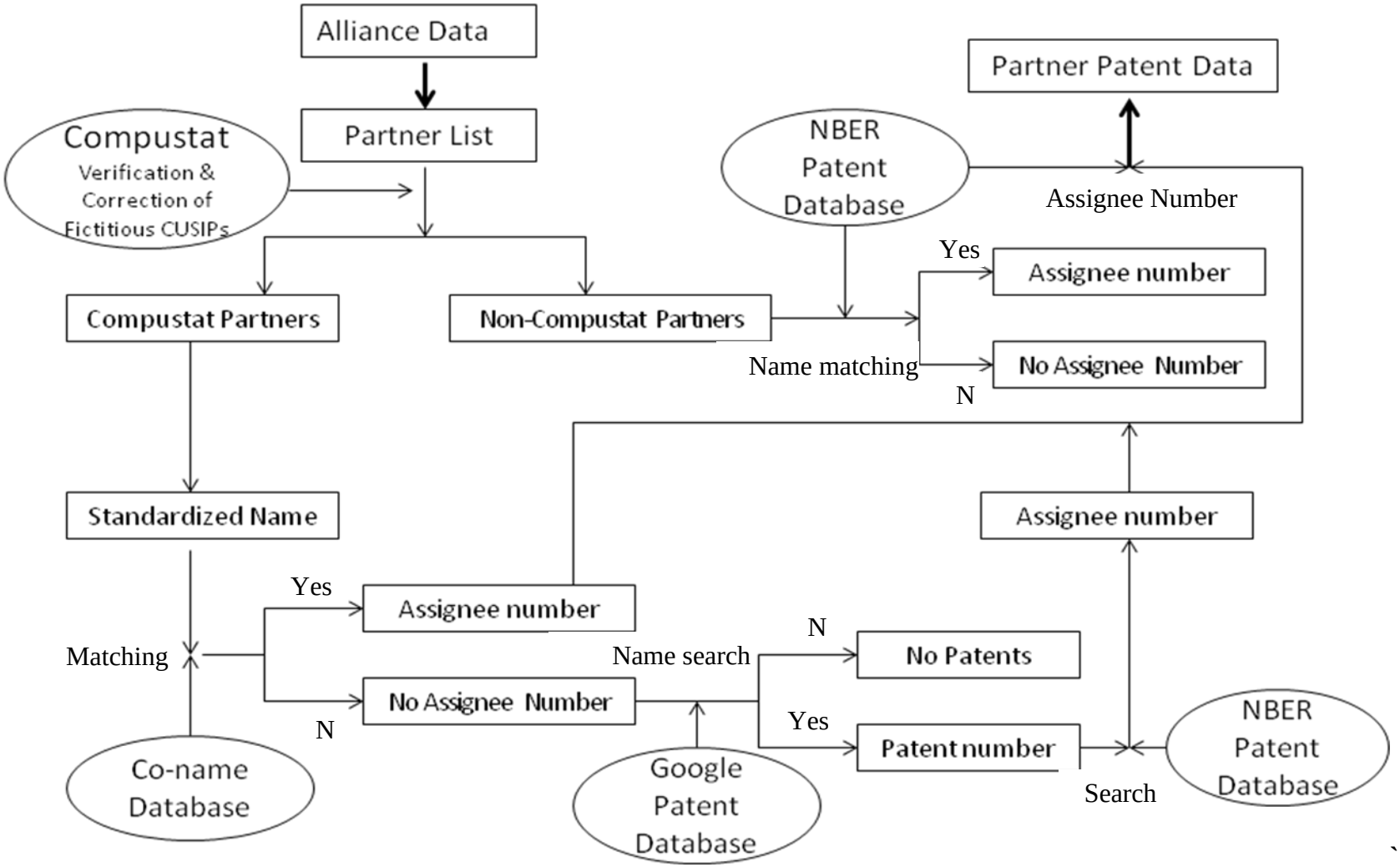
*Collecting patent data procedure is explained in Figure 4.4 in more detail.

Patent data. The third step of data collection was to collect patent data. Patent data contributed was used to the dependent variable (i.e., innovation performance), an independent variable (i.e., the intensity of technology competition), and a control variable (i.e., pre sample innovation). I constructed the patent database for the sample firms and partner firms from multiple patent databases, including USPTO, Google patent, and the updated NBER patent databases[12]. To use the NBER database information, it is necessary to identify the assignee numbers (i.e., PDPASS) of sample firms. Following Srivastava (2007), I used the name matching database and collected necessary information for remaining firms from the USPTO or Google patent databases (see Srivastava, 2007). Figure 4.4 shows the process of patent data collection that Srivastava (2007) used. Following his approach, I did not restrict the count of firms' patents to those in just technological subcategory 46 (indicating semiconductor industry patents in the NBER database). Instead, I included all patents of the sample firms obtained in the U.S.

Other data. As Figure 4.3 shows, from the COMPUSTAT database, I collected the SIC codes of sample firms and their partners, and sample firms' sales and age information. The SDC database was used to collect alliance data to measure type-strength of a focal firm, tie strength between two firms, and network ties of sample firms. Besides, I collected the information on focal firms and partner firms from various sources, such as industry reports, firms' annual reports, and firms' homepages.

[12] The home page for the new NBER patent data project (http://sites.google.com/site/patentdataproject/) provides US patent data for 1976-2006.

FIGURE 4.4
Construction of Patent Database



Source: Srivastava (2007), p.92.

4.2.4 Measures

4.2.4.1 Dependent variables

Coopetition-based innovation output. First, following prior research (Ahuja, 2000; Sampson, 2007; Schilling & Phelps, 2007; Srivastava & Gnyawali, in press), I measured the volume of a firm's innovation output using the firm's patents. Prior research suggests that patents provide a fairly reliable measure of innovation activity (Acs, Anselin, & Varga, 2002) and of innovation performance (Sampson, 2007). Second, following Sampson (2007), I considered a one-year lag between alliance announcement and patent application and measured the firm innovative performance in a three-year post-alliance window. It takes time for an announced alliance to be effective and for the participating firms to develop technologies for patent, which requires at least a one-year lag. Further, as this study focuses on a dynamic perspective and learning effects, I selected a period (three-year window) instead of a specific year. Third, consistent with previous studies, I used the number of granted patents (Ahuja & Katila, 2004), giving weights with citation numbers (Srivastava & Gnyawali, in press). Finally, to improve the matching of innovations to alliances, I developed a new measure of firm innovation performance – "coopetition-based" innovation output. This captures the innovation output only related to coopetition and is based on the patent citation patterns in the focal firm's patent portfolio. As I discussed in section 3.1.2, I captured the value from coopetition through three categories: 1) value co-created with partners, 2) value through the application of partner knowledge, and 3) value created by private efforts in the partner's domains. To capture the value of each category, I separately measured innovation in the three categories. Then, I measured coopetition-based innovation output by combining innovations from the three categories.

- *Joint innovation*. This category captured the innovation performance through value co-created with partners. If partner firms jointly develop new technologies, both companies will apply for a patent together. So, if both companies were co-assignees to patents for which they applied within three years ($t_1 \sim t_3$) after a focal alliance was announced, the patents were categorized as "joint innovation."
- *Innovation through the application of partner knowledge*. Following Mowery et al., (1996), I captured knowledge transfer by citation. I considered only one-directional citations from Firm $_i$ to Firm $_j$. That is, Citation (Firm $_i$, Firm $_j$) = Citations to Firm $_j$ patents in Firm $_i$'s patents. If a focal firm applied for patents that cited the specific partner's patents, the patents were categorized as "innovation through knowledge application.[13]"
- *Innovation in the partner's domains*. This category captured the competition benefits through additional private value creation efforts. If the focal firm applied for patents that were categorized in the same patent classes as the other partner, the patents were categorized as "innovation in partner's domains."
- *Coopetition-based innovation performance = joint innovation+ innovation through the application of partner knowledge+ innovation in the partner's domains*. If patents were observed across categories, I only considered them once based on the likelihood of coopetition relatedness. I assumed that joint innovation is more related to coopetition than the other two categories, while innovation through the application of partner knowledge is more related to coopetition than innovation in the partner's domains. Thus, if two partners were co-assignees to a specific patent and the patent cited the partner's patents, I

[13] To measure innovation through the application of partner knowledge and innovation in the partner's domains, I considered the increase measured by the difference between post alliance and pre alliance outputs. Due to citation lag, however, such measures generate many negative numbers that will violate the condition of my primary method, negative binomial regression. Instead, I added pre sample innovation performance as a control variable.

categorized the patent as joint innovation. If a patent that was in the partner's domains cited the partner's patents, I categorized the patent as innovation through the application of partner knowledge.

Overall firm innovation output. The specific procedure was the same as with coopetition-based innovation performance. I: 1) measured the volume of a firm's innovation output using the firm's patents, 2) considered a one-year lag between alliance announcement and patent application, 3) measured the firm innovative performance in a three-year post-alliance window, and 4) used the number of granted patents and then weighted them using the number of citations. The only difference between the two procedures was that this measure captured the focal firm's entire innovation performance. This aligns with previous studies (Ahuja, 2000; Ahuja & Katila, 2004; Sampson, 2007; Srivastava & Gnyawali, in press). Thus, it could be used to compare against my new measure of coopetition-based innovation performance. Further, this was the dependant variable at the portfolio level of analysis.

4.2.4.2 Independent variables

Coopetition. I captured the intensity of coopetition based on the combination of two components: 1) the intensity of competition between partners, and 2) the intensity of cooperation between partners.

The intensity of competition between partners. The intensity of competition was measured in terms of two types of competition – market competition (*Market_comp*) and technology competition (*Tech_comp*). Such categorization of competition is based on Chen's (1996) resource-based and market-side competition. *Tech_comp* captures the competition in upstream activities, while *Market_comp* captures the competition in downstream activities. While the market competition was measured by market commonality, the technology

competition was measured by similarity in technological resources (patent class overlap) as follows:

Degree of market competition = Market commonality (SIC code overlap, firm type overlap, and product market overlap in the same industry)

Degree of technology competition = Technology similarity (patent class overlap)

- *Market Competition (Market_comp)* was measured by market commonality that refers to the degree of overlap in the markets of the focal firm and its partners. The most common measure for business relatedness (similarity) between two firms uses the SIC (or NAICS) codes of the two firms (Wang & Zajac, 2008). However, this measure is too broad to reflect competition in product segments. As discussed in section 4.2.2, there are six different types of semiconductor firms (IDM, fabless, foundry, tester, equipment provider, and large diversified firm) based on value-chain activities. Further, the semiconductor industry is divided into several product market segments (refer to Figure 4.1). That is, even though two firms are operating in the same industry based on SIC codes, they may not consider the other to be a direct competitor if their firm type is different or they are producing different products. Thus, I measured market commonality by SIC code (four levels based on 4-digit SIC code), firm type, and product market segment (refer to Table 4.3).

  First, I measured market commonality by using the SIC code. Adopting Wang and Zajac (2008), I set the business similarity of two firms to be 0 if the four digits of the two firms' SIC codes are completely different, 0.2 if the first digit of the two firms' SIC codes are the same, 0.4 if the first two digits of the two firms' SIC codes are the same, and 0.6 if the first three digits of the two firms' SIC codes are the same. If the four digits of the two firms' SIC codes are the same, I considered the firm types of the two partners. If the firm types are

different, I set the business similarity of two firms to be 0.8. Finally, if their firm types are the same and product market segments overlap, I considered them to be direct competitors and set the business similarity of two firms to 1.

In the process, categorization of the product market segment was tricky. First, I collected information on the top players and segment leaders provided by semiconductor industry research firms, such as iSupply Corp., Gartner Dataquest Corp., Cahners In-Stat Group, and Semico Research Corp. However, the information did not include small firms or firms' full business segments. Thus, I collected firm information and business descriptions from various sources, such as LexisNexis Academic, company 10Ks, and firm homepages. A firm's business description provides information about its primary businesses and firm type (e.g., fabless, foundry, and tester). Second, I organized the product market segments (refer to Figure 4.1). Finally, I slotted each firm into product market segments. As some firms operate in multiple segments, I coded all categories in which firms were engaged. However, I was not sure how to categorize some firms' (around 20 percent of the samples) business segments. Thus, I received help from an expert in categorization who assessed my coding.

TABLE 4.3 Rating the Market Competition

Criterion		Ratio
Step1: SIC code overlap	If the four digits of the two firms' SIC codes are completely different	0.0
	If the first digit of the two firms' SIC codes are same	0.2
	If the first two digits of the two firms' SIC codes are same	0.4
	If the first three digits of the two firms' SIC codes are same	0.6
Step2: Firm type overlap	If the four digits of the two firms' SIC codes are same but the firm types are different. In case the firm types are IDM (or fabless), product market segments are not overlapped.	0.8
Step3: Product market segment overlap	If the four digits of the two firms' SIC codes are the same and the firm types are IDM (or fabless). At least one product market segment overlaps.	1.0

- *Technology Competition (Tech_comp)* was measured by technology similarity that refers to the degree of comparability of the strategic technological resources of the focal firm with those of its partners. Following Sampson (2007),[14] I measured technological similarity by using patent technology classes, which capture similarities in technological capabilities between firms in different industries as well as technological differences among firms in the same industry. Following previous studies (Oxley & Sampson, 2004; Sampson, 2007), I generated each partner's technological portfolio by measuring the distribution of its patents across patent classifications. This distribution is captured by a multidimensional vector, $Fi=[Fi^1 \ldots Fi^s]$, where Fi^s represents the number of patents assigned to partner firm *i* in patent class *s*. Thus, the similarity of a partner firm's technological capabilities is:

$$\text{Technological similarity} = \frac{FiFj'}{\sqrt{(FiFi')(FjFj')}}$$

Where i ≠ j. Technological similarity varies from 0 to 1, with a value of 1 indicating the greatest possible technological similarity between partner firms. Following Sampson's (2007) suggestion, I used patent subclasses to reduce the problem of measuring differences or similarities between classes. For portfolio level analysis (i.e., hypothesis 3b), I calculated this measure for every combinatorial pair of firms in the alliance portfolio and then averaged the dyadic data to get portfolio-level data.

The intensity of cooperation between partners. The intensity of cooperation is measured in terms of two types of cooperation – the type-strength of a focal alliance (*Type_coop*) and the strength of ties between two firms (*Tie_coop*). While *Type_coop,* which captures the cooperation in a focal alliance, was measured by type of alliance, *Tie_coop,* which captures the overall

[14] Sampson (2007) used patent classes to capture technological distance, but her measure can be used to capture the technological closeness in the opposite way.

cooperation (beyond the focal alliance) between two firms, was measured by repeated ties and concurrent linkages, as follows:

- *The type-strength of a focal alliance (Type_coop).* Scholars suggest that the strength in cooperation depends on the type of cooperation. Following previous studies (e.g., Contractor & Lorange, 1988; Nohria & Garcia-Point, 1991; Srivastava, 2007), I used a weighing scheme, which is meant to reflect the strength of cooperation, based on the types of collaboration (e.g., R&D, manufacturing, marketing, and licensing) across multiple scopes. Following Srivastava (2007), the weighing scheme in this study is based on the likelihood of knowledge transfer and learning potential in an alliance. In accordance with Contractor and Lorange (1988), R&D value chain activity receives the highest weight. In the semiconductor industry, manufacturing and cross-licensing alliances also play very important roles in the transfer of knowledge between partners (Grindley & Teece, 1997). Licensing and marketing alliances receive the least weight. This aligns with Anand and Khanna's (2000) finding that the effects of learning on value creation are strongest for research joint ventures, followed by production, and weakest for marketing joint ventures. As alliances may involve cooperation across multiple value-chain activities, the weight of a given alliance is a function of value-chain activities involved in the alliance. I assumed that the effects of JVs are twice as strong as the effects of contracts. Adopting Srivastava and Gnyawali (in press) and considering JV's, I used the following formula:

  The type-strength of a focal alliance (Type_coop) = (4*R&D + 3*Manufacturing + 2*Cross licensing + Licensing + Marketing + Tech-Transfer) *JV weight (joint venture 2, alliance 1)

- *The strength of ties between partners (Tie_coop).* The overall strength of ties between two firms is also based on the likelihood of knowledge transfer and learning potential in an

alliance. I conceptualized the strength of ties at the dyadic level as the overall cooperative relationship between two firms, which was operationalized by repeated ties and concurrent multiple linkages. Interestingly, repeated ties and concurrent multiple ties are informal safeguards based on the relationships between two firms beyond the focal alliance. In regard to measurement, repeated ties and concurrent multiple linkages were measured in a sophisticated way. First, they were rated based on the number of ties. Repeated ties is the accumulated number of alliances with the same partner over five years beginning the year (t_{-5} ~ t_{-1}) prior to the start of the focal alliance. Concurrent multiple linkages is the number of current linkages (alliances announced in the same (t_0) and following (t_1) years of the focal alliance) with the same partner except the focal alliance. It was 0 if there was no repeated tie or multiple linkages. Second, the effects of joint ventures are stronger than those of contracts, such as licensing (Anand & Khanna, 2000). I assumed that the effects of JVs are twice as strong as the effects of contracts. Finally, the benefits of prior alliance experience may depreciate rapidly over time. Recent experience can be a more salient source of inference and contribution to the learning, which will become more relevant to current strategic choices (Sampson, 2005). To reflect the temporal characteristics of learning experience stored in organizational memory, I employed a discounted measure of firm experience by year. I assumed that the real value of each repeated tie will depreciate 20 percent a year as follows: joint ventures (1, 0.8, 0.6, 0.4, 0.2 until the fifth year), contracts (0.5, 0.4, 0.3, 0.2, 0.1 until the fifth year).

TABLE 4.4 Measurement of the Strength of Ties (*Tie_coop*)

Nature of tie	Measure
Repeated ties	• Number of previous ties with the same partner • Joint ventures are twice as strong as contracts – 1 for one joint venture, 0.5 for one contractual alliance • 20 percent discount rate by year: for joint ventures (1, 0.8, 0.6, 0.4, 0.2 until fifth year), for contracts (0.5, 0.4, 0.3, 0.2, 0.1 until fifth year) • 0 if there is no repeated tie.
Concurrent multiple linkages	• Number of current linkages with the same partner, except the focal alliance • Joint ventures are twice as strong as contracts – 1 for one joint venture, 0.5 for one contractual alliance • 0 if there are no multiple linkages.

The balance (or interplay) between competition and cooperation. One of the key points of this study is the balance (or interplay) between competition and cooperation. Further, my primary focus is whether balanced-strong coopetition (combination of high competition and high cooperation) generates greater innovation performance than do other types of coopetition. Thus, I needed to capture both the balance between competition and cooperation and the intensities of competition and cooperation. However, there was no prior work to guide the measurement of both the balance and intensities between competition and cooperation. I considered multiple measures but each approach to measure the balance (or interplay) between the two variables had advantages and d isadvantages. Therefore, in this study, I employed two approaches.

- ***Polynomial regression***. To capture the combined effects of competition and cooperation on innovation, I used a polynomial regression equation containing the component measures, which provides benefits to capture the whole picture of the interplay between competition and cooperation. I discussed this in detail in section 4.2.5.
- ***A dummy variable of balanced-strong coopetition***. My primary focus in this study was the effects of balanced-strong coopetition on innovation. To examine my primary focus, I used

dummy variables, which was a supplement approach to polynomial regression. I created dummy variables based on typologies with a 2x2 matrix. The dummy variable was 1 if the samples were in the category of balanced-strong coopetition, 0 if not. An issue was the criterion to categorize balanced-strong coopetition. I used three criteria: 1) over the mean values, 2) over mean + 0.5 standard deviation, and 3) over mean + 1 standard deviation. While all other variables were based on continuous scales, market competition (*Market_comp*) was based on an ordinal scale. Thus, I set the criteria to create dummy variables as follows: 1) *Market_comp* was greater than 0.4 (over mean) when the partners' 2-digit SIC codes were the same; 2) *Market_comp* was greater than 0.8 when the partners' 4-digit SIC codes were the same; and 3) *Market_comp* was 1 when the partners are in the same industry (partners' 4-dight SIC codes were the same), took the same types of firm, and played in the same product segment.

- *The ratio of balanced-strong coopetition in an alliance portfolio*. Although my theoretical arguments are based on the dyadic alliances of the focal firms that were listed in SIC code 3674, I also tested hypothesis 3b at the portfolio level. Following previous works (e.g., Lavie, 2007; Srivastava & Gnyawali, in press), the "firm-year" was considered the operational unit of portfolio level analysis. In addition, adopting Baum et al. (2000), I considered alliances that were founded in previous years and were still in existence in a sampling year.

4.2.4.3 Moderators

Coopetition experience. I measured coopetition experience by the accumulated number of alliances with competitors (partners belonging to the same 4-digit SIC code) to the year prior to the start of the focal alliance. I captured coopetition experience in two different ways. First, I measured the accumulated number of alliances with competitors (partners belonging to the same

4-digit SIC code). I considered depreciation of 20 percent a year. Second, I measured the adjusted number of coopetition experiences by the types of alliance. That is, I calculated the adjusted number of coopetition experiences by multiplying the number of coopetitions with type strength that I discussed above. Coopetition experience is different from repeated ties, which is a key segment of the quality of cooperation. While repeated ties means previous alliances with the same partner, coopetition experience excludes alliances with the same partner if the partner is not a competitor, but includes previous alliances with any competitor-partners. Nonetheless, there is concern about multicollinearity. Therefore, the results of the moderating effects of coopetition experience in the relationship between coopetition (including *tie_coop*) and innovation performance should be interpreted cautiously.

4.2.4.4 Control variables

I controlled for the effects of other variables that may affect patent generation by the focal firms. Based on prior literature, I identified the variables mainly from the characteristics of focal firms themselves and alliance portfolio characteristics. Further, to control specific effects related to this research, I considered pre sample innovation, firm types, and year dummies.

Pre sample innovation. Prior patents capture a firm's technological capabilities (Patel & Pavitt, 1997), R&D spending, a firm's propensity to patent (Trajtenberg, 1990), and the knowledge stock of focal firms that may account for permanent unobserved heterogeneity among the sample firms (Schilling & Phelps, 2007). Following previous research practice (Ahuja & Katila, 2001; Sampson, 2007; Srivastava & Gnyawali, in press), I used the sum of patents obtained by the focal firm during the five years prior to entering the sample.

***Focal firm's sales*.** The literature shows that size provides a number of advantages, such as a larger store of technological knowledge and capabilities (Damanpour, 1991), greater

economies of scale (Cohen & Klepper, 1996), and the resources to tolerate an occasional unsuccessful R&D project (Damanpour, 1991). Sales of a firm may indicate its size (Cohen & Klepper, 1996; Sorensen & Stuart, 2000). Prerior studies used the log value of the focal firm's sales (Hitt, Hoskisson, Johnson, & Moesel, 1996; Mesquita, Anand, & Brush, 2008) or number of employees (Ahuja & Katila, 2001; Hitt et al., 1996) to measure its size. I used the log value of the focal firm's sales**.**

Number of ties. Number of ties represents the portfolio size and its centrality. Previous research reports that a higher degree of centrality benefits firms by bringing more new resources, growth opportunities, and innovation capabilities. Ahuja (2000) reports that in the chemical industry, more direct ties enhanced a firm's patenting rate. I measured direct ties by the sum of a focal firm's alliances in the year that a focal alliance was announced.

Firm age. I measured firm age as the log value of the difference between the year of observation and the year of firm incorporation.

Type of the firm. Considering integrated device manufacturing (IDM) as the basis, I controlled for other types of firm (such as fabless, foundries, testers, and equipment providers) as it may affect their patenting strategies.

Year dummy. Due to citation lag and a result of truncation, more recent patents may have received fewer numbers of citations than patents that were generated earlier (Hall, Jaffe, & Trajtenberg, 2001). By adding year dummies from 1991 to 2003, I controlled for the effects of systemic difference in numbers of citations to the patents year over year.

Table 4.5 lists the dependent and independent variables, their description, and measurement. This table provides a snapshot view of variables and their measurement.

TABLE 4.5: Summary of Description and Measures of Variables

Variables	Description/Measures
Dependent variables	
Coopetition-based innovation output (*Coopetition_innovation*)	The number of citations received from the patents that were successfully filed by the focal firm for three years after the alliance (from t_1 to t_3) and that were categorized as coopetition-based innovation – 1) co-assigned with the partner, 2) citing partner's patents, or 3) overlapped partner's technological domain (in the same technological subcategory)
Overall firm innovation output (*Overall_innovation)*	The number of citations received from the patents that were successfully filed by the focal firm for three years after the alliance (from t_1 to t_3).
Control variables	
Pre sample innovation *(Pre_innovation)*	The number of citations received from the patents that were successfully filed by the focal firm for three years prior to the alliance (from t_{-2} to t_0).
Firm age *(Firm_age)*	Log of firm age (alliance year - incorporation year)
Number of ties *(Num_ties)*	Number of alliances that a focal firm has in the alliance year
Focal firm's sales *(Sales_log)*	The log value of the focal firm's sales (MM $)
Firm type	Type of semiconductor firm
(Type_fabless)	• Type for firm: fabless
(Type_foundry)	• Type for firm: foundry
(Type_tester)	• Type for firm: tester
(Type_equipment)	• Type for firm: semiconductor equipment provider
Year dummy *(Year91~Year03)*	Dummy value (0,1) from 1991 to 2003
Independent variables	
The intensity of technology competition between partners *(Tech_comp)*	Technology competition *(Tech_comp)* is measured by technology similarity based on patent class overlap $\text{Technological similarity} = \frac{FiFj'}{\sqrt{(FiFi')(FjFj')}}$
The intensity of market competition between partners *(Market_comp)*	Market competition *(Market_comp)* is measured by market commonality based on 1) SIC code overlap, 2) firm type overlap, and 3) product market overlap in the same industry
The type-strength of a focal alliance *(Type_coop)*	The type-strength of a focal alliance *(Type_coop)* = (4*R&D + 3*Manufacturing + 2*Cross_licensing + Licensing + Marketing + Tech-Transfer) * JV weight (JV=2; others=1)

Variables	Description/Measures
Independent variables (cont.)	
The strength of ties between partners *(Tie_coop)*	The strength of ties between two firms *(Tie_coop)* = repeated ties + concurrent multiple ties • Repeated ties: Number of previous ties with the same partner; JVs are twice as strong as contracts; 20% depreciation rate a year • Concurrent multiple ties: Number of current linkages with the same partner, except the focal alliance; JVs are twice as strong as contracts
The interplay between competition and cooperation	
The interplay between competition and cooperation	Use a polynomial regression equation • When using negative binomial regression coefficients: *Coopetition-based Innovation (y) = Incident rate* $* e(\beta_1)^{\wedge[competition(x_i) - competition(\bar{x}_i)]} * e(\beta_2)^{\wedge[cooperation(x_j) - cooperation(\bar{x}_j)]} * e(\beta_3)^{\wedge[competition(x_i)\wedge 2 - competition(\bar{x}_i)\wedge 2]} * e(\beta_4)^{\wedge[cooperation(x_j)\wedge 2 - cooperation(\bar{x}_j)\wedge 2]} * e(\beta_5)^{\wedge[competition(x_i)* cooperation(x_j) - competition(\bar{x}_i)* cooperation(\bar{x}_j)]}$ (Incident rate = $\bar{Y}$ + constant. The average value of all controls equals $\bar{Y}$) • When using OLS regression coefficients: *Coopetition-based Innovation (y)* = $\alpha + \beta_1$*Competition + β_2*Cooperation + β_3*Competition^2 + β_4*Cooperation^2 + β_5*Competition*Cooperation. (α = constant + sum of the average values (coefficients *averages) of all controls)
Interactions between competition and cooperation	
Techcomp_ Typecoop	Interplay between technology competition and type strength of a focal alliance: *Tech_comp* x *Type_coop*
Techcomp_ Tiecoop	Interplay between technology competition and tie strength between two firms: *Tech_comp* x *Tie_coop*
Mktcomp_ Typecoop	Interplay between market competition and type strength of a focal alliance: *Market_comp* x *Type_coop*
Mktcomp_ Tiecoop	Interplay between market competition and tie strength between two firms: *Market_comp* x *Tie_coop*
The balanced-strong coopetition at dyadic level (dummy variables)	
Blncstrng_ techcomp_typecoop[1]	Balanced-strong coopetition –1 if *Tech_comp* and *Type_coop* are both over the mean, 0 if not.
Blncstrng_ techcomp_typecoop[2]	Balanced-strong coopetition –1 if *Tech_comp* and *Type_coop* are both over the mean +0.5SD, 0 if not.
Blncstrng_ techcomp_typecoop[3]	Balanced-strong coopetition – 1 if *Tech_comp* and *Type_coop* are both over the mean +1SD, 0 if not.
Blncstrng_ techcomp_tiecoop 1	Balanced-strong coopetition – 1 if Tech_comp and Tie_coop are both over the mean, 0 if not.
Blncstrng_ techcomp_tiecoop 2	Balanced-strong coopetition – 1 if Tech_comp and Tie_coop are both over the mean+0.5SD, 0 if not.
Blncstrng_ techcomp_tiecoop[3]	Balanced-strong coopetition – 1 if *Tech_comp* and *Tie_coop* are both over the mean+1SD, 0 if not.

Variables	Description/Measures
The balanced-strong coopetition at dyadic level (dummy variables) (cont.)	
Blncstrng_ mktcomp_typecoop[1]	Balanced-strong coopetition – 1 if *Market_comp* and *Type_coop* are both over the mean, 0 if not.
Blncstrng_ mktcomp_typecoop[2]	Balanced-strong coopetition – 1 if *Market_comp* is 0.8 and *Type_coop* is over the mean+0.5SD, 0 if not.
Blncstrng_ mktcomp_typecoop[3]	Balanced-strong coopetition – 1 if *Market_comp* is 1 and *Type_coop* is over the mean+1SD, 0 if not.
Blncstrng_ mktcomp_tiecoop[1]	Balanced-strong coopetition – 1 if *Market_comp* and *Tie_coop* are both over the mean, 0 if not.
Blncstrng_ mktcomp_tiecoop[2]	Balanced-strong coopetition – 1 if *Market_comp* is 0.8 and *Tie_coop* is over the mean+0.5SD, 0 if not.
Blncstrng_ mktcomp_tiecoop[3]	Balanced-strong coopetition – 1 if *Market_comp* is 1 and *Tie_coop* is over the mean+1SD, 0 if not.
The balanced-strong coopetition in alliance portfolios	
Port_blncstrng_ techcomp_typecoop[1]	The ratio of balanced-strong coopetition (*Tech_comp* and *Type_coop* are both over the mean) in an alliance portfolio
Port_blncstrng_ techcomp_typecoop[2]	The ratio of balanced-strong coopetition (*Tech_comp* and *Type_coop* are both over the mean+0.5SD) in an alliance portfolio
Port_ blncstrng_ techcomp_typecoop[3]	The ratio of balanced-strong coopetition (*Tech_comp* and *Type_coop* are both over the mean+1SD) in an alliance portfolio
Port_ blncstrng_ techcomp_tiecoop[1]	The ratio of balanced-strong coopetition (*Tech_comp* and *Tie_coop* are both over the mean) in an alliance portfolio
Port_ blncstrng_ techcomp_tiecoop[2]	The ratio of balanced-strong coopetition (*Tech_comp* and *Tie_coop* are both over the mean+0.5SD) in an alliance portfolio
Port_ blncstrng_ techcomp_tiecoop[3]	The ratio of balanced-strong coopetition (*Tech_comp* and *Tie_coop* are both over the mean+1SD) in an alliance portfolio
Port_ blncstrng_ mktcomp_typecoop1	The ratio of balanced-strong coopetition (Market_comp and Type_coop are both over the mean) in an alliance portfolio
Port_ blncstrng_ mktcomp_typecoop2	The ratio of balanced-strong coopetition (Market_comp is 0.8 and Type_coop is over the mean+0.5SD) in an alliance portfolio
Port_ blncstrng_ mktcomp_typecoop3	The ratio of balanced-strong coopetition (Market_comp is 1 and Type_coop is over the mean+1SD) in an alliance portfolio
Port_ blncstrng_ mktcomp_tiecoop1	The ratio of balanced-strong coopetition (Market_comp and Tie_coop are both over the mean) in an alliance portfolio
Port_ blncstrng_ mktcomp_tiecoop2	The ratio of balanced-strong coopetition (Market_comp is 0.8 and Tie_coop is over the mean+0.5SD) in an alliance portfolio
Port_ blncstrng_ mktcomp_tiecoop3	The ratio of balanced-strong coopetition (Market_comp is 1 and Tie_coop is over the mean+1SD) in an alliance portfolio

Variables	Description/Measures
Moderator	
Coopetition experience *(Expn_cooptn_num)*	Focal firm's coopetition experience: the accumulated number of alliances with competitors (partners belonging to the same 4-digit SIC code) to the year prior to the start of the focal alliance • Depreciation of 20 percent a year
Coopetition experience *(Expn_cooptn_adj)*	Focal firm's coopetition experience: the adjusted number of alliances (weighted by *Type_coop*) with competitors (partners belonging to the same 4-digit SIC code)
Interactions of coopetition experience with competition and cooperation	
Expn_techcomp	*Expn_cooptn* x *Tech_comp*
Expn_mktcomp	*Expn_cooptn* x *Market_comp*
Expn_typecoop	*Expn_cooptn x Type_coop*
Expn_tiecoop	*Expn_cooptn* x *Tie_coop*
Thre way interactions	
Expn_techcomp_typecoop	*Expn_cooptn* x *Tech_comp* x *Type_coop*
Expn_techcomp_tiecoop	*Expn_cooptn* x *Tech_comp* x *Tie_coop*
Expn_mktcomp_typecoop	*Expn_cooptn* x *Market_comp* x *Type_coop*
Expn_mktcomp_tiecoop	*Expn_cooptn* x *Market_comp* x *Tie_coop*

4.2.5 Statistical Methods

I tested the hypotheses using two different statistical methods. First, using negative binomial regression, I tested the entire model, including the direct effects of independent variables (the intensities of competition and cooperation) and the balance of competition and cooperation on the dependent variable (coopetition-based innovation) as well as the moderating effects of coopetition capabilities on the relationship between coopetition and coopetition-based innovation. Second, I used polynomial regression that enables researchers to test congruence hypotheses in a more comprehensive way. Using polynomial regression, I tested the direct effects of independent variables and the joint effect of the two independent variables on dependent variable (innovation performance).

Negative binomial regression. The dependent variable, the number of patents for which a focal firm applies in given years, is a count variable. Further, this variable takes only non-negative integer values (Sampson, 2007). Therefore, the linear regression model may not be appropriate (Long & Freese, 2006). A Poisson regression provides a baseline model for such count data but the basic Poisson model makes the strong assumption that there is no heterogeneity in the sample. However, for count data, the variance may often exceed the mean. The presence of such over-dispersion causes standard errors of parameters to be underestimated, resulting in the overstatement of levels of statistical significance. To correct for over-dispersion, a negative binomial regression model can be used. The negative binomial regression model "addresses the failure of the Poisson regression model, by adding a parameter, α, that reflects unobserved heterogeneity among observations" (Long & Freese, 2006:372). The parameter α indicates the degree of dispersion in the predictions. When α is zero, the negative binomial regression model becomes the same as the Poisson regression model. Another advantage of a

negative binomial regression model is that it provides generalization, which allows for heterogeneity on the mean (Hausman, Hall, & Griliches, 1984).

Polynomial regression. To consider both competition and cooperation, this study needs three-dimensional analysis. Therefore, I also used a "polynomial regression" to examine the effects of the balance between competition and cooperation. The formula was:

- When using negative binomial regression coefficients: *Coopetition-based Innovation (y)* = *Incident rate* * $e(\beta_1)^{\wedge[competition(x_i) - competition(\bar{x}_i)]} * e(\beta_2)^{\wedge[cooperation(x_j) - cooperation(\bar{x}_j)]} * e(\beta_3)^{\wedge[competition(x_i)\wedge 2 - competition(\bar{x}_i)\wedge 2]} * e(\beta_4)^{\wedge[cooperation(x_j)\wedge 2 - cooperation(\bar{x}_j)\wedge 2]} * e(\beta_5)^{\wedge[competition(x_i)* cooperation(x_j) - competition(\bar{x}_i)* cooperation(\bar{x}_j)]}$ (Incident rate = $\bar{Y}$ + constant. The average value of all controls equals $\bar{Y}$)
- When using OLS regression coefficients: *Coopetition-based Innovation (y)* = $\alpha + \beta_1$*Competition + β_2*Cooperation + β_3*Competition^2 + β_4*Cooperation^2 + β_5*Competition*Cooperation. (α = constant + sum of the average values (coefficients *averages) of all controls)

For decades, difference scores have been widely used in both micro and macro organizational research (Edwards & Parry, 1993). In most cases, difference scores are used to represent congruence (i.e., fit, match, similarity, or agreement) between two components, which is then viewed as a predictor of some outcome (Edwards & Parry, 1993). To avoid many methodological problems associated with different scores, scholars (e.g., Edwards, 2002; Edwards & Parry, 1993) suggest using a polynomial regression equation containing the component measures as an alternative procedure.

Edwards (2002: 391-392) argues that polynomial regression analysis has several advantages. First, polynomial regression circumvents problems of reduced reliability created

when component measures are subtracted from one another. Second, by using component measures in their original form, polynomial regression avoids ambiguities that result when the component measures are reduced to a single score. Third, whereas different scores confound the effects of their components, polynomial regression allows comprehensive assessment of the separate and joint effects of the components. Finally, polynomial regression preserves the inherently three-dimensional relationship between the components and the outcome, thereby enabling researchers to develop and test congruence hypotheses that are more comprehensive and complex than the simplified models implied by difference scores.

I reported both 1) the regression tables including interaction terms of competition and cooperation and 2) the figures portrayed in terms of quadratic regression equations of the interplay between competition and cooperation and their corresponding three dimensional response surfaces. I examined both the regression coefficients and the shape of the figures to test the hypotheses. Despite the advantages of polynomial equations, the interpretative difficulties prevent the widespread use of polynomial regression equations in the study (Edwards, 2002). To overcome the interpretative difficulties, scholars (e.g., Edwards, 2002) suggest using the response surface methodology, which provides a framework for testing and interpreting polynomial regression equations. Based on the response surface methodology, I focused on two features of surfaces: 1) stationary point (i.e., the point at which the slope of the surface is 0 in all directions), and 2) the slope of the surface along various lines of interest.

5.0 RESULTS AND ANALYSIS

In this chapter, I discuss the test results of the hypotheses described in Chapter 4. As mentioned in the previous chapter, I primarily used negative binomial regression to test the effects of coopetition and coopetition capability on innovation performance. To further investigate the relationships that some hypotheses expect, I additionally used polynomial regression that gives more concrete pictures of the relationships. Following the results of the hypothesis testing by quantitative analysis, the last section (section 5.7) provides the findings of the qualitative empirical research that provide illustrative support for several hypotheses, including hypotheses 4b and 4c.

5.1 Descriptive Statistics (Sample Characteristics)

Table 5.1 reports the means, standard deviation, and minimum and maximum values of all the variables for the sample alliances. Table 5.2 reports the Pearson correlation among all the variables. Table 5.3 reports the Pearson correlation among the variables in alliance portfolio level. The asterisk in Tables 5.2 and 5.3 indicates that the Pearson correlation coefficient is significant at the 0.05 or lower level. Refer to Table 4.5 (in section 4.2.4) that describes the variables used to test the hypotheses.

In this study, I provided a new measure of innovation performance – coopetition-based innovation. I measured the coopetition-based innovation performance as the sum of the citations received by the focal firm's patents in three categories: 1) co-assigned patents, 2) patents citing the partner's patents, and 3) patents in the same subclasses as the partner's patents. In the hypothesis testing and analysis, I primarily used the new measure of innovation performance –

coopetition-based innovation[15].

Model 0 in Table 5.4 is the base model that shows the effects of only control variables with a one-year lag. Like previous studies, I input sales, firm age, number of ties, and pre-sample patents as primary control variables. The effects of sales and pre-sample patents on the innovation output are positive and significant. In this study, I input additional control variables or excluded a typical control variable as follows. First, I input year dummies from 1991 through 2003 to control for the effects of the systemic difference in citations year over year.[16]. The coefficients of year dummies in the base model (model 0) clearly show that there are significant effects from the timing of patent. While there are significant positive effects from 1991 to 1993, there are significant negative effects from 1998 to 2003. The effects of the period from 1994 to 1997 are not significant. Year dummy variables were included in all regression tables but I only presented year dummy variables in Tables 5.4 and 5.5 and did not present them for the models in other tables to save space.

Second, I added firm type (such as fabless, foundries, and testers) as a control because firms with different types may differ in their patenting strategies. Among the firm types, the effect of a semiconductor equipment provider on innovation is negative and significant. Third, I excluded R&D from the control list because sales and R&D were highly correlated and there were many missing values on R&D. Correlations among control variables are still high. However, high correlation between control variables does not influence estimates of the independent variables (Wooldridge, 2009: 98).

Finally, adjusted the standard errors for focal firms' multiple alliances. Sampson (2005)

[15] To ensure this measure is appropriate, I compared it with overall innovation performance which was a typical measure used in the literature (refer to Appendix A). Results reported were based on this measure (*Coopetition_innovation*).

[16] Hall et al. (2001) observed the decline in the number of citations received in recent years, which is a result of truncation. Thus, truncation reinforces the need to use appropriate controls for the timing of citations.

noted that, when a firm is involved in multiple alliances during the same period, not all errors are independent. To correct for the lack of independence between observations involving the same firm, Sampson (2005) used a technique that creates a super observation. Following the technique (using cluster command in stata), I adjusted standard errors to address the correlation among observations issue as there are repeated observations for many firms. Thus, standard errors were adjusted for 118 clusters based on focal firms.

I discuss four kinds of coopetition based on the combinations of two kinds of competition – technology competition (*Tech_comp*) and market competition (*Market_comp*) – and two kinds of cooperation – a cooperative type of a focal alliance (*Type_coop*) and overall cooperation between two partners beyond the focal alliance (*Tie_coop*). As I noted in section 4.2.4.2, *Tech_comp* captures the competition in upstream activities, while *Market_comp* captures the competition in downstream activities. Further, *Type_coop* captures the cooperation in a focal alliance, while *Tie_coop* captures the overall cooperation (beyond the focal alliance) between two firms. Even though I used different kinds of competition and cooperation, I expected the effects of the two types of competition (and the effects of the two types of cooperation) would be similar and did not develop separate hypotheses for each type of competition and cooperation. Different from my expectations, however, there are low correlations between competition measures (correlation between *Tech_comp* and *Market_comp:* 0.18) and between cooperation measures (correlation between *Type_coop* and *Tie_coop:* 0.02). This lack of strong correlation between related measures causes concern about construct validity of one or both of them.

In the following sections, I first discuss the effects of competition (H1) and cooperation (H2) on coopetition-based innovation,b then the effects of the balance between competition and cooperation both at the dyadic level (H3a) and at the alliance portfolio level (H3b), and finally the

moderating role of coopetition capabilities in the relationship between coopetition and innovation performance (H4).

TABLE 5.1: Summary Statistics of Variables

	Variable	Num	Mean	Std. Dev.	Min.	Max.
1	*Coopetition_innovation*	1930	3856.99	7218.60	0	46909
2	*Overall_innovation*	1930	10031.36	12548.09	0	58348
3	*Pre_innovation*	1930	10935.22	12485.92	0	57370
4	*Firm-age*	1930	3.00	0.87	0	4.29
5	*Num_ties*	1930	15.42	14.95	1	51
6	*Sales_log*	1930	7.35	2.24	0	10.43
7	*Type_fabless*	1930	0.13	0.33	0	1
8	*Type_foundry*	1930	0.04	0.20	0	1
9	*Type_tester*	1930	0.01	0.11	0	1
10	*Type_equipment*	1930	0.04	0.18	0	1
11	*YEAR91*	1930	0.09	0.28	0	1
12	*YEAR92*	1930	0.09	0.28	0	1
13	*YEAR93*	1930	0.10	0.30	0	1
14	*YEAR94*	1930	0.10	0.30	0	1
15	*YEAR95*	1930	0.07	0.26	0	1
16	*YEAR96*	1930	0.07	0.26	0	1
17	*YEAR97*	1930	0.08	0.27	0	1
18	*YEAR98*	1930	0.07	0.26	0	1
19	*YEAR99*	1930	0.08	0.26	0	1
20	*YEAR00*	1930	0.05	0.22	0	1
21	*YEAR01*	1930	0.03	0.18	0	1
22	*YEAR02*	1930	0.06	0.24	0	1
23	*YEAR03*	1930	0.06	0.24	0	1
24	*Tech_comp*	1930	0.43	0.43	0	1
25	*Market_comp*	1930	0.37	0.37	0	1
26	*Type_coop*	1930	6.96	3.55	3	20
27	*Tie_coop*	1930	2.40	7.14	0	56.2
28	$Expn\_cooptn_{\_num}$	1930	2.97	2.86	0	11.3
29	$Expn\_cooptn_{\_adj}$	1930	36.13	37.02	0	141.4
30	$Blncstrng\_techcomp\_typecoop^{1}$	1930	0.27	0.45	0	1
31	$Blncstrng\_techcomp\_typecoop^{2}$	1930	0.07	0.25	0	1
32	$Blncstrng\_techcomp\_typecoop^{3}$	1930	0.02	0.15	0	1
33	$Blncstrng\_techcomp\_tiecoop^{1}$	1930	0.16	0.36	0	1
34	$Blncstrng\_techcomp\_tiecoop^{2}$	1930	0.09	0.29	0	1
35	$Blncstrng\_techcomp\_tiecoop^{3}$	1930	0.05	0.22	0	1
36	$Blncstrng\_mktcomp\_typecoop^{1}$	1930	0.24	0.42	0	1

	Variable	Num	Mean	Std. Dev.	Min.	Max.
37	*Blncstrng _mktcomp_typecoop*^{2}	1930	0.04	0.21	0	1
38	*Blncstrng _mktcomp_typecoop*^{3}	1930	0.01	0.09	0	1
39	*Blncstrng _mktcomp_tiecoop*^{1}	1930	0.09	0.28	0	1
40	*Blncstrng _mktcomp_tiecoop*^{2}	1930	0.02	0.15	0	1
41	*Blncstrng _mktcomp_tiecoop*^{3}	1930	0.00	0.00	0	0
42	*Techcomp_typecoop*	1930	0.02	1.51	-4.8	6.24
43	*Techcomp_tiecoop*	1930	0.89	3.44	-5.22	26.27
44	*Mktcomp_typecoop*	1930	0.00	1.25	-4.13	6.92
45	*Mktcomp_tiecoop*	1930	-0.30	2.19	-20.1	6.22
46	*Expn_techcomp*	1930	0.14	1.22	-3.62	4.68
47	*Expn_mktcomp*	1930	-0.21	1.00	-3.11	5.22
48	*Expn_ typecoop*	1930	0.24	6.06	-20.92	27.58
49	*Expn_ tiecoop*	1930	4.03	20.68	-123.96	203.82
50	*Expn_ techcomp_typecoop*	1930	0.18	4.22	-26.07	33.22
51	*Expn_ techcomp_tiecoop*	1930	1.46	10.37	-64.86	100.71
52	*Expn_ mktcomp_typecoop*	1930	0.19	3.59	-22.41	37.56
53	*Expn_ mktcomp_tiecoop*	1930	-0.59	6.33	-76.16	21.53
54	*Port_blncstrng_techcomp_typecoop*^{1}	475	0.19	0.32	0	1
55	*Port_blncstrng_techcomp_typecoop*^{2}	475	0.05	0.18	0	1
56	*Port_blncstrng_techcomp_typecoop*^{3}	475	0.01	0.07	0	1
57	*Port_ blncstrng_techcomp_tiecoop*^{1}	475	0.06	0.17	0	1
58	*Port_ blncstrng_techcomp_tiecoop*^{2}	475	0.02	0.09	0	1
59	*Port_ blncstrng_techcomp_tiecoop*^{3}	475	0.01	0.05	0	0.5
60	*Port_blncstrng_mktcomp_typecoop*^{1}	475	0.25	0.36	0	1
61	*Port_blncstrng_mktcomp_typecoop*^{2}	475	0.06	0.2	0	1
62	*Port_blncstrng_mktcomp_typecoop*^{3}	475	0.0	0.03	0	0.5
63	*Port_blncstrng_mktcomp_tiecoop*^{1}	475	0.06	0.17	0	1
64	*Port_blncstrng_mktcomp_tiecoop*^{2}	475	0.02	0.1	0	1
65	*Port_blncstrng_mktcomp_tiecoop*^{3}	475	0.0	0.0	0	0

TABLE 5.2: Correlation Matrix (Pearson Product Moment Correlation)

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1	*Coopetition_innovation*	1.00																			
2	*Overall_innovation*	0.66*	1.00																		
3	*Pre_innovation*	0.48*	0.74*	1.00																	
4	*Firm-age*	0.26*	0.45*	0.56*	1.00																
5	*Num_ties*	0.47*	0.72*	0.76*	0.50*	1.00															
6	*Sales_log*	0.35*	0.54*	0.70*	0.55*	0.69*	1.00														
7	*Type_fabless*	-0.19*	-0.29*	-0.32*	-0.38*	-0.30*	-0.49*	1.00													
8	*Type_foundry*	-0.08*	-0.12*	-0.11*	-0.18*	-0.12*	-0.07*	-0.08*	1.00												
9	*Type_tester*	-0.05*	-0.08*	-0.09*	0.001	-0.09*	-0.01	-0.04	-0.02	1.00											
10	*Type_equipment*	-0.10*	-0.15*	-0.16*	-0.02	-0.15*	-0.07*	-0.07*	-0.04	-0.02	1.00										
11	*Tech_comp*	0.40*	0.14*	0.14*	0.03	0.15*	0.18*	-0.04	-0.04	-0.03	-0.09*	1.00									
12	*Market_comp*	-0.004	-0.15*	-0.20*	-0.19*	-0.23*	-0.20*	0.08*	0.08*	0.10*	-0.06*	0.18*	1.00								
13	*Type_coop*	0.10*	0.08*	0.06*	0.04	0.03	-0.02	-0.02	-0.08*	-0.03	0.05*	0.02	0.004	1.00							
14	*Tie_coop*	0.44*	0.27*	0.24*	0.12*	0.35*	0.22*	-0.11*	-0.03	-0.04	-0.06*	0.29*	-0.12*	0.02	1.00						
15	*Expn_cooptn_num*	0.25*	0.41*	0.67*	0.49*	0.64*	0.67*	-0.32*	-0.04	-0.07*	-0.17*	0.11*	-0.20*	-0.01	0.20*	1.00					
16	*Expn_cooptn_adj*	0.25*	0.40*	0.71*	0.49*	0.69*	0.67*	-0.31*	-0.08*	-0.08*	-0.16*	0.12*	-0.21*	-0.03	0.22*	0.98*	1.00				
17	*Blncstrng_techcomp_typecoop*[1]	0.35*	0.17*	0.11*	0.08*	0.11*	0.12*	-0.09*	-0.04	-0.01	-0.05*	0.60*	0.09*	0.40*	0.24*	0.08*	0.06*	1.00			
18	*Blncstrng_techcomp_typecoop*[2]	0.17*	0.05*	0.06*	0.07*	0.02	0.04	-0.04	-0.04	-0.01	-0.02	0.28*	0.06*	0.49*	0.08*	0.03	0.02	0.44	1.00		
19	*Blncstrng_techcomp_typecoop*[3]	0.19*	0.10*	0.15*	0.08*	0.08*	0.10*	-0.06*	-0.03	-0.02	-0.03	0.19*	0.02	0.42*	0.12*	0.08*	0.07*	0.26*	0.58*	1.00	
20	*Blncstrng_ techcomp_tiecoop*[1]	0.40*	0.20*	0.19*	0.06*	0.27*	0.21*	-0.11*	-0.01	-0.05*	-0.08*	0.46*	0.05*	0.05*	0.64*	0.19*	0.19*	0.38*	0.14*	0.15*	1.00
21	*Blncstrng_ techcomp_tiecoop*[2]	0.46*	0.24*	0.22*	0.10*	0.30*	0.21*	-0.11*	-0.03	-0.03	-0.06*	0.36*	-0.04	0.03	0.74*	0.19*	0.21*	0.28*	0.11*	0.15*	0.74*
22	*Blncstrng_ techcomp_tiecoop*[3]	0.41*	0.23*	0.22*	0.11*	0.29*	0.20*	-0.09*	-0.05*	-0.03	-0.04	0.29*	-0.13*	0.02	0.80*	0.19*	0.21*	0.21*	0.10*	0.13*	0.54*
23	*Blncstrng_mktcomp_typecoop*[1]	0.03	-0.08*	-0.11*	-0.09*	-0.12*	-0.10*	0.04	0.02	0.03	-0.03	0.11*	0.51*	0.35*	-0.04	-0.11*	-0.12*	0.38*	0.19*	0.09*	0.07*
24	*Blncstrng_mktcomp_typecoop*[2]	0.01	-0.05*	-0.05*	-0.05*	-0.07*	-0.09*	0.05*	-0.02	0.000	0.000	0.03	0.30*	0.34*	-0.04	-0.06*	-0.06*	0.14*	0.36*	0.21*	0.003
25	*Blncstrng_mktcomp_typecoop*[3]	0.05*	0.01	0.04	0.04	0.03	0.03	0.001	-0.02	0.04	0.01	0.04	0.16*	0.26*	-0.02	0.03	0.02	0.09*	0.22*	0.28*	0.01
26	*Blncstrng _mktcomp_tiecoop*[1]	0.15*	0.01	-0.01	-0.06*	0.04	0.05*	-0.07*	0.03	-0.03	-0.06*	0.24*	0.30*	0.01	0.21*	0.02	0.01	0.19*	0.07*	0.06*	0.59*
27	*Blncstrng _mktcomp_tiecoop*[2]	0.09*	0.02	-0.02	-0.03	0.02	0.001	-0.05*	0.04	-0.02	-0.03	0.13*	0.23*	-0.02	0.13*	0.005	-0.01	0.08*	0.03	0.02	0.31*
28	*Blncstrng _mktcomp_tiecoop*[3]	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
29	*Techcomp_typecoop*	0.10*	0.06*	0.06*	0.10*	0.003	0.06*	-0.08*	0.03	0.04	-0.04	-0.01	-0.02	-0.01	0.03	0.04	0.03	0.37*	0.51*	0.50*	0.05*
30	*Techcomp_tiecoop*	0.37*	0.21*	0.19*	0.09*	0.27*	0.17*	-0.08*	-0.03	-0.02	-0.03	0.08*	-0.14*	0.03	0.89*	0.15*	0.17*	0.11*	0.03	0.09*	0.54*
31	*Mktcomp_typecoop*	-0.01	-0.03	0.03	0.05*	0.03	0.05*	0.01	-0.02	-0.02	0.001	-0.02	-0.07*	-0.07*	-0.01	0.05*	0.06*	0.05*	0.06*	0.06*	-0.03
32	*Mktcomp_tiecoop*	-0.24*	-0.17*	-0.13*	-0.04	-0.19*	-0.10*	0.02	0.01	-0.03	0.05*	-0.19*	-0.09*	-0.02	-0.72*	-0.09*	-0.11*	-0.14*	-0.05*	-0.08*	-0.27*

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
33	*Expn_techcomp*	0.12*	-0.03	0.003	-0.01	0.02	-0.06*	0.01	-0.02	0.01	0.05*	0.03	-0.06*	0.04	0.17*	0.02	0.04	0.02	0.002	0.07*	0.16*
34	*Expn_mktcomp*	0.04	-0.02	-0.10*	0.01	-0.09*	-0.07*	0.02	-0.01	-0.04	0.10*	-0.06*	-0.09*	0.05*	-0.08*	-0.13*	-0.15*	-0.04	0.002	0.01	-0.07*
35	*Expn_ typecoop*	0.11*	0.14*	0.06*	0.08*	0.01	0.04	-0.05*	-0.02	0.04	0.002	0.08*	0.01	0.15*	0.03	0.11*	0.06*	0.22*	0.10*	0.14*	0.07*
36	*Expn_ tiecoop*	0.18*	0.03	0.09*	-0.02	0.11*	0.05*	0.02	-0.04*	0.004	0.01	0.17*	-0.08*	-0.02	0.63*	0.05*	0.10*	0.07*	0.05*	0.07*	0.36*
37	*Expn_techcomp_typecoop*	0.03	0.02	0.01	-0.04	-0.01	-0.04	0.06*	-0.01	-0.04	0.02	-0.02	-0.02	0.25*	-0.03	0.01	-0.01	0.07*	0.14*	0.27*	0.002
38	*Expn_ techcomp_tiecoop*	0.23*	0.14*	0.25*	0.10*	0.25*	0.22*	-0.07*	-0.03	-0.02	-0.04	0.22*	-0.11*	-0.02	0.62*	0.27*	0.31*	0.11*	0.06*	0.08*	0.38*
39	*Expn_ mktcomp_typecoop*	-0.03	-0.03	0.03	-0.01	0.04	0.03	-0.03	0.01	0.01	-0.02	-0.02	0.04	-0.14*	0.005	0.03	0.05*	-0.11*	-0.09*	-0.06*	-0.02
40	*Expn_ mktcomp_tiecoop*	-0.18*	-0.11*	-0.18*	-0.06*	-0.20*	-0.14*	0.06*	0.01	0.03	0.004	-0.15*	0.17*	0.01	-0.65*	-0.15*	-0.19*	-0.07*	-0.03	-0.07*	-0.34*

		21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39
25	*Blncstrng_ techcomp_tiecoop*^{2}	1.00																		
26	*Blncstrng_ techcomp_tiecoop*^{3}	0.73*	1.00																	
27	*Blncstrng_mktcomp_typecoop*^{1}	-0.01	-0.05*	1.00																
28	*Blncstrng_mktcomp_typecoop*^{2}	-0.03	-0.02	0.39*	1.00															
29	*Blncstrng_mktcomp_typecoop*^{3}	-0.01	-0.02	0.16*	0.42*	1.00														
30	*Blncstrng _mktcomp_tiecoop*^{1}	0.31*	0.08*	0.28*	0.08*	0.03	1.00													
31	*Blncstrng _mktcomp_tiecoop*^{2}	0.38*	0.04	0.12*	0.05*	0.02	0.50*	1.00												
32	*Blncstrng _mktcomp_tiecoop*^{3}	.	.	.	.	.	.	.	.											
33	*Techcomp_typecoop*	0.03	0.03	0.05*	0.03	0.09*	0.02	-0.02	.	1.00										
34	*Techcomp_tiecoop*	0.69*	0.81*	-0.05*	-0.03	-0.02	0.10*	0.06*	.	0.03	1.00									
35	*Mktcomp_typecoop*	-0.03	0.000	0.35*	0.50*	0.45*	-0.02	-0.04	.	0.16*	-0.01	1.00								
36	*Mktcomp_tiecoop*	-0.39*	-0.58*	-0.02	-0.03	-0.02	0.22*	0.25*	.	-0.02	-0.65*	0.02	1.00							
37	*Expn_techcomp*	0.19*	0.20*	-0.06*	-0.01	0.02	-0.03	0.004	.	-0.02	0.20*	-0.02	-0.14*	1.00						
38	*Expn_mktcomp*	-0.05*	-0.07*	0.001	-0.03	0.07*	0.03	0.03	.	-0.02	-0.06*	0.04	0.15*	0.17*	1.00					
39	*Expn_ typecoop*	0.06*	0.01	-0.01	-0.04	0.07*	0.02	0.004	.	0.15*	0.01	-0.13*	-0.02	0.12*	0.06*	1.00				
40	*Expn_ tiecoop*	0.47*	0.58*	-0.06*	-0.02	-0.02	-0.03	-0.02	.	-0.03	0.60*	0.01	-0.62*	0.30*	-0.09*	0.01	1.00			
41	*Expn_techcomp_typecoop*	-0.02	-0.04	0.01	0.04	0.08*	0.02	-0.01	.	0.10*	-0.03	-0.05*	0.04	-0.10*	-0.05*	0.05*	-0.06*	1.00		
42	*Expn_ techcomp_tiecoop*	0.49*	0.62*	-0.07*	-0.03	-0.01	-0.02	0.001	.	-0.02	0.63*	0.02	-0.59*	0.11*	-0.14*	-0.01	0.88*	-0.05*	1.00	
43	*Expn_ mktcomp_typecoop*	-0.01	0.01	-0.08*	-0.06*	0.17*	-0.01	-0.01	.	-0.05*	0.01	0.04	-0.02	-0.06*	-0.08*	-0.13*	0.01	0.11*	0.04	1.00
44	*Expn_ mktcomp_tiecoop*	-0.43*	-0.52*	0.09*	0.06*	0.000	0.03	0.02	.	0.03	-0.61*	-0.03	0.66*	-0.21*	-0.08*	-0.01	-0.76*	0.07*	-0.72*	-0.03

TABLE 5.3: Correlation Matrix (Pearson Product Moment Correlation) in Alliance Portfolio Level Data

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1	*Coopetition_innovation*	1.00																			
2	*Overall_innovation*	0.85*	1.00																		
3	*Pre_innovation*	0.66*	0.78*	1.00																	
4	*Firm-age*	0.16*	0.24*	0.35*	1.00																
5	*Num_ties*	0.48*	0.50*	0.50*	0.27*	1.00															
6	*Sales_log*	0.36*	0.42*	0.53*	0.39*	0.44*	1.00														
7	*Type_fabless*	-0.18*	-0.19*	-0.21*	-0.32*	-0.17*	-0.34*	1.00													
8	*Type_foundry*	0.004	-0.01	-0.02	-0.15*	-0.01	0.05	-0.13*	1.00												
9	*Type_tester*	-0.04	-0.05	-0.05	0.04	-0.05	0.10*	-0.09	-0.03	1.00											
10	*Type_equipment*	-0.09	-0.09*	-0.10*	0.13*	-0.08	0.004	-0.16*	-0.06	-0.04	1.00										
11	*Port_ blncstrng_ techcomp_typecoop*[1]	0.22*	0.14*	0.11*	0.11*	0.15*	0.14*	-0.10*	-0.05	0.004	-0.02	1.00									
12	*Port_ blncstrng_ techcomp_typecoop*[2]	0.09	0.04	0.03	0.11*	0.05	0.04	-0.07	-0.04	-0.03	-0.04	0.53	1.00								
13	*Port_ blncstrng_ techcomp_typecoop*[3]	0.20*	0.15*	0.15*	0.09*	0.12*	0.07	-0.09	-0.03	-0.02	-0.04	0.30*	0.43*	1.00							
14	*Port_ blncstrng_ techcomp_tiecoop*[1]	0.24*	0.20*	0.19*	0.03	0.34*	0.22*	-0.12*	0.04	-0.06	-0.10*	0.36*	0.18*	0.18*	1.00						
15	*Port_ blncstrng_ techcomp_tiecoop*[2]	0.30*	0.27*	0.23*	0.09*	0.44*	0.17*	-0.11*	0.01	-0.04	-0.07	0.26*	0.14*	0.33*	0.62*	1.00					
16	*Port_ blncstrng_ techcomp_tiecoop*[3]	0.31*	0.29*	0.27*	0.17*	0.52*	0.21*	-0.11*	-0.04	-0.03	-0.05	0.20*	0.15*	0.26*	0.38*	0.69*	1.00				
17	*Port_ blncstrng_ mktcomp_typecoop*[1]	0.03	-0.02	-0.03	-0.04	-0.02	-0.04	0.00	0.08	0.09*	-0.05	0.50*	0.26*	0.18*	0.17*	0.07	0.04	1.00			
18	*Port_ blncstrng_ mktcomp_typecoop*[2]	0.02	0.00	-0.04	0.01	-0.05	-0.08	-0.01	-0.03	-0.03	-0.02	0.22*	0.40*	0.31*	0.02	0.07	0.08	0.48	1.00		
19	*Port_ blncstrng_ mktcomp_typecoop*[3]	0.15*	0.12*	0.11*	0.09	0.11*	0.09*	-0.04	-0.02	0.08	0.003	0.15*	0.23*	0.41*	0.11*	0.22*	0.002	0.05	0.12*	1.00	
20	*Port_ blncstrng_ mktcomp_tiecoop*[1]	0.09*	0.06	0.06	-0.07	0.10*	0.10*	-0.11*	0.14*	-0.05	-0.09*	0.26*	0.16*	0.13*	0.80*	0.43*	0.21*	0.25*	0.08	0.09	1.00
21	*Port_ blncstrng_ mktcomp_tiecoop*[2]	0.04	0.02	-0.01	-0.05	0.03	0.004	-0.09*	0.21*	-0.03	-0.05	0.14*	0.12*	0.23*	0.34*	0.54*	0.34*	0.18*	0.07	0.17*	0.60*
22	*Port_ blncstrng_ mktcomp_tiecoop*[3]	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.

5.2 The Role of Competition between Partners in Innovation

Hypothesis 1 predicts that the intensity of competition between partners will have an inverted U-shaped relationship with a focal firm's coopetition-based innovation performance. To test this hypothesis, I first calculated the technology competition based on the overlap of patent class between partners. To calculate the market competition, I considered three factors: 1) SIC code overlap, 2) overlap of the type of firm, and 3) the product market overlap.

Table 5.4 introduces the effects of competition between partners on coopetition-based innovation. Model 1 shows the effects of technology competition (*Tech_comp*) on coopetition-based innovation (*Coopetition_innovation*), while model 2 shows the effects of market competition (*Market_comp*). Figures 5.1 and 5.2 present the effects of competition (*Tech_comp* and *Market_comp*) on *Coopetition_innovation*, based on models 1b and 2b, respectively. As the results show, the hypothesis is only partially supported in terms of market competition (model 2b, Figure 5.2). The relationship between market competition and coopetition-based innovation shows an inverted-U shape. That is, *Market_comp* has a positive and significant relationship with *Coopetition_innovation*, while the squared term of market competition, *Market_comp*$^{\wedge 2}$, has a negative and significant relationship with *Coopetition_innovation* at the 0.001 level. However, the effects of *Tech_comp* are positive and significant instead of being an inverted-U relationship with *Coopetition_innovation* (model 1b, Figure 5.1).

The results imply that two different types of competition may explain two countervailing arguments and empirical reports in the literature on the effects of competition between partners on innovation performance. From the market competition perspective, two different countervailing forces – learning potential and competitive tension – play together. As the intensity of competition increases, the positive effects of learning potential increases but the negative effects

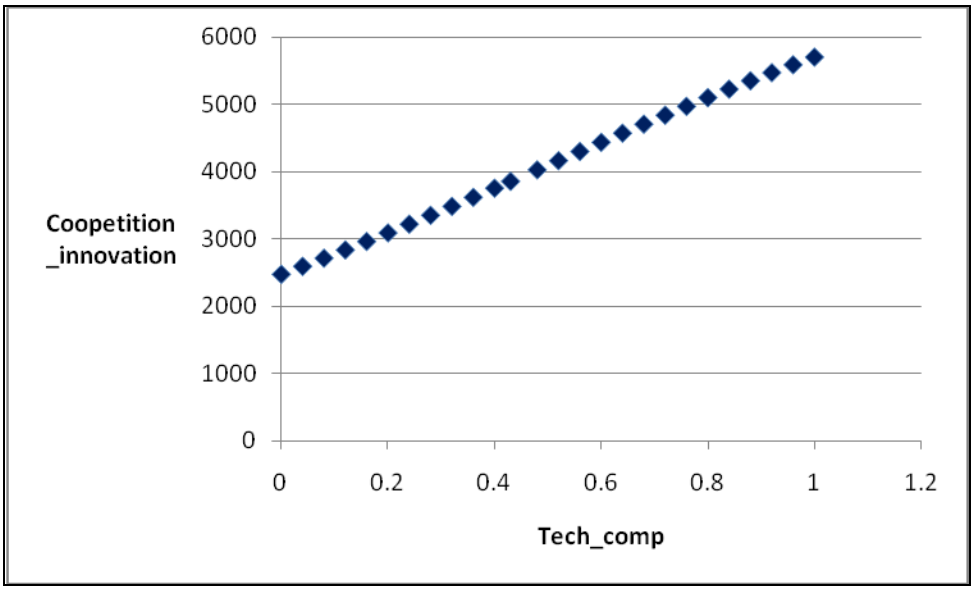
of competitive tension on innovation performance become dominant beyond a certain point.

TABLE 5.4: The Role of Competition between Partners in Coopetition-Based Innovation

Variables	Model 0	Model 1	Model 1b	Model 2	Model 2b
Pre_innovation	0.000055 (0.000016) ***		0.000054 (0.000015) ***		0.000051 (0.000016) **
Firm-age	-0.29** (0.11)		-0.21* (0.10)		-0.27* (0.11)
Num_ties	-0.01 (0.01)		-0.00 (0.01)		-0.00 (0.01)
Sales_log	0.50*** (0.07)		0.39*** (0.07)		0.50*** (0.07)
Type_fabless	-0.28 (0.38)		-0.57+ (0.34)		-0.36 (0.37)
Type_foundry	0.19 (0.25)		0.21 (0.25)		0.10 (0.25)
Type_tester	-0.06 (0.38)		0.01 (0.32)		-0.31 (0.39)
Type_equipment	-1.49** (0.46)		-1.07* (0.44)		-1.32** (0.49)
Year91	0.54** (0.18)		0.25 (0.20)		0.44* (0.18)
Year92	0.71*** (0.20)		0.42+ (0.23)		0.60** (0.20)
Year93	0.67** (0.21)		0.26 (0.20)		0.61** (0.19)
Year94	0.25 (0.25)		0.14 (0.25)		0.18 (0.23)
Year95	-0.27 (0.30)		-0.61* (0.26)		-0.30 (0.28)
Year96	-0.67* (0.27)		-0.95*** (0.26)		-0.76** (0.26)
Year97	-0.55+ (0.34)		-0.93** (0.30)		-0.58+ (0.34)
Year98	-1.03** (0.35)		-1.25*** (0.31)		-1.04** (0.39)
Year99	-1.19*** (0.32)		-1.30*** (0.36)		-1.17** (0.36)
Year00	-1.80*** (0.18)		-2.00*** (0.19)		-1.88*** (0.21)
Year01	-3.09*** (0.27)		-3.10*** (0.25)		-3.11*** (0.23)
Year02	-3.76*** (0.30)		-4.01*** (0.26)		-3.84*** (0.29)
Year03	-6.43*** (0.33)		-6.53*** (0.29)		-6.48*** (0.31)
Tech_comp		1.993*** (0.15)	1.814*** (0.14)		
Tech_comp^2		1.526* (0.69)	-0.347 (0.61)		
Market_comp				0.240 (0.44)	0.949*** (0.17)
Market_comp^2				-0.929 (0.83)	-0.897* (0.45)
Constant	4.52*** (0.46)	6.76*** (0.28)	4.35*** (0.46)	8.29*** (0.31)	4.24*** (0.48)
Lnalpha	1.22*** (0.10)	1.63*** (0.12)	1.08*** (0.10)	1.73*** (0.12)	1.20*** (0.10)
Number of alliances	1930	1930	1930	1930	1930
Number of firms	118	118	118	118	118
Log likelihood	-13968.83	-14464.46	-13811.87	-14588.05	-13949.18
Degrees of freedom	21	2	23	2	23
Wald chi square	4902.26	342.10	7784.69	2.92	6411.54

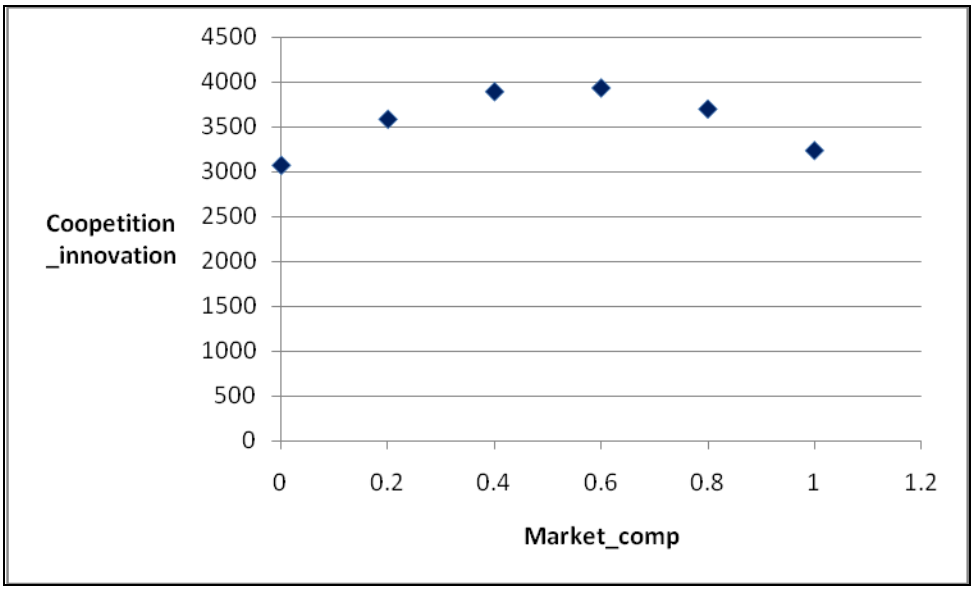
Standard errors in parentheses, + p<0.1 * p<0.05 ** p<0.01 *** p<0.001

FIGURE 5.1
The Relationship between *Tech_comp* and *Coopetition_innovation*



*Based on model 2b in Table 5.4.

FIGURE 5.2
The Relationship between *Market_comp* and *Coopetition_innovation*



*Based on model 3b in Table 5.4.

5.3 The Role of Cooperation between Partners in Innovation

Hypothesis 2 predicts that the intensity of cooperation between partners will positively affect the focal firm's coopetition-based innovation performance. To test this hypothesis, I first calculated the type strength of a focal coopetition (*Type_coop*) based on alliance types. The tie strength between two firms (*Tie_coop*) was calculated using repeated ties and concurrent linkages between partners. Table 5.5 reports the test results for this hypothesis. Models 3 and 3b capture the effects of *Type_coop* on coopetition-based innovation (*Coopetition_innovation*), while models 4 and 4b show the effects of *Tie_coop* on *Coopetition_innovation*. As the results show, this hypothesis is supported as the coefficients of the cooperative variables are positive and significant at the 0.001 or lower level in models 3b (*Type_coop*) and 4b (*Tie_coop*).

Even though Hypothesis 2 is supported, I additionally tested to determine if there is a non-linear relationship between the intensity of cooperation and coopetition-based innovation, which appears at the network level. Figures 5.3 and 5.4 present the effects of cooperation (*Type_coop* and *Tie_coop*) on *Coopetition_innovation*, based on models 5b and 6b, respectively. As Table 5.5b shows, only direct effects of *Type_coop* are significant (model 5b), even though the squared term of the variable (*Type_coop*$^{\wedge 2}$) has a negative and significant effect without controls (model 5). However, I found that there is an inverted-U relationship between *Tie_coop* and *Coopetition_innovation* (model 6b, Figure 5.4). The intensity of *Tie_coop* has a positive and significant relationship with *Coopetition_innovation* while the squared term of the variable (*Tie_coop*$^{\wedge 2}$) has a negative and significant relationship with *Coopetition_innovation* at the 0.001 level.

There may be two plausible reasons for the non-linear relationship. First, this result supports Uzzi's (1997) notion of 'over-embeddedness' at the dyadic level. That is, ties that are too strong (many relationships with the same partners) limit the number of new ideas that are

critical for innovation. Second, relationships that are too strong with certain partners may deter the focal firm from changing to meet the new demands of new environments.

TABLE 5.5: The Role of Cooperation between Partners in Coopetition-Based Innovation

Variables	Model3	Model3b	Model4	Model4b
Pre_innovation		0.000054 (0.000017) **		0.000056 (0.000016) ***
Firm-age		-0.30** (0.11)		-0.27* (0.11)
Num_ties		-0.01 (0.01)		-0.02 (0.01)
Sales_log		0.52*** (0.07)		0.50*** (0.07)
Type_fabless		-0.19 (0.37)		-0.25 (0.37)
Type_foundry		0.24 (0.25)		0.19 (0.26)
Type_tester		-0.12 (0.37)		-0.06 (0.38)
Type_equipment		-1.59*** (0.44)		-1.47** (0.45)
Year91		0.49** (0.18)		0.48** (0.18)
Year92		0.67*** (0.20)		0.60** (0.18)
Year93		0.63** (0.21)		0.59** (0.21)
Year94		0.21 (0.26)		0.23 (0.26)
Year95		-0.32 (0.31)		-0.35 (0.30)
Year96		-0.93*** (0.27)		-0.74** (0.27)
Year97		-0.63* (0.32)		-0.65+ (0.34)
Year98		-0.98** (0.35)		-1.06** (0.33)
Year99		-1.18*** (0.31)		-1.25*** (0.33)
Year00		-1.86*** (0.18)		-1.85*** (0.18)
Year01		-3.04*** (0.27)		-3.18*** (0.28)
Year02		-3.84*** (0.28)		-3.81*** (0.29)
Year03		-6.44*** (0.33)		-6.47*** (0.32)
Type_coop	0.056*** (0.01)	0.043*** (0.01)		
Tie_coop			0.071*** (0.02)	0.036*** (0.01)
Constant	7.854*** (0.31)	4.15*** (0.47)	7.94*** (0.28)	4.55*** (0.46)
Lnalpha	1.73*** (0.12)	1.21*** (0.10)	1.69*** (0.12)	1.20*** (0.10)
Number of alliances	1930	1930	1930	1930
Number of firms	118.00	118.00	118.00	118.00
Log likelihood	-14583.63	-13963.96	-14538.03	-13953.56
Degrees of freedom	1.00	22.00	1.00	22.00
Wald chi square	13.73	5465.39	17.36	4918.70

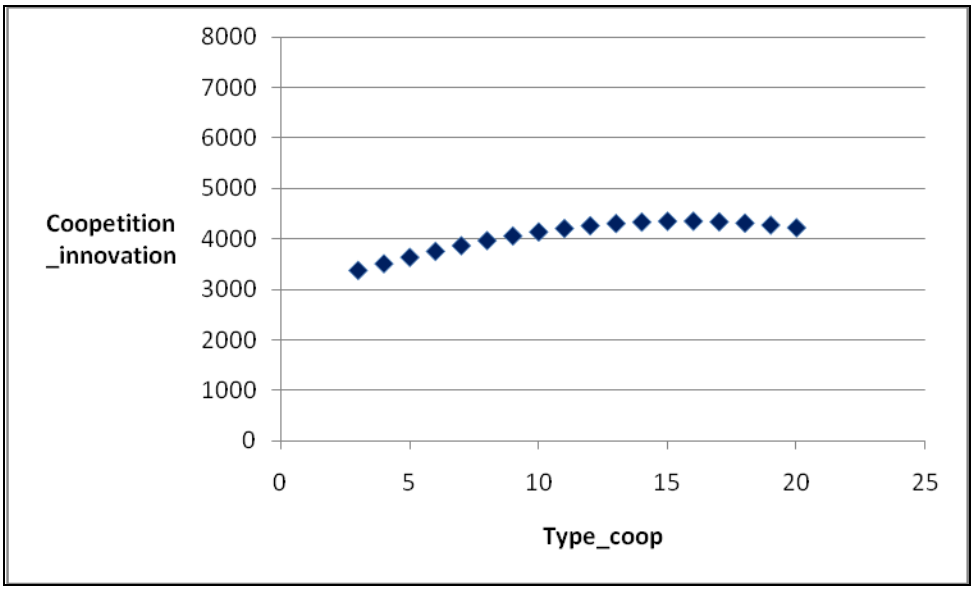
Standard errors in parentheses, * p<0.05 ** p<0.01 *** p<0.001

TABLE 5.5B: The Role of Cooperation between Partners in Coopetition-Based Innovation (incl. Squared Term)

Variables	Model5	Model5b	Model6	Model6b
Pre_innovation		0.000054 (0.000017) **		0.000055 (0.000016) ***
Firm-age		-0.30** (0.11)		-0.27* (0.11)
Num_ties		-0.01 (0.01)		-0.02 (0.01)
Sales_log		0.52*** (0.07)		0.50*** (0.07)
Type_fabless		-0.19 (0.37)		-0.23 (0.37)
Type_foundry		0.23 (0.24)		0.17 (0.28)
Type_tester		-0.13 (0.37)		-0.02 (0.37)
Type_equipment		-1.56*** (0.44)		-1.43** (0.45)
Year91		0.48* (0.19)		0.48** (0.18)
Year92		0.65*** (0.20)		0.60*** (0.18)
Year93		0.62** (0.21)		0.57** (0.21)
Year94		0.21 (0.26)		0.21 (0.27)
Year95		-0.33 (0.32)		-0.38 (0.30)
Year96		-0.91*** (0.27)		-0.79** (0.26)
Year97		-0.63+ (0.33)		-0.67* (0.34)
Year98		-0.97** (0.35)		-1.06** (0.32)
Year99		-1.18*** (0.31)		-1.28*** (0.34)
Year00		-1.86*** (0.18)		-1.89*** (0.18)
Year01		-3.03*** (0.28)		-3.21*** (0.29)
Year02		-3.83*** (0.28)		-3.84*** (0.29)
Year03		-6.43*** (0.33)		-6.49*** (0.31)
Type_coop	0.103*** (0.01)	0.051*** (0.01)		
Type_coop^2	-0.009*** (0.00)	-0.0016 (0.00)		
Tie_coop			0.123*** (0.02)	0.077*** (0.01)
Tie_coop^2			-0.0019*** (0.00)	-0.0013*** (0.00)
Constant	7.63*** (0.31)	4.13*** (0.47)	7.89*** (0.26)	4.55*** (0.46)
Lnalpha	1.72*** (0.12)	1.21*** (0.10)	1.68*** (0.12)	1.20*** (0.11)
Number of alliances	1930	1930	1930	1930
Number of firms	118.00	118.00	118.00	118.00
Log likelihood	-14579.49	-13963.77	-14530.36	-13947.42
Degrees of freedom	2	23	2	23
Wald chi square	56.15	5643.39	48.44	7433.40

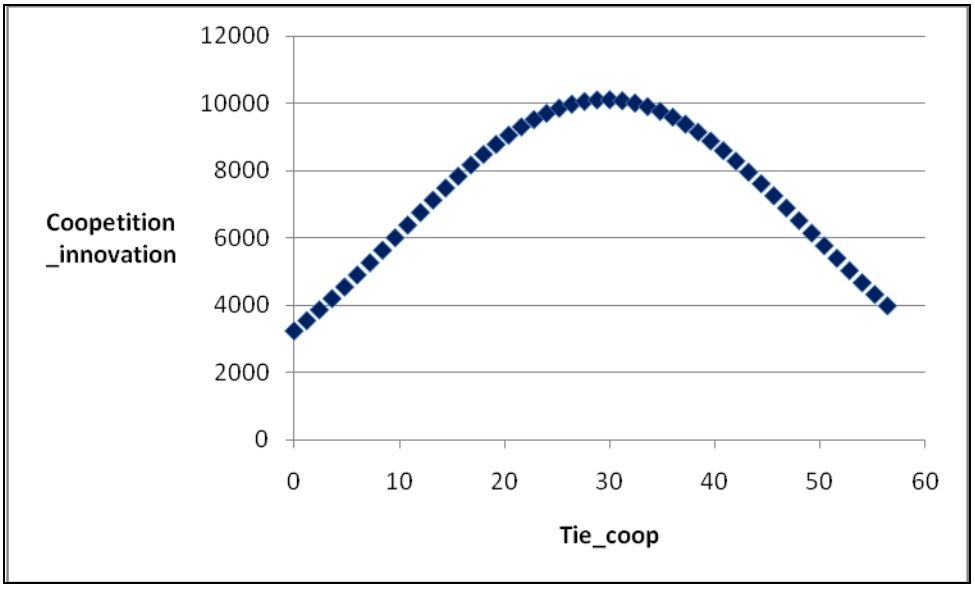
Standard errors in parentheses, * p<0.05 ** p<0.01 *** p<0.001

FIGURE 5.3
The Relationship between *Type_coop* and *Coopetition_innovation*



*Based on model 5b in Table 5.5B.

FIGURE 5.4
The Relationship between *Tie_coop* and *Coopetition_innovation*



*Based on model 6b in Table 5.5B.

5.4 The Role of Balance between Competition and Cooperation in Innovation at the Dyadic Level

Hypothesis 3a predicts that the balance between competition and cooperation will positively affect the focal firm's coopetition-based innovation. To test the hypothesis, I measured the balance in two different ways because each approach available to examine the balance (or interplay) between the two variables has its own advantages and disadvantages. First, I used polynomial regression to capture the comprehensive effects of the interplay of competition and cooperation. Second, I estimated coopetition-based innovation as a function of balanced-strong coopetition as a dummy variable[17]. As I measured the degree of competition in two ways (*Tech_comp* and *Market_comp*) and the degree of cooperation in two ways (*Type_coop* and *Tie_coop*), there were four combinations to represent coopetition. Since the inclusion of all interaction terms in one model may increase multicollinearity, I added them to the regression models separately for the hypothesis testing.

5.4.1 Polynomial regression analysis: interplay between competition and cooperation

As polynomial regression analysis has advantages in examining the interplay of two variables, I used polynomial regression to investigate the effects of combining competition and cooperation on innovation. Tables 5.6 and 5.7 report the relevant coefficients based on negative binomial regression, while Tables 5.6B and 5.7B report the coefficients from multiple regression[18]. Using the coefficients of variables from negative binomial regressions, at the top of Figures 5.6, 5.7, 5.8, and 5.9, I present surfaces in terms of quadratic regression equations of the interplay between competition and cooperation and their corresponding three dimensional

[17] The hypothesis is not about simple balance but about balanced-strong coopetititon (i.e., high intensities of competition and cooperation).

[18] To look at the regression model with controls only, refer to model 0 (negative binomial regression) and Appendix B (multiple regression).

response surfaces (refer to Section 4.2.5). On the bottom of Figures 5.6, 5.7, 5.8, and 5.9, surfaces were portrayed using the coefficients of variables from multiple regressions.

In an attempt to increase the robustness of the results, I used the coefficients from both negative binomial and multiple regressions to portray surfaces for polynomial regression analysis. Such an approach to increase robustness seems important for the following reasons. First, a limitation of polynomial regression is that, even though polynomial regression models may provide good fits within the range of data, they frequently deteriorate outside the range of the data. Second, I found that there was a mismatch between the real data and the hypothetical surface in Figures 5.7 and 5.9 (the combination of competition (*Tech_comp* or *Market_comp*) and *Tie_coop).* The discrepancy probably occurred because the data is not uniformly distributed. Figure 5.5 reports the distributions of the combinations of competition and cooperation variables. The distribution maps show that there are few or no observations in the segment of low *Tech_comp* and high *Tie_coop* and in the segments of high *Market_comp* and high *Tie_coop*. I noted that different numbers of the points in the distribution maps are due to overlapped observations within the same points because *Market_comp* was measured in ordinal scale and *Type_coop* was integer.

The results show that hypothesis 3a is partially supported. The balance between technology competition (*Tech_comp*) and cooperation (*Type_coop* or *Tie_coop*) shows positive and significant effects (models 10b and 11b and Figures 5.6 and 5.7), which supports the hypothesis. The balance between market competition (*Market_comp*) and *Tie_coop* shows positive and significant effects (model 15b and Figure 5.9), which also supports the hypothesis. Only the balance between market competition (*Market_comp)* and *Type_coop* shows an

insignificant effect (model 14b and Figure 5.8). All interaction terms based on negative binomial regression are insignificant.

Hypothesis 3a is most clearly supported by Figure 5.6 that represents a hypothetical relationship between coopetition (in the combination of *Tech_comp* and *Type_coop*) and coopetition-based innovation. Overall, the surface clearly supports the hypothesis of the balance between competition and cooperation (H3a), depicting four basic effects. First, *Coopetition_innovation* is higher when technology competition (*Tech_comp*) and type strength of the focal alliance (*Type_coop*) are both high than when *Tech_comp* and *Type_coop* are both low. Second, at the same intensity of cooperation (*Type_coop),* the higher intensity of competition (*Tech_comp*) generates the greater innovation performance (*Coopetition_innovation*). For example, when *Type_coop* is 9.80 in both surfaces in the figure, *Coopetition_innovation* increases as the intensity of *Tech_comp* increases, and the highest *Coopetition_innovation* can be achieved when the intensity of *Tech_comp* is highest (1.00). Third, the intensity of *Type_coop* is more important when the intensity of *Tech_comp* is high than when the intensity of *Tech_comp* is low. Finally, when using both negative binomial regression coefficients and OLS regression coefficients, the optimal point lies in the high intensity of competition (*Tech_comp*: 1.00) and the high intensity of cooperation (*Type_coop:* 20.00). That is, when partners are competitors with similar technological resources (the intensity of Tech_comp is high), firms will generate greater innovation performance with high intensity of *Type_coop* (e.g., a joint venture with multiple activities) than with low intensity of *Type_coop* (e.g., a licensing or marketing alliance). In Figure 5.6, both surfaces in the figure are very similar, except for the ranges of the dependent variable. That is, the range of coopetition-based innovation is wider in the bottom surface than in the top surface.

Hypothesis 3a is also supported by Figure 5.7 that represents the effects of the interplay between *Tech_comp* and *Tie_coop*. The surfaces on the top and bottom seem different but the surface on the top is very similar to part of the surface on the bottom (i.e., in the range of *Tie_coop* from 0 to 22.48 in which 97.4 percent of the observations appear). The differences between the two surfaces clearly appear when the intensities of *Tech_comp* and *Tie_coop* are both high. In the top surface, when the intensity of *Tech_comp* is high, *Tie_coop* shows an inverted_U shape. In the bottom surface, however, when the intensity of *Tech_comp* is high, *Tie_coop* does not show an inverted_U shape, rather it shows a positive relationship. As a result, the optimal points are different in the two surfaces. When we look at the optimal point, the surface on the top shows that high Tech_comp (1.00) and medium-high Tie_coop (39.34) generates the highest innovation performance. Considering that the *Tie_coops* of most samples are 0 or very low, while the maximum value of *Tie_coop* is very high, the optimal point has pretty high intensity of *Tie_coop*. The surface on the bottom clearly shows that high *Tech_comp* (1.00) and high *Tie_coop* (56.2) generate the highest innovation performance.

Figure 5.9 also supports the hypothesis. Like Figure 5.7, the surface on the top in Figure 5.9 is very similar to part of the surface on the bottom (i.e., in the range of *Tie_coop* from 0 to 22.48). The shapes suggest that, when *Market_comp* is high, the increase of *Tie_coop* will increase the innovation performance except for the range of very high intensity of *Tie_coop*. Conversely, when *Tie_coop* is high (or medium), the increase of *Market_comp* will increase innovation performance. When we look at the optimal point, the surface on the top suggests that high *Market_comp* (1.00) and mid-high *Tie_coop* (39.34) generates the highest innovation performance. The shape on the bottom shows that high *Market_comp* (1.00) and high *Tie_coop* (56.2) generate the highest innovation performance. However, the result should be interpreted

cautiously. As Figure 5.5 shows, there is no observation in the segment of high *Market_comp* and high *Tie_coop*. That is, there is mismatch between the hypothetical optimal point and real coopetition.

Figure 5.8 does not support the hypothesis with insignificant results. The figures should be interpreted cautiously. The effects of both *Market_comp* and *Type_coop* are weak. An important observation is that the optimal point in the surface based on negative binomial regression is different from the surface based on multiple regression coefficients. While the surface on the top shows that the optimal point lies in the combination of low *Market_comp* (=0.2) and high *Type_coop* (=16.60), the surface on the bottom shows that the optimal point lies in the combination of medium *Market_comp* (=0.4) and medium *Type_coop* (=11.5). In short, the role of *Market_comp* and *Type_coop* are insignificant and inconsistent across measures.

The optimal points in the combinations of competition and cooperation provide important implications. In terms of the optimal points, the intensities of competition should be high. Except for Figure 5.8 (in the combinations of *Market_comp* and *Type_coop*), all figures show that the optimal point lies in high intensity of competition (*Tech_comp* or *Market_comp*). In the combination of *Tech_comp* and *Type_coop*, the optimal point lies in high intensity of competition (Figures 5.6 and 5.7) and high intensity of cooperation, clearly supporting the hypothesis. It was noted that the intensities of *Tie_coop* at the optimal point are different across methods. When using negative binomial regression coefficients, *Tie_coop* at the optimal point is medium-high (33.72 in Figure 5.7 and 39.34 in Figure 5.9). When using OLS regression coefficients, *Tie_coop* at the optimal point is high (56.2 in Figures 5.7 and 5.9). It was noted that the optimal point in Figure 5.9 was not matched with the real coopetitions because there were no observations in that segment of high *Market_comp*

and high *Tie_coop*. One possible reason is that, as coopetition is a newer trend, it was impossible for firms to achieve the optimal point.

FIGURE 5.5

Distributions of Combinations of Competition and Cooperation

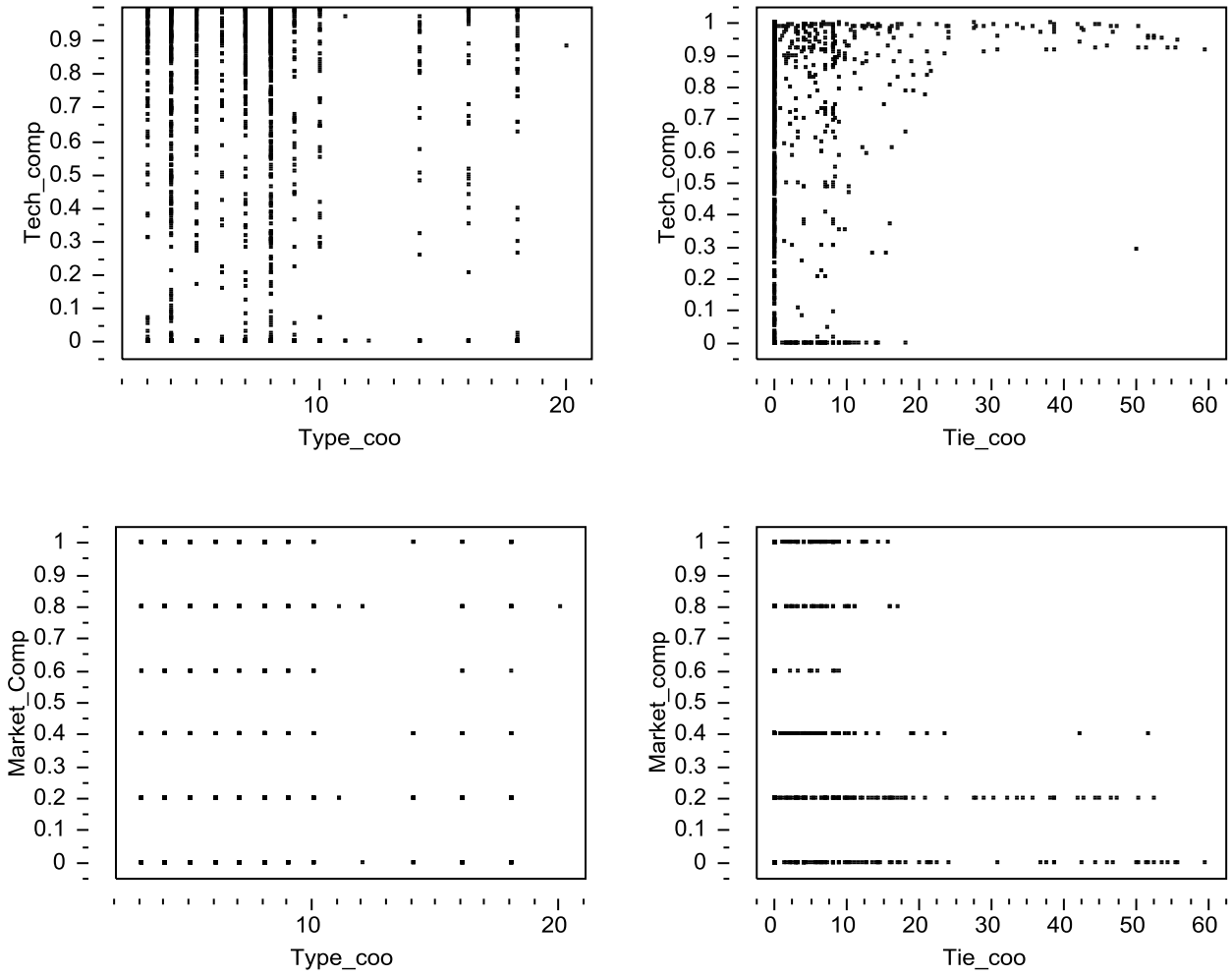


TABLE 5.6: The Effects of the Interaction between Technology Competition and Cooperation on Coopetition-Based Innovation (Using Negative Binomial Regression)

Variables	Model 7 w/o controls	Model 7b with controls	Model 8 w/o controls	Model 8b with controls
Controls		Not reported		Not reported
Tech_comp	1.9716*** (0.15)	1.7992*** (0.14)	1.6828*** (0.18)	1.7696*** (0.17)
Tech_comp^2	1.9312* (0.79)	-0.3062 (0.61)	0.96995 (0.70)	-0.4550 (0.59)
Type_coop	0.0840*** (0.02)	0.0375** (0.01)		
Type_coop^2	-0.01075** (0.00)	-0.0009 (0.00)		
Techcomp_Typecoop	0.0956*** (0.03)	0.00343 (0.03)		
Tie_coop			0.0626*** (0.01)	0.01674+ (0.01)
Tie_coop^2			-0.00093*** (0.00)	-0.00047** (0.00)
Techcomp_Tiecoop			0.00936 (0.02)	0.0157 (0.02)
Constant	6.2177*** (0.27)	4.0365*** (0.47)	6.8484*** (0.27)	4.374*** (0.46)
Lnalpha	1.62*** (0.12)	1.08*** (0.10)	1.62*** (0.12)	1.08*** (0.10)
Number of alliances	1930	1930	1.73*** (0.12)	1.21*** (0.10)
Number of firms	118.00	118.00	1930	1930
Log likelihood	-14453.23	-13808.43	-14449.13	-13810.35
Degrees of freedom	5	26	5	26
Wald chi square	404.07	8486.43	186.88	7215.35

Standard errors in parentheses, * p<0.05 ** p<0.01 *** p<0.001. See model 0 for the regression model with controls only.

TABLE 5.6B: The Effects of the Interaction between Technology Competition and Cooperation on Coopetition-Based Innovation (Using Multiple Regression)

Variables	Model 9 only controls	Model 10 w/o controls	Model 10b with controls	Model 11 w/o controls	Model 11b with controls
Controls	Not reported		Not reported		Not reported
Tech_comp		7177.37*** (347.16)	6141.98*** (299.81)	5906.13*** (373.85)	5865.17*** (324.51)
Tech_comp^2		13060.95*** (1854.82)	10157.17*** (1574.12)	7168.30*** (1789.00)	6218.29*** (1542.67)
Type_coop		336.86*** (60.26)	141.66** (53.84)		
Type_coop^2		-26.23** (8.12)	-5.41 (7.35)		
Techcomp _ Typecoop		538.61*** (97.07)	436.17*** (82.00)		
Tie_coop				340.03*** (55.96)	112.64* (49.01)
Tie_coop^2				-7.20*** (1.37)	-5.13*** (1.17)
Techcomp _Tiecoop				552.07*** (108.69)	649.15*** (92.54)
Constant	665.28 (1013.76)	-3684.12*** (554.12)	-3056.20** (1029.58)	-965.88* (393.86)	-2012.12* (936.56)
N	1930	1930	1930	1930	1930
R^2	0.328	0.208	0.460	0.303	0.506
R	0.573	0.456	0.678	0.55	0.711
ΔR^2(Base= Model 9)			0.132		0.178

Standard errors in parentheses, + p<0.1 * p<0.05 ** p<0.01 *** p<0.001. See Appendix B for the regression model with controls only.

TABLE 5.7: The Effects of the Interaction between Market Competition and Cooperation on Coopetition-Based Innovation (Using Negative Binomial Regression)

Variables	Model 12		Model 12b		Model 13		Model 13b	
	w/o controls		with controls		w/o controls		with controls	
Controls			Not reported				Not reported	
Market_comp	0.1943	(0.41)	0.9231***	(0.16)	0.4429+	(0.26)	0.9601***	(0.14)
Market_comp^2	-0.6665	(0.69)	-0.7702+	(0.44)	-0.5609	(0.56)	-0.7781*	(0.38)
Type_coop	0.1005***	(0.01)	0.0518***	(0.01)				
Type_coop^2	-0.0085***	(0.00)	-0.0014	(0.00)				
Mktcomp_Typecoop	-0.0141	(0.02)	-0.0307	(0.03)				
Tie_coop					0.1234***	(0.02)	0.0737***	(0.01)
Tie_coop^2					-0.0016***	(0.00)	-0.0011***	(0.00)
Mktcomp_Tiecoop					0.0332	(0.03)	0.0129	(0.02)
Constant	7.653***	(0.34)	3.761***	(0.47)	7.789***	(0.25)	4.2314***	(0.48)
Lnalpha	1.72***	(0.12)	1.20***	(0.10)	1.68***	(0.12)	1.18***	(0.11)
Number of alliances	1930		1930		1930		1930	
Number of firms	118.00		118.00		118.00		118.00	
Log likelihood	-14578.74		-13943.23		-14527.92		-13925.99	
Degrees of freedom	5		26		5		26	
Wald chi square	71.98		6704.77		145.25		18776.92	

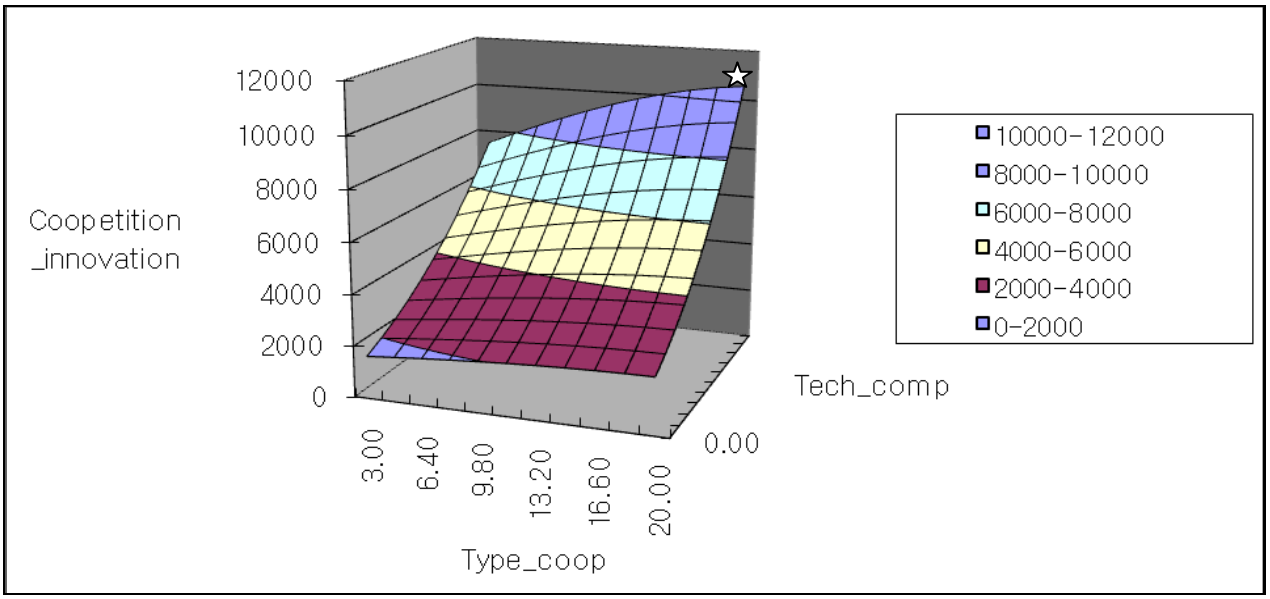
Standard errors in parentheses, * p<0.05 ** p<0.01 *** p<0.001

TABLE 5.7B: The Effects of the Interaction between Market Competition and Cooperation on Coopetition-Based Innovation (Using Multiple Regression)

Variables	Model 14		Model 14b		Model 15		Model 15b	
	w/o controls		with controls		w/o controls		with controls	
Controls			Not reported				Not reported	
Market_comp	474.45	(587.09)	2877.09***	(498.22)	1966.65***	(530.95)	3468.72***	(466.82)
Market_comp^2	-2718.20	(1709.73)	-4163.26**	(1421.19)	-2605.54+	(1517.68)	-3241.36*	(1310.91)
Type_coop	337.01***	(67.54)	136.78*	(59.55)				
Type_coop^2	-27.49**	(9.07)	-6.10	(8.11)				
Mktcomp_ Typecoop	-12.02	(131.14)	21.32	(108.66)				
Tie_coop					712.69***	(48.18)	484.12***	(42.88)
Tie_coop^2					-4.63**	(1.42)	-1.35	(1.23)
Mktcomp_ Tiecoop					472.19***	(107.47)	493.73***	(92.08)
Constant	2049.69***	(471.69)	-1184.23	(1085.84)	2144.38***	(241.23)	-1200.09	(952.64)
N	1930		1930		1930		1930	
R^2	0.016		0.343		0.221		0.442	
R	0.126		0.586		0.47		0.665	
ΔR^2 (Base=Model 9)			0.015				0.114	

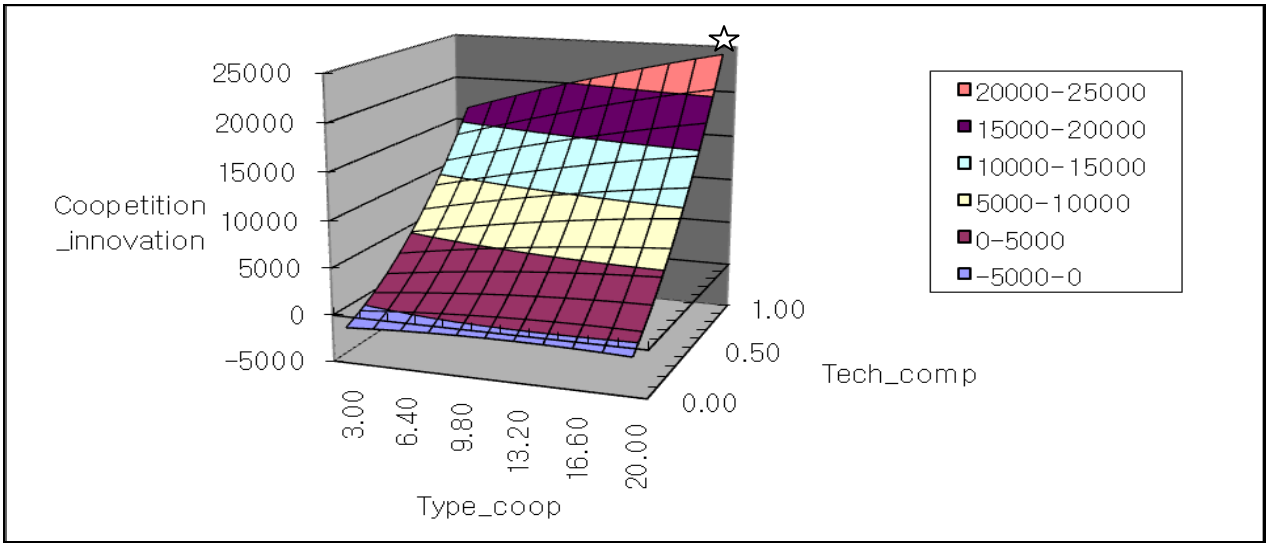
Standard errors in parentheses, + p<0.1 * p<0.05 ** p<0.01 *** p<0.001

FIGURE 5.6
Surface for the Role of Technology Competition (*Tech_comp*) and Cooperation (*Type_coop*) to Predict Innovation Performance



Tech_comp	0	<=0.1	<=0.2	<=0.3	<=0.4	<=0.5	<=0.6	<=0.7	<=0.8	<=0.9	<=1	Total
Frequency	836	37	14	28	54	59	57	73	96	171	505	1930
Type_coop	3	<=4.7	<=6.4	<=8.1	<=9.8	<=11.5	<=13.2	<=14.9	<=16.6	<=18.3	<=20	Total
Frequency	179	465	248	714	83	76	3	34	55	72	1	1930

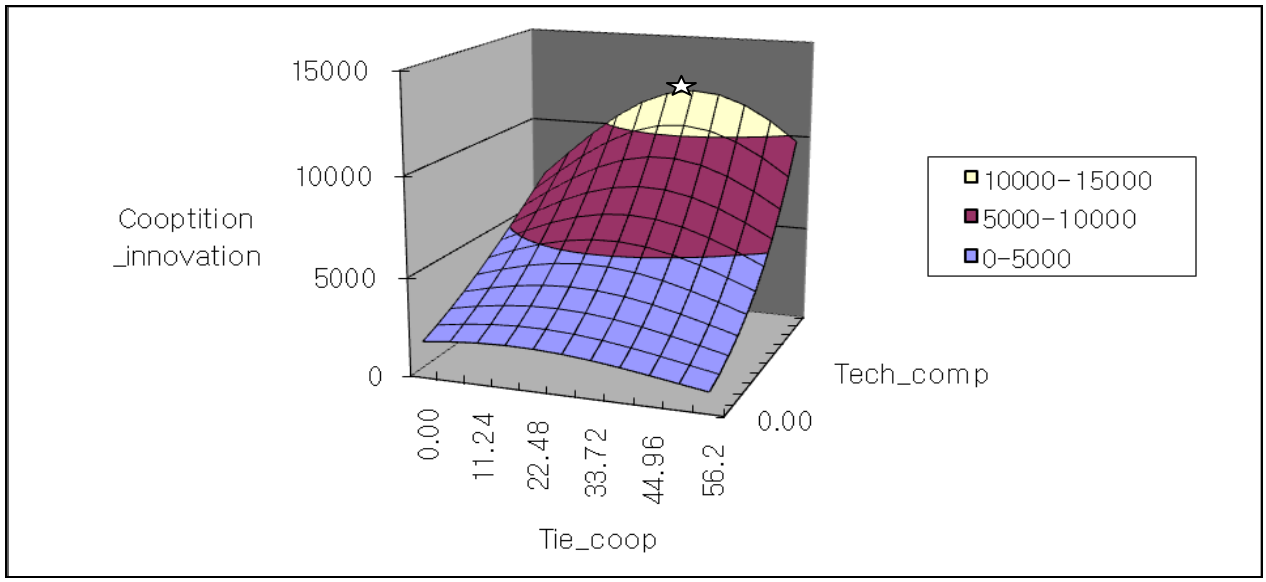
(1) Using negative binomial regression coefficient



Tech_comp	0	<=0.1	<=0.2	<=0.3	<=0.4	<=0.5	<=0.6	<=0.7	<=0.8	<=0.9	<=1	Total
Frequency	836	37	14	28	54	59	57	73	96	171	505	1930
Type_coop	3	<=4.7	<=6.4	<=8.1	<=9.8	<=11.5	<=13.2	<=14.9	<=16.6	<=18.3	<=20	Total
Frequency	179	465	248	714	83	76	3	34	55	72	1	1930

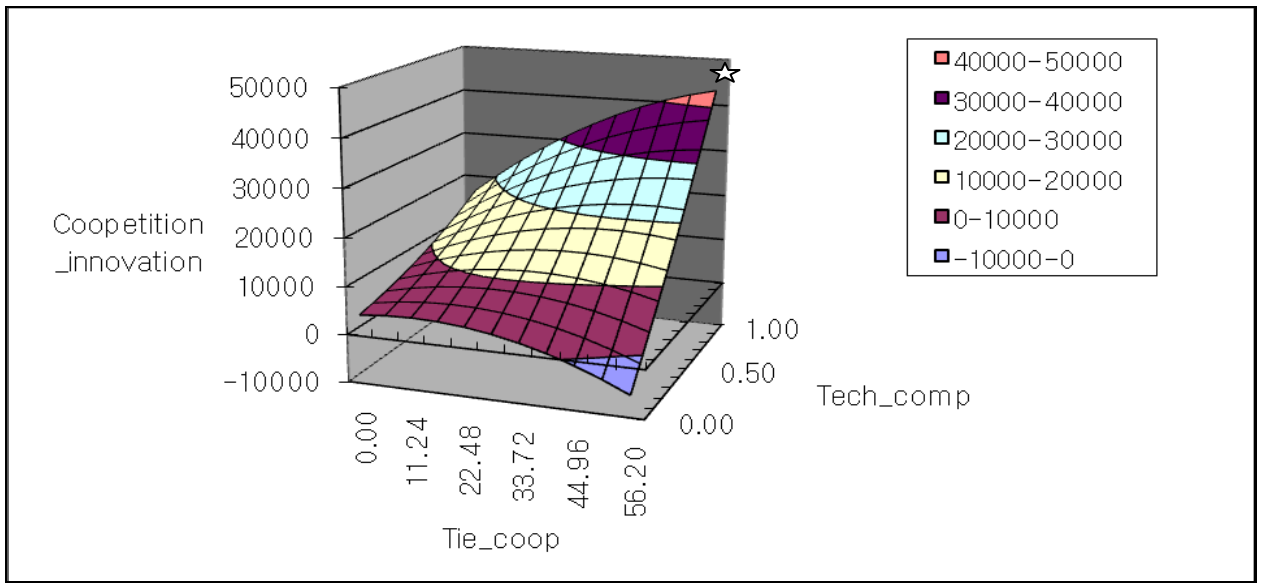
(2) Using multiple regression coefficient (stanrardized data)

FIGURE 5.7
Surface for the Role of Technology Competition (*Tech_comp*) and Cooperation (*Tie_coop*) to Predict Innovation Performance



Tech_comp	0	<=0.1	<=0.2	<=0.3	<=0.4	<=0.5	<=0.6	<=0.7	<=0.8	<=0.9	<=1	Total
Frequency	836	37	14	28	54	59	57	73	96	171	505	1930
Tie_coop	0	<=5.62	<=11.24	<=16.86	<=22.48	<=28.1	<=33.72	<=39.34	<=44.96	<=50.58	<=56.2	Total
Frequency	1493	196	137	35	16	7	12	8	12	6	8	1930

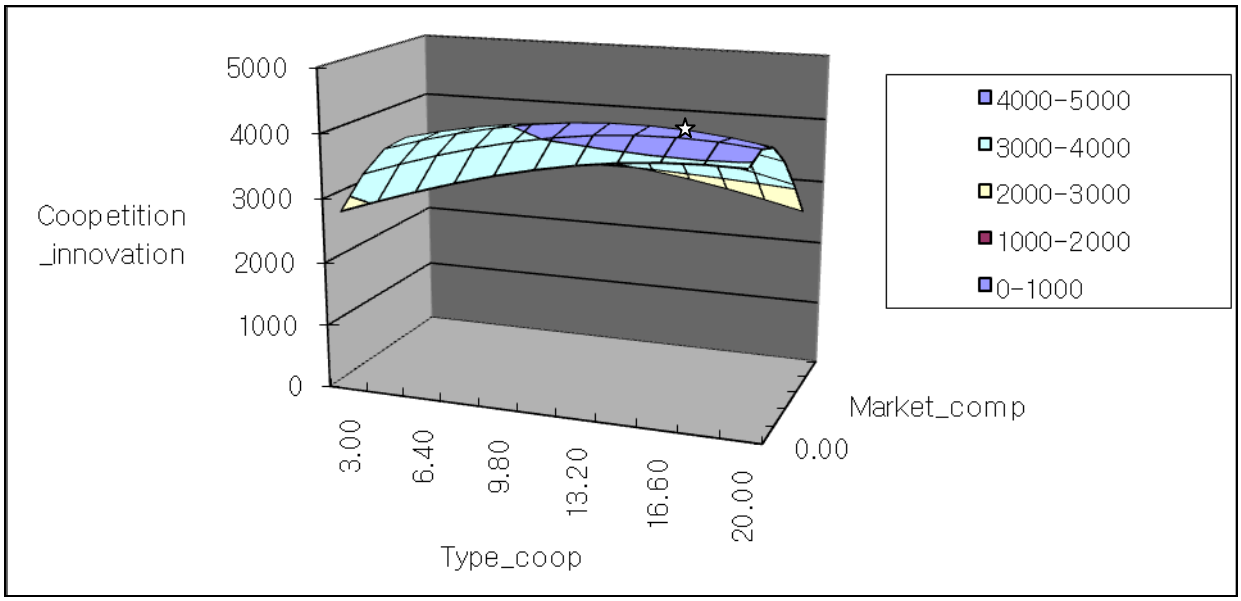
(1) Using negative binomial regression coefficient



Tech_comp	0	<=0.1	<=0.2	<=0.3	<=0.4	<=0.5	<=0.6	<=0.7	<=0.8	<=0.9	<=1	Total
Frequency	836	37	14	28	54	59	57	73	96	171	505	1930
Tie_coop	0	<=5.62	<=11.24	<=16.86	<=22.48	<=28.1	<=33.72	<=39.34	<=44.96	<=50.58	<=56.2	Total
Frequency	1493	196	137	35	16	7	12	8	12	6	8	1930

(2) Using multiple regression coefficient (stanrardized data)

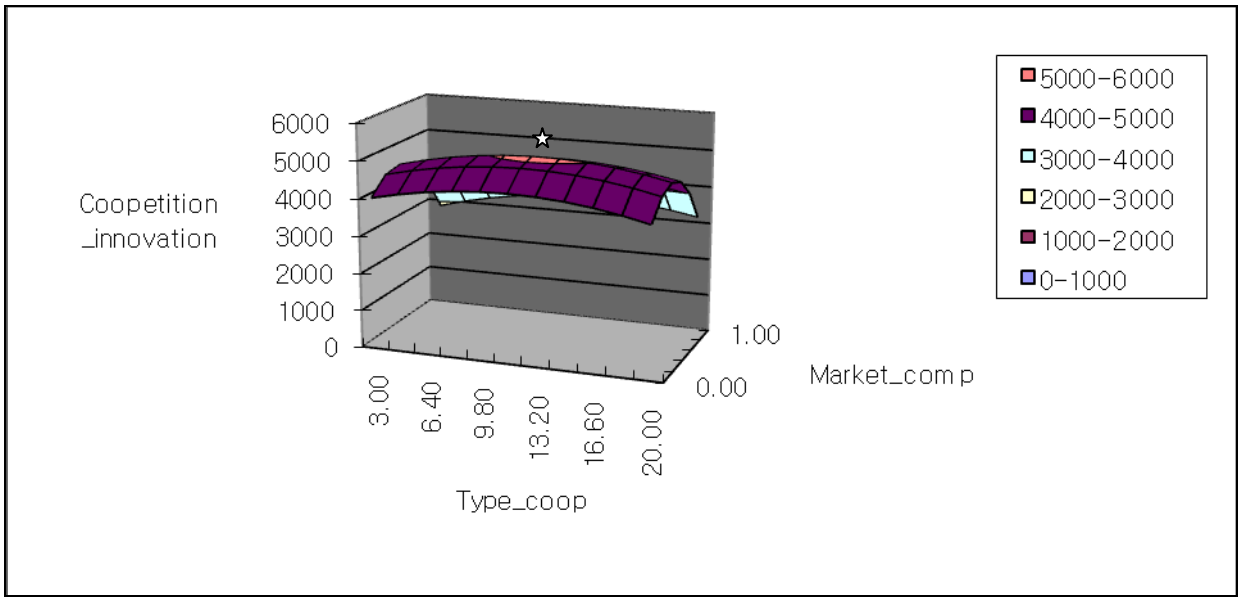
FIGURE 5.8
Surface for the Role of Market Competition (*Market_comp*) and Cooperation (*Type_coop*) to Predict Innovation Performance



Market_comp	0	0.2	0.4	0.6	0.8	1.0	Total
Frequency	605	463	275	55	232	300	1930

Type_coop	3	<=4.7	<=6.4	<=8.1	<=9.8	<=11.5	<=13.2	<=14.9	<=16.6	<=18.3	<=20	Total
Frequency	179	465	248	714	83	76	3	34	55	72	1	1930

(1) Using negative binomial regression coefficient

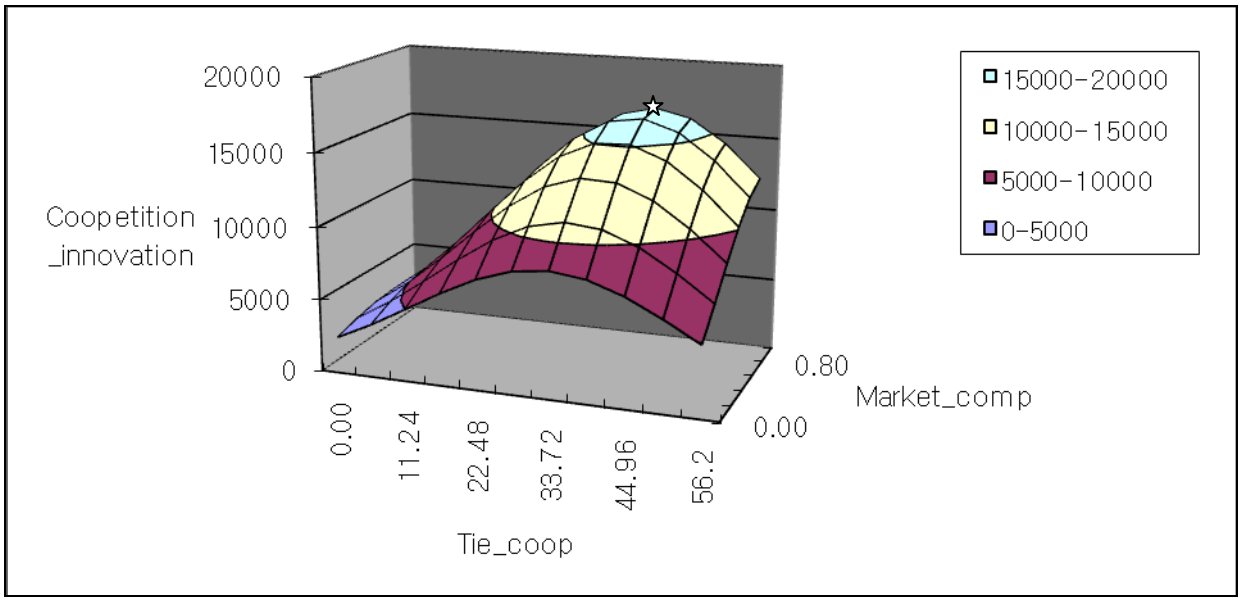


Market_comp	0	0.2	0.4	0.6	0.8	1.0	Total
Frequency	605	463	275	55	232	300	1930

Type_coop	3	<=4.7	<=6.4	<=8.1	<=9.8	<=11.5	<=13.2	<=14.9	<=16.6	<=18.3	<=20	Total
Frequency	179	465	248	714	83	76	3	34	55	72	1	1930

(2) Using multiple regression coefficient (stanrardized data)

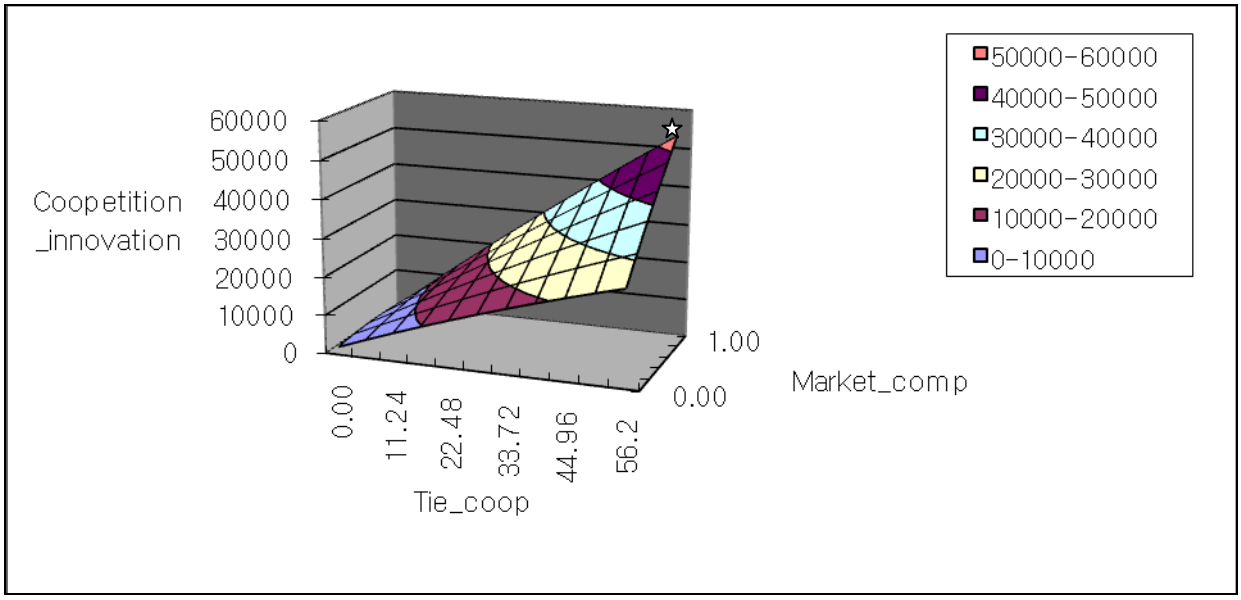
FIGURE 5.9
Surface for the Role of Market Competition (*Market_comp*) and Cooperation (*Tie_coop*) to Predict Innovation Performance



Market_comp	0	0.2	0.4	0.6	0.8	1.0	Total
Frequency	605	463	275	55	232	300	1930

Tie_coop	0	<=5.62	<=11.24	<=16.86	<=22.48	<=28.1	<=33.72	<=39.34	<=44.96	<=50.58	<=56.2	Total
Frequency	1493	196	137	35	16	7	12	8	12	6	8	1930

(1) Using negative binomial regression coefficient



Market_comp	0	0.2	0.4	0.6	0.8	1.0	Total
Frequency	605	463	275	55	232	300	1930

Tie_coop	0	<=5.62	<=11.24	<=16.86	<=22.48	<=28.1	<=33.72	<=39.34	<=44.96	<=50.58	<=56.2	Total
Frequency	1493	196	137	35	16	7	12	8	12	6	8	1930

(2) Using multiple regression coefficient (stanrardized data)

5.4.2 The dummy variables of balanced-strong coopetition at the dyadic level

My key argument is that the intensity of cooperation should be increased as the intensity of competition increases. Previous studies (e.g., Sampson, 2005) often used dummy variables to estimate the effects of a subgroup of an independent variable. To test my key interests, I estimated coopetition-based innovation as a function of balanced-strong coopetition as a dummy variable. I measured balanced-strong coopetition via three dummy variables that captured the extent of balanced-strong coopetition. The criteria to create dummy variables are 1) over the mean values, 2) over mean + 0.5 standard deviation, and 3) over mean + 1 standard deviation in four different combinations. For example, when I used the first criterion, balanced-strong coopetition equals one if competition and cooperation are both over mean intensities, and zero if not. While all other variables are based on continuous scales, market competition (*Market_comp*) is based on an ordinal scale. Thus, I set the criterion to create dummy variables as follows: 1) *Market_comp* is greater than 0.4 (over the mean) that happens when partners' 2-digit SIC codes are the same; 2) *Market_comp* is greater than 0.8 that happens when partners' 4-digit SIC codes are the same; and 3) *Market_comp* is 1 that happens when partners are in the same industry (partners' 4-dight SIC codes are the same), take the same types of firm, and play in the same product segment. That is, when I used the third criterion of balanced strong coopetition in combination with market competition and cooperation, balanced-strong coopetition equals 1 if market competition equals 1 and cooperation is greater than mean plus 1 standard deviation, and zero if not.

Tables 5.8 and 5.9 report the test results for this hypothesis by using the dummy variables of balanced-strong coopetition. Table 5.8 presents the effects of balanced-strong coopetition in terms of high technology competition (*Tech_comp*) and high cooperation (*Type_coop* or *Tie_coop*), while Table 5.9 presents the effects of balanced-strong coopetition in terms of high

market competition (*Market_comp*) and high cooperation. As the results show, this hypothesis (H3a) is strongly supported as most coefficients of the dummy variables are positive and significant at the 0.001 or lower level in both tables. One interesting finding was that there were no observations in the category of the combination of high market commonality (*Market_comp* =1) and high intensity of *Tie_coop* (mean + 1 standard deviation) (models 27 and 27b).

TABLE 5.8: The Effects of Balanced-Strong Coopetition (High Technology Competition and High Cooperation) on Coopetition-Based Innovation

Variables	Model 16 w/o controls	Model 16b with controls	Model 17 w/o controls	Model 17b with controls	Model 18 w/o controls	Model 18b with controls
Controls		Not reported		Not reported		Not reported
Blncstrng_ techcomp_typecoop[1]	1.25*** (0.12)	0.98*** (0.06)				
Blncstrng_ techcomp_typecoop[2]			0.87*** (0.12)	0.78*** (0.17)		
Blncstrng_ techcomp_typecoop[3]					1.22*** (0.20)	0.86*** (0.20)
Constant	7.74*** (0.30)	4.63*** (0.45)	8.17*** (0.29)	4.55*** (0.46)	8.20*** (0.29)	4.54*** (0.46)
Lnalpha	1.68*** (0.12)	1.17*** (0.10)	1.72*** (0.12)	1.21*** (0.10)	1.72*** (0.12)	1.21*** (0.10)
Number of alliances	1930	1930	1930	1930	1930	1930
Number of firms	118	118	118	118	118	118
Log likelihood	-14527.38	-13916.32	-14578.67	-13957.02	-14580.21	-13963.20
Degrees of freedom	1	22	1	22	1	22
Wald chi square	115.41	6579.83	55.37	5943.32	37.07	5241.69

Standard errors in parentheses, + p<0.1 * p<0.05 ** p<0.01 *** p<0.001. Dummy variables of balanced strong coopetition: [1] over mean, [2] over mean + 0.5 SD, [3] over mean+1SD.

TABLE 5.8: The Effects of Balanced-Strong Coopetition (High Technology Competition and High Cooperation) on Coopetition-Based Innovation (cont.)

Variables	Model 19 w/o controls	Model 19b with controls	Model 20 w/o controls	Model 20b with controls	Model 21 w/o controls	Model 21b with controls
Controls		Not reported		Not reported		Not reported
Blncstrng_ techcomp_tiecoop[1]	1.39*** (0.13)	0.90*** (0.07)				
Blncstrng_ techcomp_tiecoop[2]			1.63*** (0.16)	0.93*** (0.08)		
Blncstrng_ techcomp_tiecoop[3]					1.67*** (0.24)	0.87*** (0.05)
Constant	7.87*** (0.26)	4.55*** (0.45)	7.94*** (0.26)	4.55*** (0.45)	8.06*** (0.27)	4.57*** (0.47)
Lnalpha	1.68*** (0.12)	1.19*** (0.11)	1.68*** (0.12)	1.20*** (0.11)	1.70*** (0.12)	1.21*** (0.11)
Number of alliances	1930	1930	1930	1930	1930	1930
Number of firms	118	118	118	118	118	118
Log likelihood	-14529.62	-13936.59	-14529.86	-13946.11	-14550.00	-13957.05
Degrees of freedom	1	22	1	22	1	22
Wald chi square	116.23	6097.76	98.26	6385.01	47.89	10659.09

Standard errors in parentheses, + p<0.1 * p<0.05 ** p<0.01 *** p<0.001. Dummy variables of balanced strong coopetition: [1] over mean, [2] over mean + 0.5 SD, [3] over mean+1SD.

TABLE 5.9: The Effects of Balanced-Strong Coopetition (High Market Competition and High Cooperation) on Coopetition-Based Innovation

Variables	Model 22	Model 22b	Model 23	Model 23b	Model 24	Model 24b
	w/o controls	with controls	w/o controls	with controls	w/o controls	with controls
Controls		Not reported		Not reported		Not reported
Blncstmg_ mktcomp_typecoop[1]	0.12 (0.18)	0.40*** (0.11)				
Blncstmg_ mktcomp_typecoop[2]			0.12 (0.24)	0.37** (0.14)		
Blncstmg_ mktcomp_typecoop[3]					0.76** (0.28)	0.87** (0.29)
Constant	8.23*** (0.31)	4.46*** (0.47)	8.25*** (0.29)	4.50*** (0.46)	8.25*** (0.29)	4.54*** (0.46)
Lnalpha	1.73*** (0.12)	1.21*** (0.10)	1.73*** (0.12)	1.22*** (0.10)	1.73*** (0.12)	1.22*** (0.10)
Number of alliances	1930	1930	1930	1930	1930	1930
Number of firms	118	118	118	118	118	118
Log likelihood	-14588.95	-13960.95	-14589.30	-13967.09	-14588.34	-13966.75
Degrees of freedom	1	22	1	22	1	22
Wald chi square	0.47	5849.58	0.25	5450.77	7.46	4867.61

Standard errors in parentheses, + p<0.1 * p<0.05 ** p<0.01 *** p<0.001. Dummy variables of balanced strong coopetition: [1] over mean, [2] over mean + 0.5 SD, [3] over mean+1SD.

TABLE 5.9: The Effects of Balanced-Strong Coopetition (High Market Competition and High Cooperation) on Coopetition-Based Innovation (cont.)

Variables	Model 25	Model 25b	Model 26	Model 26b	Model 27	Model 27b
	w/o controls	with controls	w/o controls	with controls	w/o controls	with controls
Controls		Not reported		Not reported		Not reported
Blncstmg_ mktcomp_tiecoop[1]	0.75** (0.27)	0.72*** (0.12)				
Blncstmg_ mktcomp_tiecoop[2]			0.79*** (0.23)	0.69** (0.22)		
Blncstmg_ mktcomp_tiecoop[3]					0.00 (.)	0.00 (.)
Constant	8.16*** (0.30)	4.47*** (0.45)	8.23*** (0.29)	4.52*** (0.46)	8.26*** (0.29)	4.52*** (0.46)
Lnalpha	1.72*** (0.12)	1.21*** (0.10)	1.73*** (0.12)	1.21*** (0.10)	1.73*** (0.12)	1.22*** (0.10)
Number of alliances	1930	1930	1930	1930	1930	1930
Number of firms	118	118	118	118	118	118
Log likelihood	-14579.92	-13955.17	-14586.23	-13965.08	-14589.41	-13968.83
Degrees of freedom	1	22	1	22	1	22
Wald chi square	7.68	5538.15	12.26	4765.00	.	4902.26

Standard errors in parentheses, + p<0.1 * p<0.05 ** p<0.01 *** p<0.001. Dummy variables of balanced strong coopetition: [1] over mean, [2] over mean + 0.5 SD, [3] over mean+1SD.

5.5 The Role of Balanced-Strong Coopetition in Innovation at the Alliance Portfolio

Hypothesis 3b predicts that the higher the ratio of balanced-strong cooperation in an alliance portfolio, the greater the overall firm innovation performance. This hypothesis deals with the role of balance between competition and cooperation, in terms of balanced-strong coopetition, in overall firm innovation at the portfolio level. To test this hypothesis, I classified an alliance as balanced-strong coopetition if competition and cooperation intensities were both high. This measure was developed using the same method of dummy variables that was discussed in section 5.4.2. However, there are three differences. In this section, I: 1) identified the balanced-strong coopetition at the portfolio level, 2) used overall firm innovation performance as well as coopetition-based innovation as the dependent variable to test whether the balance logic can be applied to the firm (or alliance portfolio) level, and 3) used the ratio of balanced-strong coopetition among entire alliances in an alliance portfolio. To create a portfolio level indicator, I generated the number of balanced-strong coopetitions by summing the balanced-strong coopetitions in a focal firm's alliance portfolio. After that, I calculated the ratio of balanced-strong coopetition by dividing the number of balanced-strong coopetitions by the total number of alliances in the alliance portfolio.

Tables 5.10 and 5.11 report the test results for this hypothesis by using the ratio of balanced-strong coopetition in an alliance portfolio. Table 5.10 presents the effects of balanced-strong coopetition in terms of high technology competition (*Tech_comp*) and high cooperation (*Type_coop* or *Tie_coop*), while Table 5.11 presents the effects of balanced-strong coopetition in terms of high market competition (*Market_comp*) and high cooperation (*Type_coop* or *Tie_coop*). As the results show, hypothesis 3b is partially supported as some coefficients of the variables are positive and significant at the 0.001 or lower level (models 28b, 31b, and 37b). This result

suggests that firms can generate greater innovation performance when they have a higher ratio of balanced-strong coopetition in their alliance portfolios in three combinations (*Tech_comp* x *Type_coop, Tech_comp* x *Tie_coop*, and *Market_comp* x *Tie_coop*) than when they have a lower ratio of balanced-strong coopetition. The effects of the combination of high *Market_comp* and high *Type_coop* are insignificant, however.

One interesting finding was that the results that used "over mean value" as the criterion of balanced-strong coopetition are consistent with the results of the polynomial regression analysis (refer to section 5.4.1). Further, the effects of the ratio of balanced-strong coopetition on innovation are insignificant when I used higher criteria (mean + 0.5 standard deviation or mean + 1 standard deviation) for balanced-strong coopetition. The results can be explained by the fact that the optimal points in surfaces in polynomial regression analysis lie in high competition and the medium-high range (which is over mean but not very high) of cooperation. Meanwhile, consistent with section 5.4.1, there were no observations in the category of high market commonality (*Market_comp*=1) and high tie strength (*Tie_coop* = over mean + 1 standard deviation).

Even though hypothesis 3b predicts the effects of the coopetition ratio in an alliance portfolio on overall firm innovation, I also tested to determine if there is a significant effect on coopetition-based innovation. This is important to keep consistency in terms of the primary dependent variable (i.e., *Coopetition_innovation*) and to compare the results of two different measures of innovation (*Overall_innovation* versus *Coopetition_innovation*). I calculated portfolio level coopetition-based innovation (*Coopetition_innovation)* by averaging dyadic level coopetition-based innovations. Tables 5.12 and 5.13 report the results. As the results show, the ratio of balanced-strong coopetition in an alliance portfolio has a stronger effect on coopetition-

based innovation than on overall firm innovation. This result suggests that firms can also generate greater coopetition-based innovation performance when they have a higher ratio of balanced-strong coopetition in their alliance portfolios in all four combinations (*Tech_comp* x *Type_coop*, *Tech_comp* x *Tie_coop*, *Market_comp* x *Type_coop*, and *Market_comp* x *Tie_coop*) than when they have a lower ratio of balanced-strong coopetition. Further, the effects are significant even at a higher level of criteria for balanced-strong coopetition (models 40b, 41b, 43b, 46b, 48b, and 49b).

TABLE 5.10: The Effects of the Ratio of Balanced-Strong Coopetition (High Technology Competition and High Cooperation) on Overall Innovation in an Alliance Portfolio

Variables	Model 28	Model 28b	Model 29	Model 29b	Model 30	Model 30b
	w/o controls	with controls	w/o controls	with controls	w/o controls	with controls
Controls		Not reported		Not reported		Not reported
Port_ blncstrng_ techcomp_typecoop[1]	1.78** (0.65)	0.50** (0.18)				
Port_ blncstrng _ techcomp_typecoop[2]			1.06 (0.96)	0.49 (0.34)		
Port_ blncstrng _ techcomp_typecoop[3]					5.60** (1.87)	0.60 (0.81)
Constant	7.62*** (0.36)	5.03*** (0.50)	8.00*** (0.31)	5.01*** (0.50)	7.95*** (0.30)	5.00*** (0.49)
Lnalpha	1.54*** (0.08)	0.60*** (0.13)	1.56*** (0.08)	0.61*** (0.13)	1.55*** (0.08)	0.61*** (0.13)
Number of portfolios	475	475	475	475	475	475
Number of firms	118.00	118.00	118.00	118.00	118.00	118.00
Log likelihood	-3591.54	-3293.86	-3600.63	-3295.85	-3596.12	-3296.60
Degrees of freedom	1.00	22.00	1.00	22.00	1.00	22.00
Wald chi square	7.46	1061.24	1.23	1074.33	8.92	1064.04

Standard errors in parentheses, + p<0.1 * p<0.05 ** p<0.01 *** p<0.001l. The criteria of balanced strong coopetition are as follows: [1] over mean, [2] over mean + 0.5 SD, [3] over mean+1SD.

TABLE 5.10: The Effects of the Ratio of Balanced-Strong Coopetition (High Technology Competition and High Cooperation) on Overall Innovation in an Alliance Portfolio (cont.)

Variables	Model 31	Model 31b	Model 32	Model 32b	Model 33	Model 33b
	w/o controls	with controls	w/o controls	with controls	w/o controls	with controls
Controls		Not reported		Not reported		Not reported
Port_ blncstrng _ techcomp_tiecoop[1]	3.73* (1.68)	0.70* (0.31)				
Port_ blncstrng _ techcomp_tiecoop[2]			6.51** (2.39)	0.36 (0.50)		
Port_ blncstrng _ techcomp_tiecoop[3]					10.15*** (2.80)	-0.61 (0.84)
Constant	7.69*** (0.39)	5.00*** (0.50)	7.75*** (0.35)	5.00*** (0.49)	7.85*** (0.33)	4.99*** (0.49)
Lnalpha	1.53*** (0.09)	0.60*** (0.13)	1.52*** (0.09)	0.61*** (0.13)	1.53*** (0.09)	0.61*** (0.13)
Number of portfolios	475	475	475	475	475	475
Number of firms	118.00	118.00	118.00	118.00	118.00	118.00
Log likelihood	-3587.59	-3295.32	-3585.46	-3296.67	-3588.69	-3296.71
Degrees of freedom	1.00	22.00	1.00	22.00	1.00	22.00
Wald chi square	4.94	1166.77	7.43	1218.60	13.18	1313.59

Standard errors in parentheses, + p<0.1 * p<0.05 ** p<0.01 *** p<0.001. The criteria of balanced strong coopetition are as follows: [1] over mean, [2] over mean + 0.5 SD, [3] over mean+1SD.

TABLE 5.11: The Effects of the Ratio of Balanced-Strong Coopetition (High Market Competition and High Cooperation) on Overall Innovation in an Alliance Portfolio

Variables	Model 34	Model 34b	Model 35	Model 35b	Model 36	Model 36b
	w/o controls	with controls	w/o controls	with controls	w/o controls	with controls
Controls		Not reported		Not reported		Not reported
Port_ blncstrng _ mktcomp_typecoop[1]	-0.23 (0.41)	0.16 (0.21)				
Port_ blncstrng _ mktcomp_typecoop[2]			-0.03 (0.88)	0.22 (0.29)		
Port_ blncstrng _ mktcomp_typecoop[3]					4.56** (1.72)	1.25 (0.98)
Constant	8.12*** (0.34)	4.96*** (0.52)	8.07*** (0.30)	4.98*** (0.50)	8.04*** (0.30)	5.01*** (0.49)
Lnalpha	1.57*** (0.08)	0.61*** (0.13)	1.57*** (0.08)	0.61*** (0.13)	1.56*** (0.08)	0.61*** (0.13)
Number of portfolios	475	475	475	475	475	475
Number of firms	118.00	118.00	118.00	118.00	118.00	118.00
Log likelihood	-3601.41	-3296.44	-3601.58	-3296.57	-3600.20	-3296.55
Degrees of freedom	1.00	22.00	1.00	22.00	1.00	22.00
Wald chi square	0.33	1036.17	0.00	1094.90	6.99	1108.37

Standard errors in parentheses, + p<0.1 * p<0.05 ** p<0.01 *** p<0.001. The criteria of balanced strong coopetition are as follows: [1] over mean, [2] over mean + 0.5 SD, [3] over mean+1SD.

TABLE 5.11: The Effects of the Ratio of Balanced-Strong Coopetition (High Market Competition and High Cooperation) on Overall Innovation in an Alliance Portfolio (cont.)

Variables	Model 37	Model 37b	Model 38	Model 38b	Model 39	Model 39b
	w/o controls	with controls	w/o controls	with controls	w/o controls	with controls
Controls		Not reported		Not reported		Not reported
Port_ blncstrng _ mktcomp_tiecoop[1]	1.47 (1.13)	0.54* (0.24)				
Port_ blncstrng _ mktcomp_tiecoop[2]			1.27 (2.41)	0.20 (0.51)		
Port_ blncstrng _ mktcomp_tiecoop[3]					0.00 (.)	0.00 (.)
Constant	7.96*** (0.33)	4.95*** (0.51)	8.04*** (0.31)	5.00*** (0.50)	8.07*** (0.30)	5.00*** (0.49)
Lnalpha	1.56*** (0.08)	0.61*** (0.13)	1.56*** (0.08)	0.61*** (0.13)	1.57*** (0.08)	0.61*** (0.13)
Number of portfolios	475	475	475	475	475	475
Number of firms	118.00	118.00	118.00	118.00	118.00	118.00
Log likelihood	-3599.83	-3295.80	-3601.24	-3296.76	-3601.58	-3296.80
Degrees of freedom	1.00	22.00	1.00	22.00	1.00	22.00
Wald chi square	1.69	1027.90	0.28	1072.83	.	1026.04

Standard errors in parentheses, + p<0.1 * p<0.05 ** p<0.01 *** p<0.001. The criteria of balanced strong coopetition are as follows: [1] over mean, [2] over mean + 0.5 SD, [3] over mean+1SD. There is no observation at Port_balstrng_mkt _tie_ratio [3]

TABLE 5.12: The Effects of the Ratio of Balanced-Strong Coopetition (High Technology Competition and High Cooperation) on Coopetition-Based Innovation in an Alliance Portfolio

Variables	Model 40	Model 40b	Model 41	Model 41b	Model 42	Model 42b
	w/o controls	with controls	w/o controls	with controls	w/o controls	with controls
Controls		Not reported		Not reported		Not reported
Port_ blncstrng _ techcomp_typecoop[1]	2.89*** (0.48)	1.26*** (0.21)				
Port_ blncstrng _ techcomp_typecoop[2]			2.06* (0.84)	1.26*** (0.38)		
Port_ blncstrng _ techcomp_typecoop[3]					7.27*** (1.73)	2.08 (1.39)
Constant	6.27*** (0.30)	4.54*** (0.51)	6.94*** (0.30)	4.47*** (0.53)	6.92*** (0.29)	4.45*** (0.51)
Lnalpha	1.79*** (0.09)	1.14*** (0.12)	1.85*** (0.09)	1.17*** (0.12)	1.84*** (0.09)	1.18*** (0.12)
Number of portfolios	475	475	475	475	475	475
Number of firms	118.00	118.00	118.00	118.00	118.00	118.00
Log likelihood	-2895.72	-2716.97	-2913.23	-2724.36	-2908.77	-2727.17
Degrees of freedom	1.00	22.00	1.00	22.00	1.00	22.00
Wald chi square	35.95	721.72	5.97	826.96	17.66	753.54

Standard errors in parentheses, + p<0.1 * p<0.05 ** p<0.01 *** p<0.001. The criteria of balanced strong coopetition are as follows: [1] over mean, [2] over mean + 0.5 SD, [3] over mean+1SD.

TABLE 5.12: The Effects of the Ratio of Balanced-Strong Coopetition (High Technology Competition and High Cooperation) on Coopetition-Based Innovation in an Alliance Portfolio (cont.)

Variables	Model 43	Model 43b	Model 44	Model 44b	Model 45	Model 45b
	w/o controls	with controls	w/o controls	with controls	w/o controls	with controls
Controls		Not reported		Not reported		Not reported
Port_ blncstrng _ techcomp_tiecoop[1]	4.39* (1.71)	1.48** (0.50)				
Port_ blncstrng _ techcomp_tiecoop[2]			6.99** (2.30)	1.06 (0.74)		
Port_ blncstrng _ techcomp_tiecoop[3]					10.65*** (2.78)	-0.88 (0.82)
Constant	6.61*** (0.42)	4.41*** (0.50)	6.72*** (0.37)	4.41*** (0.51)	6.85*** (0.34)	4.40*** (0.51)
Lnalpha	1.81*** (0.10)	1.17*** (0.12)	1.81*** (0.10)	1.19*** (0.12)	1.83*** (0.10)	1.19*** (0.12)
Number of portfolios	475	475	475	475	475	475
Number of firms	118.00	118.00	118.00	118.00	118.00	118.00
Log likelihood	-2900.81	-2724.95	-2900.81	-2727.90	-2904.71	-2728.34
Degrees of freedom	1.00	22.00	1.00	22.00	1.00	22.00
Wald chi square	6.59	1197.07	9.22	989.09	14.71	1387.99

Standard errors in parentheses, + p<0.1 * p<0.05 ** p<0.01 *** p<0.001. The criteria of balanced strong coopetition are as follows: [1] over mean, [2] over mean + 0.5 SD, [3] over mean+1SD.

TABLE 5.13: The Effects of the Ratio of Balanced-Strong Coopetition (High Market Competition and High Cooperation) on Coopetition-Based Innovation in an Alliance Portfolio

Variables	Model 46	Model 46b	Model 47	Model 47b	Model 48	Model 48b
	w/o controls	with controls	w/o controls	with controls	w/o controls	with controls
Controls		Not reported		Not reported		Not reported
Port_ blncstrng _ mktcomp_typecoop[1]	0.41 (0.37)	0.67** (0.21)				
Port_ blncstrng _ mktcomp_typecoop[2]			0.58 (0.96)	0.56+ (0.34)		
Port_ blncstrng _ mktcomp_typecoop[3]					5.11** (1.67)	3.30*** (0.83)
Constant	6.98*** (0.34)	4.35*** (0.52)	7.05*** (0.29)	4.44*** (0.52)	7.05*** (0.31)	4.46*** (0.51)
Lnalpha	1.86*** (0.09)	1.17*** (0.12)	1.86*** (0.09)	1.19*** (0.12)	1.86*** (0.09)	1.18*** (0.12)
Number of portfolios	475	475	475	475	475	475
Number of firms	118	118	118	118	118	118
Log likelihood	-2915.69	-2724.58	-2915.87	-2727.57	-2914.62	-2727.29
Degrees of freedom	1.00	22.00	1.00	22.00	1.00	22.00
Wald chi square	1.19	846.57	0.36	900.92	9.31	1101.57

Standard errors in parentheses, + p<0.1 * p<0.05 ** p<0.01 *** p<0.001. The criteria of balanced strong coopetition are as follows: [1] over mean, [2] over mean + 0.5 SD, [3] over mean+1SD.

TABLE 5.13: The Effects of the Ratio of Balanced-Strong Coopetition (High Market Competition and High Cooperation) on Coopetition-Based Innovation in an Alliance Portfolio (cont.)

Variables	Model 49	Model 49b	Model 50	Model 50b	Model 51	Model 51b
	w/o controls	with controls	w/o controls	with controls	w/o controls	with controls
Controls		Not reported		Not reported		Not reported
Port_ blncstrng _ mktcomp_tiecoop[1]	2.42+ (1.37)	1.22** (0.47)				
Port_ blncstrng _ mktcomp_tiecoop[2]			2.49	(2.83) 0.61	(1.24)	
Port_ blncstrng _ mktcomp_tiecoop[3]					0.00	(.) 0.00
Constant	6.91*** (0.35)	4.38*** (0.50)	(0.51) 7.03***	(0.32) 4.42***	(0.51) 7.09***	(0.31) 4.42***
Lnalpha	1.85*** (0.09)	1.18*** (0.12)	(0.12) 1.86***	(0.09) 1.19***	(0.12) 1.86***	(0.09) 1.19***
Number of portfolios	475	475	475	475	475	475
Number of firms	118.00	118.00	118.00	118.00	118.00	118.00
Log likelihood	-2912.70	-2726.00	-2915.18	-2728.29	-2916.13	-2728.44
Degrees of freedom	1.00	22.00	1.00	22.00	1.00	22.00
Wald chi square	3.11	953.52	0.77	812.81	.	800.68

Standard errors in parentheses, + p<0.1 * p<0.05 ** p<0.01 *** p<0.001. The criteria of balanced strong coopetition are as follows: [1] over mean, [2] over mean + 0.5 SD, [3] over mean+1SD. There is no observation at Port_balstrng_mkt _tie_ratio [3]

5.6 The Moderating Role of Coopetition Capability in Innovation

Hypothesis 4a predicts that a focal firm's coopetition experience will positively moderate the relationship between balanced-strong coopetition and the focal firm's coopetition-based innovation performance. To test the hypothesis, I captured coopetition experience in two different ways. First, I measured the accumulated number of alliances with competitors (partners belonging to the same 4-digit SIC code). Second, I measured the adjusted number of coopetition experiences by the types of alliance. That is, I calculated the adjusted number of coopetition experiences by multiplying the number of coopetitions with *Type_coop*. The results are almost identical in both approaches, and therefore, I report only the results by using the accumulated number of coopetitions in Tables 5.14, 5.15, 5.16 and 5.17. The results using the adjusted number of coopetition experiences are reported on Appendix C.

The results provide only very modest and partial support to the hypothesis. Coopetition experience positively moderates only the relationship between coopetition (*Tech_comp* and *Type_coop*) and coopetition-based innovation (model 54b). This result suggests that firms with more coopetition experience can generate greater innovation performance in coopetition in terms of technology competition and type strength than firms with less coopetition experience. However, coopetition experience does not affect the relationship between coopetition in other combinations and innovation. There are two possible reasons for the weak support for the hypothesis. First, the main effects of coopetition experience are strong, but the interaction effects are limited. Second, coopetition experience partially overlapped with *Tie_coop* (correlations are 0.1975) because repeated ties include pre-sample coopetitions with the same partner. Therefore, interaction effects are limited. In the following section, I report the results of the qualitative case study research that addresses some limitations of the study of coopetition capabilities and helps to provide illustrative support insights.

TABLE 5.14: The Moderating Role of Coopetition Experience in the Relationship between Coopetition (*Tech_comp* and *Type_coop*) and Coopetition-Based Innovation

Variables	Model 52	Model 52b	Model 53	Model 53b	Model 54	Model 54b
	w/o controls	with controls	w/o controls	with controls	w/o controls	with controls
Controls		Not reported		Not reported		Not reported
Expn_cooptn_num	0.31** (0.11)	0.14* (0.07)	0.33*** (0.09)	0.17** (0.06)	0.32*** (0.09)	0.17** (0.06)
Expn_cooptn_num^2	-0.05* (0.02)	-0.03** (0.01)	-0.05** (0.02)	-0.03** (0.01)	-0.04** (0.02)	-0.03** (0.01)
Tech_comp			2.02*** (0.21)	1.81*** (0.13)	2.03*** (0.18)	1.84*** (0.11)
Tech_comp^2			0.88 (0.70)	-0.28 (0.54)	1.01 (0.66)	-0.30 (0.53)
Type_coop			0.10*** (0.03)	0.04* (0.01)	0.10*** (0.02)	0.03* (0.01)
Type_coop^2			-0.01*** (0.00)	-0.002 (0.00)	-0.01*** (0.00)	-0.001 (0.00)
Techcomp _typecoop					0.09** (0.03)	0.01 (0.02)
Expn_ techcomp					-0.13*** (0.04)	-0.03 (0.03)
Expn_ typecoop					0.002 (0.00)	-0.01** (0.00)
Expn_techcomp _typecoop					-0.01 (0.02)	0.02* (0.01)
Constant	7.50*** (0.45)	4.98*** (0.48)	5.51*** (0.40)	4.65*** (0.52)	5.47*** (0.39)	4.68*** (0.54)
Lnalpha	1.67*** (0.11)	1.20*** (0.10)	1.55*** (0.11)	1.06*** (0.10)	1.55*** (0.11)	1.05*** (0.10)
Number of alliances	1930	1930	1930	1930	1930	1930
Number of firms	118.00	118.00	118.00	118.00	118.00	118.00
Log likelihood	-2912.70	-14514.86	-13950.33	-14366.03	-14356.86	-13782.99
Degrees of freedom	2	23	6	27	10	31
Wald chi square	8.88	5932.24	520.10	13683.31	3099.09	38030.92

Standard errors in parentheses, + p<0.1 * p<0.05 ** p<0.01 *** p<0.001.

TABLE 5.15: The Moderating Role of Coopetition Experience in the Relationship between Coopetition (*Tech_comp* and *Tie_coop*) and Coopetition-Based Innovation

Variables	Model 55	Model 55b	Model 56	Model 56b
	w/o controls	with controls	w/o controls	with controls
Controls		Not reported		Not reported
Expn_cooptn_num	0.30*** (0.09)	0.16** (0.06)	0.31*** (0.09)	0.18** (0.06)
Expn_cooptn_num^2	-0.04** (0.02)	-0.03** (0.01)	-0.04* (0.02)	-0.03** (0.01)
Tech_comp	1.87*** (0.21)	1.76*** (0.14)	1.93*** (0.17)	1.82*** (0.15)
Tech_comp^2	0.43 (0.74)	-0.35 (0.53)	0.36 (0.70)	-0.41 (0.51)
Tie_coop	0.03 (0.02)	0.02** (0.01)	0.04 (0.03)	0.02 (0.01)
Tie_coop^2	-0.0002 (0.00)	-0.0003+ (0.00)	-0.001 (0.00)	-0.001*** (0.00)
Techcomp_tiecoop			0.04+ (0.02)	0.03 (0.02)
Expn_ techcomp			-0.17*** (0.05)	-0.06+ (0.03)
Expn_ tiecoop			0.002 (0.01)	0.002 (0.00)
Expn_ techcomp_tiecoop			-0.02 (0.01)	-0.01 (0.01)
Constant			6.11*** (0.37)	5.00*** (0.52)
Lnalpha			1.55*** (0.11)	1.06*** (0.10)
Number of alliances			1930	1930
Number of firms			118.00	118.00
Log likelihood			-14363.46	-13786.89
Degrees of freedom			10.00	31.00
Wald chi square			5117.53	128996.97

Standard errors in parentheses, + p<0.1 * p<0.05 ** p<0.01 *** p<0.001.

TABLE 5.16: The Moderating Role of Coopetition Experience in the Relationship between Coopetition (*Market_comp* and *Type_coop*) and Coopetition-Based Innovation

Variables	Model 57		Model 57b		Model 58		Model 58b	
	w/o controls		with controls		w/o controls		with controls	
Controls			Not reported				Not reported	
Expn_cooptn_num	0.34***	(0.10)	0.16*	(0.07)	0.35***	(0.11)	0.16*	0.35***
Expn_cooptn_num^2	-0.05**	(0.02)	-0.03**	(0.01)	-0.05**	(0.02)	-0.03**	-0.05**
Market_comp	0.90**	(0.29)	0.98***	(0.16)	0.91**	(0.28)	0.98***	(0.15)
Market_ comp^2	-1.68	(1.06)	-0.78	(0.48)	-1.72+	(0.99)	-0.81+	(0.48)
Type_coop	0.13***	(0.02)	0.05***	(0.01)	0.12***	(0.02)	0.05***	(0.01)
Type_coop^2	-0.02***	(0.00)	-0.002	(0.00)	-0.02***	(0.00)	-0.003	(0.00)
Mktcomp _typecoop					-0.004	(0.04)	-0.04	(0.03)
Expn_ mktcomp					-0.001	(0.06)	0.02	(0.03)
Expn_ typecoop					0.01	(0.01)	-0.0004	(0.00)
Expn_mktcomp _typecoop					-0.004	(0.01)	0.01	(0.01)
Constant	6.56***	(0.45)	4.34***	(0.48)	6.58***	(0.46)	4.24***	(0.46)
Lnalpha	1.65***	(0.11)	1.18***	(0.10)	1.65***	(0.11)	1.18***	(0.10)
Number of alliances	1930		1930		1930		1930	
Number of firms	118		118		118		118	
Log likelihood	-14491.17		-13924.03		-14490.56		-13922.82	
Degrees of freedom	6		27		10		31	
Wald chi square	126.08		7494.37		192.14		20001.18	

Standard errors in parentheses, + p<0.1 * p<0.05 ** p<0.01 *** p<0.001.

TABLE 5.17: The Moderating Role of Coopetition Experience in the Relationship between Coopetition (*Market_comp* and *Tie_coop*) and Coopetition-Based Innovation

Variables	Model 59		Model 59b		Model 60		Model 60b	
	w/o controls		with controls		w/o controls		with controls	
Controls			Not reported				Not reported	
Expn_cooptn_num	0.28**	(0.10)	0.15*	(0.07)	0.27**	(0.10)	0.15*	(0.07)
Expn_cooptn_num^2	-0.04*	(0.02)	-0.03**	(0.01)	-0.04*	(0.02)	-0.03**	(0.01)
Market_comp	0.94***	(0.20)	0.99***	(0.15)	0.91***	(0.21)	0.96***	(0.13)
Market_ comp^2	-1.53*	(0.77)	-0.79+	(0.42)	-1.44+	(0.76)	-0.75+	(0.43)
Tie_coop	0.09***	(0.02)	0.07***	(0.01)	0.10***	(0.02)	0.08***	(0.01)
Tie_coop^2	-0.001***	(0.00)	-0.001***	(0.00)	-0.001***	(0.00)	-0.001***	(0.00)
Mktcomp_tiecoop					0.001	(0.04)	-0.01	(0.02)
Expn_mktcomp					0.03	(0.05)	0.04	(0.03)
Expn_ tiecoop					-0.01	(0.00)	-0.002	(0.00)
Expn_ mktcomp_tiecoop					0.003	(0.02)	0.01	(0.01)
Constant	7.11***	(0.41)	4.69***	(0.49)	7.11***	(0.41)	4.71***	(0.49)
Lnalpha	1.64***	(0.12)	1.16***	(0.10)	1.63***	(0.12)	1.16***	(0.10)
Number of alliances	1930		1930		1930		1930	
Number of firms	118		118		118		118	
Log likelihood	-14468.08		-13907.09		-14465.50		-13905.46	
Degrees of freedom	6		27		10		31	
Wald chi square	943.15		19557.90		2357.83		15513.82	

Standard errors in parentheses, + p<0.1 * p<0.05 ** p<0.01 *** p<0.001.

5.7 Results of Qualitative Research: A Case Study[19]

I conducted an exemplar case of balanced-strong coopetition, i.e., a joint venture called S-LCD between two rivals Samsung Electronics and Sony Corporation. Results of the case study help to illustrate the following:

(1) The nature of the relationship between Samsung and Sony before establishing the joint venture, which shows that this is a balanced-strong coopetition case

(2) The way the coopetition was formed and evolved over time (from the balance perspective)

(3) The outcomes of the coopetition

(4) Samsung's and Sony's coopetition capabilities and their impact on value appropriation from the coopetition.

5.7.1 Analysis on an ex-ante relationship between partners

Competitive relationship between partners. Sony Corporation and Samsung Electronics have similar resources and status[20]. As Table 5.18 shows, the two firms have similar assets, sales volume, and brand rankings. Further, Sony Corporation and Samsung Electronics are major players in Japan and Korea, respectively, in consumer electronics.

TABLE 5.18: Comparison between Sony Corporation and Samsung Electronics

Resources	Samsung Electronics [a]		Sony Corporation	
	2003	2009	2003	2009
Total Assets (US$ million)	32,751	101,355	83,786	137,714
Sales (US$ million)	54,114	119,103	67,178	77,216
Global Brand (Ranking)	25	19	20	34

Source: Annual Reports of Sony and Samsung Electronics, USPTO, Business Week.
[a] Samsung Electronics data is based on consolidated financial statements. Total assets in 2003 are based on non-consolidated financial data.

[19] Some parts of this section (e.g., sections 5.7.2 and 5.7.3) are included in Gnyawali & Park (2011). I further expanded the case as it relates to coopetition capabilities and dynamics of coopetition.
[20] In terms of resources, the literature suggests that if firms have similar resources they can be direct competitors.

Moreover, the two firms are key competitors that operate in the same industry (primary SIC: 3651). They compete in various markets, including the TV market. Their business areas have increasingly overlapped over time.

TABLE 5.19: Sony Corporation's and Samsung Electronics' Businesses and Major Products

	Samsung Electronics	Sony Corporation
Primary SIC	3651 - Household audio and video equipment	3651 - Household audio and video equipment
Secondary SICs	3674 - Semiconductors and related devices 3661 - Telephone and telegraph manufacturing apparatus 3571 - Electronic computers 3572 - Computer storage devices	3944 - Games, toys, and children's vehicles 3652 - Prerecorded records and tapes 7812 - Motion picture & video production 6159 - Misc. business credit institutions
	Product (Global Ranking, Year)	Product (Global Ranking, Year)
Components	Semiconductor-Dram (#1, 2009) Semiconductor-Flash Memory (#1, 2009) TFT-LCD (#1, 2009)	
Hardware	LCD TV (#1, 2009) Handset (#2, 2009) Digital Camera (#3, 2009)	LCD TV (#3, 2009) Handset (Sony-Ericson) (#5, 2009) Digital Camera (#2, 2009) Game Console (#3, 2009)
Software		Film (Sony/Universal) (#3, 2009) Music (#2, 2009)

Sources: LexisNexis Academic, Annual Reports of Sony and Samsung Electronics

However, the relationship between the two firms is not so simple. Any comparison of Sony and Samsung Electronics will be inevitably inexact (Chang, 2008) due to their different firm histories, cultures (Japan vs. Korea), and businesses. Sony has long been a company that produces innovative consumer products, such as the Walkman and Compact Disc. It is expanding its businesses to the software industries, including movies, music, and games. Samsung Electronics, which is under Samsung Group, has long been identified as a manufacturer of parts (e.g., semiconductor and display) for the electronics industry (see Chang, 2008 for more detail). While

Samsung Electronics became a major electronics company by producing various consumer products (ranked number one in the TV market and number two in the handset market), the company is still very strong in component markets, ranking number two in the semiconductor industry (following Intel) as the largest producer of DRAM and flesh memory. In 2006, as liquid crystal display (LCD) became another key product area, Samsung created a separate division for the LCD business. In sum, the two firms are direct competitors in the same industry (SIC 3651), even though they have different strengths – Sony in software and Samsung in components manufacturing.

Cooperative relationship between partners. Start of cooperative relationships occurred through a buyer-supplier relationship between Samsung and Sony in the semiconductor industry. In 2001, Samsung became a supplier of flash memory to Sony. In the same year, Sony established a strategic alliance with Samsung in the memory stick business. The alliance was to strengthen technical cooperation by developing and marketing electronic products centered on Sony's memory stick technology. Samsung was to explore the use of Sony's memory sticks in its various products, including DVD players, mobile phones, personal computers, and televisions.

Overall, however, the relationship between Samsung and Sony before the joint venture was dominated by competition. Despite their fierce rivalry, the two firms established a joint venture (called S-LCD) in April 2004 to develop and produce 7th generation (motherglass size of 1 870 x 2 200mm) liquid crystal display (LCD) panels for flat screen TVs. The initial investment was US$1 billion from each firm, and they tripled their investment and moved on to the 8th generation technology within a few years. Samsung contributed its technological strengths in the LCD technology while Sony contributed its technological strengths and brand recognition in television.

5.7.2 Dynamics of Samsung-Sony coopeitition

I examined the dynamics of coopetition at two stages: the formation of coopetition and the evolution of coopetition. I observed that the balanced perspective is critical at both stages.

The formation of coopetition. My analysis of the coopetition suggests that a strong governance mode with balance and commitment of top management are important factors at the stage of coopetition formation. First, the two rival firms took a strong governance mode with balance. For S-LCD, the two rivals created an equity joint venture. Each party holds a 50 percent interest (Samsung owns 50 percent plus one share) in the venture, with the CEO of the joint venture coming from Samsung and the CFO from Sony. Therefore, the two firms have a strong governance mode with equal ownership and balanced influence over the joint venture. In terms of the type of alliance, the joint venture manufactures amorphous TFT liquid crystal display (LCD) panels for televisions and computers. The S-LCD originally produced seventh generation panels. In 2008, S-LCD extended to eighth-generation LCD panels. Each firm purchases 50 percent of the LCD panels that S-LCD produces. This is consistent with prior research in transaction cost economics that suggests that by adopting an equity joint venture structure, the hazards of opportunism can be mitigated because incentives are more closely aligned (Oxley, 1997; Oxley & Sampson, 2004; Sampson, 2004). Second, top management from the two firms had close relationships and gave strong commitments to the joint venture. For example, owing to a request from Sony, Mr. Jae-Yong Lee, the current president of Samsung Electronics and the eldest son of the Samsung group chairman, became a member of the board of directors of S-LCD. As Samsung possesses both LCD and PDP technologies, Sony wanted to a strong commitment to S-LCD from Samsung's top management.

The evolution of coopetition. The coopetitive relationship has evolved over time in response to changing environments. In Figure 5.10, I present areas of collaboration and

competition mainly through S-LCD and illustrate how coopetition evolved. The upper part of the figure illustrates areas of competition and the lower part illustrates collaboration; moving from left to right provides the evolution of coopetition from 2003 to 2010.

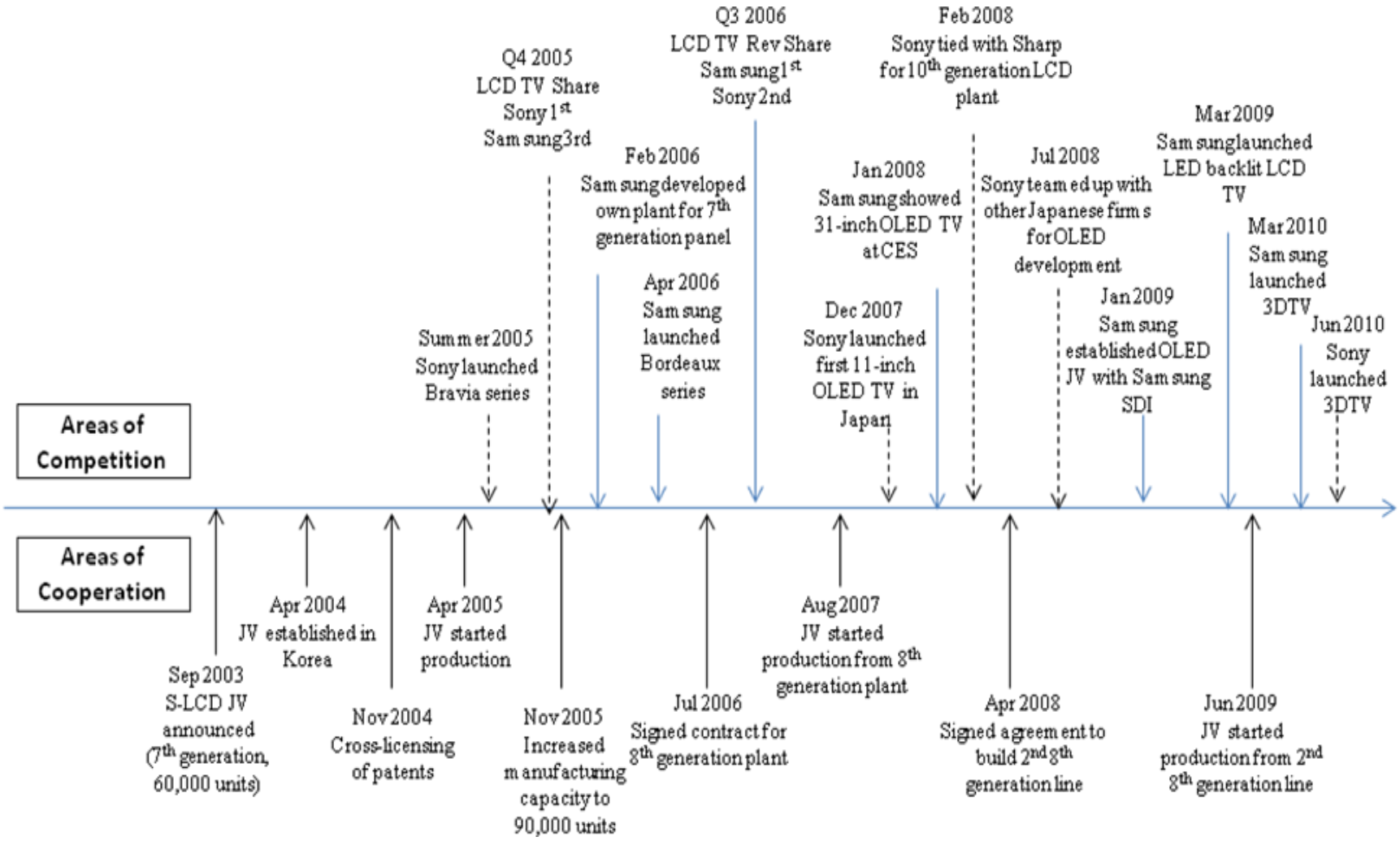
The S-LCD case clearly shows that, when the cooperation with competitors succeeds, both firms become more direct competitors. Before the joint venture, Samsung and Sony were not major players in the digital TV market. Sharp and Philips were ranked number one and two. However, Sony became number one when it introduced Bravia LCD TV using panels produced by S-LCD. And Samsung Electronics took the number one spot a year later with its Bordeaux series. Samsung and Sony became first and second in the market for four years from 2006 to 2009. Second, the two firms developed new products, such as LED TV and 3D TV, and display technologies, such as OLED, which are related to, but beyond, the alliance boundaries. Finally, in February 2008, Sony announced a joint venture with Sharp Corporation, the third largest LCD TV maker at that time, for tenth generation LCD panels. Through this LCD joint venture with another competitor, Sony has reduced its dependence on Samsung, which increases the balance of power between the two firms.

While continually competing with each other to be the industry leader, two partners can increase their cooperation as well. Since the establishment of S-LCD in 2004, Samsung and Sony have deepened their resource commitments to the venture. S-LCD started with seventh generation LCD panel production in April 2005 and the production capacity increased from 60,000 to 100,000 panels per month through additional investments. Based on their tremendous success with seventh generation technology, they invested in an eighth generation plant, which produces LCD panels of 46” and larger. S-LCD started eighth generation production in August 2007 with a production capacity of 50,000 substrates per month. In June 2009, S-LCD launched

a second eighth generation line with a production capacity of 70,000 substrates per month. Further, the two firms developed additional cooperative relationships beyond S-LCD. In November 2004, they reached a cross-licensing agreement that applied to over 20,000 patents, which facilitated knowledge sharing and product development. In the agreement, balance was critical. That is, they cross-licensed almost equal number of patents (11,000 patents from Samsung and 13,000 patents from Sony). Further, they balanced competition and cooperation, while facilitating a knowledge sharing approach that also protected their core knowledge. While facilitating knowledge sharing by cross-licensing, the two firms tried to maintain the uniqueness of each company and promoted healthy competition in the market. So-called "Differentiated Technology Patents," such as Sony's PlayStation architecture and Samsung's home networking technology, are excluded from the cross-licensing agreement. The agreement also does not apply to TFT-LCD and OLED display patents. In addition, the Sony group, including Samsung, won the DVD battle with its Blu-ray technology prevailing over the Toshiba group's HD-DVD. As a result, the two firms created multiple linkages during that period.

In sum, in the dynamics of coopetition, balance appears to be critical for the success of coopetition. At the formation of coopetition stage, two rivals can balance their influence and contributions to the joint venture through the governance mode (50:50 equity shares). At the evolution of the coopetition, coopetition may increase both competition and cooperation. When coopetition succeeds, partners become more direct competitors. Further, their competitive goals conflict because both firms are aiming for market leadership. Naturally, competitive tension was severe. From the balance perspective, for coopetition success, such increased competition should be balanced with increased cooperation. Partners can deepen their interdependence by finding additional opportunities to increase cooperation in other areas.

FIGURE 5.10
Evolution of Coopetition between Sony Corporation and Samsung Electronics



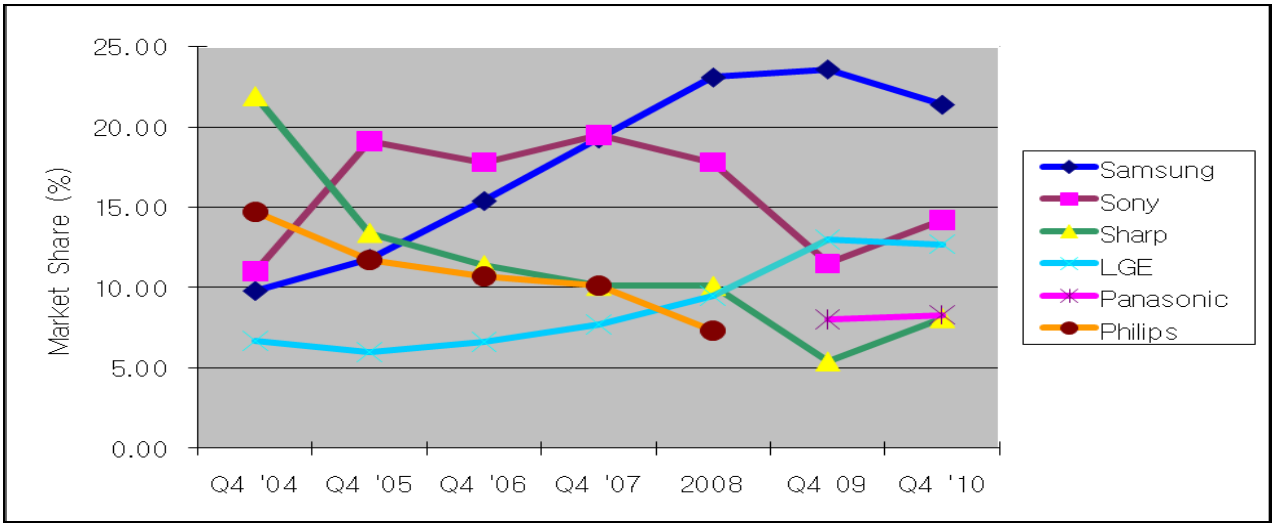
Source: Updated from Gnyawali & Park (2011)

5.7.3 Outcomes of Samsung-Sony coopetition

Coopetition between Samsung and Sony had a tremendous impact on both firms, the LCD segment, and the TV industry as a whole. I focused on how this coopetition enabled the firms to both create and appropriate value.

Value creation for the partners. The Samsung-Sony coopetition created substantial value for the firms. First, the success of S-LCD and its impact on the partners are evident when we look at the market shares (refer to Figures 5.11 and 5.12 for trends in market shares). Before S-LCD produced LCD panels, Sony and Samsung were ranked third and fourth among LCD TV manufacturers (behind Sharp and Philips). In the 4th quarter of 2010, however, Samsung and Sony were ranked as the first and second TV makers, respectively, in both the total TV market and the LCD TV segment (DisplaySearch, Feb 18, 2009). Furthermore, the combined market share of Samsung and Sony increased from 18.4 percent in the 3rd quarter of 2004 to 35.6 percent in 2010, while the combined share of other firms in the top 5 has decreased from 39.6 percent to 29.1 percent during the same period.

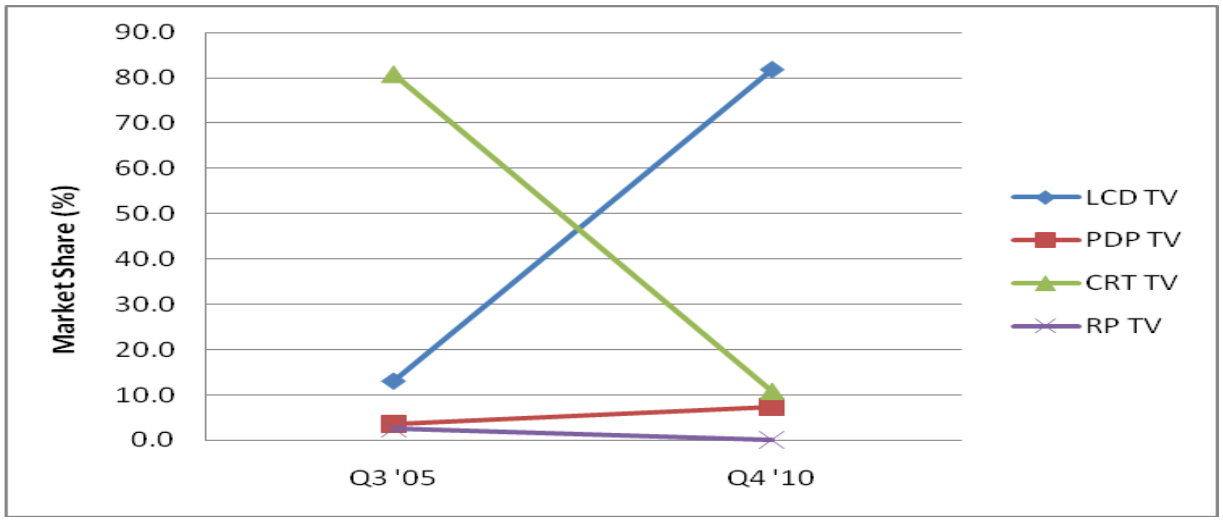
FIGURE 5.11
Market Share (Revenue Basis) of the Top Five Firms in the LCD TV Segment



Data for Q3 ’05 are based on units and Data for 2008 are for the whole year.
Source: DisplaySearch

Second, S-LCD created more value for both firms by winning the standardization battle between LCD and PDP technologies. The market share for the LCD segment grew from 13 percent in the 3rd quarter of 2005 (right after S-LCD started to produce LCD panels) to 81.8 percent in the 4th quarter of 2010. Even though the PDP segment increased from a 3.6 percent to 7.3 percent market share during the same period, LCD dominated the TV industry partly because the two leading firms, Samsung and Sony, focused on the LCD segment through their joint venture. While Matsushita (now Panasonic) and LG Electronics, rivals of Sony and Samsung in their domestic markets, focused on PDP, Samsung and Sony focused on LCD. LG and Panasonic increased their LCD products since 2008. As a result, LCD now leads the large flat panel TV segment.

FIGURE 5.12
Change in Market Share of Key TV Segments



Source: DisplaySearch

Value appropriation by the partners. Both partners were able to reap a lot of benefits from the collaboration and resulting coopetition. As mentioned earlier, Sony's TV business was suffering when the joint venture was announced in 2003. Through the partnership, Sony was able to quickly enter the large flat screen TV segment and get stable supply of LCD panels. As a

result, it was able to launch the Bravia model in a very short time. Because of Sony's brand name and expertise on TV, Bravia became an instant hit and Sony unseated Sharp from its top market position in LCD TV sales (refer to Figure 5.11). Thus, while Sony was experiencing deep problems in the flat screen TV market, the joint venture with a capable competitor enabled Sony to quickly catch-up with market trends.

Samsung seems to have appropriated even greater value from S-LCD. Samsung has set the technological standards in the industry by leveraging its internal technological strengths and technological and market leadership gained through the partnership with Sony. Samsung took the lead in the large sized LCD panel segment and gained a favorable position in the battle over technical standards. Since 2006, Samsung has been the leading company in the total TV market as well as the LCD segment, while Sony has been ranked second. Samsung is the largest LCD panel producer through its own plants in addition to the S-LCD plant. As a result, while Sony received strong returns through focused investment in LCD within a short period of time, Samsung became the largest TV maker and panel producer. It appears that firm-specific knowledge and capabilities played an important role in value appropriation from coopetition, which I discuss later.

5.7.4 The role of coopetition capabilities

In this section, I report how coopetition capabilities enable coopetition partners to generate benefits and long-term success. I investigated coopetition capabilities from three perspectives: 1) coopetition experience, 2) organizational structure – dedicated unit and divisional autonomy, and 3) coopetition mindset.

Coopetition experience. From 1994 to 2003 (during the 10-year period before the joint venture), Sony and Samsung have similar alliance experiences with 102 and 112 alliances,

respectively. About 30 percent (Sony 27.5 percent and Samsung 29.5 percent) of the alliances are coopetitions. To categorize coopetitions, I considered both primary and secondary SICs of a focal firm because the semiconductor business (SIC 3674) was the dominant business generating the largest revenue for Samsung even though its primary SIC code is 3651. Thus, coopetition is an alliance with any partner that has the same 4-digit SIC code as the focal firm's primary or secondary SIC code. Although Sony and Samsung engaged in a similar number of alliances and coopetitions, there are several important differences in the two firms' alliance compositions. First, compared to Samsung, Sony seems to prefer joint ventures more than strategic alliances. While 46.4 percent of Sony's established coopetitions are joint ventures, Samsung has only one coopetitive joint venture out of 33 alliances (3 percent). Also, while Sony is engaged in many multilateral partnerships, Samsung is mostly involved in bilateral relationships. The average number of partners in the alliances is 4.57 and 2.15 for Sony and Samsung, respectively. While only 35.7 percent Sony's coopetitions are bilateral relationships, Samsung prefers bilateral relationships (90.9 percent) when they engage in coopetition. Finally, the firms have different focuses on their coopetition types. While Sony's coopetitions involve R&D (42.9 percent), manufacturing (25.0 percent), and cross technology transfer (21.4 percent), the coopetitions of Samsung are more engaged in licensing (33.3 percent), R&D (30.3 percent), and supply agreement (24.2 percent). Thus, in terms of type strength of coopetition, Sony achieved a higher intensity of cooperation.

Sony has more joint ventures with competitors but Samsung has more bilateral strategic alliances with competitors. The effects on the two firms from their coopetition experiences may depend on such differences in alliance types. Literature suggests that bilateral coopetition is more challenging. In dynamic and rapidly changing environments, flexibility is critical. In terms of

flexibility, firms can obtain more benefits from strategic alliances than joint ventures and firms can adapt to the new environments more easily.

TABLE 5.20: Samsung and Sony's Coopetition Experiences[1]

	Sony Corporation	**Samsung Electronics**
Period	1994-2003	1994-2003
Number of coopetitions (Number of total alliances)	28 (102)	33 (112)
• JVC	13 (46.4%)	1(0.03%)
• Strategic alliances	15 (53.6%)	32(97.0%)
• Average number of partners	4.57	2.15
• Bilateral alliances	10 (35.7%)	30 (90.9%)
Coopetition Types[2]		
• R&D	12(42.9%)	10(30.3%)
• Manufacturing	7(25.0%)	5(15.2%)
• Cross Tech Transfer	6(21.4%)	1(3.0%)
• Tech Transfer	1(3.6%)	6(18.2%)
• Cross Licensing	0(0.0%)	3(9.1%)
• Marketing	3(10.7%)	4(12.1%)
• Licensing	4(14.3%)	11(33.3%)
• Royalties	1(3.6%)	3(9.1%)
• Supply agreement	1(3.6%)	8(24.2%)
Sum	35(125.0%)	51(154.5%)

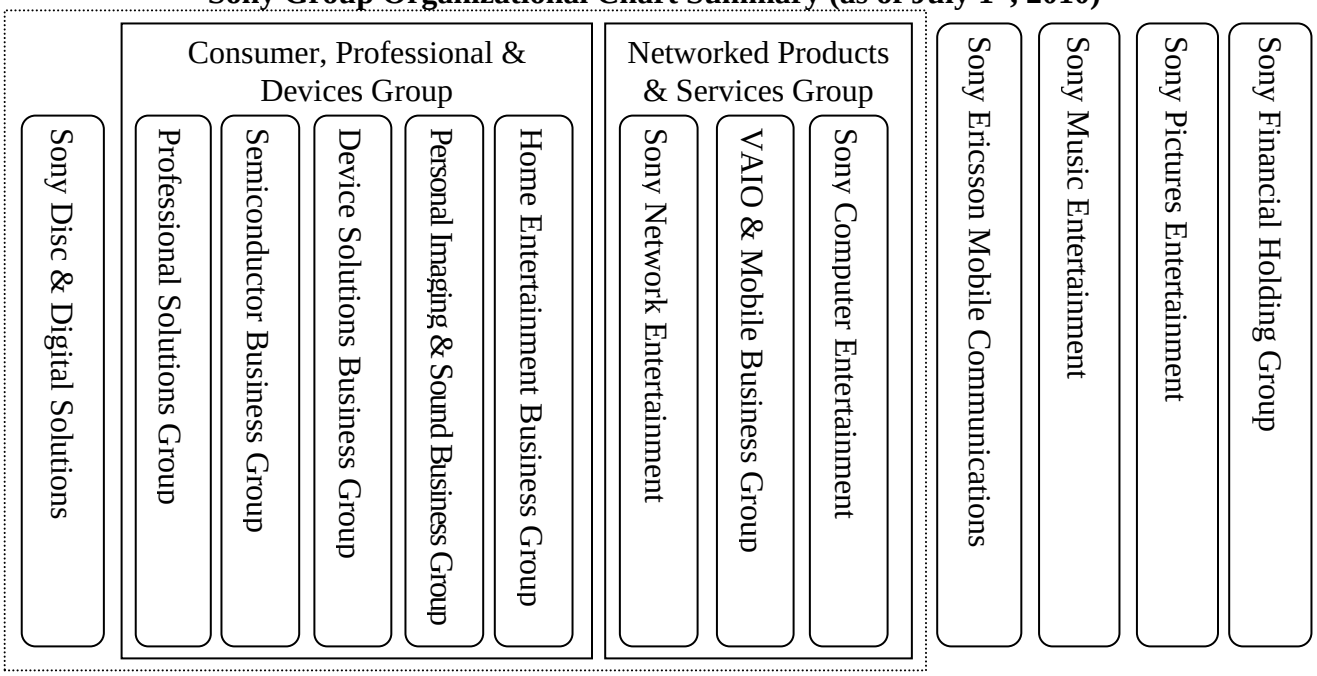
[1] Coopetition is an alliance with any partners having SIC code overlapped with a focal firm's primary or secondary SICs.
[2] Some alliance types are multi-counted. Percentage is calculated by dividing up number of types by number of coopetitions.

***Organizational structure: Combination of dedicated function and divisional autonomy*.** As discussed in section 5.7.1, both firms are engaged in various product markets. Although their organizational structures have changed somewhat, Samsung and Sony use a divisional structure, in which divisional managers make operating decisions (refer to Figures 5.13, 5.14, 5.15, and 5.16).

Both Samsung and Sony have very competitive cultures among individual divisions (Samsung) or groups (Sony) within the organization. Sony implemented a company structure in which individual product divisions have separate balance sheets and income statements, and operate almost like independent companies. The divisional structure offers clear accountability, but individual divisions can become too independent as Chang noted: "Sometimes product divisions in the same firm are "silos": they compete with each other rather than cooperate (Chang, 2008: p.106)."

Samsung Electronics has also maintained a strong business divisional structure. As of 2006, Samsung Electronics had five broadly defined divisions: digital media, telecommunications, digital appliances, semiconductors, and LCDs (refer to Figure 5.15). Within these divisions, there are 13 global business managers (GBM), which are more narrowly defined product lines, such as computers, mobile communications, and memory. The GBMs are in charge of production and sales for their businesses, are responsible for profitability, decide strategy, and manage foreign subsidiaries. The Samsung model is closer to the principle of a multidivisional structure in that it pays incentives to its employees according to their departments' and business divisions' performance (see Chang, 2008 for more detail).

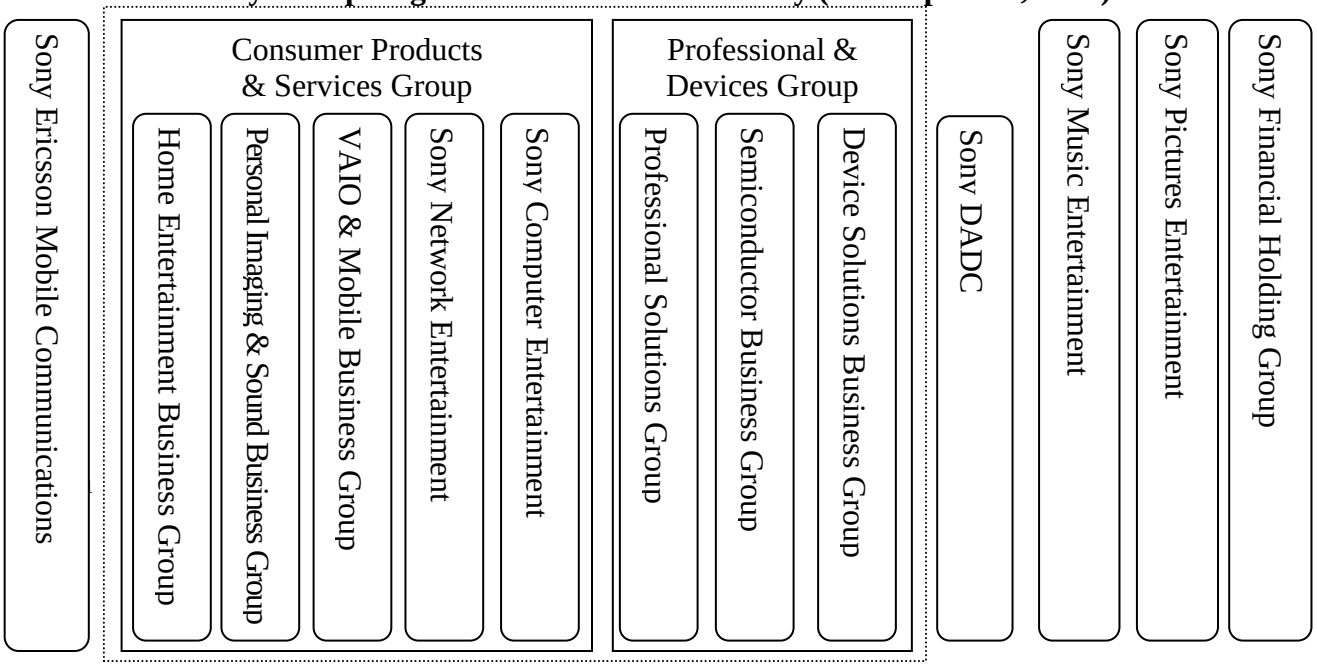
FIGURE 5.13
Sony Group Organizational Chart Summary (as of July 1st, 2010)



- Global Sales & Marketing Platform
- Manufacturing, Logistics, Procurement and CS Platform
- R&D, Common Software Platform

Source: Sony website (www.sony.net)

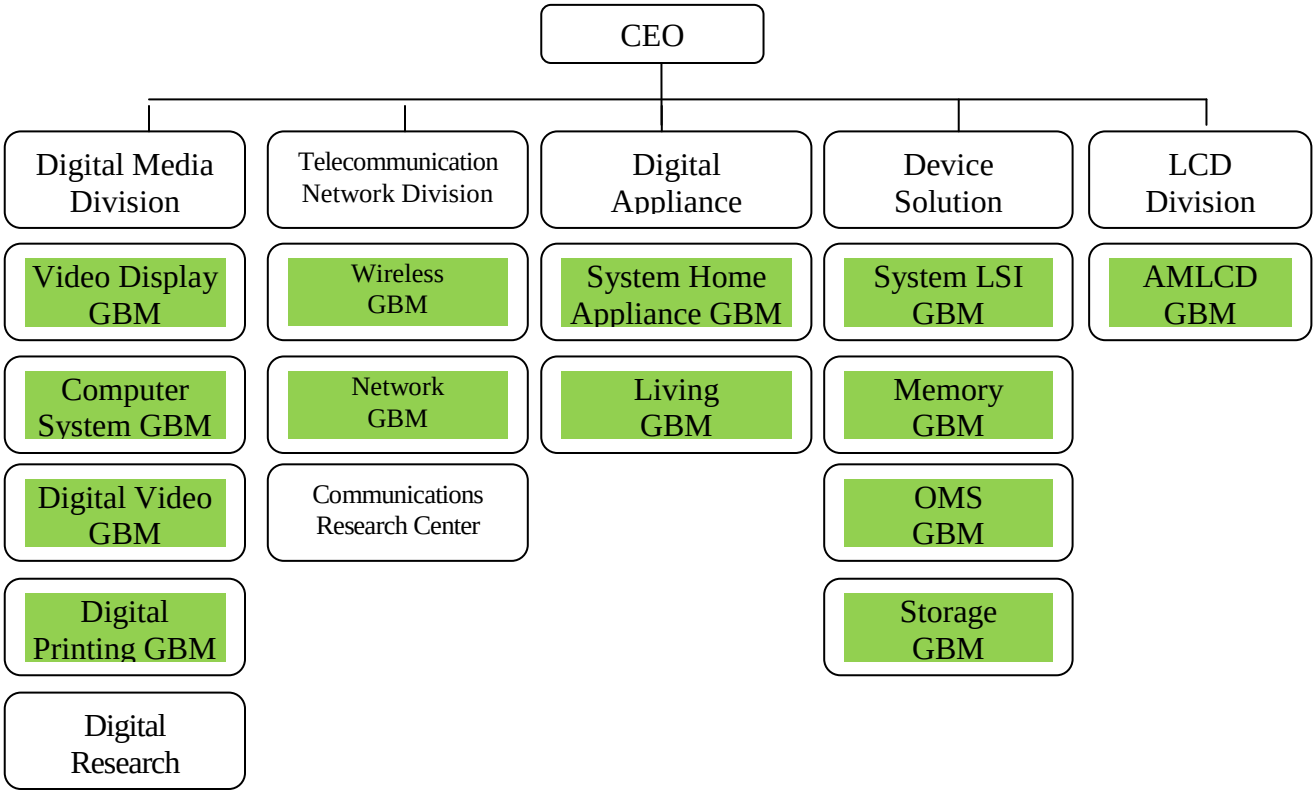
FIGURE 5.14
Sony Group Organizational Chart Summary (as of April 1st, 2011)



Common Platforms
- Global Sales & Marketing Platform
- Manufacturing, Logistics, Procurement and CS Platform
- R&D, Common Software Platform

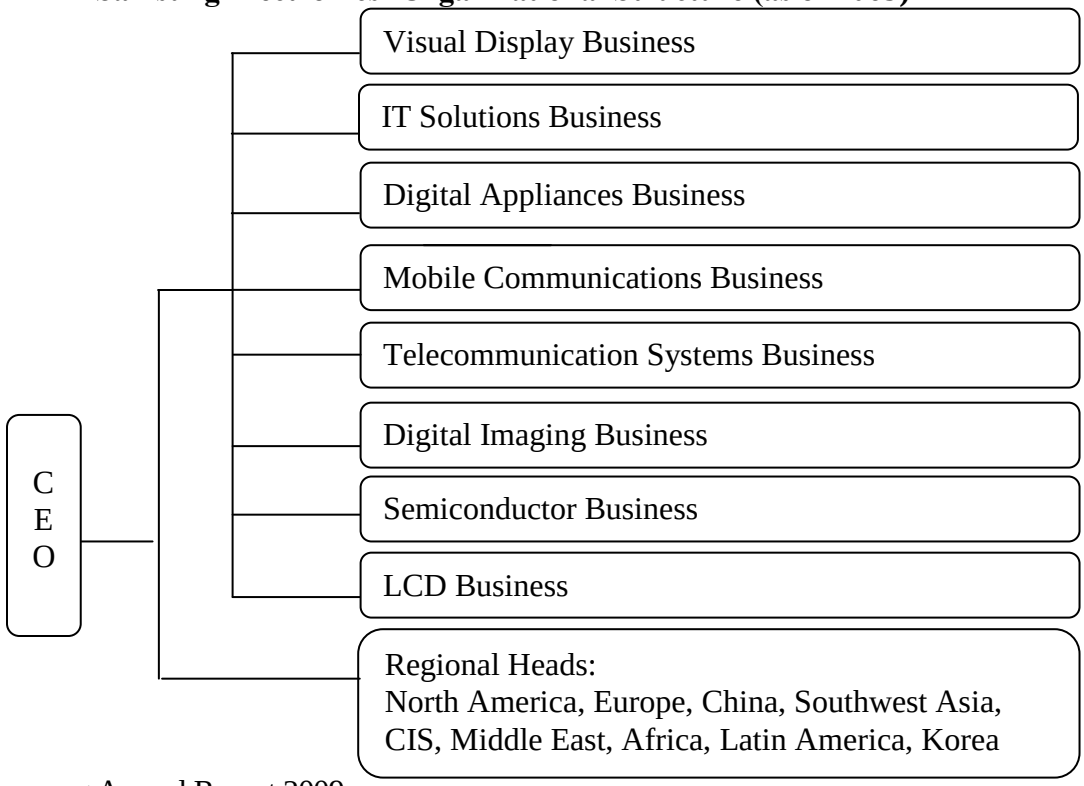
Headquarters

FIGURE 5.15
Samsung Electronics' Organizational Structure (as of 2006)



Source: Chang (2008: 130)

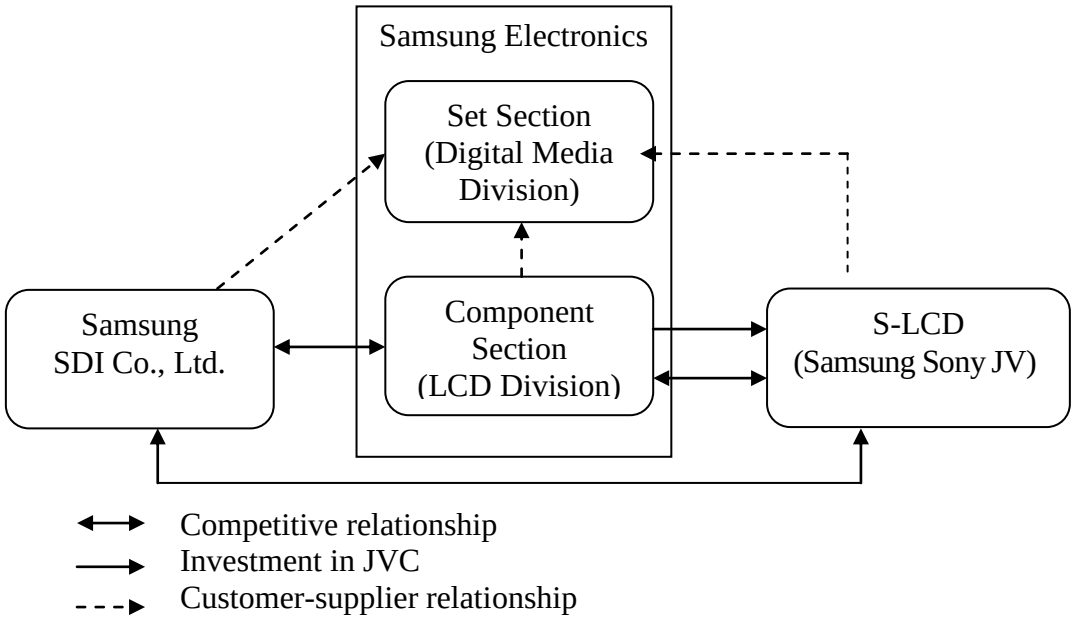
FIGURE 5.16
Samsung Electronics' Organizational Structure (as of 2009)



Source: Samsung Annual Report 2009

In short, the two firms have similar organizational structures (multi-divisional structure) where individual divisions or groups have a lot of autonomy that allows them to operate like independent companies. Therefore, inter-unit competition is severe. The natural question, then, is what are the differences between the two firms? A significant difference in the organizational structures is Samsung's unique business composition. As Figure 5.15 shows, Samsung Electronics has an organizational structure that is divided into set divisions (digital media, telecommunications, and digital appliances) and part divisions (semiconductors and LCDs). Although the firm changed its organizational structure in 2009, the businesses of Samsung Electronics were composed of set businesses and component businesses during most research periods. Further, "Samsung's different businesses, such as semiconductor, mobile communication, and LCD, compete with each other to demonstrate their units' achievements (Chang, 2008, p.133)." When Samsung's digital media division purchases LCD panel from S-LCD, they engage in price negotiate just like they do with external firms. Figure 5.17 shows how S-LCD is simultaneously competing and cooperating with different divisions of Samsung. Samsung's relationship with S-LCD is complicated. Samsung Electronics' LCD division has its own facilities and the digital media division produces both LCD TV and PDP TV. Thus, Samsung purchases LCD panels from not only S-LCD but also from its own LCD division. Also, the digital media division purchases PDP panels from Samsung SDI, an affiliate of the Samsung Group and the second largest PDP producer (following Panasonic). As a result, competition between units of Samsung Electronics (or broadly the Samsung Group) facilitates technological development and Samsung Electronics (i.e., digital media division) can provide wide range of products.

FIGURE 5.17
Samsung's Coopetition Capability from an Internal Structure Perspective



A natural follow-up question will be: how Samsung can handle conflicts stemming from internal competition and create synergies among its disparate divisions? Another fundamental difference between the structures of Samsung Electronics and Sony is that Samsung is controlled by a separate unit, which was originally named the "Office of Secretaries," and later changed to the "Group Strategic Planning Office."[21] It was a group-level staff organization that helps the Chairman of Samsung Group oversee individual affiliates. Thus, the strength of Samsung was explained by the "tripartite management system" that is composed of balanced cooperation among the Chairman of Samsung Group, the Group Strategic Planning Office, and the CEOs of individual affiliates (see Chang, 2008 for more detail). Of course, like most diversified enterprises that adopt a multidivisional structure, Sony also has corporate staff (i.e., headquarter) that supervises the performance of individual units (groups) and makes strategic decisions from a

[21] The unit was dissolved in 2009 and therefore the coordination function at the business group level has weakened.

corporate perspective. However, "Sony's headquarter has a minimal role and no power to induce resource sharing and cooperation (Chang, 2008: 123)."

In sum, Samsung seems to have a more desirable organizational structure for pursuing coopetition. Through the divisional structure, individual divisions have clear accountability and stay creative. The chairman of Samsung Group and his staff organization, a dedicated unit, coordinate conflicts and make strategic decisions at the corporate or business group level.

Coopetition Mindset. A win-win approach of open-minded executives was critical to success. Top management should oversee the big picture and search for new opportunities to cooperate with partners. Top management of both firms shows an open minded approach pursuing simultaneous cooperation and competition. Mr. Murayama says that, "in consumer electronics, it's hard to keep secrets long anyway, and being open with Samsung is key to making the joint venture work. If we put up barriers, they'll close up too" (WSJ, 2006)[22]. "The Sony-Samsung alliance is certainly a win-win," declares Sang Wan Lee, president of Samsung's LCD unit (BusinessWeek, 2006)[23].

Coopetition is full of conflicts. Role conflicts are especially serious obstacles to be addressed. To deal with role conflicts, the mindset of both top management and middle level managers is important to generate better performance. In terms of middle level managers' who are affected by corporate culture, there are some differences between the two firms. First, from a learning perspective, Samsung seems more active and progressive. As a late entrant to the electronics industry as compared to other global firms, Samsung Electronics has tried to maintain a willingness to learn from those firms. In contrast, Sony's past strengths and history of success with in-house technological development may have somewhat hindered it, when compared to

[22] http://buiznt.cob.calpoly.edu/cob/MGT/Pendergast/sp06/303/Sony-Samsung%20Rivalry%20and%20Alliance.htm (accessed on April 23, 2011).
[23] http://www.lifewhile.com/money/10420335/detail.html (accessed on April 23, 2011).

Samsung. "A 'Not Invented Here (NIH)' syndrome – the idea that if it is not invented by Sony, it is not good enough – makes Sony move slower than its rivals in the digital era. For Sony, who has taken pride in its reputation as a "do-it-yourself" innovator, the rapid regeneration of old technologies and the introduction of new ones have challenged Sony's ability to keep up with all the latest trends" (Luh, 2003, p.242). Perhaps this is why Sony did not invest in LCD or PDP while its competitors did. Instead, Sony tried to develop OLED technology (Luh, 2003). Involvement in S-LCD shows that Sony realized the importance of coopetition in the digital era.

Another difference lies in their corporate histories and business structures. Samsung has evolved from a firm producing key parts such as semiconductors and LCDs to a major manufacturer of consumer electronics. In the process, Samsung had cooperated with customers that were competitors in the final products. For example, as the second largest handset producer, Samsung is fiercely competing with major companies, such as Apple and Nokia. However, these firms are also major customers of Samsung's semiconductor and LCD divisions. That is, besides formal alliances, Samsung has developed customer-supplier relationships with competitors. Therefore, even though both Samsung and Sony have many alliance experiences, Samsung was able to develop a more critical mindset that is critical for pursuing coopetition.

In sum, Samsung seems to have the more favorable conditions to develop the coopetition capabilities that are critical for pursuing coopetition and managing the tension in the dynamic evolution of those relationships. First, Samsung has more bilateral agreement in coopetition, while Sony has engaged in more multilateral agreements. Through bilateral relationships, firms may be able to learn more critical know-how to deal with conflicts in coopetition. Second, Samsung has an ideal organizational structure with a combination of dedicated unit and divisional autonomy. Its set-part structure makes it possible to pursue coopetition and derive

benefits from the relationships, while a dedicated unit coordinates the relationship more effectively. Finally, through its business relationships and organizational structure, Samsung can naturally develop a coopetition mindset that is critical for coopetition success.

5.7.5 Summary of the case study

This case showed that coopetition can be successful, due to two critical factors: 1) balance and 2) participating firms' coopetition capabilities.

An important finding is that balance is a clear characteristic of coopetition. The two rivals established a joint venture with balance: 1) 50:50 equity shares, and 2) the CEO from Samsung and the CFO from Sony. Further, the coopetition has evolved with balance between competition and cooperation. One interesting finding was that the success of the joint venture caused severe competition between the two partners in the TV market. The increased competition was balanced with increased cooperation, including subsequent investment in the joint venture, cross patent exchange, and so on. A balanced formation and evolution seems critical to the coopetition's success, including growth of market share in the TV market, success in the display standardization battle (LCD vs. PDP), and a stable and long-term relationship[24].

Another important finding is that coopetition capabilities seem to play a critical role in the success of coopetition. I examined three components of coopetition capabilities: 1) coopetition experience, 2) coopetition mindset, and 3) organizational structure with a combination of divisional autonomy and a dedicated unit. The two partner firms have a lot of experience with coopetition and a well-developed coopetition mindset. Further, Samsung, which seems to appropriate more value from the coopetition, has a unique organizational structure with a combination of divisional autonomy and a dedicated unit. In sum, firms with coopetition

[24] According to Park and Russo (1996), alliances with competitors are more temporal. However, S-LCD is still operating after eight years.

capability seem to better manage complex coopetition issues than do firms with little or no coopetition capability.

5.8 Summary of Results

The purpose of this analysis was to empirically examine the research questions presented at the beginning of this study. The analysis tested hypotheses concerning the effects of the intensity of competition (hypothesis 1), the intensity of cooperation (hypothesis 2), and the balance of competition and cooperation (hypothesis 3a and 3b) on coopetition-based innovation. Further, using both quantitative and qualitative methods, I examined the moderating role of coopetition capability in the relationship between coopetition and innovation performance (hypotheses 4a, 4b, and 4c). The results empirically answered the research questions and provided support (or partial support) to most of the hypotheses.

I tested hypothesis 1 with two types of competition (*Tech_comp* and *Market_comp*) and hypothesis 2 with two types of cooperation (*Type_coop* and *Tie_coop)*. I tested hypotheses 3a and 3b using four different combinations to represent coopetition with two types of competition (*Tech_comp* and *Market_comp*) and two types of cooperation (*Type_coop* and *Tie_coop*). Hypotheses 4b and 4c are supported by the case study.

The results show that firms generated greater innovation performance when the intensity of competition, the intensity of cooperation, and the balance of competition and cooperation increase. Further, firms' coopetition capabilities positively moderate the relationship between coopetition and innovation performance.

TABLE 5.21: Summary of Hypotheses and Test Results

	Hypothesis	Test Results
H1	The intensity of competition between partners, in terms of both market competition and technology competition, will have an inverted U-shaped relationship with a focal firm's coopetition-based innovation performance. Specifically, a moderate level of competition between a focal firm and its partner contributes more to the focal firm's innovation output than do very low or very high levels of competition between partners.	**Significance**: Statistically significant with the variable "market competition (*Market_comp)"* **Direction**: As predicted (∩) **Decision**: Hypothesis is partially supported
H2	The intensity of cooperation, in terms of both the type-strength of a focal alliance and the strength of ties between two firms, will positively affect the focal firm's coopetition-based innovation performance, mainly in the dimensions of joint innovation and innovation through the application of partner knowledge, ceteris paribus.	**Significance**: Statistically significant **Direction**: As predicted (+) **Decision**: Hypothesis is supported
H3a	The greater intensity of competition between partners that is balanced with the greater intensity of cooperation between them, the greater the focal firm's coopetition-based innovation performance. Specifically, balanced-strong coopetition, based on a high degree of cooperation and a high degree of competition, contributes more to firm innovation than does cooperation-dominant, competition-dominant, or weak coopetition.	**Significance**: Statistically significant with *Tech_comp* and *Type_coop* combination across methods. Statistically significant with other combinatons with certain methods. **Direction**: As predicted (+) **Decision**: Hypothesis is partially supported
H3b	The higher the ratio of balanced-strong coopetition a firm has in its alliance portfolio, the greater the overall firm innovation performance, ceteris paribus.	**Significance**: Statistically significant with three (*Tech_comp* and *Type_coop*; *Tech_comp* and *Tie_coop; Market_comp* and *Tie_coop*) out of four combinations at over mean criteria **Direction**: As predicted (+) **Decision**: Hypothesis is partially supported

TABLE 5.21: Summary of Hypotheses and Test Results (Cont.)

	Hypotheses	Test Results
H4a	A focal firm's coopetition experience will positively moderate the relationship between balanced-strong coopetition and the focal firm's coopetition-based innovation performance.	**Significance**: Statistically significant with the combination of *Tech_comp* and *Type_coop* **Direction**: As predicted (+) **Decision**: Hypothesis is partially supported
H4b	Firms with executives that have a coopetition mindset will positively moderate the relationship between balanced-strong coopetition and the focal firm's coopetition-based innovation performance.	**Direction**: As predicted (+) **Decision**: Illustrative support is provided through case study
H4c	A focal firm's organizational structure with the combination of dedicated unit and divisional autonomy will positively moderate the relationship between balanced-strong coopetition and the focal firm's coopetition-based innovation performance.	**Direction**: As predicted (+) **Decision**: Illustrative support is provided through case study

6. DISCUSSSION AND IMPLICATIONS

In this dissertation, I examined the following research questions: 1) to what extent does coopetition impact firm innovation performance? and 2) to what extent does a firm's coopetition capability influence the relationship between coopetition and firm innovation performance? A review of the literature showed that firms have increasingly engaged in coopetition (Bengtsson & Kock, 2000; Luo, 2007a). Coopetition is particularly important for innovation in high tech industries (Dagnino & Rocco, 2009; Gnyawali et al., 2008) where firms confront challenges such as short product life cycles, technological convergence, and massive R&D costs (Gnyawali & Park, 2009). Scholars argue that coopetition is important to gain both cooperation benefits and competition benefits (Lado et al., 1997; Bengtsson et al., 2010). Despite the practical importance and increasing popularity of coopetition from the academic arena, research that has empirically examined the effects of coopetition on innovation is limited (Yami et al., 2010) and has reported inconsistent results. This underscored the need for a systematic examination of the effects of coopetition on innovation.

In addressing the inconsistent findings of the relationship between coopetition and innovation, this study attempted to shift the focus of discussion from whether coopetition is beneficial for innovation to how, when, and to what extent firms can reap the benefits of coopetition. To shift focus, I conceptualized coopetition with three aspects: 1) competition between partners, 2) cooperation between partners, and 3) the interplay between the two. As coopetition consists of the simultaneous pursuit of competition and cooperation, it is necessary to investigate the two elements together in order to understand complex, deeper situations. Although conceptual advancements have been made, empirical coopetition research has not systematically investigated the two elements or the interplay between the two.

Further, I noted that, even though coopetition provides opportunities to gain benefits that arise from both cooperation and competition, firms may not obtain all the benefits because managing coopetition is very challenging and complex. In this regard, I paid attention to the two possible factors to influence that potential innovation performance that firms can achieve from coopetition relationships: 1) the balance between competition and cooperation and 2) the role of a firm's coopetition capability.

First, this research demonstrated the importance of the balance between competition and cooperation in coopetition. As scholars (e.g., Gnyawali, 2010) suggest that a deeper examination of paradox is likely to develop a better understanding of coopetition, I noted that tension from paradoxical factors, such as competition versus cooperation and knowledge sharing versus knowledge protection, may play a critical role in coopetition-based innovation. In this regard, some scholars (e.g., Chen, 2008; Das & Teng, 2000) suggest that firms should balance the contradictory forces (i.e., competition and cooperation) to generate the most positive effects. Building on the transparadox (Chen, 2008) and balancing strategy (Das & Teng, 2000) perspectives, I suggested that coopetition tension may play a positive role (i.e., creative tension) in innovation when competition and cooperation are balanced.

Second, this study provided evidence that coopetition capability is critical to manage coopetition and generate greater performance. From the dynamic capability perspective, I note that understanding the role of a firm's specific capability to manage coopetition, which I term as "coopetition capability," is critical to examine the effects of coopetition on innovation. That is, the dynamic (Luo, 2007b) and paradoxical (Chen, 2008) nature of coopetition calls for understanding the moderating role of a firm's coopetition capability in the relationship between coopetition and innovation performance. A lack of proper capability to understand coopetition's

characteristics and manage paradoxical issues may lead to suboptimal performance. However, empirical research has not systematically examined how firms develop capabilities to deal with tension from such paradoxical phenomena and dynamic changes. I identified three important components of coopetition capabilities: 1) coopetition experience, 2) coopeititon mindset, and 3) organizational structure and then empirically examined them.

Based on the conceptual and methodological advancements, this study provided empirical evidence regarding the effects of coopetition and coopetition capability on coopetition-based innovation. First, it demonstrated that coopetition based on market competition (*Market_comp*) has an inverted-U shape with innovation, while coopetition based on technology competition (*Tech_comp*) has positive effects on innovation. Previous work based on market competition from a categorical approach reported inconsistent results, i.e., positive, negative, or no effects of coopetition on innovation. Using an ordinal scale, this study showed that coopetition based on market competition has a non-linear relationship with innovation. Further, it revealed that coopetition based on technology competition shows a different shape (positive relationship with innovation) than coopetition based on market competition. Second, it showed that, when competition and cooperation are considered together, the balance between competition and cooperation generates greater innovation performance from coopetition than does the unbalance between competition and cooperation. The optimal balance between competition and cooperation seems to be high intensity of competition and high intensity (*Type_coop)* or medium-high intensity (*Tie_coop)* of cooperation. Further, the case study suggests that the balance is important not only at the formation of coopetition but also at the evolution of coopetition. Finally, this study demonstrated the important role of coopetition capability in the relationship between coopetition and innovation.

Through both the case study and the qualitatitive study, this research provided several very significant findings that have important implications for research in coopetition, innovation, competition, and cooperation, in general. In the section below, I discuss the major findings and implications of my research. I also outline some limitations of the research and suggest directions for future research.

6.1 Discussion of Research Findings

6.1.1 The role of competition between partners in innovation

The results showed that the relationship between market competition and coopetition-based innovation is an inverted-U shape. However, the effects of technology competition (*Patent_simil)* are positive and significant instead of being an inverted-U relationship. The results imply that two different types of competition affect firm innovation differently, which explains two countervailing arguments and empirical reports on the effects of competition between partners on innovation performance in the literature. Chen (1996) suggested that market commonality and resource similarity are key indicators of competitors. Building on Chen's (1996) argument, Park, Gnyawali, & Srivastava (in press) suggest that two potentially countervailing forces will be at work in coopetition. First, similarity increases the likelihood of scanning and monitoring external resources, accessing and acquiring external resources, and leveraging these resources for competitive advantage (Cohen & Levinthal, 1990; Lane & Lubatkin, 1998; Mowery et al., 1996). Second, high similarity between the focal firm and its partners suggests that these firms are competitors with each other, thereby increasing the competitive tension (Chen, Su, & Tsai, 2007) and reducing the likelihood of the focal firm to access, acquire, and leverage knowledge from its portfolio of alliances.

The results of this study suggested that two countervailing forces – learning potential and competitive tension – play differently in market competition (*Market_comp*) and technology competition (*Tech_comp*). From the market competition perspective, the two countervailing forces play together. As the intensity of competition increases, the positive effects of learning potential increase, but the negative effects of competitive tension on alliance performance become dominant beyond a certain point. That is, when market commonality is high, opportunism is likely to increase because knowledge gained from the partner through a collaborative relationship can be used against the same partner in order to effectively compete in the market (Gnyawali & Park, 2009). Firms also worry about unintended knowledge leakage. This high competitive tension may cause a low level of knowledge sharing and a narrow scope of cooperation and, in turn, result in a low level of innovation output.

From the technology competition perspective, however, it seems that the benefits of learning potential from resource similarity outweigh the downside. The test results hypothesis 1 support the notion of relative absorptive capacity (Lane & Lubatkin, 1998). That is, the more experience the firms have in solving similar types of problems, the easier it will be for the focal firm to find ways to apply the newly assimilated knowledge (Lane & Lubatkin, 1998). Further, if the focal firm and its partners have high technological overlap, they are more likely to be aware of the value of a partner's knowledge and have a motivation to learn from them. The results can be explained from another perspective. Scholars argue that a coopetitive relationship frequently cooperates in upstream activities and compete in downstream activities (Bengtsson & Kock, 2000; Walley, 2007). As technology competition is more related to upstream activities, the results might be affected by both competition and cooperation. Nonetheless, the results are different from the arguments that the competitive tension and redundancies created from resource

similarity might inhibit firm innovation especially beyond a certain point. In this regard, I noted that there was an overlap between measures of technology competition and one segment of the dependent variable (i.e., coopetition-based innovation). Thus, the results should be interpreted cautiously.

6.1.2 The role of cooperation between partners in innovation

The results showed that both the type strength of a focal coopetition (*Type_coop*) and the strength of ties between two firms (*Tie_coop*) positively affect the focal firm's coopetition-based innovation. That is, when *Type_coop* or *Tie_coop* is high, firms can generate greater innovation performance through coopetition than when *Type_coop* or *Tie_coop* is low.

Transfer of tacit knowledge to solve complex problems may be the key in innovation in technical collaboration. This study suggested that the high intensity of *Type_coop* may facilitate innovation through the adaptation of practices, such as co-location (von Hippel, 1994) and working together on a regular basis, which makes possible the transfer of knowledge (Heiman & Nickerson, 2004) from both knowledge sharing (shared parts) and knowledge spillover (non-shared parts) (Lavie, 2006). This study also suggested that strong ties (i.e., high intensity of *Tie_coop*) at the dyadic level may facilitate innovation by reducing both motivational and cognitive problems of knowledge transfer (Szulanski, 1996), serving as a trust-based governance mechanism (Rowley et al., 2000), and facilitating reciprocity and long-term perspectives (Kogut, 1989; Uzzi, 1997).

Additional tests found that the effects of *Tie_coop* on innovation show an inverted-U shape. The results suggest that *Tie_coop* (repeated ties and multiple linkages with the same partners) may facilitate knowledge transfer, which may help innovation. However, beyond a certain point (very high intensity of *Tie_coop*), the transferred knowledge from partners with many repeated and

multiple relationships may not be beneficial to innovation. The results can be explained from multiple perspectives. First, the results suggest that the logic of structural embeddedness (i.e., the position of a given organization in a broader network structure) (Uzzi, 1999), can be applied to relational embeddedness (i.e., the dyadic relationships or ties between the actor and each of its partners) (Gulati, 1998). Similar to the notion of "overembeddedness" (Uzzi, 1999), tie strength positively affects innovation performance. However, ties that are too strong (many relationships with the same partners) may limit the number of new ideas that are critical for innovation or deter the focal firm from changing to meet the demands of new environments. Second, the results can be explained from a social capital perspective which suggests the role of social capital on knowledge (or resource) transfer (Tsai, 2002; van Wijk, Jansen, & Lyles, 2008), but does not reveal whether knowledge (or resource) transfer was beneficial to the organization (Maurer, Bartsch, & Ebers, 2011). That is, social capital developed through *Tie_coop* (repeated ties and concurrent linkages) merely provides opportunities for resource transfer but implies little about the extent to which resources are actually used (Maurer et al., 2011). Finally, the results can be explained from the context perspective. Daskalaki (2010) suggests that, in creative industries, balancing bonding and bridging of ties leads to the formation of persistent yet flexible network boundaries and identities that are constantly re-adjusted. Conguent with Daskalaki (2010), it is possible that, in the semiconductor industry in which the environment is rapidly changing, firms may need a certain degree of tie strength for knowledge transfer and a certain degree of flexibility (too high an intensity of *Tie_coop* may hurt the flexibility) to adapt to new environment.

6.1.3 The role of balance between competition and cooperation in innovation at the dyadic level

One of the key conceptual arguments advanced in this dissertation is that the balance between competition and cooperation enhances innovation performance. Using multiple approaches, I examined the role of balance between competition and cooperation in innovation.

The polynomial regression analysis that I introduced in the coopetition literature provides valuable information on the role of balance between competition and cooperation in innovation. Surfaces based on polynomial regression clearly show that when the intensity of *Tech_comp* is high, the innovation performance increases with an increase in the intensities of cooperation (*Type_coop* or *Tie_coop*) (Figures 5.6 and 5.7). At the optimal points, the intensity of competition in terms of both *Tech_comp* and *Market_comp* is high, while the intensity of cooperation is high (*Type_coop* in Figure 5.6) or medium-high (over the mean value but not so high) (*Tie_coop* in Figures 5.7 and 5.9). In short, polynomial regression analysis suggests that the balance between competition and cooperation is important to generate greater coopetition-based innovation. That is, the combination of high *Tech_comp* and high *Type_coop* generates the greatest innovation performance. Based on negative binomial regression coefficients, however, the optimal balance points are not symmetrical in the combination of competition and *Tie_coop*. Rather they lean against competition (i.e., high competition and medium-high (over the mean but not so high *Tie_coop*)).

Even though polynomial regression analysis has benefits in examining the interplay between two elements (i.e., competition and cooperation) of coopetition, I employed another approach – a dummy variable for balanced-strong coopetition because my primary focus was whether a balanced-strong coopetition (high competition and high cooperation) could generate greater innovation performance. The results were all positive and significant. That is, firms with

higher ratios of balanced-strong coopetition (i.e., high competition and high cooperation) in their alliance portfolios generate greater innovation performance than firms with lower ratios of balanced-strong coopetition do.

Further, the case study of S-LCD, an excellent example of balanced-strong coopetition, extends the balance logic further. That is, the case study suggests that balance between competition and cooperation is important even in the evolution stage of coopetition. The Samsung-Sony joint venture shows that the success of coopetition may cause higher intensity of competition between the two partners and the increased competition should be balanced with increased cooperation in the evolution of the coopetition.

Overall, the balance between competition and cooperation positively influences coopetition-based innovation performance. In terms of the combination between *Tech_comp* and *Type_coop*, the balance positively affects coopetition-based innovation. In terms of competition (*Tech_comp* or *Market_comp*) and *Tie_coop*, an optimal point of balance seems to be a high intensity of competition and medium-high intensity of *Tie_coop*. When they cooperate with more direct competitors, firms need stronger *Tie_coop* (higher than the mean value) to generate greater innovation performance. However, a high intensity of *Tie_coop* (e.g., too many repeated ties and/or concurrent multiple linkages) may hurt innovation.

6.1.4 The role of balanced-strong coopetition in innovation at the alliance portfolio

The concept of balance between competition and cooperation appears meaningful at the alliance portfolio level. Results showed that the ratio of balanced-strong coopetition in an alliance portfolio positively affects innovation performance with three out of four combinations of competition and cooperation. Only the combination between *Market_comp* and *Type_coop* was insignificant. Further, the effects of balanced-strong coopetition were significant only when

I used ‘over the mean value’ as the criterion to categorize balanced-strong coopetition, while using stronger level criteria (i.e., over mean + 0.5 standard deviation or over mean + 1 standard deviation) generated insignificant results.

The results suggest that the balancing strategy is also important at the portfolio alliance level. Consistent with dyadic level analysis, however, very high-level balance may reduce the positive effects. This can be explained by the polynomial regression analysis discussed above. That is, the optimal points (i.e., stationary points) in surfaces lie on the combination of high competition and medium cooperation (over the mean value but not high). It is interesting to note that the results at the portfolio level are consistent with the results of polynomial regression analysis at the dyadic level.

6.1.5 The moderating role of cooperation capability in innovation

A key conceptual advancement in this dissertation is the moderating role of coopetition capability in the relationship between coopetition and innovation performance. Through both qualitative and quantitative approaches, I examined coopetition capability along the following three elements: coopetition experience, coopetition mindset, and organizational structure.

The case study suggests that the coopetition mindset of top management and middle managers is critical to generating greater performance from a coopetition relationship. As coopetition is dynamic in nature (Luo, 2007b), the ratio between competition and cooperation changes during the coopetition period. As S-LCD became successful, the two competitor partners became more direct competitors. If only the intensity of competition between partners increases while the intensity of cooperation is constant, it is not likely that the relationship can continue. The literature reports that alliances with direct competitors are more temporal (Park & Russo, 1996). I observed that the two partner firms made subsequent investments in S-LCD and

expanded their cooperative relationships while the success of S-LCD led to more competition between them in the TV market. Thus, an increase in the intensity of competition was balanced by an increase in the intensity of cooperation. In short, to generate greater innovation performance in a coopetitive relationship, it is not enough to simply balance competition and cooperation at the beginning of the alliance, but the firm must also have the capability to create balance and manage that balance throughout the coopetition lifecycle. Literature suggests that elements of a coopetition mental model might include recognizing the importance of coopetition, scanning the environment for coopetition opportunities, and developing ways to effectively engage in actual collaborative relationships with competitors (e.g., Gnyawali & Park, 2009). Building on these ideas mentioned above, I suggested that a coopetition mindset includes continuously seeking a win-win method with competitor-partners during the partnership period. From the dynamic perspective, success in coopetition requires many capabilities, such as 1) to coordinate conflicts within the firm and between partners, 2) to estimate the evolving costs and benefits of coopetition, 3) to make necessary adjustments to the cooperation-competition ratio, and 4) to maintain the bargaining power balance. In sum, seeing a bigger picture with a win-win approach and balancing competition and cooperation in dynamic situations as well as understanding the importance of coopetition and capturing the coopetition opportunities are key factors of the coopetition mindset, which is one of the key success factors of coopetition.

From the case study, I also found that an organizational structure with a combination of a dedicated unit and divisional autonomy is important in managing a coopetition relationship. When firms can separate two units in a coopetition relationship - one to cooperate with the partner and the other to compete with the partner - the independence of the divisions with high degrees of autonomy can simplify the relationship. That is, firms can clarify the roles of

managers and employees who have been accustomed to pure competition or pure cooperative relationships. Thus, divisional autonomy can address the issue of role conflicts raised by Bengtsson and Kock (2008). Meanwhile, when individual divisions or groups with a lot of autonomy compete with each other to generate better contributions to the firm (which increases efficiency within a competitive culture), a dedicated unit is necessary to coordinate individual divisions, create synergy, and resolve conflicts among divisions within the firm and between partners. The dedicated unit might also enable the firm to capture, share, and disseminate the coopetition (or alliance in general) management know-how associated with prior experience. This underscores the need for and challenge in balancing divisional autonomy with the coordination of conflicted divisional interests involved in the firm.

Finally, coopetition experience was examined using both qualitative and quantitative approaches. The hypothesis test of coopetition experience showed partial support (in terms of *Tech_comp* and *Type_coop*) for the hypothesis that coopetition experience enhances the relationship between coopetition and innovation performance. Although the quantitative research shows partial support for the hypothesis, the case study suggested that coopetition experience is critical for coopetition success. Both firms have many coopetition experiences (around 30 percent of over 100 alliances for 10 years before the joint venture announcement were coopetitions). Further, Samsung engaged in more strategic alliances with more bilateral relationships that managed the coopetition more effectively than did Sony, which engaged in more joint ventures with more multilateral relationships. The case suggests that coopetition experience with dyadic relationships may have a greater influence than do multilateral relationships. In sum, firms with dynamic capability, which is composed of coopetition

experience, a coopetition mindset, and an organizational structure with the combination of divisional autonomy and a dedicated unit, are likely to better manage complex coopetition issues.

6.2 Contributions and Implications

This study makes several contributions to the literature. Figure 6.1 summarizes this dissertation's major contributions to four streams of the literature: coopetition, innovation, competition, and cooperation in general.

6.2.1 Contribution to the coopetition literature

In an endeavor to contribute to the coopetition literature, both theoretical and methodological improvements were pursued. First, in terms of theoretical improvements, a contribution of this research lies in a conceptualization and operationalization of coopetition. Building on previous works (e.g., Bengtsson et al., 2010; Chen, 2008; Das & Teng, 2000; Gnyawali et al., 2008; Luo, 2007a), I conceptualized coopetition as being composed of three components: 1) competition between partners, 2) cooperation between partners, and 3) the interplay between competition and cooperation. Although previous works imply that coopetition is composed of three components, there was no empirical work to operationalize coopetition by considering the three components. Gnyawali et al. (2008) suggest that the tension from the paradoxical and dynamic nature of coopetition will clearly appear when the degrees of competition and cooperation are both high. Thus, it is essential that the conceptualization and operationalization of coopetition consider both competition and cooperation to explore the role of tension in coopetition.

Second, this study investigated the moderating role of the firm's capabilities to manage coopetition. Although managing dynamic and paradoxical situations inherent in coopetition requires specialized capabilities (i.e., coopetition capabilities), there was a lack of attention to the

firm's coopetition capability in the coopetition literature. To advance our understanding of coopetition capabilities, I identified three key elements of coopetition capabilities: 1) coopetition experience, 2) coopetition mindset, and 3) organizational structure (i.e., combination of divisional autonomy and dedicated unit).

Third, by adopting the transparadox approach (Chen, 2008) based on the Chinese Middle Way perspective (Chen, 2002, 2008), this study extended the notion of the balance of opposites (Das & Teng, 2000). This is initial empirical research to show that the balance between competition and cooperation generates greater innovation performance, even though the optimal balance may be not symmetric.[25] Further, through a case study of a balanced-strong coopetition, I demonstrated that the balance is important not only at the formation of coopetition, but also as it evolves.

Methodologically, this dissertation differentiated itself from previous studies by measuring coopetition as a continuous variable based both on the intensity of competition and the intensity of cooperation. In this study, I measured coopetition using four combinations based on two types of competition (technology competition and market competition) and two types of cooperation (type strength of a focal coopetition and tie strength between two firms. As far as I know, this dissertation is initial empirical research to capture coopetition from both the competition and cooperation sides with continuous and ordinal variables, instead of dichotomous (or categorical) variables. Further, to investigate the role of the balance between competition and cooperation, I employed polynomial regression analysis, which is newly introduced in the coopetition literature. Polynomial regression analysis has strengths when examining the interplay of two elements through three-dimensional analysis. This study shows that polynomial

[25] The optimal balance between competition and cooperation may not be symmetric, but leaning toward the competition side. That is, the optimal points (i.e., stationary points) in shapes of polynomial regression lie in the combinations of high competition and medium cooperation.

regression analysis provides valuable information (e.g., optimal points) and a clear picture about the interplay of the two elements (i.e., competition and cooperation) of coopetition. As coopetition is composed of both competition and cooperation, future research should use polynomial regression analysis more frequently to investigate the role of coopetition.

Previous studies reported inconsistent results of coopetition effects (i.e., positive, negative, or no effects on innovatrion) based on a categorical approach. This study demonstrated that coopetition based on market competition has an inverted-U relationship with innovation, while coopetition based on technology competition has a positive influence on coopetition-based innovation. This study also showed that the effects of coopetition on innovation are positively affected by the balance between competition and cooperation. Further, through both qualitative and quantitative approaches, this study provided evidence that a firm's coopetition capability plays a critical role in moderating the relationship between coopetition and innovation performance.

6.2.2 Contribution to the innovation literature

To advance the literature on coopetition and its impact on innovation, it is important to focus on the outcomes that are directly related to coopetition activities. Regarding the composition of value ("innovation" in this study) that a focal firm can create and appropriate through coopetition, I newly conceptualized coopetition-based innovation (i.e., innovation performance through coopetition) that is composed of three components: 1) joint innovation, 2) innovation through knowledge application, and 3) innovation in the partner's domains.

Methodologically, the new measure of coopetition performance (i.e., coopetition-based innovation) helps resolve a huge hurdle in coopetition (or general alliance) research on innovation – the difficulty in matching innovations directly with alliances (Ahuja et al., 2008).

Further, the new innovation measure at the alliance (or coopetition) level enables researchers to employ tools for multilevel analysis (e.g., hierarchical linear modeling (HLM)). As it is difficult to get coopetition (or alliance) level performance, previous studies have used overall firm innovation as a proxy. When researchers use overall innovation performance at the coopetition level of performance, however, the dependent variables for the dyadic (or alliance) level and portfolio (or firm) level are the same, which may limit the use of multilevel analytical tools. Future studies can conduct multilevel research by using overall innovation performance and coopetition-based innovation (an innovation measure for the individual coopetition level this study provides).

This study provided evidence that competition, cooperation, and the balance between competition and cooperation have positive and significant effects on coopetition-based innovation. Further, the moderating effects of coopetition experience on innovation were investigated.

6.2.3 Contribution to the competition literature

Although the main focuses of this study were on coopetition and innovation, this research contributes to the literature of competition. The competition literature has dealt with competition mainly at the industry (or market) level (e.g., Aghion et al., 2005; Ritala, in press) or from the competitor perspective (action and response in competitive dynamics research). Even though little research (e.g., Khanna et al., 1998) has paid attention to the competition between partners, efforts to operationalize the varying intensity of competition between partners were limited. That is, most alliance research examined the effects of competition between partners on innovation from a categorical perspective (competitor versus collaborator) based on SIC code. To address the gaps in the literature, I focused on the intensity of competition between partners. Following

the competition literature that identified competitors from both the market and resource sides, I captured the varying intensity of competition between partners in terms of two types of competition: technology competition and market competition.

Methodologically, I advanced a measure of market competition (*Market_comp*) based on the SIC code (four levels based on 4-digit SIC code), firm type, and product market segment overlap. Previous studies have used various measures to capture market competition, such as key competitors reported in annual reports (Ritala et al., 2008), SIC code overlap (Wang & Zajac, 2008), and attack and response. However, the first two measures are too narrow or too broad to capture the competition between partners. The last measure is limited in pinpointing whether the attacks and responses are related to a specific firm. This study offers another measure to apply to the competition between two firms.

By investigating technology competition and market competition separately, this study revealed that the two competitions affect innovation performance in a coopetition relationship differently. While market competition has an inverted-U relationship with innovation, technology competition has a positive relationship with innovation. The technology competition literature, including patent race studies, focuses mainly on the position of partners. This study suggests that when a focal firm and its partner have similar patent endowment in terms of patent class overlap, they can generate greater innovation performance than partners with dissimilar patents.

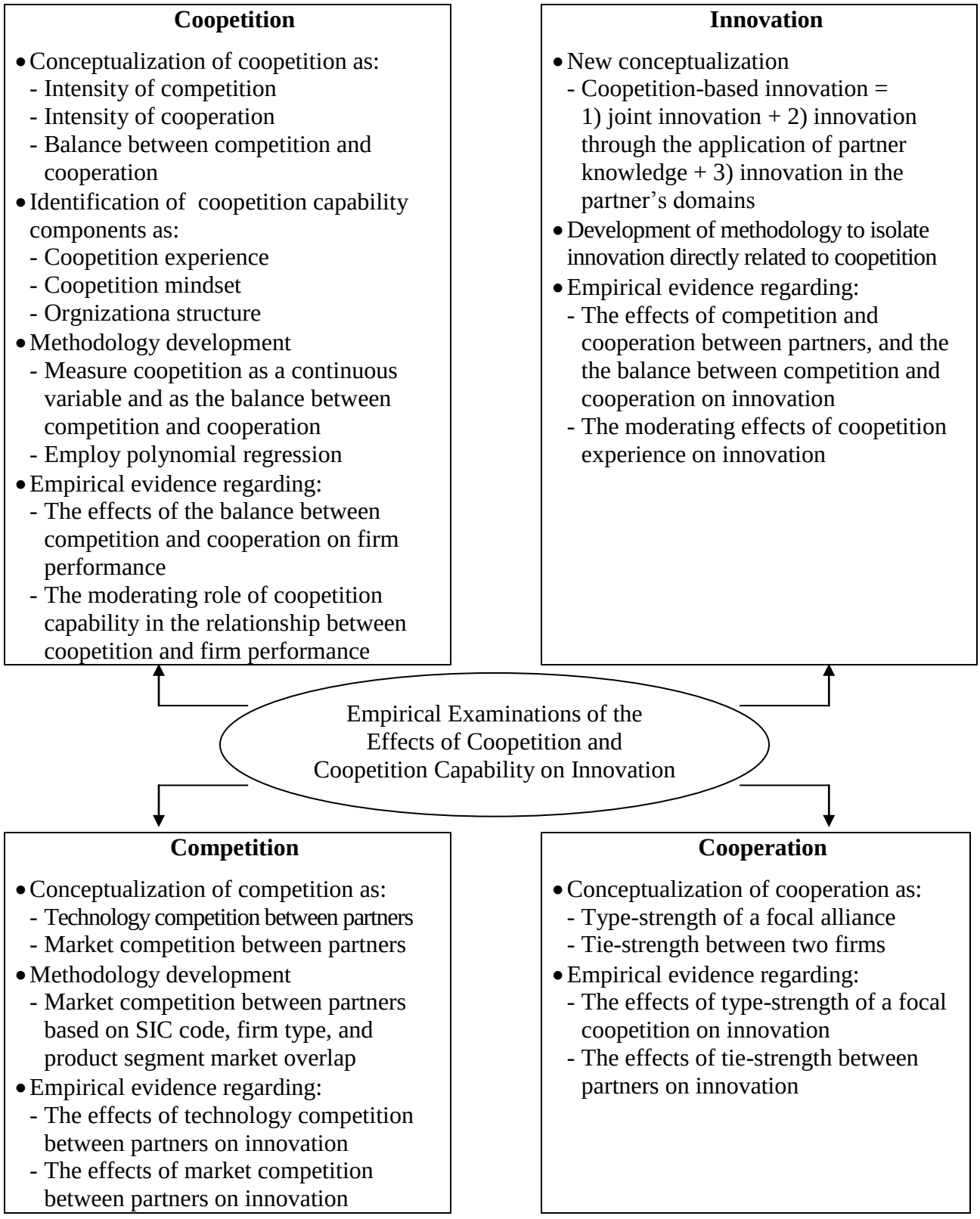
6.2.4 Contribution to the cooperation literature

This study contributes to the literature of cooperation in general. First, I conceptualized cooperation with two dimensions: 1) type strength of a focal alliance (*Type_coop*) and 2) tie strength between partners (*Tie_coop*). Even though the two dimensions of cooperation are

distinct, the efforts to classify the dimensions (or types) of cooperation and capture the effects of each dimension in the same phenomenon were limited.

By examining the two dimensions of cooperation at the same time, this research revealed that each type of cooperation shows similar but distinct effects on innovation. This study demonstrated that the intensity of cooperation (i.e., *Type_coop* and *Tie_coop*) has a positive relationship with coopetition-based innovation. Through additional tests, this study revealed that *Tie_coop* (tie-strength between two firms) has an inverted-U relationship with innovation, which suggests that the logic of structural embeddedness can apply to relational embeddedness. That is, this study demonstrates that Uzzi's notion of 'overembeddedness' can be applied to the dyadic level as well. In the similar vein, this study implied that cooperative rent-seeking behavior might help firms their strategic flexibility (Volberda, 1996) up to a certain point but high degree cooperation might generate strategic inflexibility (Bresser & Harl, 1986). Further, this study supported some scholars' (e.g., Maurer et al., 2011) arguments that social capital facilitates knowledge transfer, but the transferred knowledge may not be beneficial.

FIGURE 6.1
Contributions to the Literature



6.2.5 Managerial implications

In addition to the contributions to the academic literature, this dissertation also offers managers suggestions for managing coopetition. The innovation performance implications of coopetition are highly relevant for many companies in the high-tech sector. Further, as coopetition entails high uncertainty in terms of both the environment and partner behaviors, firms need to engage in a partnership with caution and ex post adjustments are necessary. Coopetition requires managers to redefine the competition with a more complex and multifaceted manner and walk the fine line between collaborating in good faith and competing to enhance their own strategic outcomes (Gnyawali et al., 2006). Furthermore, managers confront more challenges due to the dynamic nature of coopetition (Luo, 2007b). Over time, the incentive to invest more in cooperating or competing with a given firm changes (Morris, Kocak, & Ozer, 2007; Barnir & Smith, 2002). As a result, coopetition needs more capabilities in order to estimate the evolving costs and benefits of coopetition, to keep the balance of bargaining power, and to make necessary adjustments to the cooperation-competition ratio. Yet, the study of the role of coopetition and the role of coopetition capabilities in innovation is very limited.

This study examined the effects of coopetition and the balance between competition and cooperation on firm innovation. Through large scale longitudinal quantitative research, I demonstrated that coopetition can be helpful to generate greater innovation performance in the high tech industry. In the process, the balance between competition and cooperation is critical. Further, how to understand and manage the tension rising from paradoxical factors in coopetition is critical for selecting partners and managing (or coordinating) the paradoxical factors and conflicts within and between firms. This study investigated whether and to what extent a firm's capability to manage coopetition positively influences the relationship between coopetition and

firm innovation. The findings in this study from both quantitative and qualitative approaches provide insights for managers considering a coopetition strategy, forming a coopetition in a more balanced way, and developing coopetition capabilities in order to generate greater coopetition performance.

6.3 Limitations and Directions for Future Research

6.3.1 Limitations of the research

This research has several limitations and the findings need to be interpreted in light of these limitations. First, I tried to isolate coopetition-based innovation through three aspects: 1) joint innovation, 2) citing partners, and 3) innovation in partners' domains. Conceptually, this allows the isolation of the innovation related to coopetition. Further, the results of hypothesis testing show that this new measure generates the results that match my conceptual arguments. However, the second and third segments of coopetition-based innovation may be influenced by focal firms' existing activities. Thus, I first considered the measure based on the increase from pre-alliance to post-alliance. However, the increase measure generates negative performance partly due to a significant citation lag (which was discussed in section 5.1). When innovation performance (the dependent variable) is negative, I could not use the typical methods (Poisson regression or negative binomial regression) that have been used in the innovation literature to measure the count data and to resolve over-dispersion characteristics of patent data. Therefore, I did not use the increase measure in this study. Instead, I added pre-sample innovation performance as a control variable. Future research needs to advance this measure.

Second, and related to the above, the measure of technology competition is partly overlapped with the dependent variable, coopetition-based of innovation. I used patent class overlap to measure the intensity of technology competition. One component of coopetition-based

innovation is patents in the partner's domain. Thus, two measures partly overlap. As a result, the increase in technology competition may cause higher innovation performance, which calls for cautious interpretation of the results.

Third, as discussed in section 5.1, the lack of correlation between two types of competition and two types of cooperation cause concern about a lack of construct validity. In this regard, I argue that the different types of competition and cooperation capture different segments of competition and cooperation. While *Tech_comp* captures the competition in upstream activities, *Market_comp* captures the competition in downstream activities. While *Type_coop* captures the cooperation in a focal alliance, *Tie_coop* captures the overall cooperation between two firms. Further, while firms can select focal alliance types (*Type_coop*), tie strength between firms (*Tie_coop)* is influenced by firm age, history, and other factors. Thus, many firms with short histories and limited alliance experience have limited *Tie_coop* compared to firms with a lot of alliance experience and long histories. Then, I had to develop separate constructs for each type of competition and cooperation. To maintain a lean model, however, I used the current construct and measures. Future research needs to develop the measures to capture the specified constructs and examine the relationships in detail.

Finally, another limitation is due to the characteristics of data. As Figure 5.5 shows, the distribution of *Tie_coop* (repeated ties and concurrent linkages) is very skewed and there are a lot of 0's (no ties with the partner except for the focal alliance). Further, there are few or no observations in the segment of low *Tech_comp* and high *Tie_coop* and in the segments of high *Market_comp* and high *Tie_coop*. Such non-uniform distribution calls for cautious interpretation of the results. Therefore, I provide distribution and frequency of competition and cooperation variables.

6.3.2 Direction for future research

While this dissertation studied many aspects of coopetition and coopetition capabilities, several interesting issues remain for future research.

First, this study was motivated to understand coopetition tension and its role in innovation. Tension is inherent in coopetition due to paradoxical factors, such as value creation versus value appropriation, and knowledge sharing versus knowledge protection. Scholars (e.g., Gnyawali, 2010) suggest that understanding and managing coopetition tension may be the key to understanding the effects of coopetition on firm performance, including innovation performance. Research on coopetition tension is in its early stages and there are many remaining issues. Future research could conceptually advance and empirically investigate the nature, antecedents, and consequences of tension. Originally, I tried to examine tension in this dissertation but I changed the focus of the research due to the difficulty of measuring tension. Through in-depth case studies and interviews with managers who engaged in coopetition, researchers could examine the tension that appeared in a coopetition relationship, which could advance our understanding of the role of tension in coopetition.

Second, future study can further advance the conceptualization and measurement of competition and cooperation. In this dissertation, I examined the effects of two types of competition and two types of cooperation on innovation. As I discussed in the limitations section, I found that there is a lack of strong correlation between different types of competition and different types of cooperation. The effects of different combinations of competition and cooperation were also different. Although I tried to explain the results through a series of possible reasons, it is still necessary to advance our understanding of why and how coopetitions in different combinations of competition and cooperation can differently influence firm

performance. Further, it is necessary to develop measures to better capture each construct. Especially, despite its importance in advancing our understanding of the relationship between coopetition and innovation, there seems to be a lack of attention to technology competition and no appropriate measure of technology competition between partners. Future research could conceptually advance technology competition and develop its measures.

Third, this study underscored the importance of the balance between competition and cooperation and examined some aspects of the balance in a coopetition relationship. I suggested that the balance strategy is important to generate greater performance in the long term. However, the optimal balance may vary in different contexts and in different measures. Future research could advance the balance logic further by considering different contexts and empirically examining the role of balance. As far as I know, this study is an initial work using polynomial regression to examine the effects of coopetition and the balance between competition and cooperation. Future research can apply polynomical regression to other firm performance (e.g., financial performance) and to other industries to generalize the findings in this study.

Fourth, as I discussed above, coopetition-based innovation is conceptually advanced in terms of isolation of innovation related to coopetition. However, it is still limited in its ability to capture the difference between pre-sample and post-sample innovation performance, even though I considered pre-sample innovation as a control. Future research needs to advance the measure of coopetition-based innovation to further isolate innovation directly related to coopetition activities.

Fifth, Bengtsson et al. (2010) suggest that coopetition is well-suited for multi-level analysis to fully capture coopetitive dynamics that have not yet received attention in prior work. Further, coopetition processes at different levels are interlinked and could influence each other

(Bengtsson et al., 2010). In line with their logic, "how do portfolio level factors influence individual coopetition performance, vice versa?" is an important question to understand the role of coopetition in firm performance. Future research could include multilevel research. Using my conceptualization and measure of coopetition-based innovation, future study could generate innovation performance at the alliance portfolio level. Using multilevel regression modeling (e.g., hierarchical linear modeling method (HLM)), researchers could examine the effects of coopetition and coopetition capabilities on innovation performance at different levels, such as individual coopetition, alliance portfolio, and firm levels. Empirical testing at a multilevel context will help us understand the effects of coopetition and coopetition capabilities on firm performance more comprehensively.

Finally, even though I did not report it, I found that there are differences between the samples under SIC3674 and the samples that are considered to be semiconductor firms but whose primary SIC code is not 3674. I note two possible reasons: 1) a different ratio of global vs. domestic coopetition between the two groups, and 2) distinct characteristics across different industries. One of the possible reasons may be the different ratio of global firms or global coopetition. As Gnyawali and Park (2011) suggest, researchers could compare two groups, one global and the other domestic, to draw similarities and differences. While cross-national coopetition is more complex than domestic, cross-national coopetition with a global scope may offer more opportunities than does domestic coopetition.The study and comparison of global and domestic coopetition could be conducted as large-scale empirical research or as an in-depth case study. Second, researchers could conduct a longitudinal empirical study with samples selected from across multiple industries. Many studies focused on either a longitudinal research with

samples in a specific industry or a cross sectional research with samples from multiple industries but in a specific period. Future study needs to pursue a cross sectional longitudinal analysis.

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APPENDICES

APPENDIX A

The Comparison of the Effects of Coopetition-based Innovation and Overall Firm Innovation

In this study, I provide a new measure of innovation performance – coopetition-based innovation. To ensure this measure is appropriate, I compare coopetition-based innovation with overall innovation performance, which is a typical innovation measure. Table A1 shows that the log-likelihood of coopetition-based innovation is greater than that of overall innovation (models A1 and A2). When adding new variables in the base model, the increases in log-likelihood are greater in the model using coopetition-based innovation compared to the models using overall innovation (models A2, A3, B2, and B3). Based on these results, I primarily use a new measure of innovation performance – coopetition-based innovation (Innovn_cooptn) – in the analysis.

TABLE A1: The Comparison of the Effects of Coopetition-Based Innovation and Overall Firm Innovation

	Only Controls				Adding Patent Similarity				Adding Market Similarity			
	Model A1		Model A2		Model A3		Model A4		Model A5		Model A6	
DV	Coopetition-based innovation (1)		Overall Coopetition (2)		Coopetition-based innovation (3)		Overall Coopetition (4)		Coopetition-based innovation (5)		Overall Coopetition (6)	
Year dummies	Not reported		Not reported		Not reported		Not reported		Not reported		Not reported	
Innovn_pre	0.000055***	(0.000007)	0.000052***	(0.000004)	0.000054***	(0.0000007)	0.000052***	(0.000004)	0.000051***	(0.000007)	0.000052***	(0.000004)
Firm-age	-0.29***	(0.07)	-0.15***	(0.04)	-0.21***	(0.06)	-0.13***	(0.04)	-0.27***	(0.07)	-0.15***	(0.04)
Num_ties	-0.01+	(0.01)	-0.01***	(0.00)	-0.00	(0.00)	-0.01***	(0.00)	-0.00	(0.01)	-0.01***	(0.00)
Sales_log	0.50***	(0.04)	0.58***	(0.02)	0.39***	(0.03)	0.56***	(0.02)	0.50***	(0.04)	0.57***	(0.02)
Type_fabless	-0.28	(0.18)	-0.02	(0.09)	-0.57***	(0.16)	-0.05	(0.09)	-0.36*	(0.17)	-0.02	(0.09)
Type_foundry	0.19	(0.23)	0.59***	(0.12)	0.21	(0.21)	0.61***	(0.12)	0.10	(0.23)	0.58***	(0.12)
Type_tester	-0.06	(0.42)	-0.35	(0.22)	0.01	(0.39)	-0.34	(0.22)	-0.31	(0.42)	-0.36	(0.22)
Type_equipment	-1.49***	(0.26)	-1.65***	(0.13)	-1.07***	(0.24)	-1.62***	(0.13)	-1.32***	(0.27)	-1.64***	(0.13)
Tech_comp					1.81***	(0.10)	0.24***	(0.06)				
Tech_comp^2					-0.35	(0.52)	-0.34	(0.29)				
Market_comp									0.95***	(0.16)	-0.01	(0.08)
Market_comp^2									-0.90*	(0.44)	0.25	(0.24)
Constant	4.52***	(0.33)	5.09***	(0.16)	4.35***	(0.32)	5.14***	(0.17)	4.24***	(0.33)	5.06***	(0.17)
Lnalpha	1.22***	(0.03)	-0.04	(0.03)	1.08***	(0.03)	-0.05	(0.03)	1.20***	(0.03)	-0.04	(0.03)
Number of alliances	1930		1930		1930		1930		1930		1930	
Log likelihood	-13968.83		-16824.73		-13811.87		-16813.71		-13949.18		-16823.94	
Degrees of freedom	21.00		21.00		23.00		23.00		23.00		23.00	
Wald chi square	1241.15		3038.31		1555.08		3060.36		1280.46		3039.89	
Likelihood Ratio Test					(3) – (1) =313.93***		(4) –(2) =22.05***		(5) – (1) =39.30***		(6) – (2) =1.58	

Standard errors in parentheses, + p<0.1 * p<0.05 ** p<0.01 *** p<0.001

APPENDIX B
Results of Multiple Regressions

The innovation literature has used negative binomial regression or Poisson regression to analyze the patent output. Considering the characteristics of patent data (e.g., count data and very much skewed distribution), such methods have strengths to capture the effects of the variables. However, many scholars are accustomed to OLS and believe that OLS also has strengths, such as the interpretation of the results.

Table A2 provides the results of multiple regressions on the same models. For the direct effects of competition and cooperation variables (Tables A3, A4, A5a, A5b, A5c, and A5d), the results are consistent in terms of statistical significance with the results of negative binomial regression. However, differences were found in the interaction effects across different methods. First, the effects of interaction terms between competition and cooperation are different. While interaction terms in negative binomial regression are insignificant, those in OLS regression are positive and significant except for Mktcomp_Typecoop. Second, the moderating effects of coopetition experience in the relationship between coopetition and innovation are different. While the three way interaction terms (coopetition experience x Market_comp x cooperation (either Type_coop or Tie_coop)) in negative binomial regression are insignificant, those in OLS regression are positive and significant. Only a three way interaction term (coopetition experience x Tech_comp x Type_coop) is consistent across methods.

TABLE A2: Comparison between Negative Binomial Regression Results and OLS Results

Hwp #	DV	IV	Negative Binomial Regression		Multiple Regression	
			w/o controls	With controls	w/o controls	With controls
H1	Coopetition-based innovation performance (*Coopetition_innovation*)	Tech_comp	(+)	(+)	(+)	(+)
		Market_comp	Insignificant	Inverted-U	Insignificant	Inverted-U
H2		Type_coop	Inverted-U	(+)	Inverted-U	(+)
		Tie_coop	Inverted-U	Inverted-U	Inverted-U	Inverted-U
H3a		***Dummy Variable*** Blncstmg_ techcomp_typecoop	(+)	(+)	(+)	(+)
		Blncstmg_ techomp_tiecoop	(+)	(+)	(+)	(+)
		Blncstmg_ mktcomp_typecoop	(+)	(+)	(+)	(+)
		Blncstmg_ mktcomp_tiecoop	(+)	(+)	(+)	(+)
		Interaction Techcomp_Typecoop	(+)	Insignificant	(+)	(+)
		Techcomp_Tiecoop	Insignificant	Insignificant	(+)	(+)
		Mktcomp_Typecoop	Insignificant	Insignificant	Insignificant	Insignificant
		Mktcomp_Tiecoop	Insignificant	Insignificant	(+)	(+)
H4a		Expn_ techcomp_typecoop	(+)	Insignificant	(+)	Insignificant
		Expn_ techcomp_tiecoop	Insignificant	Insignificant	(-)	(-)
		Expn_ mktcomp_typecoop	Insignificant	Insignificant	(+)	(+)
		Expn_ mktcomp_tiecoop	Insignificant	Insignificant	Insignificant	(+)

*Interaction terms: see Tables 5.6, 5.6B, 5.6, and 5.7B in section 5.4.

Tables A3 and A4 provide the results of multiple regressions on the role of competition and cooperation between partners in coopetition-based innovation. Tables A5a, A5b, A5c, and A5d provide the results of the dummy variable fot balanced-strong coopetition. Tables A6a, A6b, A6c, and A6d introduce the moderating role of coopetition experience in the relationship between coopetition and coopetition-based innovation.

TABLE A3: OLS Regression − The Role of Competition between Partners in Coopetition-Based Innovation

Variable	Model A7		Model A8		Model A8b		Model A9		Model A9b	
	Only controls		w/o controls		With controls		w/o controls		With controls	
Pre_innovation	0.327***	(0.037)			0.314***	(0.034)			0.320***	(0.037)
Firm-age	-0.087***	(0.025)			-0.034	(0.023)			-0.078**	(0.025)
Num_ties	0.146***	(0.035)			0.124***	(0.032)			0.170***	(0.035)
Sales_log	0.105**	(0.036)			0.030	(0.033)			0.112**	(0.036)
Type_fabless	-0.022	(0.023)			-0.034	(0.021)			-0.022	(0.023)
Type_foundry	0.018	(0.020)			0.038*	(0.018)			0.017	(0.020)
Type_tester	0.025	(0.019)			0.034*	(0.017)			0.017	(0.019)
Type_equipment	-0.015	(0.020)			0.010	(0.018)			-0.008	(0.020)
Year91	0.098**	(0.030)			0.057*	(0.028)			0.093**	(0.030)
Year92	0.086**	(0.031)			0.060*	(0.028)			0.079*	(0.031)
Year93	0.112***	(0.031)			0.062*	(0.028)			0.114***	(0.031)
Year94	0.060+	(0.032)			0.058*	(0.029)			0.060+	(0.031)
Year95	0.006	(0.029)			-0.030	(0.027)			0.010	(0.029)
Year96	-0.045	(0.029)			-0.069**	(0.027)			-0.044	(0.029)
Year97	-0.033	(0.030)			-0.069*	(0.028)			-0.031	(0.030)
Year98	-0.109***	(0.029)			-0.132***	(0.026)			-0.104***	(0.029)
Year99	-0.102***	(0.030)			-0.127***	(0.027)			-0.098***	(0.029)
Year00	-0.085**	(0.027)			-0.113***	(0.025)			-0.082**	(0.027)
Year01	-0.060*	(0.025)			-0.077***	(0.022)			-0.053*	(0.024)
Year02	-0.086**	(0.028)			-0.117***	(0.026)			-0.088**	(0.028)
Year03	-0.073*	(0.028)			-0.090***	(0.026)			-0.072*	(0.028)
Tech_comp			0.425***	(0.021)	0.362***	(0.018)				
Tech_comp^2			0.138***	(0.021)	0.111***	(0.018)				
Market_comp							0.037	(0.030)	0.151***	(0.025)
Market_comp^2							-0.064*	(0.030)	-0.078**	(0.025)
N	1930		1930		1930		1930		1930	
R2	0.328		0.182		0.449		0.002		0.341	
R	0.573		0.427		0.670		0.045		0.584	
ΔR2 (base=model A7)					0.121				0.013	

Standard errors in parentheses, + p<0.1 * p<0.05 ** p<0.01 *** p<0.001

TABLE A4: OLS Regression – The Role of Cooperation between Partners in Coopetition-Based Innovation

Variable	Model A10	Model A10b	Model A11	Model A11b
	w/o controls	With controls	w/o controls	With controls
Controls		Not reported		Not reported
Type_coop	0.171*** (0.033)	0.078** (0.029)		
Type_coop^2	-0.103** (0.033)	-0.030 (0.030)		
Tie_coop			0.574*** (0.042)	0.404*** (0.037)
Tie_coop^2			-0.147*** (0.042)	-0.094** (0.036)
N	1930	1930	1930	1930
R2	0.014	0.331	0.204	0.420
ΔR2 (base=model A1)		0.003		0.092

Standard errors in parentheses, + p<0.1 * p<0.05 ** p<0.01 *** p<0.001

ABLE A5: The Effects of Balanced-Strong Coopetition (High *Tech_comp* and High *Type_coop*) on Coopetition-Based Innovation

Variables	Model A12	Model A12b	Model A13	Model A13b	Model A14	Model A14b
	w/o controls	with controls	w/o controls	with controls	w/o controls	with controls
Controls		Not reported		Not reported		Not reported
Blncstrng_ techcomp_typecoop[1]	0.35*** (0.02)	0.28*** (0.02)				
Blncstrng_ techcomp_typecoop[2]			0.17*** (0.02)	0.15*** (0.02)		
Blncstrng_ techcomp_typecoop[3]					0.19*** (0.02)	0.14*** (0.02)
N	1930	1930	1930	1930	1930	1930
R2	0.12	0.40	0.03	0.35	0.03	0.35
ΔR2 (base=model A7)		0.07		0.02		0.02

Standard errors in parentheses, + p<0.1 * p<0.05 ** p<0.01 *** p<0.001. Dummy variables of balanced strong coopetition: [1] over mean, [2] over mean + 0.5 SD, [3] over mean+1SD.

TABLE A5b: The Effects of Balanced-Strong Coopetition (High *Tech_comp* and High *Tie_coop*) on Coopetition-Based Innovation

Variables	Model A15	Model A15b	Model A16	Model A16b	Model A17	Model A17b
	w/o controls	with controls	w/o controls	with controls	w/o controls	with controls
Controls		Not reported		Not reported		Not reported
Blncstrng_ techcomp_tiecoop[1]	0.40*** (0.02)	0.30*** (0.02)				
Blncstrng_ techcomp_tiecoop[2]			0.46*** (0.02)	0.35*** (0.02)		
Blncstrng_ techcomp_tiecoop[3]					0.41*** (0.02)	0.30*** (0.02)
N	1930	1930	1930	1930	1930	1930
R2	0.16	0.41	0.21	0.44	0.17	0.41
ΔR2 (base=model A7)		0.08		0.11		0.08

Standard errors in parentheses, + p<0.1 * p<0.05 ** p<0.01 *** p<0.001. Dummy variables of balanced strong coopetition: [1] over mean, [2] over mean + 0.5 SD, [3] over mean+1SD.

TABLE A5c: The Effects of Balanced-Strong Coopetition (High *Market_comp* and High *Type_coop*) on Coopetition-Based Innovation

Variables	Model A18	Model A18b	Model A19	Model A19b	Model A20	Model A20b
	w/o controls	with controls	w/o controls	with controls	w/o controls	with controls
Controls		Not reported		Not reported		Not reported
Blncstmg_ mktcomp_typecoop[1]	0.03 (0.02)	0.07*** (0.02)				
Blncstmg_ mktcomp_typecoop[2]			0.01 (0.02)	0.04* (0.02)		
Blncstmg_ mktcomp_typecoop[3]					0.05* (0.02)	0.05** (0.02)
N	1930	1930	1930	1930	1930	1930
R2	0.0008	0.33	0.0002	0.33	0.003	0.33
R	0.03	0.57	0.01	0.57	0.05	0.57
ΔR2 (base=model A7)		0.0042		0.0016		0.0025

Standard errors in parentheses, + p<0.1 * p<0.05 ** p<0.01 *** p<0.001. Dummy variables of balanced strong coopetition: [1] over mean, [2] over mean + 0.5 SD, [3] over mean+1SD.

TABLE A5d: The Effects of Balanced-Strong Coopetition (High *Market_comp* and High *Tie_coop*) on Coopetition-Based Innovation

Variables	Model A21	Model A21b	Model A22	Model A22b	Model A23	Model A23b
	w/o controls	with controls	w/o controls	with controls	w/o controls	with controls
Controls		Not reported		Not reported		Not reported
Blncstmg_ mktcomp_tiecoop[1]	0.15*** (0.02)	0.14*** (0.02)				
Blncstmg_ mktcomp_tiecoop[2]			0.09*** (0.02)	0.08*** (0.02)		
Blncstmg_ mktcomp_tiecoop[3]					0.00 (.)	0.00 (.)
N	1930	1930	1930	1930	1930	1930
R2	0.02	0.35	0.01	0.33	0.00	0.33
R	0.14	0.59	0.10	0.57	0.00	0.57
ΔR2 (base=model A7)		0.0196		0.0065		-

Standard errors in parentheses, + p<0.1 * p<0.05 ** p<0.01 *** p<0.001. Dummy variables of balanced strong coopetition: [1] over mean, [2] over mean + 0.5 SD, [3] over mean+1SD.

TABLE A6: The Moderating Role of Coopetition Experience in the Relationship between Coopetition (*Tech_comp* and *Type_coop*) and Coopetition-Based Innovation

Variables	Model A24	Model A24b	Model A25	Model A25b	Model A26	Model A26b
	w/o controls	with controls	w/o controls	with controls	w/o controls	with controls
Controls		Not reported		Not reported		Not reported
Expn_cooptn_num	0.40*** (0.03)	-0.15*** (0.04)	0.34*** (0.03)	-0.14*** (0.04)	0.34*** (0.03)	-0.15*** (0.04)
Expn_cooptn_num^2	-0.24*** (0.03)	-0.08** (0.03)	-0.20*** (0.03)	-0.07** (0.03)	-0.21*** (0.03)	-0.07** (0.03)
Tech_comp			0.39*** (0.02)	0.36*** (0.02)	0.38*** (0.02)	0.35*** (0.02)
Tech_comp^2			0.13*** (0.02)	0.11*** (0.02)	0.13*** (0.02)	0.10*** (0.02)
Type_coop			0.17*** (0.03)	0.06* (0.03)	0.16*** (0.03)	0.06* (0.03)
Type_coop^2			-0.11*** (0.03)	-0.02 (0.03)	-0.12*** (0.03)	-0.04 (0.03)
Techcomp _typecoop					0.09*** (0.02)	0.08*** (0.02)
Expn_ techcomp					0.12*** (0.02)	0.13*** (0.02)
Expn_ typecoop					0.02 (0.02)	0.01 (0.02)
Expn_techcomp _typecoop					0.03 (0.02)	0.04* (0.02)
N	1930	1930	1930	1930	1930	1930
R2	0.10	0.35	0.26	0.47	0.29	0.49
R	0.32	0.59	0.51	0.69	0.54	0.70
ΔR2 (base=model A7)		0.02		0.14		0.16

Standard errors in parentheses, + p<0.1 * p<0.05 ** p<0.01 *** p<0.001

TABLE A6b: The Moderating Role of Coopetition Experience in the Relationship between Coopetition (*Tech_comp* and *Tie_coop*) and Coopetition-Based Innovation

Variables	Model A27	Model A27b	Model A28	Model A28b
	w/o controls	with controls	w/o controls	with controls
Controls		Not reported		Not reported
Expn_cooptn_num	0.26*** (0.02)	-0.14*** (0.03)	0.28*** (0.03)	-0.11** (0.04)
Expn_cooptn_num^2	-0.17*** (0.02)	-0.06** (0.02)	-0.17*** (0.02)	-0.07** (0.02)
Tech_comp	0.29*** (0.02)	0.29*** (0.02)	0.36*** (0.02)	0.36*** (0.02)
Tech_comp^2	0.10*** (0.02)	0.09*** (0.02)	0.08*** (0.02)	0.06*** (0.02)
Tie_coop	0.41*** (0.05)	0.32*** (0.04)	0.31*** (0.06)	0.15** (0.05)
Tie_coop^2	-0.11* (0.04)	-0.09* (0.04)	-0.24*** (0.05)	-0.22*** (0.04)
Techcomp_tiecoop			0.34*** (0.05)	0.39*** (0.05)
Expn_ techcomp			0.05* (0.02)	0.05** (0.02)
Expn_ tiecoop			-0.03 (0.05)	0.05 (0.04)
Expn_ techcomp_tiecoop			-0.17** (0.05)	-0.21*** (0.04)
N	1930	1930	1930	1930
R2	0.33	0.51	0.36	0.54
R	0.57	0.71	0.60	0.73
ΔR2 (base=model A7)		0.18		0.21

Standard errors in parentheses, + p<0.1 * p<0.05 ** p<0.01 *** p<0.001

TABLE A6c: The Moderating Role of Coopetition Experience in the Relationship between Coopetition (*Market_comp* and *Type_coop*) and Coopetition-Based Innovation

Variables	Model A29		Model A29b		Model A30		Model A30b	
	w/o controls		with controls		w/o controls		with controls	
Controls			Not reported				Not reported	
Expn_cooptn_num	0.42***	(0.03)	-0.14***	(0.04)	0.43***	(0.03)	-0.14***	(0.04)
Expn_cooptn_num^2	-0.24***	(0.03)	-0.08**	(0.03)	-0.24***	(0.03)	-0.07*	(0.03)
Market_comp	0.10***	(0.03)	0.14***	(0.03)	0.10***	(0.03)	0.15***	(0.02)
Market_ comp^2	-0.07*	(0.03)	-0.07**	(0.02)	-0.07*	(0.03)	-0.07**	(0.02)
Type_coop	0.16***	(0.03)	0.06*	(0.03)	0.16***	(0.03)	0.06*	(0.03)
Type_coop^2	-0.11***	(0.03)	-0.03	(0.03)	-0.11***	(0.03)	-0.03	(0.03)
Mktcomp _typecoop					-0.01	(0.02)	0.01	(0.02)
Expn_ mktcomp					0.05*	(0.02)	0.07***	(0.02)
Expn_ typecoop					0.06**	(0.02)	0.05**	(0.02)
Expn_mktcomp _typecoop					-0.01	(0.02)	-0.02	(0.02)
N	1930		1930		1930		1930	
R2	0.12		0.36		0.12		0.37	
R	0.35		0.60		0.35		0.61	
ΔR2 (base=model A7)			0.03				0.04	

Standard errors in parentheses, + p<0.1 * p<0.05 ** p<0.01 *** p<0.001

TABLE A6d: The Moderating Role of Coopetition Experience in the Relationship between Coopetition (*Market_comp* and *Tie_coop*) and Coopetition-Based Innovation

Variables	Model A31		Model A31b		Model A32		Model A32b	
	w/o controls		with controls		w/o controls		with controls	
Controls			Not reported				Not reported	
Expn_cooptn_num	0.30***	(0.03)	-0.15***	(0.04)	0.30***	(0.03)	-0.14***	(0.04)
Expn_cooptn_num^2	-0.19***	(0.03)	-0.07**	(0.03)	-0.17***	(0.03)	-0.06*	(0.03)
Market_comp	0.13***	(0.03)	0.15***	(0.02)	0.12***	(0.03)	0.14***	(0.02)
Market_ comp^2	-0.07**	(0.03)	-0.06**	(0.02)	-0.05+	(0.03)	-0.04	(0.02)
Tie_coop	0.57***	(0.05)	0.47***	(0.04)	0.67***	(0.05)	0.53***	(0.04)
Tie_coop^2	-0.19***	(0.05)	-0.16***	(0.04)	-0.13*	(0.05)	-0.08+	(0.04)
Mktcomp_tiecoop					0.16***	(0.04)	0.18***	(0.03)
Expn_mktcomp					0.11***	(0.02)	0.12***	(0.02)
Expn_ tiecoop					-0.01	(0.03)	0.05+	(0.03)
Expn_ mktcomp_tiecoop					0.04	(0.04)	0.06*	(0.03)
N	1930		1930					
R2	0.26		0.45					
R	0.51		0.67					
ΔR2 (base=model A7)			0.12					

Standard errors in parentheses, + p<0.1 * p<0.05 ** p<0.01 *** p<0.001

APPENDIX C
Results of Analysis Not Reported in the Body

TABLE A7: The Effects of the Interaction between Technology Competition and Cooperation on Coopetition-Based Innovation

Variables	Model A33 w/o controls		Model A33b with controls		Model A34 w/o controls		Model A34b with controls	
Year dummies			Not reported				Not reported	
Pre_innovation			0.00***	(0.00)			0.00***	(0.00)
Firm-age			-0.22*	(0.10)			-0.21*	(0.10)
Num_ties			-0.00	(0.01)			-0.01	(0.01)
Sales_log			0.40***	(0.07)			0.39***	(0.07)
Type_fabless			-0.51	(0.33)			-0.55	(0.34)
Type_foundry			0.25	(0.24)			0.21	(0.25)
Type_tester			-0.02	(0.32)			0.02	(0.32)
Type_equipment			-1.14**	(0.41)			-1.08*	(0.44)
Tech_comp	1.9716***	(0.15)	1.7992***	(0.14)	1.6828***	(0.18)	1.7696***	(0.17)
Tech_comp^2	1.9312*	(0.79)	-0.3062	(0.61)	0.96995	(0.70)	-0.4550	(0.59)
Type_coop	0.0840***	(0.02)	0.0375**	(0.01)				
Type_coop^2	-0.01075**	(0.00)	-0.0009	(0.00)				
Techcomp_Typecoop	0.0956***	(0.03)	0.00343	(0.03)				
Tie_coop					0.0626***	(0.01)	0.01674+	(0.01)
Tie_coop^2					-0.00093***	(0.00)	-0.00047**	(0.00)
Techcomp_Tiecoop					0.00936	(0.02)	0.0157	(0.02)
Constant	6.2177***	(0.27)	4.0365***	(0.47)	6.8484***	(0.27)	4.374***	(0.46)
Lnalpha	1.62***	(0.12)	1.08***	(0.10)	1.62***	(0.12)	1.08***	(0.10)
Number of alliances	1930		1930		1.73***	(0.12)	1.21***	(0.10)
Number of firms	118.00		118.00		1930		1930	
Log likelihood	-14453.23		-13808.43		-14449.13		-13810.35	
Degrees of freedom	5		26		5		26	
Wald chi square	404.07		8486.43		186.88		7215.35	

Standard errors in parentheses, * p<0.05 ** p<0.01 *** p<0.001

TABLE A8: The Effects of the Interaction between Market Competition and Cooperation on Coopetition-Based Innovation

Variables	Model A35		Model A35b		Model A36		Model A36b	
Year dummies			Not reported				Not reported	
Pre_Innovation			0.00**	(0.00)			0.00***	(0.00)
Firm-age			-0.28**	(0.11)			-0.27*	(0.11)
Num_ties			-0.00	(0.01)			-0.00	(0.01)
Sales_log			0.52***	(0.07)			0.50***	(0.07)
Type_fabless			-0.24	(0.37)			-0.33	(0.37)
Type_foundry			0.16	(0.24)			0.13	(0.25)
Type_tester			-0.38	(0.38)			-0.27	(0.39)
Type_equipment			-1.42**	(0.45)			-1.36**	(0.47)
Market_comp	0.1943	(0.41)	0.9231***	(0.16)	0.4429+	(0.26)	0.9601***	(0.14)
Market_comp^2	-0.6665	(0.69)	-0.7702+	(0.44)	-0.5609	(0.56)	-0.7781*	(0.38)
Type_coop	0.1005***	(0.01)	0.0518***	(0.01)				
Type_coop^2	-0.0085***	(0.00)	-0.0014	(0.00)				
Mktcomp_Typecoop	-0.0141	(0.02)	-0.0307	(0.03)				
Tie_coop					0.1234***	(0.02)	0.0737***	(0.01)
Tie_coop^2					-0.0016***	(0.00)	-0.0011***	(0.00)
Mktcomp_Tiecoop					0.0332	(0.03)	0.0129	(0.02)
Constant	7.653***	(0.34)	3.761***	(0.47)	7.789***	(0.25)	4.2314***	(0.48)
Lnalpha	1.72***	(0.12)	1.20***	(0.10)	1.68***	(0.12)	1.18***	(0.11)
Number of alliances	1930		1930		1930		1930	
Number of firms	118.00		118.00		118.00		118.00	
Log likelihood	-14578.74		-13943.23		-14527.92		-13925.99	
Degrees of freedom	5		26		5		26	
Wald chi square	71.98		6704.77		145.25		18776.92	

Standard errors in parentheses, * p<0.05 ** p<0.01 *** p<0.001

TABLE A9: The Moderating Role of Coopetition Experience (Adjusted by Type Strength) in the Relationship between Coopetition (Technology Competition and Cooperation) and Coopetition-Based Innovation

Variables	Model A37		Model A37b		Model A38		Model A38b	
	w/o controls		with controls		w/o controls		with controls	
Year dummies			Not reported				Not reported	
Patent_simil	2.03***	(0.17)	1.83***	(0.12)	1.90***	(0.19)	1.80***	(0.15)
Patent_simil^2	1.10	(0.68)	-0.33	(0.56)	0.45	(0.70)	-0.45	(0.53)
Type_strength	0.10***	(0.02)	0.03*	(0.01)				
Type_strength^2	-0.02***	(0.00)	-0.00	(0.00)				
Expn_cooptn_adj	0.03***	(0.01)	0.01*	(0.01)	0.03***	(0.01)	0.01*	(0.00)
Expn_cooptn_adj^2	-0.00**	(0.00)	-0.00**	(0.00)	-0.00**	(0.00)	-0.00**	(0.00)
Patsimil_typestrength	0.09**	(0.03)	0.01	(0.02)				
Expn_patsimil	-0.01**	(0.00)	-0.00	(0.00)	-0.01***	(0.00)	-0.00*	(0.00)
Expn_typestrength	0.00	(0.00)	-0.00**	(0.00)				
Expn_patsimil_type	-0.00	(0.00)	0.00*	(0.00)				
Tie_strength					0.04	(0.02)	0.02	(0.01)
Tie_strength^2					-0.00	(0.00)	-0.00***	(0.00)
Patsimil_tiestrength					0.03	(0.03)	0.03	(0.02)
Expn_tiestrength					-0.00	(0.00)	0.00	(0.00)
Expn_patsimil_type					-0.00	(0.00)	-0.00	(0.00)
Constant	5.50***	(0.37)	4.60***	(0.56)	6.16***	(0.35)	4.91***	(0.54)
Lnalpha	1.54***	(0.11)	1.06***	(0.10)	1.55***	(0.11)	1.06***	(0.10)
Number of portfolios	1930		1930		1930		1930	
Number of firms	118.00		118.00		118.00		118.00	
Log likelihood	-14356.23		-13786.54		-14363.40		-13789.92	
Degrees of freedom	10.00		31.00		10.00		31.00	
Wald chi square	3872.32		38736.89		7709.20		136417.02	

Standard errors in parentheses, + p<0.1 * p<0.05 ** p<0.01 *** p<0.001

TABLE A10: The Moderating Role of Coopetition Experience (Adjusted by Type Strength) in the Relationship between Coopetition (Market Competition and Cooperation) and Coopetition-Based Innovation

Variables	Model A39		Model A39b		Model A40		Model A40b	
	w/o controls		with controls		w/o controls		with controls	
Year dummies			Not reported				Not reported	
Market_simil	0.85**	(0.31)	0.96***	(0.14)	0.91***	(0.21)	0.96***	(0.13)
Market_simil^2	-1.61	(1.00)	-0.74	(0.49)	-1.40+	(0.77)	-0.70	(0.43)
Type_strength	0.12***	(0.02)	0.05***	(0.01)				
Type_strength^2	-0.02***	(0.00)	-0.00	(0.00)				
Expn_cooptn_adj	0.03***	(0.01)	0.01+	(0.01)	0.02**	(0.01)	0.01+	(0.01)
Expn_cooptn_adj^2	-0.00**	(0.00)	-0.00*	(0.00)	-0.00*	(0.00)	-0.00**	(0.00)
Mktsimil_typestrnth	-0.00	(0.04)	-0.03	(0.03)				
Expn_mktsimil	0.00	(0.00)	0.00	(0.00)	0.00	(0.00)	0.00	(0.00)
Expn_typestrength	0.00	(0.00)	-0.00	(0.00)				
Expn_mktsimil_type	-0.00	(0.00)	0.00	(0.00)				
Tie_strength					0.10***	(0.02)	0.08***	(0.01)
Tie_strength^2					-0.00***	(0.00)	-0.00***	(0.00)
Mktsimil_tiestrnth					0.01	(0.04)	-0.01	(0.02)
Expn_tiestrength					-0.00	(0.00)	-0.00	(0.00)
Expn_mktsimil_tie					-0.00	(0.00)	0.00	(0.00)
Constant	6.62***	(0.44)	4.15***	(0.47)	7.13***	(0.39)	4.58***	(0.50)
Lnalpha	1.65***	(0.11)	1.18***	(0.10)	1.63***	(0.12)	1.16***	(0.10)
Number of portfolios	1930		1930		1930		1930	
Number of firms	118.00		118.00		118.00		118.00	
Log likelihood	-14490.65		-13924.93		-14463.78		-13906.32	
Degrees of freedom	10.00		31.00		10.00		31.00	
Wald chi square	243.00		17383.85		8574.94		17685.86	

Standard errors in parentheses, + p<0.1 * p<0.05 ** p<0.01 *** p<0.001

APPENDIX D
Results of Samples with All Major Semiconductor Firms (incl. not classified as SIC 3674)

As discussed in section 4.2, one of six types of semiconductor firms is the diversified firms. For example, Samsung Electronics (2nd ranked semiconductor firm) and Toshiba (4th ranked semiconductor firm) are diversified firms and their primary SIC codes are not SIC3674 (semiconductor industry). Even though industry reports include all semiconductor firms, academic research has focused on SIC 3674 to maintain consistency and reduce possible noises.

In this study, at first I included all major semiconductor firms, but I also found noise and reported samples under SIC 3674. Researchers in future research may face the same dilemma (i.e., whether to include all major semiconductor firms or only firms classified under SIC 3674). Thus, I report the sample characteristics of different samples and the results of samples with all major semiconductor firms.

Table A11 reports the sample characteristics (such as mean, standard deviation, min, and max) of diversified semiconductor firms (not classified as SIC 3674) and total semiconductor firms (SIC 3674 and those classified as other than SIC 3674). Interestingly, samples that are not under SIC 3674 have a higher average *Tech_comp* but a lower average *Market_tech* than the average samples under SIC 3674. More distinct differences are from *Tie_coop* and *Expn_coopn*. Samples that are not classified SIC3674 have a much greater average and greater maximum value than SIC 3674 samples. Samples that are not part of SIC 3674 have much less coopetition experience (*Expn_coopn*) than samples that are under SIC 3674.

Table A12 reports the results of different samples with 1) SIC 3674 (number of samples: 1930), 2) not SIC 3674 (number of samples: 1476), and total semiconductor firms (number of

samples: 3406). The results of the main effects are consistent across the different samples. However, the interaction effects are different.

TABLE A11: Sample Characteristics of Diversified Semiconductor Firms

Variable	Diversified Semiconductor Firms (Not SIC3674)					All Semiconductor Firms				
	Num	Mean	SD	Min	Max	Num	Mean	SD	Min	Max
Tech_comp	1476	0.53	0.44	0	1	3406	0.48	0.43	0	1
Market_comp	1476	0.27	0.31	0	1	3406	0.33	0.35	0	1
Type_coop	1476	7.04	3.24	3	18	3406	6.99	3.42	3	20
Tie_coop	1476	10.71	17.77	0	89.2	3406	6.00	13.52	0	89.2
Expn_cooptn_num	1476	0.58	0.89	0	4.5	3406	1.93	2.53	0	11.3
Expn_cooptn_adj	1476	5.88	8.46	0	39.6	3406	23.02	32.13	0	141.4

TABLE A12: Comparison of the Hypothesis Testing among Different Groups of Samples

Hwp #	IV	SIC3674		Not SIC3674		Total	
		w/o controls	With controls	w/o controls	With controls	w/o controls	With controls
H1	Tech_comp	(+)	(+)	(+)	(+)	(+)	(+)
	Market_comp	---	Inverted-U	---	Inverted-U	---	Inverted-U
H2	Type_coop	Inverted-U	(+)	Inverted-U	(+)	Inverted-U	(+)
	Tie_coop	Inverted-U	Inverted-U	Inverted-U	Inverted-U	Inverted-U	Inverted-U
H3a	Techcomp _Typecoop	(+)	---	(−)	---	---	---
	Techcomp _Tiecoop	---	---	---	(+)	---	(+)
	Mktcomp _Typecoop	---	---	(−)	---	(−)	---
	Mktcomp _Tiecoop	---	---	(−)	(−)	(−)	(−)
H4a	Exp_Techcomp _Typecoop	---	(+)	(+)	---	(+)	(+)
	Exp_Techcomp _Tiecoop	---	---	(+)	(+)	---	(−)
	Exp_Mktcomp _Typecoop	---	---	(+)	---	(+)	---
	Exp_Mktcomp _Tiecoop	---	---	---	(−)	---	---

*--- insignificant