STRATEGICALLY POISED: BALANCING, LEARNING, AND INNOVATING IN COOPETITION

THREE ESSAYS ON THE INTERPLAY BETWEEN COMPETITION AND COOPERATION

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ABSTRACT

This research dissertation explores the firm strategy of *coopetition*, a neologism denoting simultaneous cooperation and competition. Coopetition as a phenomenon has accrued prominence in practice, with economic actors placing a higher emphasis on constructing "positive sum" scenarios with competing partners. However, strategic management scholarship lacks clarity in explaining how the tensions and tradeoffs associated with coopetition may influence the formulation and the implication of coopetition.

With a theoretical and empirical focus on the benefits and caveats of coopetition, this dissertation elucidates coopetition from three angles. First, I theorize the socio-cognitive aspects in balancing competition and cooperation between firms. Second, I investigate firm learning experience in strategic alliances and patent searches as the antecedents to coopetition. Third, I examine the contingency effects of multiple network embeddedness on the relation between coopetition pursuits and innovation performance.

The empirical setting of my dissertation research is technology-driven industries, because firms in this setting show high heterogeneity in the key theoretical foci (i.e. coopetition, learning, interorganizational relations, and innovation). The firm sample includes U.S. public firms in multiple high-tech industries (i.e. pharmaceuticals, computers and peripheral equipment, electronics and electronic components, aerospace and aircraft, telecommunication, and medical devices). I construct a panel data with firm-year observations of financial records, alliance and M&A records, and patent records from 1987 to 2006 to test my hypotheses.

Key findings are summarized below.

Balancing (Chapter 2):

- Clarifying the interplay between emotionality and rationality in competitive dynamics hybridism
- Explaining interfirm interaction modes with different degrees of competition and cooperation

- Informing managers about the confounding effect of emotion-driven action proclivities
- Recalibrating strategic focus on value-based interdependence with competitors

Learning (Chapter 3):

- Explaining the effects of firm learning experiences on strategic decisions regarding coopetition
- Identifying a motivating effect of past strategic alliances and a hindering effect of firm patent searches on its coopetition pursuit
- Depicting path dependency in organization learning and relationship building
- Informing managers about the connection between learning experiences, firm capabilities, and coopetition tradeoff
- Providing guidance to strategize firm relationships with competitors by evaluating firm learning proficiency and coopetition as a competency development opportunity

Innovating (Chapter 4):

- Teasing out the contingency effects of alliance network and knowledge network embeddedness on the relation between coopetition and innovation
- Clarifying the logic behind network-based augmenting and dampening effects on the impact of horizontal integration on firm innovation performance
- Demonstrating the differential impacts of firm positions in multiple networks to inform managerial decision regarding leveraging coopetition to improve innovation
- When strategizing coopetition, innovation-driven firm managers should consider interfirm social power interdependence and firm knowledge base influence

DEDICATION

For my mother whose strong spirit inspires me,

my grandmother whose unconditional love enables me,

my father who has devoted his effort to support my education,

and to the loving memory of my late grandfather

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"I was born not knowing and have had only a little time to change that here and there."

– Richard Feynman,
theoretical physicist & educator, Nobel laureate (1918 – 1988)

Pursuing my Ph.D. has been an incredible journey of discovery, reflection, and growth. Through much ambiguity and anguish, I have taken my fill of ambrosia in the change of my "not knowing". Such a pursuit is a precarious endeavor not for the faint of heart, yet a tremendous privilege bequeathed only to the luckiest. With the guidance, support, and love from my mentors, colleagues, friends and family, I am one amongst the luckiest. I can find no word to aptly express my gratitude towards those who have enabled me to complete this journey. However, I appreciate the opportunity here to give my best attempt.

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From the gate that decrees *Lasciate ogne speranza, voi ch'intrate*[1], the Ph.D. journey commences its tortuous path. With angsts, I entered; with strengths, I persevered. I could not have been happier that I chose this path, and I owe it all to those who supported me along the way.

This is not the end, but the beginning to the rest of my adventure.

Aurora Liu
Toronto, Canada
January 31, 2018

[1] "*Abandon all hope, ye who enter here*" – Dante Alighieri (Divine Comedy, Inferno: Canto III, line 9)

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1 INTRODUCTION

1.1 RESEARCH TOPIC

The topic of investigation in this dissertation is *coopetition*, a portmanteau combining *cooperation* and *competition*. Coopetition refers to the partnership between competing entities to gain higher payoffs in a positive-sum game (Brandenburger & Nalebuff, 2011). In such a game, the opportunities of synergy exist, in which entities can create higher public value through a partnership than going it alone in the field; subsequently, each entity internalizes a portion of the synergistic value, leading to private value gains for all players (Brandenburger & Nalebuff, 1995). In other words, coopetition is a strategy to increase individual payoff (i.e. private value) by first enhancing the total game payoff (i.e. public value).

Coopetition is deployed on levels ranging from persons, organizations, to national sovereignties: workers vying for the same promotion opportunity in a group benefit from good team performance when they maintain a collegial relationship; firms racing to gain more market share may achieve greater profits when they collaborate to expand the market size; countries negotiate trade deals to boost their own economic growths while facilitating the development of their competitors (e.g. the U.S.A and China).

Here, I focus on coopetition as a firm strategy to gain competitive advantage. While paradoxical at first glance, there can be strong incentives for the firm to pursue coopetition.

Competing firms operating in the same market space often accrue a common set of strategic factors, and they are distinguished by the degrees to which each firm develops these factors (Hamel, Doz, & Prahalad, 1989). In other words, competing firms need to develop strengths along similar dimensions, and they may recognize complementarities between their weaknesses and a competitor's strengths.

For example, Apple and Microsoft compete in the consumer electronics industry and develop expertise in similar technological areas but to different extents: while Apple out-competes Microsoft in functional integration amongst different devices within the Apple ecosystem, Microsoft claims leadership in the market by its operating systems that are developed to complement most products offered by other companies in the field. Hence, an opportunity of synergy is present between Apple and Microsoft to form a strategic alliance: Apple may leverage Microsoft's market presence to capture more users by developing integration between the iOS and Windows operating systems; Microsoft may learn from Apple's expertise in functional designs for different devices, such as mobile tablets and smart phones.

Upon his return as Apple's CEO, Steve Jobs declared at the Boston Macworld Conference in 1997:

> *"Apple needs help from other partners … and relationships that are destructive are no help to anybody in this industry today… We have to let go of the notion that for Apple to win, Microsoft has to lose."*

In a similar tone, Jobs's successor Tim Cook noted in his speech at the 2015 BoxWorks event regarding Apple's strategic pursuit of coopetition with Microsoft in the enterprise platform market:

> *"Apple and Microsoft can partner on more things than we can compete on, and that is what the customer wants… Office on the Mac is a force. Partnering with Microsoft is great for our customers and that's why we do it."*

Firms pursue coopetition to leverage complementary resources and capabilities in gaining synergy (Lado, Boyd, & Hanlon, 1997). Through coopetition, competitors may share critical resources to increase the efficiency of innovation, production, and value creation. Furthermore, firms can learn from their competitors to develop capabilities crucial for success in the field. However, firms need to overcome major barriers to benefit from coopetition. Opportunism is the first obstacle, since partnering with rivals leads to the possibility of misappropriation (Conner & Prahalad, 1996). The focal firm must place a certain level of trust in its partner to facilitate the collaboration, because no enforceable contract can exhaustively preempt all misappropriation threats (Chen & Miller, 2015; Tsai, Su, & Chen, 2011). With trust, the firm becomes susceptible to undercutting by an opportunistic opponent.

Tunnel vision is another caveat. In coopetition, firms inevitably become hyper-focused on their opponents' actions, since close contacts and interactions in the partnership draw attention from the firms onto each other (Chen & Miller, 2015). With the partners being competitors in the same business field, firms become ever more vigilant and devote

high cognitive efforts to noting, analyzing, and strategizing vis-à-vis their opponents' behaviors, since miscalculation can manifest into costly losses. Consequently, the firms can lose sight of better opportunities, or worse, blinded by the threats outside the coopetitive relationship. In summary, coopetition can yield competitive advantage to the firm, yet it may cause dangerous pitfalls. Given the co-existence of benefits and harms, how do firms strategize coopetition to enhance their competitiveness?

1.2 LITERATURE OVERVIEW

The phenomenon of cooperation between competitors (i.e. coopetition) has attracted growing interests from management scholars (Brandenburger & Nalebuff, 2011; Chen & Miller, 2015; Gnyawali & Madhavan, 2001). Firms strategically forge cooperation with certain rivals to create value by collaborative learning and joint innovation (Hamel, 1991). Anecdotal examples of value-creating coopetition abound. Apple and IBM compete in the integrated computer system market, while concurrently cooperating to develop and refine technological knowledge (Hagedoorn, Carayannis, & Alexander, 2001). Samsung and Sony are direct rivals in the consumer electronics market, and they simultaneously collaborate on research and development (R&D) (Gnyawali & Park, 2011).

Value-creating coopetition can provide significant competitive advantage for innovation-driven firms. However, theoretical understanding of this strategy remains elusive. On a related front, research on value-creating cooperation in strategic management has yielded fruitful results. The alliance literature demonstrates that inter-connected firms gain competitive advantage from resource sharing and rent creation (Lavie, 2006),

knowledge complementarity (Makri, Hitt, & Lane, 2010), and organizational learning (Phene & Tallman, 2014). Furthermore, strategic alliances between competitors often lead to horizontal integration. For example, strategic alliances between competitors increase the likelihood of consolidation through mergers and acquisitions (M&A) (Angwin, 2007), as synergy becomes more tangible over the course of the partnership.

Synergy through coopetition exists because competing firms often share common grounds in resource development, knowledge implementation, and learning goals (Browning, Beyer, & Shetler, 1995). Due to such commonalities, cooperation with competitors can yield greater competitive advantage to the firm through learning opportunities and innovation enhancement than functional partnerships, such as a supplier-buyer alliance (Chen & Miller, 2015). On the other hand, competitive tension exerts non-trivial impacts on the decision and the outcome of inter-firm cooperation, because value erosion instead of value creation is plausible when rivalrous firms behave opportunistically (Chen & Miller, 2015). For instance, knowledge exchange between competitors may result in "learning race", in which a firm unilaterally absorbs the core knowledge from its partner (Khanna, Gulati, & Nohria, 1998; Yang, Zheng, & Zaheer, 2015).

Therefore, coopetition stands as a unique managerial phenomenon, which requires distinct theoretical treatments than non-competitive collaboration. Although coopetition research continues to accrue momentum, it remains in a fragmented state and has yet to be integrated into the main strategic management literature. Few studies emphasize the

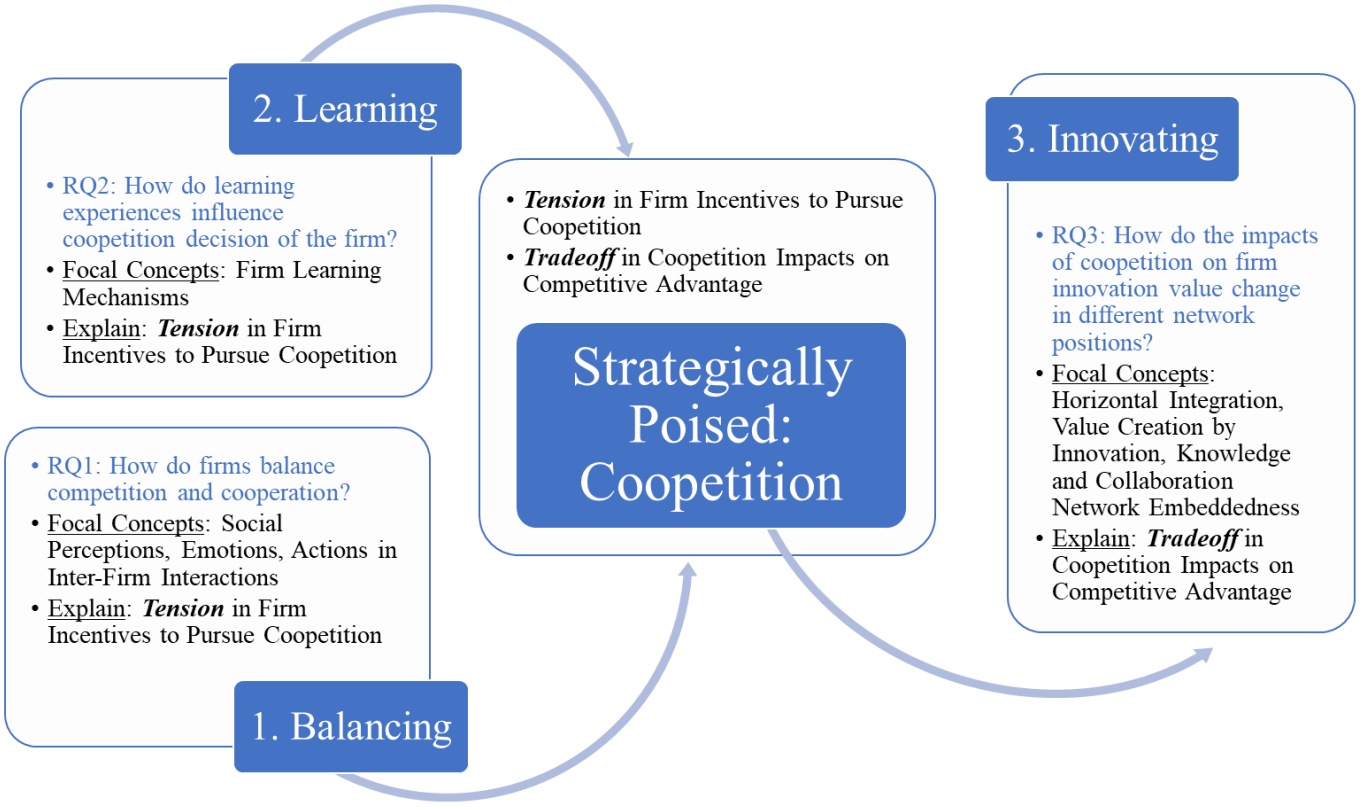
tension and tradeoff associated with coopetition, leaving a theoretical gap in strategic management literature.

1.3 RESEARCH DESIGN

1.3.1 Structural Framework

The overarching theme of my dissertation is to examine the tension and tradeoff associated with coopetition. Shedding light on the positive and negative externalities of coopetition, the research here contributes to theoretical understanding on how firms reach and leverage friendships with their foes to gain competitive advantage. My dissertation is structured in three interconnected research streams, illustrated in Figure 1.1. Focusing on the balancing, learning, and innovating facets in coopetition, the three streams explain the tension in firm incentives to pursue coopetition, and the tradeoff in the impacts of coopetition on firm competitive advantage.

Figure 1.1 Structural Framework of Three Research Streams



In *Balancing* (Chapter 2), I address the socio-cognitive aspects of the firm in balancing competition and cooperation, leading to the emergence of competitive dynamics hybridism, in which coopetition stands central in inter-firm interactions. The focal concepts in this chapter are social perceptions, emotions, and actions of the firm in the context of interactions with competitors. The theoretical development in this chapter explains the tension in firm incentives to pursue coopetition by examining competitive dynamics hybridism in a socio-cognitive lens. In theorizing the causal links between the above concepts, this chapter answers the research question:

RQ 1. How do firms balance competition and cooperation?

In *Learning* (Chapter 3), I examine the impacts of firm learning mechanisms on firm propensities to pursue coopetition in the technology-driven industries. Coopetition provides competitive advantage through firm learning opportunities, yet it exacerbates learning race pitfalls. Therefore, understanding how firm learning influences firm decisions to pursue coopetition will yield insights on how the firm can build competency through coopetition while avoiding commitment to unnecessary exploration. The empirical work here complements the conceptual development in Chapter 3 to explain the tension in firm incentives to pursue coopetition from an organization learning perspective. Conceptual and empirical analysis answers the research question:

RQ 2. How does firm learning influence the decision to pursue coopetition?

In *Innovating* (Chapter 4), I investigate factors that alter the positive and negative externalities of coopetition on firm innovation in the technology-driven industries. Starting from horizontal integration to represent deepened coopetition, I tease out the moderation effects of multiple network embeddedness on the impact of horizontal integration on firm innovation value. The focal concepts in this chapter are horizontal integration, value creation by innovation, knowledge and collaboration network embeddedness. By elucidating the moderation effects of multiple networks in which a focal firm is placed, the conceptual and empirical analysis in this chapter explains the tradeoff in the impacts of coopetition on firm competitive advantage. The research question guiding the investigation here is:

> *RQ 3. How do network positions moderate the impacts of coopetition on firm innovation?*

1.3.2 Empirical Setting

The empirical setting for Chapters 3 – 4 is technology-driven industries in the United States. My goals in these two research streams are two-fold: first, to explain the variance in firm incentives to pursue coopetition from an organization learning perspective; and second, to tease out the network contingency effects regulating the impacts of coopetition on firm innovation. Therefore, the firm sample must contain variance in coopetition pursuits, learning and innovative activities.

In technology-driven industries, learning and innovation are critical for firm competitive advantage. Depending on the focal firm's strategic positioning, it may engage in R&D, exploration and experimentation to various degrees. Moreover, firms in these industries pursue coopetition at higher frequencies than sectors with low technological intensities. Similarly, strategic positioning alters how much firms engage in strategic alliances, joint ventures, and/or M&As with other players in the same industry. Technology-driven industries thus provide a suitable empirical setting to analyze the correlations between firm learning, coopetition, and innovation.

According to the Science, Technology and Innovation (STI) Scoreboard[2] reports on international comparison of firm innovation intensities, firms in the United States engage in vigorous learning and innovation, measured in R&D investments, scientific research and technological invention. Figure 1.2 and Figure 1.3[3] below show the comparison between selected developed and developing countries in their historic R&D investments. Figure 1.2 demonstrates the changes of business R&D expenditure in the U.S., Japan, and EU from 1991 to 2003. The U.S. leads in the developed economy in terms of overall R&D expenditure in the private sector.

Figure 1.3 illustrates the 2003 strategic mapping in R&D investment, which indicates that the U.S. ranks high internationally in innovation human capital (measured in

[2] The Organisation for Economic Co-operation and Development (OECD) conducts biennial studies to monitor innovation activities in different countries. All reports and data are published with free access from the *OECD iLibrary*.

[3] Figure 1.2 and Figure 1.3 are adapted from the 2005 report of *OECD Science, Technology and Industry Scoreboard* (OECD, 2005: pp21-23).

the number of researchers per 1,000 employees) and R&D intensity (measured in R&D expenses as % GDP). Furthermore, public firms in the U.S. report standardized financial records to the Securities and Exchange Commission regularly, thus providing reliable data to gauge critical variables such as firm assets, strategic activities, and performances.

Figure 1.2 Changes of Business R&D Expenditure in 1991-2003

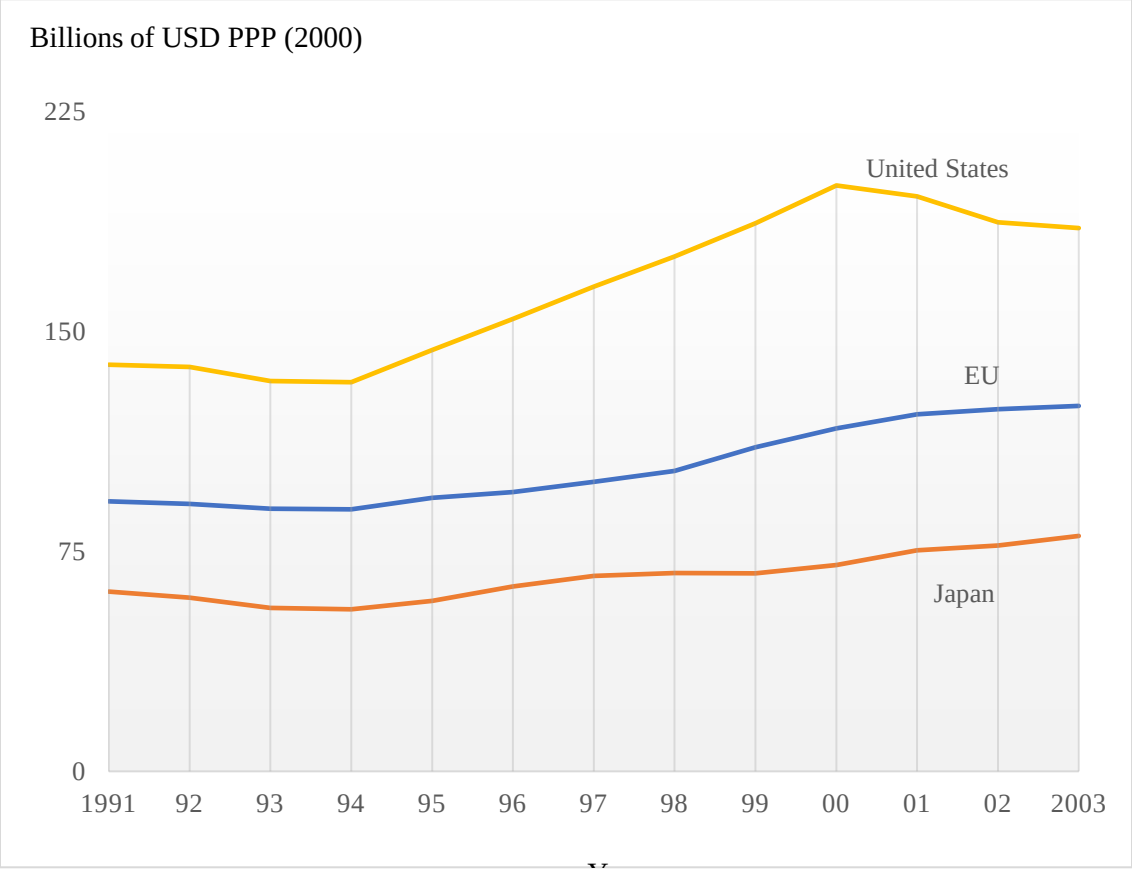
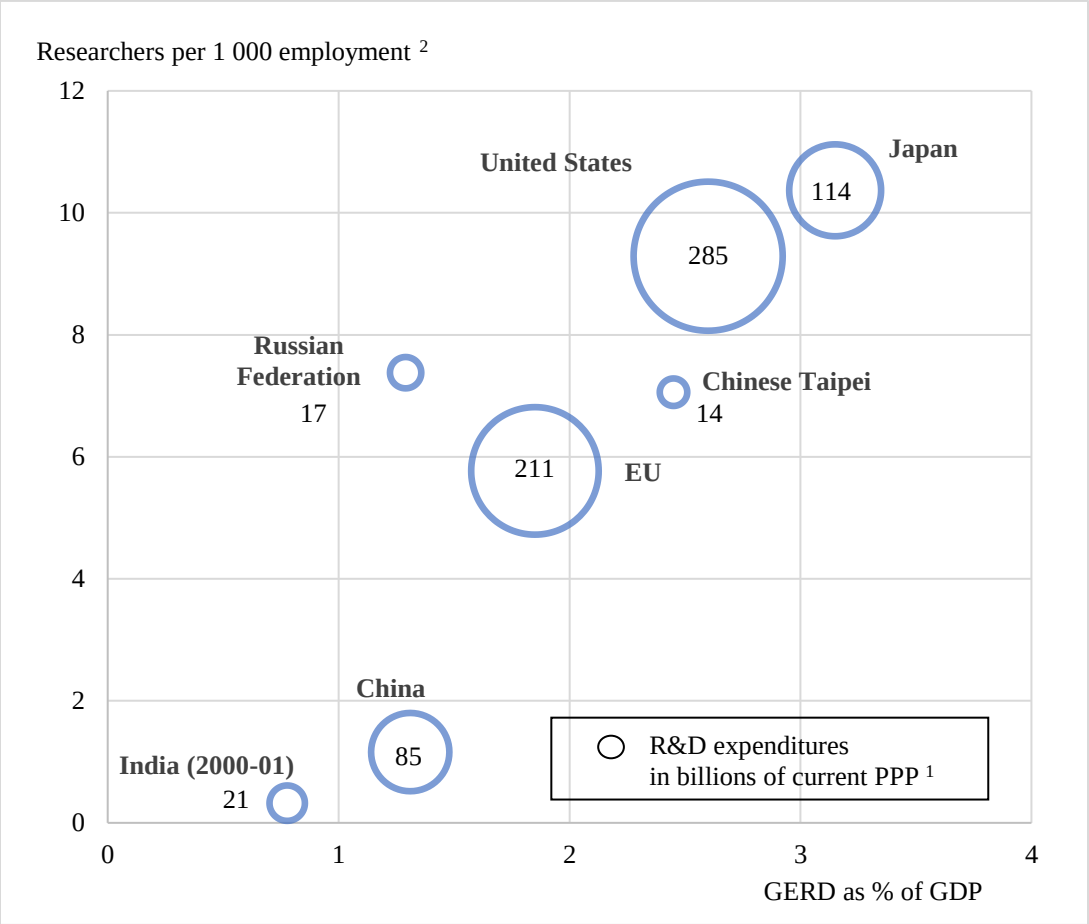


Figure 1.3 R&D Expenditure and Innovation Human Capital in Selected Countries (2003)



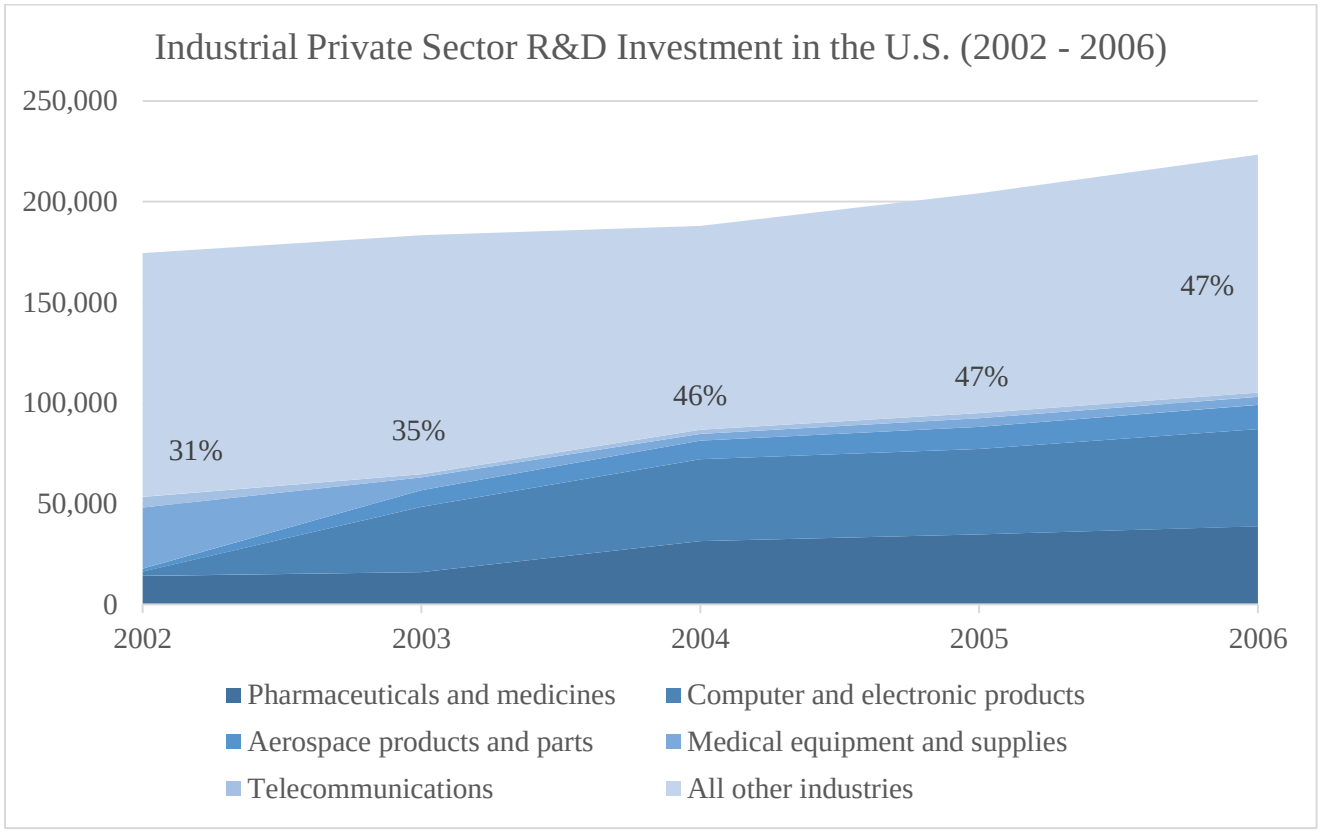
1. The size of the bubble represents R&D expenditure in billions of current USD in purchasing power parities (PPP).
2. For researchers per 1,000 persons employed: EU, 2002; United States, 1999; and India, 1998.

To identify technology-driven industries, I rely on the Business Research and Development and Innovation Survey (BRDIS) by the National Science Foundation (NSF). Table 1.1 and Figure 1.4 (collated from the BRDIS data) show a snapshot of private R&D investments in different industries from 2002 to 2006, highlighting high innovation intensities in the technology-driven industries. The aggregate private R&D investment in pharmaceuticals and medicines, computer and electronic products, aerospace products and parts, medical equipment and supplies manufacturing, and telecommunications takes up between 31% (in 2002) and 47% (in 2006) of the total private R&D investment across all industries. Moreover, these industries demonstrated a consistent upward trend in R&D intensities throughout the observation timeframe.

Table 1.1 Private R&D Investment and Industrial Size in the United States from 2002 to 2006

Year	2002		2003		2004		2005		2006	
	Industrial Size (Firm Count)	Private R&D Investment (US$)	Industrial Size (Firm Count)	Private R&D Investment (US$)	Industrial Size (Firm Count)	Private R&D Investment (US$)	Industrial Size (Firm Count)	Private R&D Investment (US$)	Industrial Size (Firm Count)	Private R&D Investment (US$)
All industries	29,001	$174,408	37,843	$183,305	41,029	$188,035	43,880	$204,250	44,266	$223,365
Pharmaceuticals and medicines	313	$14,186	299	$15,949	394	$31,444	445	$34,798	483	$38,813
Computer and electronic products	666	$2,087	2,434	$32,495	3,226	$40,691	3,425	$42,463	2,795	$48,251
Aerospace products and parts	951	$1,508	170	$8,203	160	$9,224	254	$10,928	132	$11,995
Medical equipment and supplies	2,808	$30,307	713	$6,370	661	$3,313	869	$4,343	923	$3,998
Telecommunications	84	$5,349	122	$1,625	214	$2,052	108	$2,539	162	$2,135

Figure 1.4 Industrial R&D Intensity Snapshot from 2002 to 2006 in the United States



Percentage of aggregate private R&D investment from pharmaceuticals and medicines, computer and electronic products, aerospace products and parts, medical equipment and supplies, and telecommunications sectors in all industries

Therefore, I gather firm data from the following industries in my dissertation:

- Pharmaceuticals (SIC 2833-2836)
- Computers and peripheral equipment (SIC 3571-3579)
- Electronics and electronic components (SIC 3671-3679)
- Aerospace and aircraft (SIC 3721-3769)
- Telecommunications (4812-4813, 4822, 4899)
- Medical devices (3841-3845)

My sample includes all public firms in the above industries per company primary Standard Industrial Classification (SIC) codes obtained from SEC filings. Data for the empirical research include financial statements, strategic alliance and M&A records, and patent archives for listed firms in the U.S. from 1987 to 2006. The primary sources for these records are SEC (accessed through COMPUSTAT), United States Patent and Trademark Office (USPTO), Thomson Reuters Securities Data Company (SDC) Platinum ™, and Factiva.

1.4 SUMMARY OF KEY FINDINGS

Combining the three research streams on balancing, learning, and innovating in coopetition, this dissertation sheds light on how firms reach and leverage a strategically poised position to gain competitive advantage. Theoretical knowledge of the tension and tradeoff of coopetition informs managerial practitioners how to strategize partnerships with

competitors. I summarize the key findings, in terms of theoretical contributions and managerial implications, from each chapter below.

Chapter 2 conceptualizes the coupling between emotionality and rationality of strategic decisions in the social context of inter-firm interactions, and explains how such interplay manifests in competitive dynamics hybridism. The balance between cooperation and competition emerges from the managerial cognitive reactions driven by firm-level perceptions and emotions, in addition to rational planning driven by resources and capabilities.

When dealing with social interactions with competitors, the strategic pitfalls caused by perceptive distortion and emotive escalation are often amplified. Managers should be cognizant about their perceptive interpretation and emotive reaction regarding a competitor's action and motive. Acknowledging the confounding effect from emotion-driven action motives, managers will gain a clear vision as they evaluate value-based interdependence with competitors when strategizing the interfirm interaction mode.

Chapter 3 teases out the impacts of firm learning experiences on coopetition pursuit propensities. I report the empirical findings from the technology-driven industries in the U.S. from 1987 to 2006 to demonstrate how firm strategic decision to pursue coopetition is influenced by their capability-building experiences through patent-based and alliance-based learning. Firms with more experiences in strategic alliances showed increased propensities to engage in coopetition, whereas firms with more experiences in patent searches were less likely to pursue coopetition.

Taking a path-dependent lens, the conceptual development and empirical findings here yield knowledge about how organization learning impacts strategic decision in the context of coopetition. Successful learning through coopetition depends on a firm's capabilities to learn, and this chapter teases out what type of past learning experiences can enhance coopetition as a competency development opportunity. Managers may use the insights from this chapter to evaluate the tradeoff in coopetition (e.g. providing knowledge access yet posing learning race threats) based on the firm's learning proficiency in different mechanisms.

Chapter 4 reports the moderation effects of alliance and knowledge network embeddedness in regulating the main impact of coopetition on innovation performance of the firm. With different positions in the alliance network, firms face distinct social power constraints. Similarly, knowledge network position of a firm reflects the influence and information recombination of its knowledge base. These network constraints of the firm may influence how effective coopetition manifests as a strategy to improve innovation performance. I identify augmenting effects from alliance and knowledge network centrality (i.e. reflecting a firm's social connectiveness and knowledge influence, respectively), and a dampening effect from alliance network structural hole (i.e. reflecting a firm's ability to access resources from different sources).

These findings imply that when a focal firm controls a central and influential network position in the competition field, it can harness coopetition more effectively as a mechanism to boost innovation; in contrast, when a firm gains resource access from diverse

sources, the impact of coopetition on its innovation performance tends to be smaller. From the insights here, managers at innovation-driven firms may strategize from a network perspective, noting the differential impacts of multiple networks when they consider leveraging coopetition to improve innovation.

Table 1.2 summarizes the key findings from the three chapters in terms of theoretical contributions and managerial implications. Taken together, this dissertation sheds a light on the antecedents and implications of coopetition as a firm strategy. My work contributes to the strategic management literature with insights on the balance between competition and cooperation, the path dependence in firm learning and coopetition strategy, and the network-based contingency effects in the results of coopetition.

Table 1.2 Summary of Key Findings

Chapter	Theoretical Contributions	Managerial Implications
Balancing	• Clarifying the interplay between emotionality and rationality in competitive dynamics hybridism • Explaining interfirm interaction modes with different degrees of competition and cooperation	• Informing managers about the confounding effect of emotion-driven action proclivities • Recalibrating strategic focus on value-based interdependence with competitors
Learning	• Explaining the effects of firm learning experiences on strategic decisions regarding coopetition • Identifying a motivating effect of past strategic alliances and a hindering effect of firm patent searches on its coopetition pursuit • Depicting path dependency in organization learning and relationship building	• Informing managers about the connection between learning experiences, firm capabilities, and coopetition tradeoff • Providing guidance to strategize firm relationships with competitors by evaluating firm learning proficiency and coopetition as a competency development opportunity
Innovating	• Teasing out the contingency effects of alliance network and knowledge network embeddedness on the relation between coopetition and innovation • Clarifying the logic behind network-based augmenting and dampening effects on the impact of horizontal integration on firm innovation performance	• Demonstrating the differential impacts of firm positions in multiple networks to inform managerial decision regarding leveraging coopetition to improve innovation • When strategizing coopetition, innovation-driven firm managers should consider interfirm social power interdependence and firm knowledge base influence

2 BALANCING COMPETITION AND COOPERATION: SOCIAL COGNITION OF THE FIRM AND COMPETITIVE DYNAMICS HYBRIDISM

2.1 ABSTRACT

I address how firms balance competition and cooperation from a sociocognitive perspective. The competitive dynamics literature posits a hybrid view of interfirm relations, which conceptualizes a continuum of rivalrous, competitive-cooperative, and relational modes of firm interactions. I theorize the sociocognitive antecedents to firm decisions on mode shifts by clarifying the interdependence between emotionality and rationality in competitive dynamics. Focusing on firm perception, emotion, and actions, I develop propositions to explain how social cognition within interfirm relations lead to interaction modes with different degrees of competitiveness and cooperativeness. My analysis makes theoretical contributions to competitive dynamics and behavioral theory of the firm.

2.2 INTRODUCTION

A central theme in strategic management research focuses on firm decisions to balance competition and cooperation (Chen & Miller, 2012) and how these firm-level strategic decisions influence dyad-level interfirm interactions, including competitive attacks and rivalry (Baum & Silverman, 2002), alliances and other cooperative relations (e.g. Baum, Calabrese, & Silverman, 2000; Dussauge, Garrette, & Mitchell, 2000; Gnyawali &

Madhavan, 2001). To shed light on the balance between interfirm competition and cooperation, it is critical to apply the sociocognitive theoretical lens to analyze how firm social cognition (e.g. firm perceptions of competitor actions and attributes) influence firm social behaviors (e.g. rivalrous attacks and/or relational building) (Chen & Miller, 2015).

A key stream of research in the competitive dynamics paradigm has provided influential knowledge on how interfirm interactions take form as firms strategize competition and cooperation from a sociocognitive perspective. Extant investigations delineate an array of firm-level sociocognitive elements that are influential on dyad-level interactions, including firm awareness, motivations, and comparative capabilities (i.e. the AMC framework) (Chen & Miller, 2015), competitive domain identities (Livengood & Reger, 2010), interfirm social comparison (Kim & Tsai, 2012), and firm competitive perceptions (e.g. Gao, Yu, & Cannella, 2017; Trapido, 2012; Tsai, Su, & Chen, 2011). Interestingly, growing research illustrates that firms become aware of the opportunities to gain competitive advantage through relational contacts with competitors, and concurrently perceive the competitors as partners instead of rivals (Brandenburger & Nalebuff, 2011).

It is especially critical to tease out the role of firm social cognition in firm behavioral decisions (i.e. elicit competitive attack vs pursue relational contacts) when competitive tension is palpable between the interacting firms (Chen & Miller, 2015; Chen, Su, & Tsai, 2007), because competitive perceptions can arouse strong emotions in the focal firm, which yield significant impacts on firm behaviors (Hodgkinson & Healey, 2011). For example, a focal firm may experience tangible negative feelings towards a competitor when

it sees the competitor as a rival and the competitor action as an attack (Chen, 1996). Similarly, firms emotionally respond in a negative manner when they perceive organization identity threats from competitors in proximal competitive domains (Livengood & Reger, 2010). Although it has been noted that emotions can impact competitive and cooperative behaviors on the firm-level, current understanding on interfirm competition-cooperation balance is limited by a deficiency in theoretical development of firm emotions and their behavioral implications in the social context of interfirm interactions (Ashkanasy, Humphrey, & Huy, 2017; Huy, 2012; Menges & Kilduff, 2015).

In their seminal work, Chen and Miller (2012; 2015) put forth a hybrid view of competitive dynamics by synthesizing critical insights from extant research on interfirm rivalry, co-opetition, and alliances. The hybrid view of competitive dynamics conceptualizes interfirm relations as modes of interactions (i.e. firm actions and reactions), including the rivalrous, competitive-cooperative, and relational modes, along a continuous spectrum with mixed competition and cooperation (Chen and Miller, 2015). This hybrid view has led to an intellectual curiosity: given that interfirm interactions vary in the degrees of competition and cooperation, how do firms "transcend the divides and dichotomies between competition and cooperation" (Chen & Miller, 2015: p771); or more broadly, "under what conditions must the balance shift between competitive-cooperative, rivalrous, and relational modes" (Chen & Miller, 2015: p771)?

To answer the above question regarding the shift of interfirm hybrid interaction mode along the competition-cooperation spectrum, I need to understand the interlace

between rationality and emotionality throughout the cognitive-behavioral cascade of firm decisions regarding interfirm actions/reactions. Although it has been noted that the role of emotions is critical in the manifestation of bounded rationality in the decision-making process (Simon, 1967; 1983), firm strategy research largely focuses on the cognitive and situational constraints of rational decisions, leaving firm emotions in a black box (Gavetti, 2011; Powell, Lovallo, & Fox, 2011). The deficiency in conceptualization on firm emotions has hindered theoretical progress in competitive dynamics, and more broadly, behavioral strategy (Ashkanasy et al., 2017; Huy, 2012; Menges & Kilduff, 2015).

In this analysis, I fill the above knowledge gap in strategic management using a sociocognitive theoretical lens. Specifically, I integrate formative insights from the organizational group emotions literature into competitive dynamics to unpack its hybridism. I introduce firm-level emotionality into the current AMC framework to explain the impacts of firm social cognition (e.g. competitive perceptions) on firm behavioral decisions regarding the competitive-cooperative, rivalrous, and relational interaction modes. I delineate the types of firm emotions aroused by the perceptions of competitor motivations and capabilities as the focal firm becomes aware of the competitor, and I continue to elucidate the behavioral implications of these firm emotions. Overall, my analysis teases out how variations in firm competitive perceptions lead to positive or negative emotions, and how different firm-level emotional responses towards a competitor cause the firm-dyad interaction mode to shift.

My conceptual framework advances the sociocognitive perspectives of strategic management in the following ways. First, I contribute to the hybrid view of competitive dynamics by examining "under what conditions must the balance shift between competitive-cooperative, rivalrous, and relational modes" (Chen & Miller, 2015: p771) through the sociocognitive theoretical lens. My conceptual framework highlights the role of firm-level emotionality in the sociocognitive-behavioral cascade (i.e. competitive perceptions, social emotions, and interfirm actions/reactions) that leads to the shifts of hybrid interaction mode on the firm-dyad level. Second, I contribute to burgeoning research on organizational group emotions. I delineate the firm-level, collective emotional responses to competitor actions and attributes by clarifying how variations in a focal firm's competitive perceptions can cause positive or negative emotions of the firm. Furthermore, my theoretical development of firm emotions sheds a light on the missing link that mediates the impacts of firm social cognition on firm behavioral decisions regarding interfirm competition and cooperation.

In doing so, my analysis contributes to behavioral strategy and behavioral theory of the firm. I highlight emotionality on the firm level as the "bounds" in "bounded rationality" (Simon, 1983) that governs firm strategic decisions regarding interfirm relationships. My conceptual model explains how emotional responses lead to competitive and cooperative behaviors of the firm that may align with or deviate from the results of rational thinking. Overall, I construct a sociocognitive perspective of competitive dynamics hybridism focusing on the role of emotionality. The conceptual framework developed here yields complementary insights to extant economic perspectives of co-opetition that follow

the rationality logic, such as cooperative game and strategic network (Brandenburger & Nalebuff, 2011; Brandenburger & Stuart, 1996), syncretic rents (Lado, Boyd, & Hanlon, 1997), and resource-based view (Barney, 1991; Barney, Ketchen, & Wright, 2011).

2.3 HYBRID VIEW OF COMPETITIVE DYNAMICS

Competitive dynamics (CD) research focuses on the firm-dyad competitive actions/reactions to develop theoretical insights on interfirm relationships (Chen & Miller, 2012, 2015). A central premise in the CD paradigm posits that firm competitive and cooperative strategies are the consequences of the firm cognitive-behavioral cascade that conveys the impacts of a focal firm's social perceptions about the opponent and their dyadic relationship ex ante onto the focal firm's social behaviors (i.e. actions/reactions towards the opponent) (Chen & Miller, 2012). Stated differently, the focal firm's strategic decisions on how to act upon (or react to) a competitor (i.e. competitively vs cooperatively) are influenced by its sociocognitive depictions of the competitor actions and attributes (i.e. competitive perceptions).

Competitive perceptions of the firm become manifest when the focal firm gains awareness of the competitor, for example, when the focal firm directs its attention to analyze competitor actions (i.e. competitor analysis) (Chen, 1996), and socially compares its performances and capabilities against those of the competitor (Kim & Tsai, 2012). Competitive perceptions of the firm can yield differentiated behavioral consequences. For

example, if the focal firm interprets organizational identity threats from a competitor occupying a proximal competitive domain, it tends to develop negative emotions and reacts defensively towards the proximal competitor, often by eliciting competitive attacks; in contrast, the focal firm behaves in a more subdued manner when it perceives a competitor's domain identity to be dissimilar from its own (Livengood & Reger, 2010). Variations in the focal firm's social cognitions and social behaviors with respect to a competitor thus alter the competitiveness of the dyadic relationship (Chen & Miller, 2012).

Most prior CD studies have taken for granted that competing firms primarily take on a rivalrous stand and perceive the external firm counterparts as enemies when interacting with one another (e.g. Baum & Korn, 1996; Ferrier, 2001; Ferrier, Smith, & Grimm, 1999). However, recent investigations demonstrate that firms can often gain strategic advantages by maintaining relational contacts with their competitors (Chen & Miller, 2012; 2015). For instance, firms may leverage complementary resources for value creation through strategic alliances and joint ventures with their competitors (e.g. Baum et al., 2000; Hill & Rothaermel, 2003; Makri, Hitt, & Lane, 2010), establish mutual forbearance to reduce competitive threats in multiple markets (e.g. Markman, Gianiodis, & Buchholtz, 2009; Tieying, Subramaniam, & Cannella, 2009), form a strategic network that includes relational ties with competitors to gain bargaining power over complementors, suppliers, and buyers (Brandenburger & Nalebuff, 2011), and utilize the network ties with competitors as critical resource conduits (Gnyawali & Madhavan, 2001).

Moreover, firms often develop new competence efficiently when they learn from competitors in the same industry by gaining knowledge access through relational contacts (Grant & Baden-Fuller, 2004; Hamel, Doz, & Prahalad, 1989). In innovation-driven industries, competing firms often conduct joint exploration in new technological spaces to share the risks, and reduce costs associated with the innovation learning curve (Browning, Beyer, & Shetler, 1995; Gnyawali & Park, 2011; Irwin & Klenow, 1996).

Considering the ubiquity of relational contacts between rivalrous firms, strategy scholars have recognized the theoretical limitations in conceptualizing competition and cooperation as discrete interaction modes between firms (Chen & Miller, 2012; 2015). To capture the coexistence of competition and cooperation on the firm-dyad level, Chen and Miller (2015) put forth the hybrid view of interfirm competitive dynamics. The hybrid view depicts a spectrum of varying degrees of competition and cooperation on the firm-dyad level, which encompasses the rivalrous, competitive-cooperative, and relational interaction modes as key demarcations (Chen & Miller, 2015). When adopting the rivalrous mode, a focal firm perceives an interaction counterpart as a competitor (i.e. rival), and pursues competitive actions such as attack, retaliation, or avoidance (Chen & Miller, 2015).

However, when opportunities for value creation present in the relational contacts between competing firms, they often shift away from the rivalrous mode of interactions, and move towards the competitive-cooperative mode, or the relational mode. When adopting the competitive-cooperative mode, the focal firm perceives a competitor simultaneously as an alliance partner, and pursues cooperative or co-opetitive actions with

the aim to obtain competitive advantages; as cooperation deepens, the mode of interactions becomes relational, the interacting firms perceive each other as a stakeholder and pursue cooperative actions to "raise all boats" (Chen & Miller, 2015).

In the hybrid view framework, how the actors (i.e. a focal firm and its interaction counterpart) perceive each other can influence the strategic aims, modes, toolkits, and time horizons of their interactions (Chen & Miller, 2015). It can thus be expected that firm-level social cognitions are instrumental to how hybrid interactions become manifested on the firm-dyad level (e.g. degrees of competition vs cooperation).

More generally, CD research hinges on the behavioral implications of firm social cognition in the context of interfirm competition (Chen & Miller, 2012). Scholars have devoted effort to tease out how firm perceptions of competitors and competitive relations (i.e. competitive perceptions) can impact interfirm interactions. Chen, Su, and Tsai (2007) bring scholarly attention to the implications of competitive tension perceived by the firms on their interactions. Livengood and Reger (2010) point out how organizational identities and competitive domains are perceived by the firm can yield significant impacts on how the firm acts and reacts to its competitors. Kim and Tsai (2012) clarify how firms perceive the comparison between themselves against their competitors can influence their competitive actions. Gao et al. (2017) identify different firm reactions to competitors, depending on how firm managers perceive the magnitude and complexity of the competitive attacks.

These studies, among others in the CD literature, have produced formative knowledge on interfirm competition from a sociocognitive perspective by establishing significance in the behavioral implications of firm-level social perceptions about competitors and ex ante competitive relationships (i.e. competitive perceptions). The behavioral implications of firm competitive perceptions stand even more conspicuous when competition and cooperation are both present in hybrid interactions, such as coopetition and relational competition (Chen & Miller, 2012, 2015).

For example, when two competing firms form a strategic alliance, they come in close, often repeated, social contacts (i.e. high interfirm interaction intensity), and firm strategic managers devote heightened attention to the actions of the competitive partners (M. Chen, 1996; Johnson & Hoopes, 2003; Tsai et al., 2011). Due to the increased interfirm interaction intensity and heightened managerial attention, competitive perceptions between these firms can elicit strong cognitive-behavioral effects ("hot cognition") driven by tangible negative emotional responses in the focal firm, which can deviate from the value-driven logic (Hodgkinson & Healey, 2011). Therefore, understanding how firms emotionally respond to competitive perceptions stands at the crux of unpacking the hybridism in competitive dynamics.

However, current theories on the interplay between competition and cooperation largely rely on the value-driven rationale, for example, strategic network and cooperative game theory (Brandenburger & Nalebuff, 1995), relational and syncretic rents (Dyer & Singh, 1998; Lado et al., 1997), resource-based view and dynamic capabilities (Barney et

al., 2011; Sirmon, Hitt, & Ireland, 2007; Teece, Pisano, & Shuen, 1997), and firm learning perspectives (Hitt, Dacin, Levitas, Arregle, & Borza, 2000; Lane & Lubatkin, 1998; Phene & Tallman, 2014).

While the economic, rational aspects of cooperation between competitors are succinctly captured in the value-driven conceptualization, the sociocognitive, emotional aspects have been excluded from the boundary conditions of the abovementioned theories. Since emotionality can yield highly efficacious impacts on firm strategies (Huy, 2012; Menges & Kilduff, 2015), it is unsurprising that firms can fail to follow the rationality-based (e.g. value-driven) logic when partnering with competitors (e.g. Park & Russo, 1996; Toh & Polidoro, 2013). It is thus essential to incorporate conceptualization of firm emotions to clarify "under what conditions must the balance shift between competitive-cooperative, rivalrous, and relational modes" (Chen & Miller, 2015: p771).

2.4 FIRM EMOTIONS IN HYBRID COMPETITIVE DYNAMICS

2.4.1 Firm-Level Aggregation of Competitive Emotions

Recent research in organizational group emotions illustrates the importance of collective group emotions that converge from individual emotions elicited by group-relevant events in various organizational and strategic contexts, including interfirm competition and cooperation (Ashkanasy et al., 2017; Huy, 2012; Menges & Kilduff, 2015). It has been demonstrated that individuals may experience emotional responses to external stimuli

oriented to their social group(s) (i.e. group-relevant events) (Smith, Seger, & Mackie, 2007). Individuals respond emotionally to a group-relevant events because they self-identify as members of the social group; these individual-level emotions aroused by group-relevant events are labeled "group-based emotions" (Menges & Kilduff, 2015). Group-based emotions are privately experienced by individual group members (i.e. individual-level affect states).

Group-based emotions tend to display commonality among individual members, since these individuals share similar emotional predisposition to group-relevant events (Watson & Tellegen, 2002) and socially identify with the same group (Smith et al., 2007). Furthermore, group-based emotions can converge to the collective emotions commonly experienced by all individuals of the group through social interactions between group members (i.e. a phenomenon colloquially known as "emotional contagion") (e.g. Barger & Grandey, 2006; Barsade, 2002). Furthermore, individuals in the same group are subject to the same social norms and rules that influence their cognitive responses, and thus tend to experience similar emotional responses to group-relevant events (Clark, 1990).

Menges and Kilduff (2015) summarize the above processes by which the individual-level group-based emotions converge to the aggregate-level "group-shared emotions": "inclination" (i.e. group members display similar emotional dispositions), "identification" (i.e. emotions attributed to the group social identity), "interaction" (i.e. communications and socialization between group members), and "institutionalization" (i.e. common emotional responses attributed to group norms and rules). My theoretical

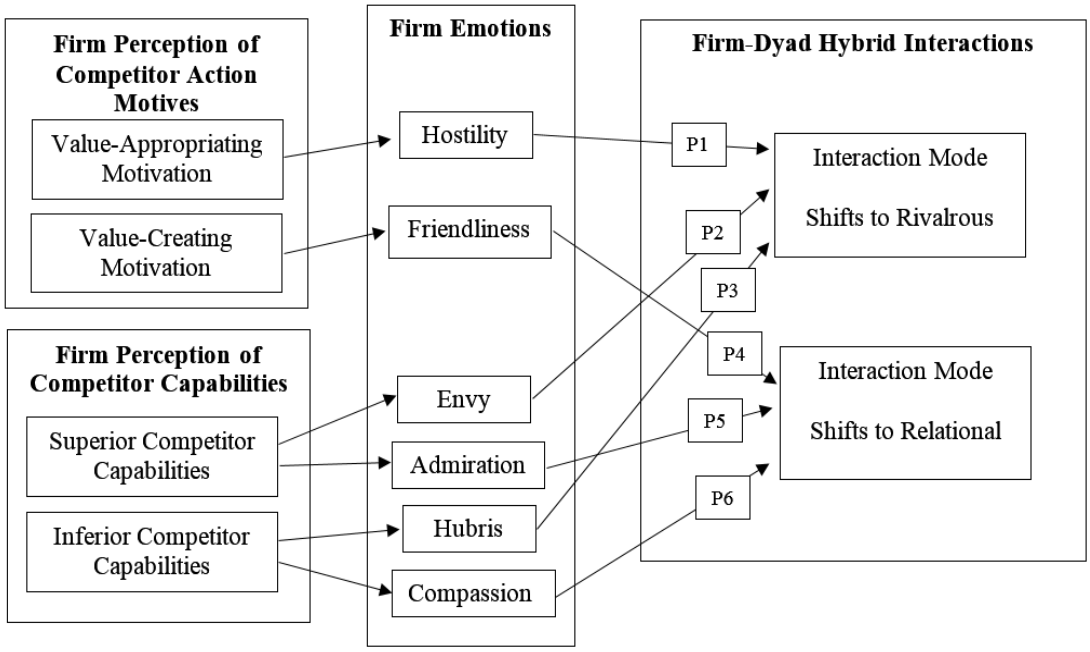
treatment of the construct of firm emotions focuses on the collective group-shared emotions attributed to the firm's aggregated perception of an external firm (i.e. the focal firm's interaction counterpart). Specifically, I hone in on the strategic context of hybrid interactions between two firms in which competition and cooperation intersect, and tease out how firm emotions resulting from firm perceptions with respect to a competitor will influence the interaction modes of hybrid competitive dynamics between the firm dyad (Huy, 2012).

Extant research on the psychology of competition (i.e. including rivalry) illustrates that a focal social actor may form competitive perceptions about the action motives of a competitor from historic interactions between the actor dyad (Kilduff, Elfenbein, & Staw, 2010). The social actor's perception of benevolent (or malicious) motivations behind the competitor action(s) will elicit positive (or negative) emotions towards the opponent, which can influence the social actor' competitive (or cooperative) behaviors in parallel to rational decision formulation (Kilduff, Elfenbein, & Staw, 2010). Additionally, social comparison is a commonly involved in competition (Garcia, Tor, & Schiff, 2013). Social actors compare the attributes (typically performance or capability indicators) of their competitors against their own (Garcia et al., 2013; Kim & Tsai, 2012), which gives rise to the focal actor's perception of the competitor's competence compared to the actor's self-concept (Garcia et al., 2013). The perception of a competitor's capabilities in comparison to those of the focal actor can elicit either positive or negative emotions, leading to distinct competitive/cooperative behaviors.

Combining the logic underpinning cross-level aggregation of emotions in a large group (e.g. firm) and the insights from psychology of competition, I posit that in the strategic context of hybrid competitive dynamics (i.e. interfirm interactions), firm perceptions of the motivations behind a competitor's action(s) and firm perceptions of competitor capabilities formed during social comparison in firm capabilities can elicit positive or negative emotions commonly experienced by the firm individuals (i.e. collective firm-level emotions).

These firm emotions can impact the focal firm's behavioral decisions on how to interact with the competitor (e.g. attack/retaliation, or collaboration), thus altering the firm-dyad balance point between competition and cooperation and shifting the interaction mode along the hybrid competitive dynamics spectrum (i.e. encompassing interfirm rivalry, co-opetition, and relations) (Chen & Miller, 2015). In the following sections, I tease out the positive and negative firm emotions attributed to perceived motivations of competitor actions, and those attributed to perceived capabilities of competitors. I develop testable propositions to elucidate the cognitive-behavioral relay that connects firm perceptions, firm emotions, and interfirm competition/cooperation (i.e. interaction mode shifts in hybrid competitive dynamics). I depict my conceptual model constructed from these propositions in Figure 2.1.

Figure 2.1 The Perceptive-Emotive Framework of Firm Social Cognition in Hybrid Competitive Dynamics



2.4.2 Firm Emotions Attributed to Perceived Motivations of Competitor Actions

First and foremost, firms pay close attention to their competitors' actions as a critical information source for strategic planning (Chen & Miller, 2012). When formulating firm strategies, decision makers rely on competitive analysis focusing on the actions elicited by the competitors (Porac & Thomas, 1990; Porac, Thomas, Wilson, Paton, & Kanfer, 1995), especially those actions directly targeted at the focal firm and its key partners in the value network (e.g. suppliers, buyers, complementors) (Brandenburger & Nalebuff, 2011). It is strategically vital for firm survival to quickly process information regarding potential rivalrous attacks, and respond in a timely manner to eliminate the value appropriation threats to itself and its network partners (Tsai et al., 2011). It is equally important for firm

success to take notice of the competitor actions motivated to build relational contacts to leverage the value creation opportunities, including competitive cooperation (i.e. co-opetition) and relational competition (Jiang, Tan, & Thursby, 2011; Roy & Sarkar, 2016).

Since the information on competitor actions is crucial for firm survival and success, strategic decision makers heighten their attention towards these actions, and devote a significant amount of mental effort to process relevant information cues to decipher the competitor's motivations behind these actions (Tsai et al., 2011). Due to such heightened attention and dedicated mental effort, the focal firm's cognitive responses to competitor actions tend to be tangible and can induce salient effects on firm behaviors (i.e. "hot cognition") (Hodgkinson & Healey, 2011).

Furthermore, when two firms start from the opposing stands, there is inherent competitive tension between these firms, which tends to augment the negative cognitive responses to each other's actions (Chen, 1996; Chen et al., 2007). For example, heightened tension between two competitors due to historic attacks often leads to mutual contempt and animosity, irrational attacks and retaliation (i.e. rivalry) (G. Kilduff et al., 2010). In summary, competitor actions can elicit tangible cognitive responses in the focal firm, which subsequently influence the focal firm's strategic decisions and behaviors with respect to the competitor (Hodgkinson & Healey, 2011).

I conceptualize two key components of firm cognitive responses to competitor actions that are influential to hybrid interactions between firms, namely, firm perception of the competitor's action motive (i.e. competitor motivation), and the collective emotional

response (i.e. firm emotion) aroused by the firm perception of competitor motivation. In the social psychology literature, research investing competitive cognition illustrates variations in the social actor's perceptions of a competitor's action motive (Brewer, 1979; Tajfel, 1982). Specifically, it is shown that social perceptions of competitor motivations are coupled with positive or negative affective tones (Nicholls, 1984). For instance, when a focal actor perceives good intentions in the competitor's action(s), the focal actor will develop a disposition of positive social emotions (e.g. feeling friendly, collaborative, or altruistic) towards the competitor; to the contrary, when a focal actor perceives an ill-willed action motive from a competitor, negative social emotions (e.g. feeling hostile) emerge as their inherent competitive tension intensifies (Kilduff et al., 2010; Tjosvold, Johnson, Johnson, & Sun, 2006).

In sum, social psychology research in competitive cognition demonstrates that social actors can form different perceptions about a competitor's action motive (e.g. perceiving a competitor action to be benevolent or malicious), and these perceptive variations in the focal actor can arouse positive or negative emotions (e.g. feeling friendly or hostile) towards the competitor (Smith et al., 2007; Tajfel, 1982). It is well established that emotions yield salient effects on the behavioral decisions of social actors (Leary, 2007; Simon, 1967), for example, the feeling of friendliness can facilitate cooperation and mitigate subsequent competition; whereas the feeling of hostility can trigger irrational competitive attacks (Kilduff & Brass, 2010; Leary, 2007; Marcel, Barr, & Duhaime, 2011). Therefore, social emotion is a critical link in the cognitive-behavioral cascade that conveys

the impacts of a focal actor's perceptions on subsequent social behaviors (i.e. competitive and cooperative actions) towards a competitor.

During the formulation of interfirm interaction (competition and cooperation) strategies, relevant firm individuals (e.g. strategic managers, competitive analysts, joint venture participants, etc.) engage in a group-based decision making process, in which firm individuals communicate and discuss their thoughts and feelings (Huy, 2012). Therefore, the focal firm forms social perceptions and experience social emotions with respect to a competitor's action on the collective, firm-level.

These firm-level cognitive responses (i.e. firm perceptions and firm emotions) to competitor actions can alter the focal firm's decision to compete (e.g. competitive attacks and retaliation) or to cooperate (e.g. co-opetition or relational competition) (Eggers & Kaplan, 2013a; Felin, Foss, & Ployhart, 2015; Gavetti & Rivkin, 2007; Johnson & Hoopes, 2003). Upon observing a competitor action, the focal firm conducts competitor analysis to decipher the motivations behind these actions to decide how to react (Chen, 1996). Simply put, the focal firm tends to retaliate when perceiving ill intentions of the competitor, or reduces competition intensity when perceiving goodwill (Chen, 1996). Following this logical vein, I conceptualize firm emotions aroused by the perception of a competitor's motivation behind the observed action(s), and how these firm emotions will impact hybrid interactions.

The overarching logic of hybrid competitive dynamics posits that competition and cooperation can co-exist on the firm-dyad level, thus a competitor may simultaneously be

a partner of the focal firm (Chen & Miller, 2015). This central thesis of the hybrid view echoes the insights from existing studies on the competition-cooperation intersection, which delineate the motivations behind interfirm competition and cooperation strategies, namely, value appropriation and value creation (Chen & Miller, 2015). Integrating seminal insights from prior research on the interplay between competition and cooperation, the hybrid view of competitive dynamics challenges the received wisdom in strategic management: the fundamental firm goal to gain competitive advantage solely manifests in a destructive manner, provoking the focal firm to appropriate as much value as possible and to eliminate competition (i.e. zero-sum game mentality) (M. Chen, 1996; Ferrier et al., 1999; Porac et al., 1995). Instead, firms often seek collaborative opportunities to co-create value with competitors by building a multi-firm value net (Brandenburger & Nalebuff, 2011), leveraging complementary assets (Dyer & Singh, 1998) and sharing syncretic rents (Lado et al., 1997), lowering exploration costs and enhancing firm learning (Lavie, 2006; Link, Teece, & Finan, 1996).

Furthermore, the firm motivation to achieve value creation underscores the strategic goal to maximize firm community profits (i.e. “raise all boats” mentality), which is foundational in the stakeholder perspective of interfirm relations (Chen & Miller, 2015). Competing firms rely on similar sets of strategic factors to produce goods and services that are valued by overlapping customer bases (Asmussen, 2015), they thus occupy similar spaces in both the strategic factor market and the product/service market. The stakeholder perspective of interfirm relations posits that a market functions as a community, where all the firms sharing the market space contribute to and depend on a common set of governing

institutions (e.g. industrial best-practices and norms) (Hannan & Freeman, 1977; Miller & Chen, 1996) and functional mechanisms (e.g. technological standards) (Anderson & Tushman, 1990; Ranganathan & Rosenkopf, 2014).

The community-based view of the market highlights that competing firms can gain competitive advantage not only from private value creation (e.g. focal firm profit maximization), but also from public value creation (e.g. added value accessible to and shared by all firms in the same market spaces) (Donaldson & Preston, 1995). In competitor-dyad hybrid interactions, a focal firm may form different perceptions about the competitor's action motives (i.e. value-appropriation vs value-creation motivations), and thus emotionally respond to the observed competitor action(s) either negatively or positively.

Perceived value appropriation and firm hostility. When the focal firm considers an observed competitor action to be an attack, such as disruption and dethronement (Ferrier et al., 1999), market-share war (Chen & Macmillan, 1992), identity domain challenge (Livengood & Reger, 2010), the focal firm perceives the competitor's motivation as value appropriation (Chen & Miller, 2015). Firm perception of the value-appropriating motivation in a competitor (Chen & Miller, 2015) arouses negative emotional responses from individuals of the focal firm, who, most saliently, feel hostile towards the competitor (Ming Jer Chen et al., 2007). The feeling of hostility is caused by firm-based event (i.e. a competitive attack), and is strategically relevant to the firm's decision on subsequent reaction. Therefore, firm individuals communicate their feelings in the group-based

strategizing process, resulting in the convergence of collective, firm-level emotion of hostility.

Negative emotions such as hostility can cause a strong impact on firm behavioral decisions regarding interfirm interactions (Hodgkinson & Healey, 2011). Firm hostility exacerbates the competitive tension between the firm dyad as the focal firm becomes motivated to retaliate and to eliminate the enemy (e.g. Baum & Korn, 1996; Chen, 1996; Chen et al., 2007). Hostility on the firm level thus contributes to the consolidation of dyadic rivalry. When experiencing the negative emotion of hostility towards a competitor, firm behaviors often deviate from rational thinking (Hodgkinson & Healey, 2011; Livengood & Reger, 2010). For example, the focal firm may attack the competitor when competitive actions do not lead to competitive advantage or even harms firm profits (e.g. when the focal firm lacks necessary capabilities to win). Consequently, the hybrid interactions on the firm-dyad level move towards the rivalrous mode.

P1. The firm perception of value-appropriating motivation of a competitor action arouses the negative firm emotional state of hostility towards the competitor, shifting firm-dyad hybrid interactions to the rivalrous mode.

Perceived value creation and firm friendliness. On the other hand, a focal firm may interpret a competitor action as a signal to build a relationship. For example, when the competitor elicits an attack against a common enemy in favour of the focal firm, or when the competitor forms a strategic alliance with the focal firm's existing partner, the focal firm may infer relation-building intentions of the competitor (Brandenburger & Nalebuff,

2011). If the focal firm considers a competitor action to be a relation-building signal, its cognitive frame of the competitor as an opponent (or enemy) becomes weakened, and eventually switched to positioning the competitor as a potential partner (Kilduff et al., 2010; Marcel et al., 2011). With the switch in the focal firm's cognitive frame with respect to the competitor (i.e. from an opponent/enemy to a potential partner), the focal firm directs its attention to evaluate the opportunity for mutual benefits through partnership; in other words, the focal firm develops the motivation to create value in collaboration with the competitor (Chen & Miller, 2015).

Concurrently, the focal firm often projects onto the competitor its goals to co-create value (i.e. expecting the social interaction counterpart to have the same subjective experiences as oneself) (Robbins & Krueger, 2005). Thus, the focal firm perceives value-creating motivations of the competitor. In the reverse direction, the focal firm's perception of value-creating motivations of the competitor enhances its cognitive frame of the competitor as a potential partner, and reinforces its motivation to co-create value with the competitor. Consequently, the focal firm develops the positive firm emotion of friendliness towards the competitor. Feeling friendly towards the competitor, the focal firm subjectively experiences less competitive tension and relaxes its defensive stand; its subsequent actions thus become less destructive (e.g. attacks and retaliation) and more constructive (e.g. collaboration) (Li, Eden, Hitt, & Ireland, 2008; Trapido, 2012). Therefore, the firm-dyad interactions evolve from animosity- to friendship-oriented, in other words, moving away from the rivalrous mode and towards the relational mode.

P2. The firm perception of value-creating motivation of a competitor action arouses the positive firm emotional state of friendliness towards the competitor, shifting firm-dyad hybrid interactions to the relational mode.

2.4.3 Firm Emotions Attributed to Perceived Capabilities of Competitors

CD research illustrates the interdependence between firm awareness of its competitor(s), firm motivations to act/react, and firm capabilities to carry out a competitive (cooperative) action (i.e. the AMC framework) (Chen & Miller, 2012; Chen et al., 2007). The AMC framework captures the sociocognitive aspects of firm strategies on competition and cooperation. When a firm becomes aware of a competitor upon observing its action(s), the focal firm makes sense of the competitor's action aim, consolidating the firm perception of its competitor's motivation (Chang & Chen, 2012; Smircich & Stubbart, 1985); concurrently, the perception of the competitor's motivation held by the focal firm influences its motivation to react to the competitor (Smircich & Stubbart, 1985). Furthermore, the focal firm evaluates its capabilities when deciding if and how to act in reference to the competitor (Chen, 1996; Hsieh, Tsai, & Chen, 2015). When strategizing how to act/react to external firms (e.g. competitors), strategic decision makers of the focal firm often make social comparison in firm capabilities between the competitor and itself (Kim & Tsai, 2012). Stated differently, social comparison in firm capabilities constitutes a key facet of competitive analysis for firm competition/cooperation strategy formulation.

Current research has demonstrated that the directionality of social comparison contributes to variations in the cognitive responses of the focal actor, which yield

significant effects on social behaviors (e.g. competition and cooperation) (Festinger, 1954). Directional (i.e. upward or downward) social comparison determines how a focal actor perceives its counterpart relative to itself (i.e. superior or inferior) (Festinger, 1954; Nickerson & Zenger, 2008). When a focal actor socially compares upward with a counterpart (e.g. the counterpart has a higher status, richer resources, or greater capabilities than the focal actor), the focal actor perceives the counterpart as superior; and when a focal actor socially compares downward with a counterpart, the focal actor views the counterpart as inferior (Garcia et al., 2013; Nickerson & Zenger, 2008). The social perception of superiority or inferiority about an interaction counterpart influences the focal actor's decisions about social interactions, because perception can affect the focal actor's behavioral motivations, including the rational and the emotional aspects of motivations (Lerner, Li, Valdesolo, & Kassam, 2015; Simon, 1986; 1967).

For example, the perception of a superior counterpart formed in upward social comparison may prompt the focal actor to build a close relationship with the counterpart, driven by a rational aim to leverage the counterpart's superiority (e.g. high status, munificent resources, robust capabilities), and/or an emotional motive to assimilate to an inspirational figure (Festinger, 1954; Tjosvold et al., 2006). On the other hand, the perception of superiority about the interaction counterpart may invoke negative emotions in the focal actor such as inequality and envy, promoting an array of destructive actions towards the referent counterpart (Nickerson & Zenger, 2008), such as deliberate sabotage and attacks. When an actor perceives inferiority in a referent counterpart during downward social comparison, she may recognize the potential dependence of the inferior counterpart

on herself and pursue a relationship to leverage the power imbalance for value gains (Emerson, 1962) (i.e. a rational motive in the socioeconomic sense).

From the emotional perspective, the focal actor may empathize with the weaker counterpart and builds social relations out of compassion (Melwani, Mueller, & Overbeck, 2012). Alternatively, social perception of inferiority in the referent counterpart can trigger the negative emotion of contempt, and the focal actor will avoid social interactions, or even elicit attacks against the inferior counterpart (Melwani et al., 2012).

When firms strategize competitive actions/reactions and relational interactions, social comparison is conducted on the level of the firm (Chen, 1996). When a focal firm conducts social comparison in firm capabilities with a competitor, it forms firm-level perceptions of superior (inferior) capabilities of the competitor. Social comparison in firm capabilities contributes to cognitive responses in the focal firm that determine its competitive (cooperative) actions and reactions towards the competitors (Kim & Tsai, 2012). The cornerstone of firm cognitive responses attributed to social comparison lies in the focal firm's perceptions of a competitor's capabilities relative to its own, and how these firm-level perceptions affect firm motivations to interact with the competitor. The focal firm's perceptions of competitor capabilities alter its motivations to act/react competitively and/or cooperatively in two distinct cognitive processes, namely, the rationality-driven decision making process and the emotionality-driven cognitive-behavioral cascade (Garcia et al., 2013; Kilduff et al., 2010; Simon, 1986).

If the focal firm perceives a competitor's capabilities to be superior to its own, it may decide rationally to utilize the learning opportunity to develop firm competence by building or maintaining relational contacts with the superior competitor (Dussauge et al., 2000). The focal firm may also arrive at the rational decision to avoid direct competition against a superior competitor, and instead to accumulate resources and develop capabilities (Chen & Miller, 2012; Chen et al., 2007).

Similarly, if the focal firm perceives a competitor's capabilities to be inferior, it may deploy the rational strategy to offer knowledge access to the inferior competitor in exchange for the competitor's complementary assets (e.g. by engaging in strategic alliances and/or establishing joint ventures) (Baum et al., 2000; Rothaermel & Boeker, 2008). The focal firm may also decide to not expend firm resources to compete against the inferior competitor, since the competitor is unlikely threatening to the focal firm's competitive advantage. The abovementioned strategic formulation results from the firm-level, rationality-driven decisions during social comparison in firm capabilities.

Additionally, the perceptions of a competitor's capabilities formed in interfirm social comparison can arouse tangible emotional responses in the firm strategic decision makers (Hodgkinson & Healey, 2011; Marcel et al., 2011), which can converge to the firm level, and collectively alter firm motivations to interact with the referent competitor (Ashkanasy et al., 2017; Huy, 2012). The effects of firm emotions on firm motivations are manifested in an instantaneous, automatic cognitive-behavioral cascade, which unfolds in parallel to the slow, rationality-driven process (Evans, 2008; Gigerenzer & Gaissmaier,

2011). Legion of research is present in social psychology and decision science that demonstrates the interactions between the fast, emotionality-driven and the slow, rationality-driven cognitive mechanisms in determining the effects of social perceptions on the motivations to engage in different modes of social interactions (Gigerenzer & Gaissmaier, 2011; Tajfel, 1982; Thibaut & Kelley, 1959). In a different research stream, organization and management scholars investigate the aggregation of individual emotions to the level of large groups, such as firm-level collective emotions (see Menges & Kilduff, 2015 for a review).

Combining these two lines of logic, I posit that the firm emotions emerging from the individual-to-firm cognitive aggregation mechanisms elicited by firm perceptions of superior (inferior) competitor capabilities formed when the focal firm makes social comparison in firm capabilities will affect the firm motivations to choose different competitive/cooperative actions towards the referent competitor, which are distinct from the rationality-driven cognitive responses in the same regard (Lerner et al., 2015). Furthermore, the emotionality-driven effects of social comparison perceptions on social interaction motivations influence decisions and behaviors in conjunction with the rationality-driven effects (Gigerenzer & Gaissmaier, 2011). Therefore, predictions on the hybrid competitive dynamics interaction modes (e.g. degree of competition vs cooperation) hinge on not only the focal firm's rational calculation in the comparison of firm capabilities, but also firm emotions aroused by the perception of superior (inferior) competitor capabilities.

Positive firm emotions in social comparison. Firms may experience positive emotions attributed to firm perceptions of competitor capabilities formed in social comparison (Garcia et al., 2013). The perception of superior competitor capabilities can elicit the sense of admiration (i.e. positive emotion) if the focal firm frames the competitor as a reference point when setting its capability development goals (van de Ven, 2015). From the rationality-based perspective, firms have economic incentives to learn from their competitors with superior capabilities by establishing relational contacts, because they can reduce exploration costs to obtain similar strategic factors (e.g. resources) that their competitors have already accumulated (Baum et al., 2000).

Extant research suggests that firms can develop new capabilities effectively by cooperating with superior competitors to lower the learning curve barrier because competitors tend to share common exploration and innovation targets (Rothaermel & Deeds, 2004). If the focal firm considers the competitor with superior capabilities as a viable knowledge source (e.g. potential partner), it will often set firm learning goals to assimilate the superior competitor (van de Ven, 2015). When the focal firm sets a superior competitor as the reference point for its capability development aspiration, it will likely experience the positive emotion of admiration towards the superior competitor (van de Ven, 2015).

Stated differently, the rational motivations to learn from the more competent competitor via relational contacts contribute to the predisposition in the focal firm to feel admiration when it forms the firm perception of superior competitor capabilities. On the

flip side, the positive feeling of admiration fuels the focal firm's aspiration to assimilate to the more competent competitor, since admiration is an adaptive social emotion that invokes the desire to improve one's self-concept (e.g. self-perception of competence) (Leary, 2007; van de Ven, 2015). When the focal firm experiences admiration attributed to its perception of superior competitor capabilities, it is emotionally motivated to improve its firm competence.

Relational interactions with superior competitors are effective mechanisms for the focal firm to gain knowledge access to improve firm competence (Leary, 2007). Therefore, admiration can augment the rationality-based, learning motivations to pursue relational contacts with competitors, such as strategic alliances and joint ventures (e.g. co-opetition) (Baum & Silverman, 2002). On the firm-dyad level, these sociocognitive responses (i.e. perceptions, emotions, and motivations attributed to upward social comparison in firm capabilities) of the focal firm will mitigate interfirm rivalry, and facilitates relational interactions between competing firms (e.g. competition-cooperation/co-opetition, relational competition) (Melwani et al., 2012; Tajfel, 1982). The firm-dyad hybrid interactions are thus likely to shift away from the rivalrous mode and towards the relational mode.

P3. The firm perception of superior capabilities in a competitor may arouse the positive emotional state of admiration towards the competitor, shifting firm-dyad hybrid interactions to the relational mode.

The perception of inferior competitor capabilities can result in a positive emotional state of compassion towards the weaker firm if the focal firm consider the competitor as part of a common stakeholder community (Goetz, Keltner, & Simon-Thomas, 2010). In this case, the focal firm's motivations for interfirm interactions follow a positive-sum logic, which guides the firm to seek syncretic rents (i.e. value creation achieved by collaborative relations between firms) (Chen & Miller, 2012; Lado et al., 1997) that enhances the competitiveness of all firms in the same stakeholder community (i.e. the aim to "raise all boats") (Chen & Miller, 2015). In other words, from the rational perspective, the focal firm may strategize relational contacts with an inferior competitor to co-create value if it views the competitor as a stakeholder community member, and recognizes the potential syncretic rents.

Concurrently, the focal firm's mindset of syncretic rent pursuit with a competitor in the same stakeholder community can prompt an emotional sense of compassion, since the underlying logic of the firm motivation is to achieve mutual benefits for the focal firm and its competitor (Chen & Miller, 2015). Therefore, the focal firm is primed to be cognizant about the limitations that an inferior competitor faces, and the comparative strengths in the focal firm itself to ameliorate these limitations (Goetz et al., 2010; Melwani et al., 2012).

Furthermore, when the focal firm socially identifies the competitor with inferior capabilities to be in the same stakeholder community, it recognizes the alignment between its own organizational identity and that of the competitor (Scott & Lane, 2000). The

alignment of social identities often lead actors to empathize with one another (Hogg & Terry, 2000). Therefore, the focal firm is likely to think in the shoes of its competitor in the same stakeholder community, and feels compassionate towards the competitor with inferior capabilities.

In summary, if the focal firm identifies a competitor as a member of the same stakeholder community, it becomes rationally motivated to seek syncretic rents with the competitor; concurrently, the firm perception of inferior competitor capabilities will likely trigger the firm emotion of compassion. The feeling of compassion motivates the pursuit of a mutually beneficial relation with the inferior competitor, the focal firm is thus more likely to interact with the competitor cooperatively than competitively. Firm compassion and syncretic rent pursuit thus act in synergy to motivate the focal firm to reduce confrontation and deepen relational contacts with an inferior competitor. On the firm-dyad level, the hybrid interactions between the focal firm and the competitor will likely shift away from the rivalrous mode and towards the relational mode.

P4. The firm perception of inferior capabilities in a competitor may arouse the positive emotional state of compassion, shifting firm-dyad hybrid interactions to the relational mode.

Negative firm emotions in social comparison. On the other hand, negative emotions can be aroused during social comparison in firm capabilities (Nickerson & Zenger, 2008; van de Ven, 2015; van de Ven, Zeelenberg, & Pieters, 2011). When a focal firm and its competitor operate in the same (or highly proximal) competitive domain(s),

the focal firm tends to see the competitor as a direct challenge to its organizational identity (Livengood & Reger, 2010) . Feeling challenged, the focal firm will likely assume a cognitive frame that positions the competitor as an opponent (van de Ven et al., 2011).

The focal firm thus becomes predisposed to negative emotions towards the competitor; furthermore, historic competitive attacks can lead to negative emotional predisposition in the firms (Kilduff et al., 2010). If a competitor has initiated an attack in the past, the focal firm will likely hold a grudge against the offensive competitor. When the focal firm harbors resentments towards a competitor due to historic competitive attack(s), it is primed to assume an oppositional stand, and thus becomes predisposed to develop more negative emotions towards the competitor in subsequent engagement, including social comparison in firm capabilities.

Upward social comparison can lead to the negative emotion of envy in a social actor (Nickerson & Zenger, 2008; van de Ven, 2015; van de Ven et al., 2011). When a focal actor perceives superior outcomes achieved by a social counterpart, the focal actor may sense inequality, or unfairness, which leads to the envious feelings (Nickerson & Zenger, 2008). The perception of superior competitor capabilities formed in upward comparison between firms can cause the focal firm to feel envious towards the referent competitor, especially when the focal firm sees the competitor as a challenge to its domain identity (Livengood & Reger, 2010) and/or harbors resentments due to historic attacks from the competitor (Kilduff et al., 2010).

Envy can drive firm behaviors to deviate from the rational motivations, such as the goal of learning from the more competent firm, leading to added costs to the focal firm (i.e. social comparison costs (Nickerson & Zenger, 2008) on the firm level). When a focal firm feels envious towards the superior competitor, it becomes inclined to implement value-appropriating actions to undercut the opponent. Not only will the focal firm miss the opportunity to develop firm capabilities by learning from the superior competitor, but it will also face retaliation for which the it is not capable to withstand.

Extant research suggests that negative emotions can yield more salient influences on behavioral motivations than rationality-based thinking (Hodgkinson & Healey, 2011; Lerner et al., 2015; van de Ven et al., 2011). Therefore, if the focal firm develops envious feelings in response to the perception of superior competitor capabilities, the focal firm will likely act in contradiction to what is predicted by the rational logic. For example, the envious firm becomes inclined to elicit competitive attacks against a superior competitor, even if it does not possess the capabilities to win the war. Instead of establishing relational contacts to learn from the superior competitor, the envious focal firm tends to minimize association to avoid unfavorable comparison by external audience (e.g. customers, suppliers, and buyers) (Kim & Tsai, 2012). Therefore, the negative firm emotion of envy attributed to the firm perception of superior competitor capabilities can shift hybrid interactions on the firm-dyad level away from the relational mode and towards the rivalrous mode.

P5. The firm perception of superior capabilities in a competitor may arouse the negative emotional state of envy towards the competitor, shifting firm-dyad hybrid interactions to the rivalrous mode.

Similarly, domain identity threats and/or historic accumulation of hostile sentiments can predispose the focal firm to develop negative emotions towards a competitor during downward social comparison. When the focal firm is primed with a negative emotional predisposition towards a competitor, it tends to focus on the deficiency when evaluating the competitor's capabilities (Melwani et al., 2012). Thus, firm perception of inferior competitor capabilities formed in downward social comparison manifests in the focal firm's mental depiction of the competitor's incompetence.

When the focal firm depicts the competitor to be incompetent, it will likely consider the competitor unworthy of an opponent. Concurrently, downward social comparison reinforces the self-concept of firm capabilities, leading the focal firm to feel superior to the referent competitor (Melwani et al., 2012). In this case, the focal firm's perception of inferior competitor capabilities becomes a cognitive lever that exaggerates its mental depiction of incompetence of the referent competitor, and aggravates over-evaluation of its self-concept of firm competence (Picone, Dagnino, & Minà, 2014). Thus, when predisposed to negative emotions towards a competitor, the perception of inferior competitor capabilities formed in downward social comparison can provoke hubris in the focal firm (Hayward & Hambrick, 1997; Picone et al., 2014).

Research in psychology of social comparison and competition points out that over-evaluation of self-concept (i.e. hubris) often prompts the social actor to develop a scornful and condescending attitude towards the inferior competitor (Melwani et al., 2012). In subsequent social interactions, such emotional aversion will likely result in severed social bonds and exacerbated competitive tension between two social actors, contributing to the development of rivalry (Kilduff et al., 2010). The sense of hubris (i.e. over-evaluation of the one's self-concept) experienced by strategic decision makers (e.g. top executives, upper echelon team) can converge and permeate throughout the firm through emotional contagion, organizational culture and institutionalization, and/or reiteration mechanisms (Menges & Kilduff, 2015).

Firm-level hubris attributed to the perception of an inferior competitor will likely lead to collective emotional aversion towards the competitor. For example, individuals within the focal firm may experience shared, firm-focused scornfulness and condescension towards the competitor that they consider incompetent and unworthy of the focal firm's engagement. Stated differently, hubris stemming from the firm perception of competitor inferiority can trigger emotional aversion towards the competitor shared by individuals within the focal firm. When individuals within the firm experience emotional aversion towards the competitor, they act in ways that reinforces the firm-level depiction of incompetence about the competitor, which influence firm strategies regarding how to interact with the competitor.

Subject to the cognitive bias of hubris, the focal firm deviates from the rational logic that guides it to seek syncretic rents by forging mutually beneficial relations (Lado et al., 1997) and to maximize value creation that "raises all boats" (Chen & Miller, 2015). Instead, it deliberately avoids social comparison by external stakeholder audience (e.g. customers and their information providers, industry and market analysts, etc.) (Kim & Tsai, 2012), and stops devoting resources to maintaining relational contacts. Furthermore, the focal firm may deliberately remove the inferior competitor from its value network, for example, by disseminating messages to key suppliers, buyers, horizontal firms (e.g. competitors and complementors) that emphasize the competitor's incompetence (Brandenburger & Nalebuff, 2011). The relational contacts between the focal firm and the competitor thus wither away, and rivalrous animosity thrives unabatedly.

P6. The firm perception of inferior capabilities in a competitor may arouse the negative emotional state of hubris, shifting firm-dyad hybrid interactions to the rivalrous mode.

2.5 DISCUSSION AND CONCLUDING REMARKS

In this study, I begin with the intellectual curiosity raised from the hybrid view of competitive dynamics: along a continuous spectrum of hybrid interactions between firms, where different degrees of competition and cooperation are balanced on the firm-dyad level (Chen & Miller, 2012; 2015), how do firms "transcend the divides and dichotomies between competition and cooperation", and "under what conditions must the balance shift between competitive-cooperative, rivalrous, and relational modes" (Chen & Miller, 2015:

p771)? A crucial key to shed light on this scholarly inquiry lies in the sociocognitive aspects of firm competition and cooperation strategies. Using a sociocognitive theoretical lens, my analysis here aims to unpack the hybridism in competitive dynamics by clarifying how variations in firm-level social perceptions about competitor actions and capabilities can affect its strategic decisions on competitive and/or cooperative interactions with the competitors (Chen & Miller, 2012; 2015).

The causality between firm perceptions and strategic decisions is captured in the central thesis in behavioral strategy and behavioral theory of the firm (Cyert & March, 1963; Powell et al., 2011), which finds its intellectual root in Herbert Simon's notion of "bounded rationality" (Simon, 1967). Bounded rationality summarizes the bias-ridden nature of the human decisions due to cognitive, situational, and emotional constraints (Lerner et al., 2015). Modern development in decision science (e.g. behavioral economics) extends from Herbert Simon's seminal research on bounded rationality to critique the conceptualization about human rationality in neoclassical economics (e.g. maximizing objective utility functions) (Simon, 1986). Leveraging key insights from the modern decision science, a robust stream of strategy studies examine how strategic decisions are influenced by firm cognition and psychology (Barney & Felin, 2013; Eggers & Kaplan, 2013b; Felin et al., 2015; Powell et al., 2011).

However, theoretical progress in strategic management along the cognitive-behavioral vein is hindered by a lack in conceptual focus on firm emotions (Ashkanasy, Humphrey, & Huy, 2017; Menges & Kilduff, 2015; Huy, 2012). Herbert Simon once stated

the prescient remark: “Hence, in order to have anything like a complete theory of human rationality, I have to understand what role emotion plays in it (1986: p29).” Without adequate understanding of how firm emotions contribute to the causality between firm perceptions and strategic decisions, the “bound” in “bounded rationality” that drives the formulation of firm strategies will remain in the dark. The gap in extant knowledge on the role of firm emotions in strategic decisions has created an impasse in the theoretical progress to unpack the competitive dynamics hybridism (Chen & Miller, 2015).

Due to heightened attention and competitive tension, emotionality can yield efficacious influences on firm decisions regarding interfirm interactions between competitors (Hodgkinson & Healey, 2011; Huy, 2012; G. Kilduff et al., 2010; Livengood & Reger, 2010), especially when the firm strategizes how to balance competition and cooperation within the firm-dyad. Compared to relational contacts with non-rivalrous entities, when a firm pursues relational contacts with its rivals, the conflicts between emotionality and rationality often stand more salient, especially when negative emotions are aroused by competitive perceptions (Garcia et al., 2013; G. Kilduff et al., 2010). Therefore, it is important to consider firm emotions in order to shed light on the scholarly inquiry regarding the competition-cooperation balance in hybrid competitive dynamics.

To unpack the competitive dynamic hybridism from a firm-level, sociocognitive perspective, I integrate insights from the organizational group emotions literature (Menges & Kilduff, 2015) into the competitive dynamics paradigm (Chen & Miller, 2015). The main goal in this study is to clarify the role of firm emotions in the firm-level cognitive-

behavioral cascade in strategic decisions regarding competition and cooperation, which conveys the impacts of firm social perceptions to firm social behaviors in the context of interfirm interactions. By defining the perceptive antecedents and behavioral implications of firm emotions in social context of interfirm hybrid interactions, I develop testable propositions to explain the emotionality-driven mechanisms that underpin how firms "transcend the divides and dichotomies between competition and cooperation" (Chen & Miller, 2015: p771), and on the firm-dyad level, "under what conditions must the balance shift between competitive-cooperative, rivalrous, and relational modes" (Chen & Miller, 2015: p771).

I conceptualize firm emotions cogent to hybrid interactions by drawing insights from the foundational discipline of social psychology. Specifically, I integrate extant knowledge of social actor emotional responses in the context of competition. Social actors experience positive or negative social emotions as they observe a competitor's actions and interpret the competitor's motivation behind the observed actions (Kilduff et al., 2010; Livengood & Reger, 2010; Vuori & Huy, 2016). For example, the perception of good intentions from a competitor can lead to genial feelings (i.e. friendliness) in the social actor; in contrast, when perceiving malicious motives, the focal actor develops hostile emotions towards the competitor (Tajfel, 1982).

Furthermore, competing actors tend to conduct social comparison in various attributes, for instance, their capabilities (Garcia et al., 2013). The valence of comparison-induced social emotions can be either positive or negative, depending on the social actor's

ex ante emotional disposition towards the competitor (Garcia et al., 2013). When comparing upwards with a competitor, the focal actor perceives superiority in the competitor capabilities, which may lead to the positive affective state of admiration or the negative sense of envy (van de Ven, 2015). During downward comparison, the focal actor perceives inferior competitor capabilities, which can result in either the positive feeling of compassion or the negative emotion of hubris associated with contempt towards the inferior competitor (Melwani et al., 2012).

In my analysis, I leverage the insights from the social psychology of competition to conceptualize firm-level competitive emotions. My conceptualization clarifies how emotionality manifested on the firm level plays a role in the sociocognitive aspects of hybrid interaction strategies to balance the firm-dyad competition and cooperation. This study advances the sociocognitive perspective in strategic management by achieving theoretical contributions in three ways.

First, the analysis contributes to competitive dynamics. I hone in on the hybrid view of competitive dynamics, which posits that interfirm relationships take form along a continuous spectrum of hybrid interactions (i.e. mixed competition and cooperation at different degrees) that encompasses the rivalrous, competitive-cooperative, and relational modes of interactions (Chen & Miller, 2012; 2015). I commence my analysis from a sociocognitive perspective to distinguish the firm-perceptive, emotive, and behavioral antecedents to the shifts between different interaction modes.

I expound the sociocognitive aspects of firm decisions on how to "transcend the divides and dichotomies between competition and cooperation" (Chen & Miller, 2015: p771), and answer the call to investigate "under what conditions must the balance shift between competitive-cooperative, rivalrous, and relational modes" (Chen & Miller, 2015: p771). By incorporating key insights from the organizational group emotions literature, I clarify how firm-level social emotions contribute to the causal connection between competitive perceptions and interfirm interaction modes, which may either align with or deviate from rationality-based accounts during relational contacts with rivals (Chen & Miller, 2015). In so doing, my analysis makes theoretical contributions to unpack the competitive dynamics hybridism.

Second, I contribute to research in organizational group emotions. There is a lack in conceptualization on how aggregated emotionality becomes manifested at the firm level (Menges & Kilduff, 2015). Research suggests that emotions, especially emotional responses, can converge to the group level, including large groups such as all members of the same firm (Smith et al., 2007). The knowledge gap in conceptual resolution on how firm-level emotional responses manifest as the consequence of firm perceptions has substantially limited theoretical advances in organizational group emotions (Menges & Kilduff, 2015).

Leveraging the research in social psychology of competition (e.g. Garcia et al., 2013; Kilduff et al., 2010), I conceptualize the role of firm emotions when the focal firm strategizes hybrid interfirm interactions from the sociocognitive perspective. Finally, my

conceptual development builds into behavioral theory of the firm and behavioral strategy. The theoretical development in my analysis takes the premise of bounded rationality in human decision making (Simon, 1967; 1986), and zeros in on how emotional constraints result in the "bound" in "bounded rationality".

Modern development in decision science form a behavioral perspective zeroes in on human emotions as a critical component in the cognitive-behavioral cascade of the decision-making process (Lerner et al., 2015). Current research in behavioral theory of the firm and behavioral strategy builds upon Herbert Simon's thesis on bounded rationality, and often draws from the modern behavioral decision scholarship (Gavetti, Greve, Levinthal, & Ocasio, 2012). However, the full theoretical potential of behavioral theory of the firm and behavioral strategy is limited by a deficiency in the theoretical treatment on firm-level emotions (Ashkanasy, Humphrey, & Huy, 2017; Menges & Kilduff, 2015; Huy, 2012). I conceptualize the collective firm-based emotional response elicited by firm social perceptions of competitor actions and capabilities.

The conceptual analysis here enhances current theoretical understanding on the "bound" in "bounded rationality", namely, how emotionality alters the rationality-driven competition and cooperation strategy formulation in the firms engaging in hybrid interactions with their competitors. My theoretical framework teases out how firm-level social emotions that are aroused by the firm's competitive perceptions can lead to competitive and cooperative behavioral decisions, which may align with or deviate from the rationality-driven predictions. In doing so, I put forth testable propositions that capture

the cognitive-behavioral cascade underpinning the formulation of competitive and cooperative strategies of the firm.

In conclusion, my analysis clarifies how firm-level social emotions aroused by competitive perceptions (i.e. social perceptions of competitor actions and capabilities) influence firm decisions on the strategies regarding the competition-cooperation balance in hybrid competitive dynamics. I develop my concepts and propositions to tease out the interplay between competition and cooperation based on the behavioral assumption of firm strategy and incorporate firm-level emotionality into behavioral strategy and behavioral theory of the firm. My study elucidates the causal connections between firm-level social perceptions, social emotions, and firm behavioral decisions on interfirm interactions, thus advances the sociocognitive perspective of strategic management.

3 LEARNING AND COOPETITION: FIRM LEARNING MECHANISMS AND THE IMPACTS ON COOPETITION PURSUIT

3.1 ABSTRACT

Coopetition is a key strategy for innovation-driven firms to learn from their competitors. However, the inherent rivalrous undercurrents between competing firms may provoke learning races, which can render cooperative synergy into mutual destruction. Hence, how well a firm can effectively learn from its partners and guard against learning races is the linchpin of its decision to pursue coopetition. In this study, I probe the theoretical relationships between learning efficacies and coopetition pursuits of innovation-driven firms. I distinguish a firm's efficacies in codified and tacit knowledge utilization, and I theorize how these learning efficacies may influence the firm's decision to pursue coopetition. I find support for my hypotheses across multiple industries with high technological intensities in the United States using a longitudinal research design.

3.2 INTRODUCTION

How does firm learning influence coopetition? In technologically intensive industries, firms pursue value-driven coopetition (Brandenburger & Nalebuff, 2011). For example, firms cooperate to create value as they share complementary resources, yet simultaneously compete to capture value as they target the same buyers (Gnyawali & Madhavan, 2001).

The crux of value creation in coopetition lies in the learning opportunities afforded to the focal firm (Hamel, 1991; Hamel, Doz, & Prahalad, 1989). For example, a firm gains direct access to its competitor's knowledge base through the alliance, thus receives the opportunity to develop critical competence (Gnyawali & Park, 2011; Hoang & Rothaermel, 2010). Such learning opportunities are instrumental to technology-driven firms, because competitive advantages hinge upon the formidable development of innovation competence, and coopetition can effectively mitigate the learning curves (Gnyawali & Park, 2011).

However, coopetition contains competitive tension that impedes firm learning efficiency (Gnyawali & Park, 2011; Yang, Zheng, & Zaheer, 2015). For example, competitors erect knowledge protection mechanisms to prevent potential opportunistic behaviors, which often reduce trust and goodwill between alliance partners (Gulati & Nickerson, 2008; Khanna, Gulati, & Nohria, 1998). Furthermore, familiarity between competitors may lead to animosity instead of trust, as rivals focus on each other more and more narrowly as a strategic partnership deepens. Exacerbated competitive tension often contributes to irrational behaviors, for example, firms start a "learning race" with their strategic partners (Yang et al., 2015). Therefore, firms face a "double-edged sword" when cooperating with direct competitors, in which strategic advantages and potential disadvantages are concurrently present.

Extant scholarship suggests that firm learning directly impacts whether coopetition manifests as strategic advantages or disadvantages. However, theoretical clarity and empirical evidence is lacking to explain how variation in firm learning may lead to

heterogeneity in firm coopetition pursuits. In particular, there is a gap in the firm learning and coopetition literature in explaining *how firms learn* (i.e. learning modes) and *how well firms learn* (i.e. learning efficacies) may lead to different intensities of coopetition pursuits of the firms. In this study, I investigate the theoretical connections between firm learning modes, learning efficacies and coopetition pursuits. In so doing, I contribute to the literature of firm learning and coopetition research. My point of departure is the following question: How is coopetition pursuit influenced by firm learning efficacies developed from past experiences in different learning modes?

First, I draw seminal insights from the firm learning literature to develop a conceptual framework of learning modes and learning efficacies. Specifically, I study two learning modes of technology-driven firms, namely, *patent-based learning* and *alliance-based learning*, and two categories of learning efficacies of these firms, namely, *absorptive capacities* (Zahra & George, 2002) and *alliance capabilities* (Rothaermel & Deeds, 2006; Wang & Rajagopalan, 2015). I conceptualize the development of absorptive capacities from patent-based learning experiences of firms, and make the distinction between *external knowledge assimilation* (Lane, Koka, & Pathak, 2006) and *internal knowledge recombination* (Lenox & King, 2004; Tsai, 2001). I conceptualize the development of alliance capabilities from alliance-based learning experiences of firms, and make the distinction between *joint exploration capabilities* and *joint exploitation capabilities* (Stettner & Lavie, 2014; Wassmer, Li, & Madhok, 2016). My conceptual framework of learning modes and learning efficacies make contributions to the literature of firm learning.

Then, I develop hypotheses on the effects of firm learning efficacies on subsequent coopetition pursuits. I focus on the tension in coopetition between learning opportunities (i.e. value creation) (Gnyawali & Park, 2011; Hamel, 1991) and learning races (i.e. value destruction) (Yang et al., 2015), and make salient the different influences on firm coopetition pursuits from their learning efficacies in external knowledge assimilation, internal knowledge recombination, joint exploration capabilities, and joint exploitation capabilities. I test my hypotheses in a panel data of alliance records and patent citations of U.S. public firms in technology-driven industrial sectors from 1990 to 2007. My theoretical and empirical analysis yields contributions to research on coopetition and firm learning.

3.3 THEORY AND HYPOTHESES

3.3.1 Coopetition and Firm Learning

Coopetition concurrently presents value creation opportunities in learning with competitors and value destruction threats in learning races against competitors (Hamel et al., 1989). Stated differently, coopetition may manifest as a mechanism to enhance firm competitive advantage from effective inter-firm learning (Hamel, 1991), or as a trigger to the irrational, excessive investment in risky innovation and costly knowledge development (Irwin & Klenow, 1996).

On one hand, firms often learn more efficiently from their competitors (Browning, Beyer, & Shetler, 1995; Irwin & Klenow, 1996; Lado, Boyd, & Hanlon, 1997). Competing firms accrue technological knowledge in overlapping domains, since they target value

capture opportunities in the same market segments. Overlaps in technological knowledge are conducive to inter-firm knowledge transfer, because knowledge overlaps facilitates cross-boundary integration and reduce value erosion of the knowledge elements during the transfer process across firm boundaries (Khanna et al., 1998; Mowery, Oxley, & Silverman, 1996). Inter-firm knowledge transfer contributes to syncretic rent creation, especially when inter-firm learning takes place between competitors (Lado et al., 1997). Prior research elucidates that enhanced syncretic rent creation and a smoothened firm learning curve positively contributes to firm coopetition pursuits (Irwin & Klenow, 1996; Lado et al., 1997).

On the other hand, coopetition may trigger irrational learning races between firms (Lane & Lubatkin, 1998; Yang et al., 2015). When competing firms engage in tacit knowledge exchange and joint capability development, they gain direct access to the intimate information about their rivals' core competencies (Grant & Baden-Fuller, 2004; Teece, 1992). Direct exposure to the details on a competitor's core competency may lead to intensified senses of rivalry and competitiveness in the firm (Livengood & Reger, 2010). As a result, firms engaging in coopetition are prone to irrational learning races (Yang et al., 2015). Learning races can destroy value by disrupting the balance between exploration and exploitation (Rothaermel & Deeds, 2004). A firm racing in learning with its rivals tend to engage in excessive exploration and under-investment in exploitation, as a result, any potential value created is not properly captured by the firm (Lavie & Drori, 2011). Coopetition thus poses value destruction threats to the firms.

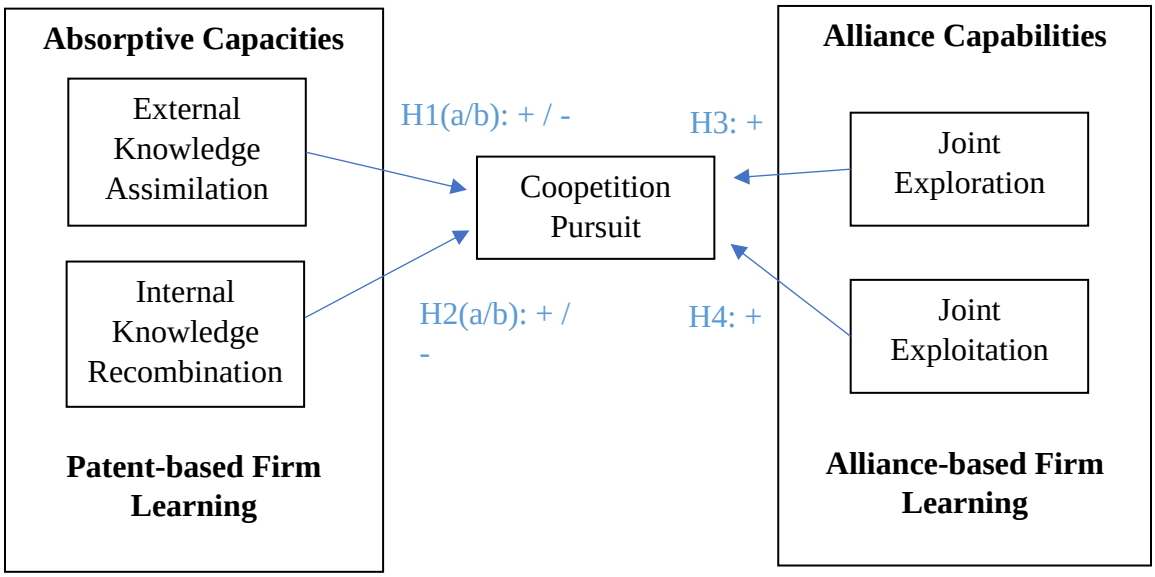
Extant research elucidates the significance of firm learning efficacies in influencing whether coopetition manifests as a syncretic rent opportunity or a learning race threat (Yang et al., 2015). However, the literature of firm learning and coopetition remains largely silent in the theoretical connections between firm learning modes, learning efficacies, and coopetition pursuits. In the following sections, I review the firm learning literature and the current coopetition research. I develop hypotheses on the effects of learning efficacies (i.e. absorptive capacities and alliance capabilities) on the firm's future coopetition pursuits. In reviewing the firm learning literature, I distinguish the absorptive capacities of external knowledge assimilation and internal knowledge recombination when firms accumulate patent-based learning experiences, and I make discernable the alliance capabilities of joint exploration and joint exploitation when firms accumulate alliance-based learning experiences. Table 3.1 captures my conceptual framework that organizes the constructs regarding firm learning modes and learning efficacies.

Table 3.1 Theoretical Framework of Firm Learning Modes and Learning Efficacies

<table>
<tr><th>Firm learning modes</th><th>Knowledge sources & learning processes</th><th>Firm learning efficacies</th><th colspan="2">Literature exemplars</th></tr>
<tr><td rowspan="2">Patent-based learning</td><td>Patent stocks of external entities, e.g. competitors, complementors, suppliers, buyers, external inventors</td><td rowspan="2">Absorptive capacities</td><td>External knowledge assimilation</td><td>Almeida, 1996; Cohen & Levinthal, 1990; Jaffe & Trajtenberg, 1996; Onal Vural, Dahlander, & George, 2013; Ziedonis, 2004</td></tr>
<tr><td>Patent stocks of staff inventors, e.g. knowledge transfer between business units, R&D project teams, individual inventors</td><td>Internal knowledge recombination</td><td>Grigoriou & Rothaermel, 2016; Lane, Koka, & Pathak, 2006; Tsai, 2001; Zahra & George, 2002</td></tr>
<tr><td rowspan="2">Alliance-based learning</td><td>Experiences in forming, maintaining and developing exploratory alliances, e.g. R&D collaboration, joint knowledge acquisition, technology transfer and licensing agreements</td><td rowspan="2">Alliance capabilities</td><td>Joint exploration capabilities</td><td rowspan="2">Dussauge, Garrette, & Mitchell, 2000; Lavie, Stettner, & Tushman, 2010; Rothaermel & Deeds, 2004, 2006; Stettner & Lavie, 2014; Vandaie & Zaheer, 2014</td></tr>
<tr><td>Experiences in forming, maintaining and developing exploitative alliances, e.g. commercialization collaboration (manufacturing, marketing), equipment supply and/or reseller alliance</td><td>Joint exploitation capabilities</td></tr>
</table>

Subsequently, I make salient the theoretical connections between firm learning modes, learning efficacies, and their coopetition pursuits. I combine insights from the firm learning literature and current research on coopetition to develop a set of hypotheses about the effects of patent- and alliance-based learning on firm coopetition pursuits. Figure 3.1 below outlines the conceptual model of the impact of firm learning on coopetition pursuit.

Figure 3.1 Conceptual Model: Firm Learning Modes, Learning Efficacies, and Coopetition Pursuit



3.3.2 Patent-Based Learning and Absorptive Capacities

In technology-driven industries, the capabilities to generate technological inventions constitute a major aspect of the firm competence base (Trajtenberg, 1990). Patenting is a legal instrument to protect the underlying intellectual property right of technological invention. Firms rely on patent protection to capture economic returns from its technological investment (i.e. R&D expenditure). Therefore, technology-driven firms commonly file for patent protection for their technological inventions. Concurrently, patent-filing firms contribute to a public information domain that contains the codified knowledge of their technological innovations because patent documents are accessible to the general public through patent offices (Hall, Jaffe, & Trajtenberg, 2005). Technology-driven firms often search in the codified knowledge domain defined by patent documents to acquire "raw materials" (i.e. technological knowledge elements) for innovation (Gruber, Harhoff, & Hoisl, 2012; Sorenson, Rivkin, & Fleming, 2006).

Searching in and drawing from the codified knowledge domain (i.e. stocks of patent documents) stands as a vital learning mechanism for technology-driven firms (Agrawal & Henderson, 2002; Sorenson et al., 2006), namely, *patent-based learning*. Firm innovation often depends on both the external sources and the internal deposit of codified technological knowledge (Agrawal & Henderson, 2002; Jaffe, Trajtenberg, & Henderson, 1993). Stated differently, firms engage in both outward-focused patent-based learning, absorbing knowledge from the patents invented by their competitors, partners, suppliers and customers, and inward-focused patent-based learning, re-absorbing knowledge from

the patents invented by their staff scientists and engineers. When firms learn from the external patent sources and the internal patent deposits, they develop different absorptive capacities for technological knowledge utilization, namely, *external knowledge assimilation* and *internal knowledge recombination* (Cohen & Levinthal, 1990; Zahra & George, 2002).

A technology-driven firm can independently transfer the codified knowledge (i.e. patent documents) across the firm boundary from external entities, including its competitors, partners, suppliers and customers. Such a boundary-spanning knowledge transfer involves potential value erosion of the technological knowledge elements, because the focal firm often does not fully internalize the technological knowledge developed by external entities (Kogut & Zander, 1992; Mowery et al., 1996). As a technology-driven firm continuously engages in more patent-based, boundary-spanning knowledge transfer, it develops increasingly robust absorptive capacities for *external knowledge assimilation*. An increase in firm absorptive capacities for external knowledge assimilation can influence firm coopetition in two opposing directions, which I develop into a pair of competing hypotheses in the following text.

On one hand, as firm absorptive capacities for external knowledge assimilation increase, the focal firm becomes more adept at acquiring competitor's technological knowledge, which is a crucial component of the competencies of technology-driven firms (Leiponen & Helfat, 2010; Levine & Prietula, 2012; Roy & Sarkar, 2016). Facing high environmental turbulence and steep learning curves, technology-driven firms strive for

high efficiency in their knowledge acquisition to gain competitive advantage from innovation (Browning et al., 1995; Irwin & Klenow, 1996; Link, Teece, & Finan, 1996). Competitors' technological knowledge constitutes a highly relevant information space from which firms can conduct local searches to obtain critical knowledge elements for effective innovation (Alexy, George, & Salter, 2013; Browning et al., 1995; Link et al., 1996). Firms with high absorptive capacities for external knowledge assimilation can learn effectively *from* competitors than those firms with low such capacities.

Furthermore, coopetition presents a significant mechanism for the participating firms to jointly generate and capture syncretic rents, which result from endogenous growth under competitive pressure as firms actively engage in innovation and organizational renewal (Lado et al., 1997). Firm innovation and organization renewal depends on firm agility and knowledge transfer across firm boundaries (Kogut & Zander, 1992; van Burg, Berends, & van Raaij, 2014). Firms with robust absorptive capacities for external knowledge assimilation tend to demonstrate high agility in adapting their organizational routines and structures to a fluid environment. Firms with robust absorptive capacities for external knowledge assimilation often incur low value loss during the process of cross-boundary resource mobilization. In coopetition, participating firms can generate syncretic rents together and capture such rents more efficiently if they are more agile in continuous adaptation and more proficient in cross-boundary resource (e.g. knowledge) mobilization (Lado et al., 1997). Stated differently, firms with high absorptive capacities for external knowledge assimilation can learn effectively *together with* competitors than those firms with low such capacities.

In summary, firms with more robust external knowledge assimilation capacities will gravitate towards more coopetition pursuits compared to firms with low such capacities, because value creation is enhanced when firms can effectively learn *from* their competitors and learn *together with* their competitors during coopetition.

Hypothesis 1(a). An increase in firm absorptive capacities for external knowledge assimilation will lead to an increase in firm coopetition pursuits.

On the other hand, firms with high absorptive capacities for external knowledge assimilation are often perceived as high competitive threats that exacerbate learning race risks to potential coopetition partners (Alexy et al., 2013; Toh & Polidoro, 2013; Yang et al., 2015). In particular, coopetition inflicts a salient risk of value-destroying learning race between firms (Yang et al., 2015). Coopetition partners gain intimate knowledge about the core competencies of one another as the inter-firm relationship deepens (Alexy et al., 2013). When such intimate knowledge is coupled with the competitive pressure between two firms, irrational competitiveness and rivalrous animosity tends to exacerbate in these firms (Browning et al., 1995; Lin, 1998). Consequently, firm innovation is driven by irrational competitive motives instead of rational value creation goals, and the learning race ensues, where competing firms innovate at such fast paces and high intensities that they cannot capture any value from their own innovation (Anand & Khanna, 2000; Khanna et al., 1998).

When facing a potential opponent with high absorptive capacities for external knowledge assimilation, the focal firm often exercises caution in its coopetition decision

to avoid value destruction from learning races. Stated differently, technology-driven firms are less willing to pursue coopetition with opponents with greater external knowledge assimilation capacities than themselves, considering the elevated probability of eliciting and subsequently losing a learning race as coopetition unfolds (Bouncken & Kraus, 2013). Consequently, firms with high external knowledge assimilation capacities will encounter fewer potential coopetition opponents and thus experience sparse coopetition pursuits.

Hypothesis 1(b). An increase in firm absorptive capacities for external knowledge assimilation will lead to a decrease in firm coopetition pursuits.

Absorptive capacities depict how well a firm can utilize knowledge elements, which encompass both external knowledge and internal knowledge (Agrawal & Henderson, 2002; Kogut & Zander, 1992; Tsai, 2001). Firm innovation depends not only on the technological knowledge sources from competitors, partners, suppliers and customers (i.e. external entities), but also on the firm's internal knowledge base, especially its core technologies, which the firm deliberately develop and accumulates over time (Agrawal & Henderson, 2002). The core of a firm's internal technological knowledge is tightly coupled with the idiosyncrasies of its organizational culture, structure, routines and designs (Kogut & Zander, 1992). A given firm pursues a distinct (i.e. chosen to fit firm characteristics) and dynamic (i.e. continuously shifting) set of patent-based learning strategies, which in combination contribute to a unique experiential learning trajectory over time (Eisenhardt & Martin, 2000). For example, a technological firm strategizes its patent-based searches according to the strengths and weaknesses of its innovation capacity, and

how the firm aspires to leverage technological opportunities and to eliminate disruptive threats in the external environment.

Due to organizational specificity of the firm's internal technological knowledge, the efficiency of firm learning while utilizing its internal knowledge is defined differently than external knowledge assimilation. In particular, firm learning from internal knowledge relies on the effectiveness of knowledge recombination via intra-organizational knowledge transfer between individual inventors, R&D teams, and business units (Carnabuci & Operti, 2013; Tsai, 2001). Generally speaking, knowledge transfer between distinct social entities often leads to potential knowledge recombination, from which innovation results from novel ways to bundle existing knowledge elements (Carnabuci & Operti, 2013; Kogut & Zander, 1992). However, not all technological knowledge element permutations can result in valuable innovation, especially when the existing knowledge elements demonstrate high tacitness to its organizational locus, which is a defining characteristic of firm internal technological knowledge (Tsoukas, 1996).

To create valuable innovation from knowledge recombination, an inventor must accurately identify the compatibility between two or more technological knowledge elements and devise a novel permutation that leverages the compatibility. Intra-organizational knowledge transfer is often conducted in effective communication, because individual inventors, R&D teams, and business units within the same firm tend to experience frequent and repeated social interactions, which are conducive to achieving

commonality in language, interaction patterns, implicit understanding and overarching philosophy (Tsai, 2001).

The intensity of intra-organizational knowledge transfer is reflected in a firm's patent-based learning utilizing its own patent stock, for instance, when two staff inventors engage in formal collaboration and/or informal social interactions within the firm, knowledge transfer occurs and forms the conduits for internal knowledge recombination (Bhaskarabhatla & Hegde, 2014; Carnabuci & Operti, 2013). Prior research elucidates that internal knowledge recombination, including formal collaboration and information interactions between inventors, R&D teams and business units, often leads to the invention of new patents that build upon the firm's own patent stock (Carnabuci & Operti, 2013; Tsai, 2001).

To sum up, the absorptive capacities of *internal knowledge recombination* define firm learning efficiency with respect to internal knowledge, which are developed by the firm via patent-based learning from its own patent stock. An increase in firm absorptive capacities for internal knowledge recombination can influence firm coopetition in two opposing directions, which I develop into a pair of competing hypotheses in the following text.

With respect to a given technology-driven firm, more robust absorptive capacity for internal knowledge recombination is associated with higher proficiency of its innovative entities (e.g. staff inventors, R&D teams, innovation departments of business units, etc.) in identifying and exploiting the compatibility between distinct technological

knowledge elements (Carnabuci & Operti, 2013). A vital aspect of coopetition is for a technology-driven firm to learn from competitor's technological knowledge, which often demonstrates potential compatibility with that of the focal firm, due to overlaps in competing firms' target product markets and resource accumulation trajectories (Irwin & Klenow, 1996).

Learning from competitors through coopetition will result in greater syncretic rents if the learner (i.e. focal firm) can effectively identify and exploit the potential compatibility between its competence base and the knowledge acquired from the competitors. In other words, firms with more robust absorptive capacities for internal knowledge recombination will likely capture greater syncretic rents from coopetition than firms lacking in such capacities, because their innovative entities are more proficient in identifying and exploiting knowledge compatibility (Browning et al., 1995; Irwin & Klenow, 1996). Consequently, firms with high absorptive capacities for internal knowledge recombination tend to purse more coopetition than firms with low such capacities

Hypothesis 2(a). An increase in firm absorptive capacities for internal knowledge recombination will lead to an increase in firm coopetition pursuits.

On the other hand, firms with robust absorptive capacities for internal knowledge recombination often depend heavily on inward-focused patent-based learning for technological innovation. In a firm with high internal knowledge recombination capacities, the innovative entities actively engage in intra-organizational knowledge transfer, and frequently exchange intimate information about their patent inventions through repeated

interactions (e.g. formal R&D collaboration and/or informal communication) (Tsai, 2001). The innovative entities develop a set of intra-organizational learning routines and common language to leverage each other's technological expertise, which increase the heuristic tendency of these inventors (or inventor teams) to engage in more inward-focused learning from the firm's patent stock (Tsai, 2001). Dependence on the firm's own patent stock for innovation concurrently intensifies the organizational inertia that prevents initiation or deepening of outward-focused patent-based learning (i.e. search in and acquire knowledge from the patents of external entities).

When firm innovation is dependent on its own patent stock, access to a competitor's knowledge through coopetition yields limited value to the focal firm. Consequently, firms with high absorptive capacities for internal knowledge recombination will not gain much competitive advantage from syncretic rent potential (i.e. learning *from* a competitor) through coopetition (Lado et al., 1997; Leiponen & Helfat, 2010; Yang et al., 2015). Collaterally, firms with high knowledge independence (e.g. when firm innovation is highly dependent on its own patent stock) likely control a self-sufficient system of knowledge utilization. In other words, a firm with high knowledge independence can gain competitive advantage from exploiting intra-organizational knowledge elements. Therefore, firms with high absorptive capacities for internal knowledge recombination will not gain much competitive advantage from learning efficiency (i.e. learning *with* a competitor) through coopetition. As a result, firms with high absorptive capacities for internal knowledge recombination tend to purse less coopetition than firms with low such capacities

Hypothesis 2(b). An increase in firm absorptive capacities for internal knowledge recombination will lead to a decrease in firm coopetition pursuits.

3.3.3 Alliance-Based Learning and Alliance Capabilities

Strategic alliance (including joint venture) is a critical mode of inter-firm cooperation, where participating firms establish a formal agreement that outlines the partnership framework (D.C. Mowery et al., 1996; Phene & Tallman, 2014). In technology-driven industries, firms are often motivated to form strategic alliances to learn from their partners (Lado et al., 1997; Link et al., 1996). First, learning firms may collaborate with alliance partners to explore new opportunities and future directions for technological innovation (Link et al., 1996). In *joint exploration*, participating firms combine partners' expertise with that of their own in identifying, predicting and setting technological trends, and jointly develop complementary resources and capabilities to capture value from such trends (Lee, Lee, & Lee, 2003; Stettner & Lavie, 2014).

Second, learning firms may collaborate with alliance partners to exploit existing opportunities in the product market (Lee et al., 2003; Stettner & Lavie, 2014). In *joint exploitation*, participating firms utilize collaboration as access to their alliance partners' knowledge to acquire complementary resources. Stated differently, strategic alliances in the format of joint exploration and joint exploitation provide firms with an important learning mechanism, namely, *alliance-based learning*, by which firms develop and acquire complementary resources.

Firms gain competitive advantage from alliance-based learning as they obtain more substantial complementary resources. However, the degree by which competitive advantage increases through alliance-based learning depends on a focal firm's *alliance capabilities* (Rothaermel & Deeds, 2006; Vandaie & Zaheer, 2014). Specifically, firms display heterogeneity in their alliance capabilities to create and capture syncretic rents from exploratory and/or exploitative partnerships (Park & Zhou, 2005). Prior research elucidates that firms can develop alliance capabilities by accumulating alliance experiences in joint exploration and joint exploitation (Stettner & Lavie, 2014). As a firm pursues more joint exploration and/or joint exploitation, it gains greater efficacy in competitive advantage gains through subsequent alliances (Stettner & Lavie, 2014). Stated differently, accumulation of experiences in joint exploration and/or joint exploitation does not end in complementary resource development and acquisition, but also contributes to the improvement of a firm's capabilities to create and capture syncretic rents from subsequent alliances.

Coopetition is a special case of strategic alliances (and joint ventures), in which the strategic partners simultaneously compete in the same (or highly overlapped) product market domains (Gnyawali & Park, 2011). Due to product market similarity, firms often develop and acquire complementary resources and capabilities more effectively through coopetition than alliances between non-competing firms (Gnyawali, 2006). Prior research points out that coopetition presents substantial syncretic rents to participating firms (Lado et al., 1997). On the other hand, competitive pressure stands salient in coopetition, which

increases value destruction threats to participating firms (e.g. eliciting a learning race) (Khanna et al., 1998; Yang et al., 2015).

In addition, competitive pressure inherent in coopetition poses challenge to govern the strategic partnership, for example, rivalry tends to trigger irrational behaviors that destabilize an inter-firm alliance (Livengood & Reger, 2010). Competitive pressure in coopetition diminishes the effective gain in competitive advantage if participating firms do not manage the coopetition properly. Specifically, alliance capabilities for joint exploration and joint exploitation are critical for effective coopetition management.

Firm *alliance capabilities for joint exploration* manifest in a firm's efficacy to create and capture public syncretic rents. Joint exploration requires firms to contribute technological expertise and proprietary knowledge for innovation, which delivers public syncretic rents to all participating firms (Lado et al., 1997). For example, when two firms collaborate on a joint innovation project, each firm contributes expert human resources (e.g. scientists, engineers, R&D managers) and shares the underlying know-hows of its key inventions (i.e. the uncodified knowledge component of the firm's inventions).

Since all participating firms expect to capture some portions of the value created in a joint innovation project, value creation constitutes public syncretic rents (Lado et al., 1997). Joint exploration contains an inherent risk stemming from the potential opportunistic behaviors of the alliance partners (Alexy et al., 2013; Lee et al., 2003). For example, an opponent firm may opportunistically appropriate the technological expertise and proprietary knowledge contributed by the focal firm beyond the alliance agreement

terms (Alexy et al., 2013). In addition, an opponent firm may opportunistically appropriate all of the public syncretic rents presented in a joint innovation project (Hamel et al., 1989; Lado et al., 1997).

The risks of opportunism in public syncretic rent creation and capture are exacerbated under competitive pressure in coopetition. Firms have robust absorptive capacities for the proprietary technological knowledge of a coopetition opponent due to high overlaps in technological knowledge domains (Mowery, Oxley, & Silverman, 1998), and they have the incentives to maximize value appropriation from innovation that concurrently contributes to the technological competencies of their rival. The more a technology-driven firm pursues joint exploration, the better it becomes at safeguarding against opportunism in public syncretic rent creation and capture.

For example, a focal firm develops mechanisms to protect its core technological competencies, such as selective disclosure of knowledge (Alexy et al., 2013), from its experience of joint exploration. Consequently, the focal firm develop more robust alliance capabilities for joint exploration. From the perspective of the focal firm, an increase in its joint exploration capabilities leads to greater efficacy of gaining competitive advantage from coopetition. Therefore, a firm with robust alliance capabilities for joint exploration will likely pursue more coopetition than firms with weak such capabilities.

Hypothesis 3. An increase in firm alliance capabilities for joint exploration will lead to an increase in firm coopetition pursuits.

Firm *alliance capabilities for joint exploitation* manifest in a firm's efficacy to create and capture private syncretic rents. In a joint exploitation partnership, firms leverage each other's existing complementary resources, typically in the commercialization processes (e.g. product manufacturing and marketing) (Lee et al., 2003; Stettner & Lavie, 2014). In the immediate terms, firms engaging in joint exploitation can quickly exploit existing opportunities in the product market without the necessity to develop such complementary resources a priori (Rothaermel, 2001).

Collaterally, these firms utilize the joint exploitation partnerships as learning opportunities to develop the complementary resources that they currently lack (Rothaermel, 2001). A focal firm gains direct access to tacit knowledge embedded in the existing complementary resources controlled by a partner via a strategic alliance for joint exploitation (Mowery, Oxley, & Silverman, 1996; Un & Asakawa, 2015). Tacit knowledge access provides the learning firm a mechanism to vicariously experience the inner workings of existing complementary resources controlled by the partner (Un & Asakawa, 2015). The learning firm thus can imitate, customize and absorb these complementary resources to gain new competencies. Such a process of imperfect imitation contributes to the creation and capture of private syncretic rents through joint exploitation (Lado et al., 1997).

The efficacy of a firm to create and capture private syncretic rents from joint exploitation depends on its proficiency in vicarious learning and imperfect imitation (Bresman, 2013; Posen, Lee, & Yi, 2013). The more a firm pursues joint exploitation, the

more it engages in vicarious learning from alliance partners. Namely, the firm repeatedly imitates, customizes and absorbs various components of the complementary resources of its joint exploitation alliance partners, as it is directly exposed to the tacit aspects of these complementary resources (Bresman, 2013). Consequently, the firm develops stronger alliance capabilities for joint exploitation over time.

Coopetition stands as a unique vicarious learning opportunity for technology-driven firms to conduct imperfect imitation of competitor competencies. In industries where environmental turbulence is high and learning curves are steep (e.g. technology-driven industries), imperfect imitation of competitors constitutes a salient mechanism to gain competitive advantage (Posen et al., 2013). Firms strategize to prevent external access to their tacit knowledge elements, such as uncodified technological know-hows, operational routines and organizational designs conducive to innovation, which are kept especially clandestine from direct competitors (Alexy et al., 2013).

Coopetition thus constitutes an instrumental access channel into competitors' tacit technological knowledge, from which a focal technology-driven firm may create and capture private syncretic rents through imperfect imitation (Hamel, 1991; Lado et al., 1997). If a firm demonstrates high alliance capabilities for joint exploitation, it will benefit more from the private portion of syncretic rents presented in coopetition. Therefore, firms with more well-developed alliance capabilities for joint exploitation are expected to pursue coopetition more actively.

Hypothesis 4. An increase in firm alliance capabilities for joint exploitation will lead to an increase in firm coopetition pursuits.

3.4 METHODOLOGY

3.4.1 Empirical Setting

To test the competing hypotheses on the effects of patent-based learning and alliance-based learning on firm coopetition pursuits, I construct a panel data from the longitudinal records of firms in the following technology-driven industrial sectors: pharmaceuticals (SIC 2833-2836), computers and peripheral equipment (SIC 3571-3579), electronics and electronic components (SIC 3671-3679), aerospace and aircraft (SIC 3721-3769), telecommunications (4812-4813, 4822, 4899), and medical devices (3841-3845).

The rationale for this empirical setting choice is two-fold. First, established research has demonstrated that firms in technology-driven industries prioritize firm learning as strategic pursuits. Firm learning is a cogent mechanism to improve the innovation performance of firms (Irwin & Klenow, 1996; Rothaermel & Deeds, 2004), which underscores firm competitive advantage in technology-driven industries (Hagedoorn, Carayannis, & Alexander, 2001). Second, stylized findings from prior studies on inter-firm interactions suggest that alliance decisions in technology-driven industries are driven by learning motivations (Hamel, 1991; Hamel et al., 1989; Mowery et al., 1996). Overall, technology-driven industries demonstrate high turbulence and steep learning curves

(Browning et al., 1995; Irwin & Klenow, 1996). Subject to these environmental conditions, competing firms in technology-driven industries often benefit from syncretic rents by coopetition (Lado et al., 1997).

Therefore, the technology-driven industries provide an ideal empirical setting for testing the conceptual model of how firm learning efficacies impact coopetition pursuits. The sampled industries consistently demonstrate high technological intensities from 1990 to 2009 according to National Science Foundation's historical surveys of industrial research and development on firms in the United States[4]. By including multiple technology-driven sectors and industries, the analysis can yield generalizable conclusions because the correlations will be limited to a less degree by the idiosyncratic nature of any given technological industry, compared to an analysis that focuses on a single industry. Stated differently, the panel data of multiple technology-driven industries increases the generalizability of empirical findings (Aguinis, Pierce, Bosco, & Muslin, 2007).

3.4.2 Sample and Data Source

I collect records of formal collaborations (including strategic alliances and joint ventures) and patent portfolio citations between publicly traded U.S. firms in the abovementioned industries. In addition, I complement the dataset with firm annual financial records for control variable construction. Firms in the United States conduct amongst the highest

[4] The National Science Foundation (NSF) is a U.S. federal agency. The NSF conducts the "Business Research and Development and Innovation Survey (BRDIS)" annually, which reports the technological intensities of various industries amongst other information. BRDIS is available from the NSF statistics portal: http://www.nsf.gov/statistics.

amounts of innovation, including R&D investments, scientific research and technological invention[5], therefore, they are appropriate subjects for the analysis here. In addition, the historical financial information of publicly traded firms in the United States is relatively complete and reliable (Li, Eden, Hitt, & Ireland, 2008), which is important for this study because financial records provide a mechanism to control the potential confounding effects due to firm heterogeneity in resource munificence and firm expenditure.

Specifically, I collect strategic alliance and joint venture records from Thomson Reuter's SDC Platinum database, which report an array of alliance characteristics and participating firm characteristics, including alliance deal announcement dates, deal contents (e.g. R&D, manufacturing, and marketing agreements), participating firm identifiers, etc. I restrict my search in the strategic alliance and joint venture data segment of the SDC Platinum database with the "participant primary SIC code" filter using the abovementioned SIC codes. The SDC Platinum database represents the most comprehensive, multi-sectoral inter-firm collaboration records, and it yields particularly reliable information for most technology-driven industries (Schilling, 2009).

However, the SDC data is by no means exhaustive, and prior studies with a focus on a single industry/sector have utilized Factiva (i.e. textual records of news articles, trade journals, company press releases, etc.) alliance announcements to complement the SDC data (D Lavie, 2007). Following a common practice in alliance research design that

[5] According to OECD's annual Science, Technology and Innovation (STI) Scoreboard reports on international comparison of firm innovation intensities. OECD conducts surveys and report firm innovation of the organization's member countries. The STI Scoreboards are available from: http://www.oecd-ilibrary.org/science-and-technology/oecd-science-technology-and-industry-scoreboard_20725345.

includes firm samples from multiple industries, I compare the deal announcement frequencies in Factiva and the deal counts in SDC Platinum on the industry level to ensure appropriate data coverage (Tafti, Mithas, & Krishnan, 2013). In all the sampled industries, the alliance announcement frequencies in Factiva and the alliance counts in SDC Platinum are highly correlated ($p<0.001$), therefore, the SDC data is reliable for the current analysis, albeit incomplete.

I collect firm annual financial records from Standard & Poor's Compustat database using the same list of SIC codes (i.e. representing technology-driven industries). Finally, I collect firm patent filing and patent citation records from the United States Patent and Trademark Office (USPTO). Matching firm-level data from SDC Platinum and Compustat to patent records posts a non-trivial challenge, since the USPTO data files do not provide a unique firm identifier. For example, the organization assignee numbers constructed by USPTO do not accurately reflect unique corporate identities, and there are copious variations in the organization name records, including misspellings and acronyms (Hall, Jaffe, & Trajtenberg, 2001). Therefore, I leverage the results of corporate-level patent assignee name matching conducted by two research groups: Hall et al., (2009) (i.e. commonly known as the NBER patent data), and a collaborative project conducted by Kogan, Papanikolaou, Seru, & Stoffman (2017).

The NBER patent data is the most comprehensive name-matching effort of corporate patent assignees in North America, particularly, the researchers achieve dynamic corporate identifier matching to USPTO assignee records, accounting for historical

corporate name changes (e.g. due to re-branding and re-structuring). The NBER patent data file is particularly valuable for the study here, since corporate patent assignees are matched to the firm universe in the Compustat North American annual fundamental database (Hall et al., 2009). However, even with the most recent extension of the NBER patent data (Bessen, 2009), it only covers corporate patent assignee, patent application and patent citation records up until 2006. Kogan et al. (2017) conducted independent research that builds upon the NBER patent data and covers corporate-level patent records until 2011.

3.4.3 Data Structure and Variable Description

I construct a panel dataset for the final analysis after triangulating and combining the abovementioned data sources to leverage the longitudinal information. Since the research question focuses on firm-level characteristics, I construct a firm-year level panel data with details outlined below. The time frame for the empirical analysis spans from 1990 to 2008. The rationale for this observational time frame is as follow. First, the SDC Platinum does not provide reliable alliance deal coverage prior to 1985[6]. Second, the frequencies of inter-firm alliances, especially technological alliances, demonstrated conspicuous variations in the 1990s and the early 2000s (Schilling, 2015). Therefore, the chosen observational period captures the changes in inter-firm collaboration and coopetition propensities, which are directly pertinent to the hypothesis testing purpose of this study. To reduce the confounding effects due to simultaneity, I implement a 1-year lag in the independent variables (i.e. the

[6] Thompson Reuters SDC Platinum "Contents and Features": http://financial.thomsonreuters.com/en/products/data-analytics/market-data/sdc-platinum-financial-securities.html. Accessed on September 27, 2016.

predictors in year t are used to predict the outcomes in year t+1). Therefore, firms with less than 2 years' financial records or patent application records are eliminated from the final sample.

To reduce sample selection bias, I include all firm records in the chosen technology-driven industries from SDC Platinum, Compustat NBER patent data and the patent data from Kogan et al. (2017). The final firm sample emerges from combining firm-year level records from all four sources (i.e. publicly traded U.S. firms in the selected industries with at least two years of records in each of Compustat, SDC Platinum, NBER patent data and Kogan et al. (2017). First, I pool the SDC Platinum alliance observations to the firm-year level, and match it to the annual financial data retrieved from Compustat North America using 6-digit CUSIP as the firm identifier (i.e. a unique identifier at the corporate level).

Second, I pool the patent citation records to the firm-year level using both chosen patent databases. By collapsing patent-level citation records to the firm-year level, I construct a dataset of firm patent portfolios (i.e. the collection of all the patents that a given firm applies in a year), in which inter-firm patent portfolio citations are the observations. Finally, I combine the firm-year level datasets into a panel data structure with a 1-year time lag in the independent variables (i.e. independent variable observations range from 1990-2007, and dependent variable observations range from 1991-2008).

The dependent variable is *firm coopetition pursuit*, which is the annual count of strategic alliances of each focal firm with other firms in the same industry (i.e. defined in the 4-digit SIC codes). I use patent backward citation counts as a proxy for absorptive

capacities. Specifically, *external knowledge assimilation* is operationalized as a count variable that captures the total backward citations in each focal firm's patents applied in each year made to the patents of external organizations. Similarly, *internal knowledge recombination* is operationalized as a count variable that captures the total backward citations in each focal firm's patents applied in each year made to its own accumulated patent stock.

I use alliance experiences as a proxy for alliance capabilities. Specifically, *joint exploration* is operationalized as a firm-year count of exploratory alliances, and *joint exploitation* is operationalized as a firm-year count of exploitative alliances. Specifically, an exploratory alliance is a deal that contains inter-firm agreements that reflect exploration (e.g. exploration, R&D, licensing, cross-licensing, exclusive licensing, cross-technology transfer, technology transfer, royalty payment terms), and an exploitative alliance is a deal that contains inter-firm agreements that reflect exploitation (e.g. manufacturing, marketing, funding, supply, original equipment manufacturing and value-added reseller). Following common practice in empirical research in firm alliances, I include the following firm-year level control variables to reduce endogeneity stemming from heterogeneity in firm resources and operation capabilities: firm size (i.e. employee number in logarithmic scale), total cash, firm intangible asset, R&D expense, advertisement expense (Lavie & Drori, 2011).

3.4.4 Econometric Model Specification

The dependent variable measures the count of coopetition relationships that a given firm pursue in an observation year. Econometrics scholars have established that when the dependent variable is a count measure, the data variance distribution often violates the normality assumption necessary for the implementation of the ordinary least square (OLS) regression model (Greene, 2003). Therefore, I fit my data to a generalized linear model (GLM) in the empirical analysis (Greene, 2003). In the literature, the Poisson specifications are commonly implemented in panel regression analysis with a count dependent variable (Whittington, Owen-Smith, & Powell, 2009).

In addition, an alpha parameter in the Poisson model specifications needs to be adjusted if the dependent variable demonstrates over dispersion, leading to the negative binomial specifications (Wooldridge, 2002). The summary statistics of my sample data unequivocally present over dispersion of the dependent count variable (i.e. for the dependent variable, std. dev. = 1.32, mean = 0.81). Therefore, I adopt the panel negative binomial regression model in testing the hypotheses in the following analysis. The negative binomial model is specified as follow:

$$p(y) = P(Y = y) = \frac{\Gamma\left(y+\frac{1}{\alpha}\right)}{\Gamma(y+1)\Gamma\left(\frac{1}{\alpha}\right)}\left(\frac{1}{1+\alpha\mu}\right)^{1/\alpha}\left(\frac{a\mu}{1+\alpha\mu}\right)^{y},$$

Equation 3.1

where μ (μ>0) represents the mean of the dependent variable (i.e. y), and α (α>0) represents the heterogeneity parameter (Greene, 2003).

Following the established practice in the literature, I implement the panel regression model with firm fixed effects to control for the endogeneity due to unobserved heterogeneity of the firms (Stettner & Lavie, 2014). Furthermore, I implement a 1-year lag in the independent variables and the control variables to control for the endogeneity due to simultaneity (Stettner & Lavie, 2014). The regression model is specified as follow:

$$ln(coopetitio\_pursuit)_{i,t} = \beta_0 + \beta_1 X_{it-1} + \beta_2 C_{it-1} + \alpha_i + \mu_{it-1} ,$$

Equation 3.2

where X_{it} denotes the independent variable vector, C_{it} denotes the control variable vector, α_i denotes the time-invariant, firm-specific intercepts (i.e. firm fixed effects), and μ_{it} denotes the random error term (i.e. time-variant, firm-specific errors); β_j denotes a series of parameter coefficients to be estimated in the regression analysis (Greene, 2003).

3.5 RESULTS

Table 3.2 and Table 3.3 below reports the descriptive statistics and the Pearson correlation coefficients of dependent, independent and control variables. All independent variables and control variables show variance inflation factors (VIF) below the suggested cut-off value of 5 (i.e. ranging from 1.06 to 4.18), with a mean VIF of the full model being 2.43. Low VIFs indicate that multicollinearity is unlikely a concern in the estimation model (Angrist & Pischke, 2009).

Table 3.2 Summary Statistics of Controls, Independent Variables, and Dependent Variables

Variables	**Observations**	**Mean**	**Std. Dev.**	**Min**	**Max**
1. Coopetition Pursuit	1515	0.807	1.317	0.000	9.000
2. External Knowledge Assimilation	1515	0.000	1.000	-0.352	12.881
3. Internal Knowledge Recombination	1515	0.000	1.000	-0.878	4.196
4. Joint Exploration	1515	0.000	1.000	-0.697	8.347
5. Joint Exploitation	1515	0.000	1.000	-0.686	9.214
6. Firm Size	1515	0.898	2.405	-5.116	5.734
7. Cash	1515	4.414	2.352	-3.772	9.446
8. Intangible Assets	1515	3.133	3.106	-5.809	11.768
9. R&D Expenses	1515	4.305	2.062	-3.170	9.408
10. Advertisement Expenses	1515	1.626	2.964	-6.908	8.161

Table 3.3 Pearson Correlation Coefficients

Variables	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1. Coopetition Pursuit	1.000									
2. External Knowledge Assimilation	0.058	1.000								
3. Internal Knowledge Recombination	0.040	0.056	1.000							
4. Joint Exploration	0.390	0.110	0.098	1.000						
5. Joint Exploitation	0.325	0.183	0.059	0.702	1.000					
6. Firm Size	0.252	0.322	0.043	0.206	0.255	1.000				
7. Cash	0.232	0.372	0.072	0.189	0.192	0.802	1.000			
8. Intangible Assets	0.178	0.168	0.058	0.011	0.003	0.628	0.574	1.000		
9. R&D Expenses	0.301	0.383	0.164	0.294	0.257	0.795	0.822	0.567	1.000	
10. Advertisement Expenses	0.272	0.259	0.038	0.210	0.224	0.523	0.519	0.436	0.490	1.000

Note: Correlations larger than |.066| are significant at $p < .05$, and those larger than |.088| are significant at $p < .01$.

Table 3.4 reports the standardized correlation coefficients of the estimated fixed effects panel negative binomial regression models. Model 1 establishes a baseline model with only the control variables. In Model 2 through Model 5, I test Hypothesis 1 to Hypothesis 4 by adding each of the four independent variables one at a time. Model 2 is fitted to test the first pair of competing hypothesis, namely, Hypotheses 1(a) and 1(b). Model 2 elucidates a negative effect of firm absorptive capacities for external knowledge assimilation on firm coopetition pursuits, which is statistically significant ($\beta = -0.104$, $p = 0.033$). Therefore, Model 2 provides support for Hypothesis 1(b). Model 3 is fitted to test the second pair of competing hypothesis, namely, Hypotheses 2(a) and 2(b). Model 3 illustrates a negative effect of firm absorptive capacities for internal knowledge recombination on firm coopetition pursuits, which is statistically significant ($\beta = -0.145$, $p = 0.015$). Model 3 yields support for Hypothesis 2(b).

I fit Model 4 to test Hypothesis 3, which predicts a positive effect of firm alliance capabilities for joint exploration on firm coopetition pursuit. Model 4 yields support for Hypothesis 3 with high statistical significance ($\beta = 0.126$, $p < 0.001$). Subsequently, I fit Model 5 to test Hypothesis 4, which predicts a positive effect of firm alliance capabilities for joint exploitation on firm coopetition pursuit. Model 5 supports Hypothesis 4 with high statistical significance ($\beta = 0.089$, $p = 0.003$). Finally, Model 6 is the full model with all independent variables and control variables estimated concurrently. In the full model, the coefficient estimates in two of the four independent variables remain statistically significant, namely, internal knowledge recombination ($\beta = -0.150$, $p = 0.01$) and joint exploration ($\beta = 0.103$, $p = 0.006$).

Table 3.4 Panel Negative Binomial Regression with Firm-Fixed Effects

Dependent Variable	Firm coopetition pursuits					
Models	Model 1 (Baseline)	Model 2 (H1)	Model 3 (H2)	Model 4 (H3)	Model 5 (H4)	Model 6 (Full)
Independent Variables						
Codified knowledge assimilation		-0.104**				-0.0728
		(0.033)				(0.136)
Codified knowledge renewal			-0.145**			-0.150**
			(0.015)			(0.012)
Tacit knowledge exploration				0.126***		0.103***
				(0.000)		(0.006)
Tacit knowledge exploitation					0.0891***	0.0267
					(0.003)	(0.468)
Controls						
Firm Size	0.221***	0.234***	0.212**	0.199**	0.193**	0.196**
	(0.009)	(0.006)	(0.013)	(0.020)	(0.023)	(0.023)
Cash	-0.0389	-0.0347	-0.0424	-0.0222	-0.0269	-0.0232
	(0.389)	(0.440)	(0.346)	(0.625)	(0.553)	(0.607)
Intangible Assets	-0.0180	-0.00859	-0.0187	-0.00449	-0.0127	0.0000758
	(0.444)	(0.721)	(0.426)	(0.848)	(0.587)	(0.997)
R&D Expenses	-0.195***	-0.191***	-0.170**	-0.186***	-0.170**	-0.153**
	(0.005)	(0.006)	(0.016)	(0.008)	(0.016)	(0.032)
Advertisement Expenses	-0.00599	0.00465	-0.00906	0.00632	0.00131	0.0100
	(0.867)	(0.897)	(0.799)	(0.857)	(0.971)	(0.777)
Constant	2.718***	2.662***	2.690***	2.609***	2.550***	2.536***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Observations	1084	1084	1084	1084	1084	1084

*All independent variables are lagged by 1 year in respect to the dependent variables; p-values are shown in parentheses; * p<0.1, ** p<0.05, *** p<0.01*

In summary, the empirical analysis yields support for the negative effects of firm absorptive capacities in both external knowledge assimilation and internal knowledge recombination on subsequent coopetition pursuits. Specifically, Hypothesis 1(b) and Hypothesis 2(b) are supported, whereas their competitive hypotheses, Hypothesis 1(a) and Hypothesis 2(a) are not supported. Furthermore, the positive effects of firm alliance capabilities in both joint exploration and joint exploitation on subsequent coopetition pursuits (i.e. Hypothesis 3 and Hypothesis 4) are supported by the empirical analysis.

3.6 DISCUSSION AND CONCLUDING REMARKS

3.6.1 Theoretical Contribution

Coopetition continues to gain practical significance to managers of firms, especially in technology-driven industries, where environmental turbulences are high and learning curves are steep (Chen, Katila, McDonald, & Eisenhardt, 2010). However, coopetition remains an under-researched topic in the strategic management scholarship. Specifically, salient research suggests firm learning as a critical antecedents to coopetition pursuits of the firms (Browning et al., 1995; Chen & Miller, 2015; Chen & Miller, 2012; Gnyawali & Park, 2011; Hamel et al., 1989). However, sparse insights exist to elucidate the theoretical connections between coopetition as a strategic decision, firm learning modes (i.e. how firms learn), and firm learning efficacies (i.e. how well firms learn).

Current research on firm learning emphasizes learning efficacies, for instance, absorptive capacities (Cohen & Levinthal, 1990) and alliance capabilities (Wang & Rajagopalan, 2015), which firms develop from the accumulation of experiences in various learning modes, including patent- and alliance-based learning (Ranjay Gulati, Lavie, & Singh, 2009; Henderson, Jaffe, & Trajtenberg, 2005; Hoang & Rothaermel, 2010; Isaksson, Simeth, & Seifert, 2016; Jaffe, Fogarty, & Banks, 1998; Jain, 2013).

The literature of firm learning, albeit robust, is lacking in the conceptual connection between different learning modes and learning efficacies. When a firm conducts patent searches to acquire knowledge elements when conducting innovation, it learns from not only the patent stocks of external entities, but also the firm's own patent stock accumulated from their past innovation (Almeida, 1996; Fleming & Sorenson, 2001; Verhoeven, Bakker, & Veugelers, 2016). How patent-based learning experience contributes to a firm's development in absorptive capacities remains theoretical vague in the current firm learning literature.

Furthermore, it is well established that firms pursue cooperative strategies (e.g. strategic alliances and joint ventures) to learn from alliance partners (Mowery et al., 1996; Vandaie & Zaheer, 2014). More saliently, coopetition offers a highly efficient learning opportunity for firms to create and capture syncretic rents together with competitors (Hamel, 1991; Hamel et al., 1989; Lado et al., 1997). However, how well a firm can leverage cooperation, including coopetition, as a learning opportunity directly hinges on

its alliance capabilities to maintain, coordinate and steer the inter-firm relationships (Wang & Rajagopalan, 2015).

Scholars investigating alliance capabilities suggest that firms develop alliance capabilities from past experiences in forging inter-firm partnerships (Rothaermel & Deeds, 2006; Vandaie & Zaheer, 2014). Specifically, firms engage in exploration and exploitation through strategic alliances (i.e. joint exploration and joint exploitation) (Lavie, Stettner, & Tushman, 2010; Stettner & Lavie, 2014), and they develop different alliance capabilities from these experiences. Conceptual distinction between joint exploration and joint exploitation capabilities is lacking in the current firm learning literature.

This study targets the abovementioned knowledge lacunae and seeks answers to the following research question: How is coopetition pursuit influenced by firm learning efficacies developed from past experiences in different learning modes? As a point of departure, I synthesize a theoretical framework to organize key constructs from the firm learning literature, and make salient the conceptual relationships between different learning modes and learning efficacies of the firms. I then investigate the impacts of distinct learning efficacies on a firm's subsequent coopetition pursuits. My analysis contributes to the firm learning literature and research on coopetition in four manners.

First, I bridge the theoretical connection between two types of firm learning modes, namely, patent-based learning and alliance-based learning, and two types of firm learning efficacies, namely, absorptive capacities and alliance capabilities. Second, I make salient the conceptual distinction between firm absorptive capacities of external knowledge

assimilation and internal knowledge recombination, which firms develop from past experiences in learning from external and internal patent stocks, respectively.

Third, I differentiate the alliance capabilities in joint exploration and joint exploitation, zeroing in on the differences in how firms leverage tacit knowledge gained from past exploratory and exploitative alliance experiences to gain efficacies in creating syncretic rents and learning from partners, especially under competitive tension. Finally, I investigate the impacts of firm learning efficacies (i.e. external knowledge assimilation capacities, internal knowledge recombination capacities, joint exploration capabilities and joint exploitation capabilities) on subsequent coopetition pursuits of the firms.

My empirical analysis disentangles the positive and the negative effects of firm learning efficacies on subsequent coopetition decisions, of which the distinction makes both theoretical and empirical contributions to coopetition research in the strategic management literature. Specifically, I test my hypotheses on the influences of firm learning efficacies on coopetition pursuits in a longitudinal panel data with a broad coverage of multiple technology-driven sectors in the U.S. from 1990 to 2007.

With regard to firm absorptive capacities in external knowledge assimilation and internal knowledge recombination (i.e. learning efficacies developed from experiences in external and internal patent-based learning modes, respectively), I developed two pairs of competing hypotheses, since high absorptive capacities simultaneously increase the focal firm's syncretic rent through coopetition (Lado et al., 1997) and amplify potential coopetition partners' tendency to avoid a learning race (Yang et al., 2015).

Stated differently, increase in firm absorptive capacities in external knowledge assimilation and internal knowledge recombination may lead to positive (H1(a) and H2(a)) or negative effects (H1(b) and H2(b)) on the firm's subsequent coopetition pursuits. My empirical investigation supports the negative effect hypotheses regarding the impact of patent-based learning on firm coopetition pursuits (i.e. H1(b) and H2(b)), whereas the competing, positive effect hypotheses (i.e. H1(a) and H2(a)) are not supported in this study.

Furthermore, I hypothesize positive effects of joint exploration capabilities and joint exploitation capabilities on firm coopetition pursuits (i.e. H3 and H4), following the logic in extant research on inter-firm learning and alliance capabilities. I found strong empirical evidence to support the positive impacts of alliance-based learning on firm coopetition pursuits (i.e. H3 and H4).

3.6.2 Limitation and Future Research

However, my analysis is not without limitations. First, my conceptualization and empirical analysis focuses on the learning modes and learning efficacies that are salient to coopetition pursuits of technology-driven firms, because coopetition is most manifest in high-technology sectors where environmental turbulences are high and learning curves are steep. Therefore, I zero in patent- and alliance-based learning modes, from which firms develop absorptive capacities in utilizing external and internal knowledge, and alliance capabilities in gaining competitive advantage from exploratory and exploitative collaboration.

Firms may pursue other modes of learning and develop additional learning efficacies. For example, firms often engage in vicarious learning from formal and informal interactions with external entities (Bresman, 2013). Additionally, learning-by-doing constitutes a critical mechanism of firm learning to improve the efficiency of operational routines, especially for manufacturing procurement, and logistics processes (Jain, 2013). Future research may continue to investigate how firms develop learning efficacies from their experiences in vicarious learning and learning-by-doing, and how these learning experiences may impact future coopetition pursuits.

Second, my empirical analysis relies on a panel data that covers a broad scope of technology-driven industries. A broad industrial scope increases the generalizability of my findings, yet limits the precision of the predictions (Bitektine & Miller, 2015; Turner, Cardinal, & Burton, 2017). Therefore, the magnitudes of effects from various learning efficacies on firm coopetition pursuits may differ from what I report here when each industry is examined in separation. Future research may continue to hone in the industry-level contextual factors, and uncover the contingencies that moderate the strengths of impacts from learning efficacies on firm coopetition pursuits, for example, technological intensity, competition pressure, market dynamics (Gnyawali & Madhavan, 2001; Ritala & Sainio, 2014).

Finally, I conduct my conceptualization and empirical investigation on the firm level, targeting the antecedents to firm decision making regarding coopetition. Factors on the levels of firm dyads and inter-firm relation (i.e. relation-specific factors) yield salient

influences on the dynamic evolution of coopetition relationships. Future research may focus on how coopetition relationships develop over time, subject to various relation-specific factors, for instance, knowledge proximity, resource overlaps, managerial perception, rivalry, trust and familiarity (Dahlander & McFarland, 2013; Gulati & Nickerson, 2008; Jiang, Bao, Xie, & Gao, 2016; Sears & Hoetker, 2014).

4 INNOVATING FROM COOPETITION: DOES HORIZONTAL INTEGRATION ENHANCE INNOVATION VALUE? CONTINGENCY EFFECTS OF ALLIANCE AND KNOWLEDGE NETWORK EMBEDDEDNESS

4.1 ABSTRACT

Extant research suggests the "double-edged sword" nature of coopetition in technology-driven industries. Specifically, coopetition may enhance value creation in firm technological innovation by providing complementary resources and learning opportunities. However, close interactions with competitors may spur competitive attacks, such as knowledge misappropriation, technological imitation, and learning races, leading to value destruction in firm innovation. The contextual conditions under which coopetition may enhance value creation or exacerbate value destruction remain unclear, begging the question: Under what conditions will the firms benefit from coopetition, or be harmed by it? In this study, I seek answers to this question as I unpack the contingency factors stemming from pluralistic network embeddedness of technology-driven firms, which are simultaneously plugged in a firm-level collaboration network and a firm-level knowledge network. I zero in on the moderation effects of network betweenness, centrality, and structural hole spanning on the baseline impacts of coopetition on firm innovation

performance. My contingency model contributes to growing research in the topics of coopetition strategy and network pluralism.

4.2 INTRODUCTION

How does collaboration network and knowledge network embeddedness influence firm coopetition and innovation? Collaboration with competitors has been conceptualized as a double-edged sword, especially in technology-driven industries. On the one hand, coopetition underscores a critical mechanism to overcome the learning curves and develop innovation capacities (Dussauge, Garrette, & Mitchell, 2000; Hamel, Doz, & Prahalad, 1989). Firms competing in the same industry often have overlapping competencies that facilitate cross-boundary resource assimilation and knowledge absorption (Gnyawali & Park, 2011; Lado, Boyd, & Hanlon, 1997). Therefore, resource acquisition from competitors in the same industry can lead to enhancement in the focal firm's subsequent technological innovation. In other words, coopetition provides value creation opportunities to augment firm technological innovation.

On the other hand, competing firms face limitations when leveraging complementary resources. For example, rivalry between firms in the same industry leads to negative sentiments (e.g. aggressiveness and distrust) that destabilize inter-firm relationships and erodes value (Chen & Miller, 2015; Livengood & Reger, 2010; Sirmon, Gove, & Hitt, 2008). Firms who pursue coopetition come into close contact with their competitors, for example, they engage in frequent interactions, share organizational knowledge, and contribute complementary resources to a collaborative project (Khanna,

Gulati, & Nohria, 1998b). Such intimate inter-firm interactions between competitors may stabilize inter-firm relationships, however, close proximity between competitors can also breed rivalry as firms perceive threats and challenges directly and tangibly (Chen & Miller, 2015; Livengood & Reger, 2010). Rivalry between coopetition opponents can promote competitive attacks (e.g. proprietary knowledge misappropriation, technological imitation) and learning races against partners, which will erode potential value gains from coopetition, and even destroy firm innovation competencies (Andrevski, Brass, & Ferrier, 2016; Yang, Zheng, & Zaheer, 2015). In other words, coopetition spurs value destruction threats to diminish firm technological innovation.

Extant studies on inter-firm strategies and firm innovation illustrate both augmenting and diminishing effects of coopetition on firm innovation (Bouncken & Kraus, 2013; Frankort, 2016; Gnyawali, Madhavan, He, & Bengtsson, 2016; Toh & Polidoro, 2013). Such contradicting results beg the question: Under what conditions will the coopetition pursuit of a focal firm augment or diminish firm innovation performance? A gap exists in the current literature where theoretical insights are sparse in the contextual factors that moderate the impacts of coopetition on firm innovation, limiting the value of practical guidance for managers on the strategies of collaboration with competitors (Park, Srivastava, & Gnyawali, 2014).

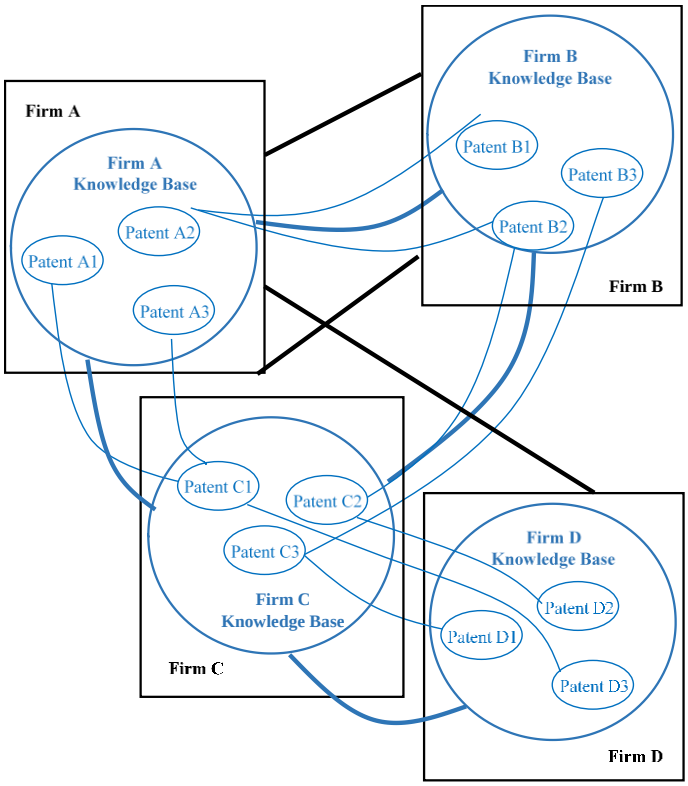
In a parallel research stream, seminal work on organizational networks illustrates network embeddedness as a critical environmental factor that influences the effect of inter-firm strategies, including cooperation with competitors, on innovation performance

(Ahuja, 2000a; Gulati, 1998; Lee, Song, & Yang, 2016; Singh, Kryscynski, Li, & Gopal, 2015; Wal, Alexy, Block, & Sandner, 2016). For example, an inter-organizational collaboration network manifests when firms pursue strategic alliances, joint ventures, or other formal collaboration (Schilling, 2015; Schilling & Phelps, 2007). Organizational network scholars demonstrate the significant impacts of collaboration network positions on technological innovation of the firms (Ahuja, 2000b; Burt, 1987; Schilling & Phelps, 2007; Singh et al., 2015). In addition, recent conceptualization brings growing attention to the effect of knowledge network embeddedness on firm innovation (Phelps, Heidl, & Wadhwa, 2012). Distinct from collaboration network where inter-firm ties represent formal, social interactions between firms, a knowledge network captures the interdependencies between firm knowledge bases, for instance, knowledge network embeddedness of the firm can reflect knowledge influences, and technological overlaps with other firms in the same or a similar innovation space (Phelps et al., 2012).

The majority of organizational network research focuses on the isolated impact of network embeddedness on innovation in a given relational context, for example, alliance-based collaboration network (e.g. Schilling & Phelps, 2007; Singh et al., 2015). The network pluralism view calls for further investigations on how firm performances vary depending on their positions in different types of networks (Shipilov et al., 2014). Most conspicuously, technology-driven firms often pursue partnerships (e.g. joint R&D) with other firms, and independently search for information in the public domain of knowledge (e.g. published patents) to develop innovation competence (Guan & Liu, 2016; Ranganathan & Rosenkopf, 2014).

While inter-firm partnerships plug a focal firm in a collaboration network, independent knowledge absorption leads to embeddedness in a firm-level knowledge network. Specifically, if a focal firm absorbs codified knowledge from an external firm's patent stock, and integrates such information into its own knowledge base, then these two firms are tied in a knowledge network on the firm level. Figure 4.1 below illustrates the pluralistic embeddedness of firms in the inter-organization collaboration network and knowledge network. Since a firm may demonstrate different patterns in its inter-firm partnership and knowledge search pursuits, the firm can experience varied influences from these two types of networks.

Figure 4.1 Pluralistic Network Embeddedness Illustration: Firm-Level Collaboration and Knowledge Networks



Legends

Patent-level tie (i.e. technological class co-assignment)

Firm-level knowledge network tie (i.e. aggregated from patent-level tie)

Firm-level collaboration network tie (e.g. strategic alliances, joint ventures)

Notes

1. Firm A and Firm B are tied in both the firm-level collaboration network and the firm-level knowledge network
2. Firm A and Firm C are tied in only the firm-level knowledge network
3. Firm A and Firm D are tied in only the firm-level collaboration network
4. Firm B and Firm D are tied in neither the firm-level collaboration network nor the firm-level knowledge network
5. Firm B and Firm C are tied in both the firm-level collaboration network and the firm-level knowledge network
6. Firm C and Firm D are tied only in the firm-level knowledge network

Technology-driven firms often seek coopetition to gain knowledge access and the opportunity to develop innovation competency (Gnyawali & Park, 2011; Hamel et al., 1989), hence firm coopetition pursuit is often coupled with the concurrent embeddedness in the firm-level collaboration network and knowledge network. Therefore, when investigating the contextual factors that influence the strategic impact of coopetition on firm innovation, it is critical to examine both types of firm-level network embeddedness. Due to a dearth of network pluralism conceptualization in coopetition research, the knowledge gap remains unbridged with regard to the contextual moderators that alter the impacts of coopetition on firm innovation.

To fill the knowledge gap, I develop a contingency model to unpack the interactions between coopetition and pluralistic network embeddedness. Specifically, I conceptualize the moderation effects of centrality and structural hole spanning of firm positions in two types of firm-level networks, collaboration network and knowledge network. I test my hypotheses in a panel data set constructed from the longitudinal records of public technology-driven firms in the US in 1990 - 2008.

The study makes the following contributions to extant management literature. First, adopting the theoretical lens of organization network embeddedness, I clarify the environmental conditions under which coopetition can be beneficial or detrimental to firm innovation. In doing so, the resulted insights bring us closer to resolving the debate on the strategic impact of coopetition on technology-driven firms (e.g. Gnyawali, Madhavan, He, & Bengtsson, 2014; Park et al., 2014). Second, I contribute to burgeoning research on

network pluralism, answering the call for scholarly attention to the phenomenon in which firms experience different network-based constraints, when they maintain different types of ties with external entities (e.g. Guan & Liu, 2016; Shipilov et al., 2014).

Honing in on technology-driven firms, I synthesize the salient insights from inter-firm collaboration network and knowledge network research (e.g. Phelps et al., 2012; Ranganathan & Rosenkopf, 2014; Schilling & Phelps, 2007; Wang, Rodan, Fruin, & Xu, 2014), and apply them in the context where learning opportunity and competitive tension intertwine to influence firm strategy formulation (i.e. coopetition pursuit). Finally, my analysis provides conceptual rationale and empirical supports for the implementation of network positioning and knowledge search strategies for firms aiming to gain innovation competency from their competitors (Hamel et al., 1989).

4.3 THEORY AND HYPOTHESES

4.3.1 Coopetition and Firm Innovation

In technology-driven industries, firm innovation constitutes a critical dimension of competitive advantage. Firms leverage internal resources, capabilities, and external relationships with competitors and complementors to gain competencies, including innovation performances (Dyer & Singh, 1998; Hitt, Dacin, Levitas, Arregle, & Borza, 2000; Lado et al., 1997; Srivastava & Gnyawali, 2011). Cooperation between competitors, or coopetition, is an important inter-firm strategy by which technology-driven firms gain

innovative competence (Chen & Miller, 2015; Hamel et al., 1989; Lado et al., 1997). Firms competing in the same industry likely demonstrate similarities in their general resources and capabilities, because competitors offer similar products and services in the downstream market and rely on a common set of general strategic factors in the upstream market (Chen & Miller, 2015; Dierickx & Cool, 1989; Grimpe & Hussinger, 2013).

For example, competitors in technology-driven industries make similar technological investments, recruit experts with similar technological and scientific backgrounds, and conduct similar knowledge application processes during product innovation (Browning, Beyer, & Shetler, 1995; Mowery, Oxley, & Silverman, 1998; Sears & Hoetker, 2014). On the other hand, technology-driven industries often display high diversity in the details of technological specifications in their products, and a high degree of variations in customer preferences (Davis, Eisenhardt, & Bingham, 2009). Therefore, on the nuanced level of technological product specificities, firms become specialized in distinct knowledge domains and cater to disparate demand niches (Haeussler, Patzelt, & Zahra, 2012).

Stated differently, inter-firm similarities in general strategic factors and distinctions in specialized knowledge domains provide high complementarities in the resources and capabilities between competitors in technology-driven industries. Therefore, competitors can effectively create and capture syncretic rents by sharing, integrating, and recombining their complementary resources and capabilities (Lado et al., 1997). For example, when competitors collaborate to conduct innovation, they may overcome the steep learning

curves in technological investment more efficiently, yielding enhancement to subsequent innovation performances (Hamel et al., 1989; Irwin & Klenow, 1996; Jain, 2013).

However, the effectiveness of coopetition in enhancing firm innovation is limited by competitive tension (Ang, 2008; Wu, 2012). Extant literature elucidates the inherent danger of learning races between competing firms in the technology-driven industries (Yang et al., 2015). A learning race occurs when the trajectories of firm technological development become highly visible amongst competitors (Yang et al., 2015). When firms engage in coopetition, they gain intimate access to the tacit knowledge associated with their opponents' technological development process (Alexy, George, & Salter, 2013; Mowery, Oxley, & Silverman, 1996). Therefore, coopetition increases the visibility of technological development trajectories of competing firms, leading to augmented threats of learning races between firms. Extant literature establishes the negative impacts of learning races on subsequent firm innovation performances (Yang et al., 2015).

Furthermore, direct knowledge access to competitors' technological investments increase competitive tension (Pahnke, Katila, & Eisenhardt, 2015). For example, incumbents aspire to maintain technological dominance in the industry, while entrants attempt to dethrone the leaders in the competitive field. When an incumbent gains direct knowledge access to the technological investments of the entrants through coopetition, the incumbent may misappropriate the knowledge access and elicit direct attacks on the entrants to preempt potential technological disruption (Ansari & Krop, 2012; Hill & Rothaermel, 2003; Tripsas, 1997). Therefore, coopetition may elicit competitive attacks on

potential disruptors of the technological status quo, yielding an overall negative effect on firm innovation performance (Park & Russo, 1996). It remains debatable under what conditions firms gain enhancements or suffer diminutions in their innovation performances when they pursue coopetition with other firms in the same industry, a knowledge gap I target to fill in the following analysis.

Baseline. Coopetition pursuit can yield beneficial or detrimental impacts on firm innovation performance.

4.3.2 Collaboration Network and Coopetition

Innovation is vital for technology-driven firms. Operating in a fast-paced environment, a technology-driven firm must continuously learn and renew its innovation competency to remain competitive (Sosa, 2011; Tripsas, 1997). Coopetition represents a critical strategy to access valuable knowledge from competitors in the same industry (Hamel, 1991; Hamel et al., 1989). In addition, firms often pursue collaboration with complementary firms to jointly create added value, including partnerships with suppliers, buyers, and horizontal complementors in related technological industries (Dyer & Singh, 1998; Grimpe & Hussinger, 2013; Makri, Hitt, & Lane, 2010). The position of a focal technology-driven firm in a firm-level collaboration network can exert non-trivial effects upon the direct impacts of coopetition pursuit on firm innovation.

In a collaboration network, inter-firm ties represent formal partnerships, for example, strategic alliances, joint ventures, participation in technological setting

committees, and R&D consortia (Schilling, 2015). Collaboration network ties function as the conduits for resource flows between the nodes (i.e. firms), such as complementary assets, social capital, and information (Gnyawali & Madhavan, 2001; Khanna, Gulati, & Nohria, 1998a). For example, strategic alliances provide a focal firm with access to the firm resources, business relations, and tacit knowledge of its partners (Kogut & Zander, 1993; Mowery et al., 1996). Therefore, a firm's connectivity in the collaboration network is instrumental to its abilities to acquire and direct external resources, which can alter how coopetition influences the innovation performance of technology-driven firms (Gnyawali & Madhavan, 2001; Srivastava & Gnyawali, 2011).

When considering the contextual effects of network connectivity, two approaches are commonly applied to investigate firm network positions, namely, the whole-network approach that examines the ties amongst all firms embedded in the same network, and the ego-network approach that zeros in on the local community of the focal firm (Kilduff & Brass, 2010). I tease out the contingency effects of whole-network betweenness centrality and ego-network structural hole spanning, which capture a firm's collaboration network connectivity and thus reflect how the focal firm may be influenced by the opportunities and threats associated with coopetition.

Whole-network betweenness. Betweenness centrality captures the probability of a focal network node standing in the shortest paths linking two distal entities in the whole network (Freeman, 1977, 1978). Conceptually, whole-network betweenness indicates a focal firm's role in relaying total network resource flows, including those circulating

amongst the firm's direct collaboration partners, and the resources indirectly accessed from distal collaboration network participants (Freeman, 1978). When the focal firm occupies a collaboration network position with high betweenness, it is likely to gain power in determining what resources are mobilized in the whole network, and how these resource flows are directed (Freeman, 1977, 1978). For example, a firm occupying a whole-network bridging position may selectively reveal knowledge from one entity to another (Alexy et al., 2013), or act as the gatekeeper for knowledge and complementary asset influx from distal technological domains (Gilsing, Nooteboom, Vanhaverbeke, Duysters, & van den Oord, 2008; Schilling & Fang, 2014).

Therefore, a firm with high whole-network betweenness in a collaboration network can exert more power over a larger set of network entities, compared to the firms with low whole-network betweenness scores (Freeman, 1978). Therefore, the focal firm is less likely to experience attacks from competitors who participate in the same network due to a deterrent effect from the firm's elevated power (Chen, 1996; Gnyawali & Madhavan, 2001). Furthermore, when a firm gains control over network resource flows, it is more likely to become the technological leader in the industry, because the focal firm can determine the industry-level technological trajectories by manipulating information and asset mobilization in the inter-firm collaboration network (Gilsing et al., 2008; Schilling & Phelps, 2007; Stephenson & Zelen, 1989). Since challenging the technological leader in a given industry often incurs great costs and may lead to firm demise (e.g. Aghion & Howitt, 1992; Tripsas, 1997), competitors are less likely to elicit competitive attacks on firms with high collaboration network connectivity.

Potential competitive attacks, for example, learning race, information misappropriation, and unwarranted imitation, underpin a main constraint for the effectiveness of coopetition as a strategy to enhance firm innovation (Chen & Miller, 2015; Lado et al., 1997). When a firm occupies a collaboration network position with high whole-network betweenness, it is protected from the potential detrimental impact of competitive attacks, and thus more likely to gain innovation competence from coopetition pursuit. I thus hypothesize a positive moderation effect of whole-network betweenness in an inter-firm collaboration network on the relationship between coopetition pursuit and innovation performance of technology-driven firms.

> *Hypothesis 1. Collaboration network betweenness positively moderates the baseline effect of firm coopetition pursuit on innovation performance, such that a focal firm with higher betweenness is more likely to benefit from coopetition and less likely to be harmed.*

Ego-network structural hole spanning. As argued above, the connectivity of a focal firm in the whole network increases the potential benefits and decreases the potential detriments from coopetition on firm innovation (i.e. the baseline effect). This begs the question: how does local network connectivity of the firm alter this baseline effect? Prior studies demonstrate that a given node may display different degrees of connectivity in the local network (i.e. ego network) and in the whole network (e.g. see Kilduff & Brass, 2010 for a comprehensive review). Compared to a firm that bridges distal network constituents and gains control of the total network flows (i.e. a firm with high whole-network

betweenness), a firm who is well-connected to its direct partners in the local collaboration network may experience different network dynamics. A structural hole refers to an ego network position that insulates the network flows between either side of the hole (Burt, 1992). When a firm spans a structural hole in its local collaboration network, it may serve as the resource broker and coordinator amongst these disconnected partners (Burt, 2004).

A structural hole spanning firm in a local collaboration network is likely to experience elevated coordination costs in order to maintain a stable local community (Bizzi, 2013; Shipilov & Li, 2008). For example, when a conflict of interests emerges between two collaborators of a focal firm, it must strategize to reestablish a social balance between these firms. Since it is more likely for disjointed firms to disagree (e.g. when two firms do not maintain a direct partnership, there is less constraint for them to act in coherence), the structural hole spanning firms often experience a higher frequency of such conflicts in a given local collaboration community. In other words, a position that spans a large number of ego network structural holes entails high coordination costs for the focal firm, because it becomes increasingly more difficult to achieve private and public values in a given local collaboration network as the number of disjointed partners increases (Bizzi, 2013; Tatarynowicz, Sytch, & Gulati, 2015; Wang, 2016).

Arguably, the local network coordinator may gain benefits by strategically brokering network flows to achieve private value gain (Schilling & Fang, 2014; Wal et al., 2016). However, exploiting network resources in its own advantage injects more instability in the focal firm's ego network, especially when such actions are visible to the firm's direct

partners (Bizzi, 2013; Xiao & Tsui, 2007). When a firm strategically manipulates network resource flows, such as by relaying knowledge leakage from one direct partner to another (Pahnke, McDonald, Wang, & Hallen, 2015), it may benefit from such maneuvers in the short-run. Over time, the disadvantageous partners may elicit competitive attacks, and send negative signals to other network constituents. Consequently, the private value obtained by the focal firm will wear away in the long-run.

When firms engage in coopetition, a major constraint derives from the necessity to coordinate inter-firm power imbalance and manage competitive tension (Chen & Miller, 2012, 2015; Gnyawali & Madhavan, 2001). A structural hole spanning firm bears high coordination costs in its local collaboration network, which leaves it with reduced capacities to maintain a power balance and keep competitive tension at bay amongst competitors from its coopetition pursuits. As a result, the potential benefits from coopetition will diminish, and the potential detriments, such as those stemming from competitive attacks, will be more tangible.

> *Hypothesis 2. Collaboration network structural hole spanning negatively moderates the baseline effect of firm coopetition pursuit on innovation performance, such that a focal firm who spans more local structural holes is less likely to benefit from coopetition and more likely to be harmed.*

4.3.3 Knowledge Network and Coopetition

In technology-driven industries, firms search in the public knowledge domain to acquire knowledge elements for product innovation (Fleming & Sorenson, 2001; Guan & Liu, 2016; Henderson, Jaffe, & Trajtenberg, 2005). For example, firms conduct searches in scientific publications, trade journals, market reports, and technological patents to absorb knowledge from these sources. As firms innovate and create novel knowledge, they concurrently make contributions to the public knowledge domain. For instance, when firms file for patents to protect intellectual property rights, they are legally required to disclose the proprietary knowledge of the technological inventions. If the patents are issued, then the information in the patent documents (e.g. patent description, technological claims, and drawings) is integrated into public knowledge domain.

For technology-driven firms, patents invented by external entities (e.g. firms, universities, and individuals) constitute a major knowledge source for their technological innovation (Fleming & Sorenson, 2001, 2004). Therefore, it is common for technology-driven firms to utilize the published patents invented by other firms and integrate relevant knowledge elements in its own innovation process. A focal firm may absorb codified knowledge independently by conducting searches in the public knowledge domain, since the patents invented by other firms become public information once they are published (Fleming & Sorenson, 2004; Guan & Liu, 2016).

Technology-driven firms often conduct innovation based on the existing inventions in proximal technological domains (Henderson et al., 2005). For example, firms may utilize

the aggregated knowledge of prior technological inventions in the industry to inform their technological investments, so that their innovation is aligned with the industrial technological trends (Bhaskarabhatla & Hegde, 2014; Fleming & Sorenson, 2004; Sorenson, Rivkin, & Fleming, 2006). Alternatively, firms pursue imperfect imitation of the existing inventions by their competitors as a mechanism of incremental innovation (Posen, Lee, & Yi, 2013). Such openness of knowledge exchange in firm innovation leads to interdependencies between firm knowledge bases (Bhaskarabhatla & Hegde, 2014).

On the one hand, the knowledge base of a focal firm exerts influences on the technological innovation of other firms who draw knowledge elements from the focal firm knowledge bases. On the other hand, when the focal firm acquires knowledge elements from the knowledge bases of other firms, and assimilates these external knowledge elements in subsequent inventions, the technological overlaps between these firms increase as a result. A knowledge network depicts the inter-connectivity amongst firm knowledge bases, and thus reflects the interdependencies of firm knowledge bases (Guan & Liu, 2016; Wang et al., 2014). When firms draw knowledge elements inward from the knowledge bases of other firms, and when they contribute knowledge elements outward, these firms become embedded in a knowledge network (Phelps et al., 2012). Specifically, when a focal firm utilizes the knowledge elements generated by another firm in its product innovation, these two firms form a knowledge network tie; when a focal firm's knowledge elements are incorporated into another firm's product innovation, these two firms form a knowledge network tie (Guan & Liu, 2016; Wang et al., 2014).

Extant studies demonstrate that the structural characteristics of firm positions in a knowledge network reflect their knowledge influences and technological overlaps with other knowledge network constituents (Phelps et al., 2012). A key mechanism to benefit from coopetition lies in knowledge access from competitors, and the flip side is knowledge leakage that gives rise to potential harms (Hamel, 1991; Hamel et al., 1989). Therefore, it is important to consider the knowledge influence of a focal firm, and its technological overlaps with external entities when examining the impacts of coopetition on firm innovation.

Knowledge network centrality. The centrality of a firm in the knowledge network captures its knowledge influence. Knowledge network ties conduct knowledge influences cascading from a centrally positioned firm to a peripheral firm (Ranganathan & Rosenkopf, 2014; Wang et al., 2014). A centrally positioned firm (i.e. high knowledge network centrality) with robust knowledge network ties is able to exert high knowledge influences on a large number of network constituents, both directly and indirectly (e.g. Battke, Schmidt, Stollenwerk, & Hoffmann, 2016; Ranganathan & Rosenkopf, 2014; Wang et al., 2014).

When a focal firm's knowledge base serves as the source of codified knowledge from which other technology-driven firms draw information during their innovation processes, the focal firm exerts direct knowledge influences on these innovation followers. As the innovation followers integrate elements from the focal firm's knowledge base and innovate, they often create inventions that trace along the focal firm's innovation footsteps,

culminating to the industry- or sector-wide technological trajectories (Dosi, 1982; Mani & Nandkumar, 2016; Teece, 2008). Concurrently, the innovation followers contribute to the public knowledge domain, spreading the knowledge influence from the focal firm to even more technology-driven firms, and thus reinforcing the technological trajectories initially shaped by the focal firm's innovation (e.g. Mani & Nandkumar, 2016).

Worded differently, a firm with high centrality in the knowledge network controls a prominent and influential knowledge base that can impact the innovation directions and outcomes of a large number of external firms in a proximal innovation space (e.g. operating in the same or related industries). Effectively, the more centrally a firm is positioned in the knowledge network, the more power it wields over how industry-wide technological standards are established, maintained, or modified (e.g. Ranganathan & Rosenkopf, 2014). Incumbent firms in the same industry often gain competitive advantage by reinforcing and adhering to extant technological standards (i.e. the status quo), they are thus motivated to guard against competitive attacks that may challenge and undermine the status quo (Adner & Kapoor, 2015; Jiang et al., 2011).

Potential competitive attacks from those who are familiar with the focal firm's core competence underpin major threats from coopetition, and post hefty limitations on learning opportunities from competitors during coopetition (Chen & Miller, 2015). When pursuing coopetition, a focal firm with high knowledge influence is effectively protected by its technological followers whose innovations trace along the same technological trajectories from the detrimental effects of competitive attacks, because it is in the technological

followers' interests to eliminate threats to the extant technological standards (Leiponen, 2008; Ranganathan & Rosenkopf, 2014). In addition, the firm with high knowledge influence gains an advantage in learning from the coopetition partners, because the focal firm can exercise control over the industry-wide technological standards, which reduces the uncertainty in any exploratory activities such as firm learning (Leiponen, 2008). Therefore, a firm with high knowledge network centrality can better select and absorb a coopetition partner's novel knowledge that will reinforce its innovation competence and the industry status quo. Thus, knowledge network centrality can enhance the potential benefits and mitigate the potential detriments from coopetition for technology-driven firms.

> *Hypothesis 3. Knowledge network centrality positively moderates the baseline effect of firm coopetition pursuit on innovation performance, such that a focal firm with higher centrality is more likely to benefit from coopetition and less likely to be harmed.*

Knowledge network structural hole spanning. In a firm-level knowledge network, the ties between two firms represent the connections between their knowledge bases (Phelps et al., 2012). When two firms have knowledge bases that are highly overlapped in multiple technological domains, they will have a strong tie in the firm-level knowledge network (Guan & Liu, 2016; Wang et al., 2014). In the local knowledge network of a focal firm (i.e. the ego network), the direct alters represent knowledge bases that are in the proximal technological domains relative to the focal firm's core innovation competence.

To the contrary, a disconnection in the local knowledge network (i.e. a knowledge network structural hole) reflects a cross-domain knowledge gap (Burt, 2004). When a firm spans knowledge network structural holes, it bridges the cross-domain knowledge gaps as its knowledge base demonstrate technological overlaps with a multitude of disjointed external firm knowledge bases (e.g. Guan & Liu, 2016).

When a technology-driven firm spans structural holes in the knowledge network, it is likely to gain experience in combining and utilizing external knowledge elements (i.e. boundary-spanning knowledge recombination) in its innovation process (Burt, 2004). As a firm accumulates more experiences in boundary-spanning knowledge recombination, it will gain higher knowledge absorptive capacities, so that the focal firm becomes increasingly capable in absorbing and assimilating external knowledge (Reagans, Mcevily, Reagan, & Mcevily, 2003).

In other words, a firm that spans more structural holes in the knowledge network can develop higher absorptive capacities, which lend strengths to the focal firm to benefit from the learning opportunities in coopetition (Lane & Lubatkin, 1998; Ritala & Hurmelinna-Laukkanen, 2013). Coopetition provides innovation-enhancing knowledge access to technology-driven firms that can effectively absorb and assimilate competitors' technological competencies (Irwin & Klenow, 1996; Roy & Sarkar, 2016). Competitors in the same technological industry can achieve higher R&D efficiency in collaboration if they can effectively integrate the knowledge elements in their opponents' technological competence bases (Zahra & George, 2002).

Therefore, if a technology-driven firm is capable of absorbing the knowledge elements in its competitors' technological competence bases, then the focal firm will likely gain high economic returns to its innovation as it benefits from the innovation-enhancing effects of coopetition (Grindley, Mowery & Silverman, 1994; Hamel et al., 1989). When a focal firm spans multiple knowledge network structural holes, it develops substantial absorptive capacities in assimilating and recombining disjointed external knowledge (Burt, 2004; Lane, Koka, & Pathak, 2006). As a result, structural hole spanning in the knowledge network augments the effects of innovation-enhancing knowledge access from coopetition, thus increasing the potential positive impacts of coopetition on the economic values of firm innovation.

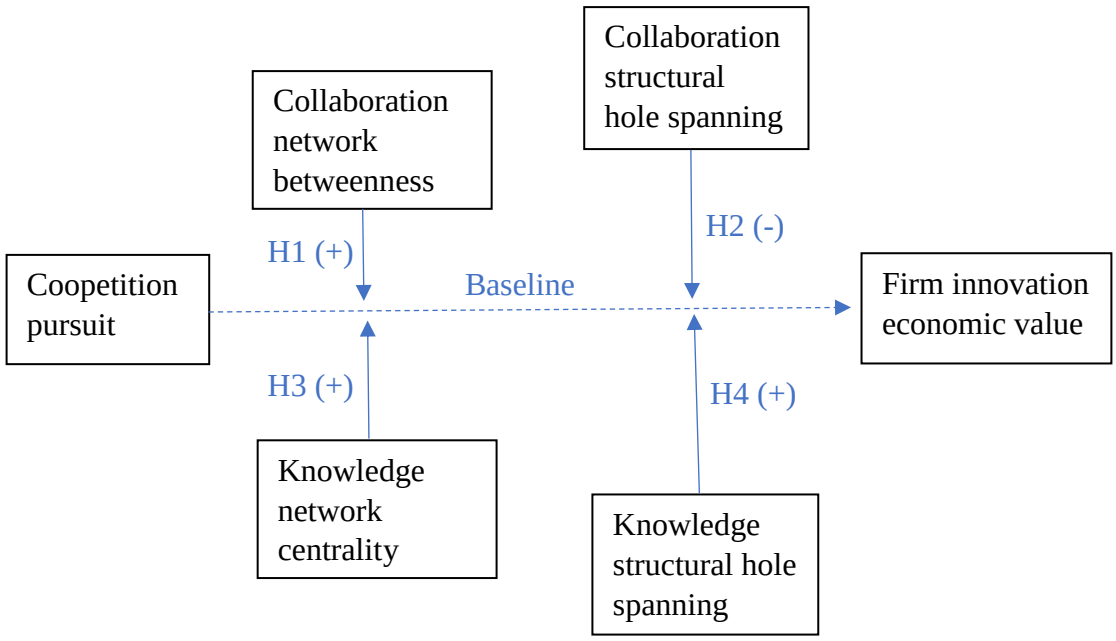
Furthermore, high absorptive capacities effectively protect the focal firm from potential learning race threats in coopetition. When two firms demonstrate asymmetric learning capabilities in a partnership, the firm with higher learning capabilities has more competitive advantages (Yang et al., 2015). In coopetition, when the focal firm develops high absorptive capacities to integrate external knowledge, it is more likely to come out on top if the coopetition partner elicits a learning race (Lane & Lubatkin, 1998; Yang et al., 2015). Therefore, a firm in the knowledge network position that spans structural holes will potentially experience less negative effects from coopetition.

Hypothesis 4. Knowledge network structural hole spanning positively moderates the baseline effect of firm coopetition pursuit on innovation performance, such that

a focal firm that spans more knowledge network structural holes is more likely to benefit from coopetition and less likely to be harmed.

In the following section, I test the moderation effect hypotheses in several technology-driven industries in the US. My dataset encompasses six industries with high technological intensities, as identified by the National Science Foundation. Taken together, the moderation effects constitute a contingency model of coopetition, collaboration network, knowledge network, and firm innovation. Figure 4.2 provides an illustration for the contingency model developed thus far.

Figure 4.2 Contingency Model of Collaboration and Knowledge Network Embeddedness, Coopetition Pursuit, and Firm Innovation



4.4 METHODOLOGY

4.4.1 Empirical Setting

I test my hypotheses in a panel data set constructed from the longitudinal records of public firms in six technology-driven industrial sectors in the US that are identified by the National Science Foundation as featuring high technological intensities, namely, pharmaceuticals (SIC 2833-2836), computers and peripheral equipment (SIC 3571-3579), electronics and electronic components (SIC 3671-3679), aerospace and aircraft (SIC 3721-3769), telecommunications (SIC 4812-4813, 4822, 4899), and medical devices (SIC 3841-3845). Industries with high technological intensities demonstrate a fast pace of innovation progress and steep learning curves (Jain, 2013), therefore, firms will likely rely on inter-firm relations with competitors for innovation.

In addition, prior studies report that firm structural attributes in a collaboration network and a knowledge network significantly impact technology-driven firms (Wang et al., 2014). Thus, industries with high technological intensities constitute a fitting empirical setting to unpack the interactions between coopetition and the structural attributes of collaboration and knowledge network on firm innovation. The quantitative analysis encompasses multiple technology-driven industrial sectors to increase the generalizability of my findings. I choose an observation period of 1990 - 2008 to ensure reliable longitudinal data from 1990, and to avoid the confounding effects from a major exogenous shock in 2008 (i.e. subprime mortgage financial crisis), so that the validity of the empirical analysis is reinforced.

4.4.2 Data and Sample

I combine several data sources to construct the panel data set in this study. First, I collect merger and acquisition (M&A) records, strategic alliances, and joint ventures from Thomson Reuter's SDC Platinum database, which represents the industry standard for corporate relation records (Schilling, 2009). Second, I combine, compare, and corroborate the NBER patent data (Bessen, 2009; Hall, Jaffe, & Trajtenberg, 2001) and firm-level patent records of public US firms created and published by Kogan et al. (2015). Third, I extract firm annual financial records of the focal firms in my sample (i.e. US public firms) from Standard & Poor's COMPUSTAT database.

I merge and pool the records to the firm-year level. The final panel data set includes 362 unique firms, after list-wise deletion of entries with incomplete records spanning an observation period of at least two years (i.e. complete records for at least two years are required to implement the lagged data structure), and 1217 firm-year observations (i.e. an unbalanced panel since certain firms entered and exited the industries over the overall observational period 1990 – 2008).

4.4.3 Variable Description

Firm innovation economic value. My theoretical development elucidates the economic value of firm technological inventions as the metric for innovation performance. Specifically, the dependent variable captures the economic impacts of patent issues that are private to the innovating firms in subsequent econometrics analysis. I operationalize *firm*

innovation economic value using the aggregated economic values of the patents invented by a focal firm in a given patent application year (Kogan, Papanikolaou, Seru, & Stoffman, 2015). Specifically, Kogan et al. (2015) construct a patent-level measure for the economic values of innovation using firm stock price disturbances manifested uniquely as the result patent issuance:

$$\xi_j = (1 - \bar{\pi})^{-1} \frac{1}{N_j} E[v_j | r_j] \; M_j.$$

Equation 4.1

ξ is the economic value of patent j, constructed from multiplying firm stock return after patent issuance and the market capitalization M of the patent assignee on the day before patent issuance is announced; the patent-level metric is then aggregated to the firm-year level, and adjusted to by firm sizes, where B_{ft} denotes book assets of firm f in year t, and θ_{ft} denotes the aggregated and size-adjusted *firm innovation economic value* (i.e. the dependent variable used in the econometrics analysis here):

$$\Theta_{f,t}^{sm} = \sum_{j \in P_{f,t}} \xi_j,$$

Equation 4.2

$$\theta_{f,t}^{m} = \frac{\Theta_{f,t}^{m}}{B_{ft}},$$

Equation 4.3

Coopetition pursuit. The independent variable *coopetition pursuit* is operationalized by the annual count of merger & acquisition (M&A), in which the acquirers and the targets operate in the same industry, defined by their primary 4-digit Standard Industry Codes (i.e. SIC). The 4-digit SIC represents the most granular level of the industrial classification scheme. The SIC classification reflects the product and service characteristics, and it has been found to be highly relevant for technology-driven sectors (Katila, Rosenberger, & Eisenhardt, 2008; Lavie, 2007). Since my empirical context encompasses industries with high technological intensities, SIC classification at the 4-digit level provides an accurate, longitudinal proxy for product-based competition between firms.

In technology-driven industries, horizontal cooperation between firms in the same industry often lead to full integration (e.g. M&A) (Makri et al., 2010; Sears & Hoetker, 2014). Therefore, M&A within the same industry constitutes a conservative proxy for coopetition (i.e. cooperation between competitors that result in full integration). One may consider an alternative proxy for *coopetition pursuit*, which is strategic alliances between competitors. Since the collaboration network in my analysis is constructed from strategic

alliance records, I use M&A records as the proxy for coopetition pursuit to reduce endogeneity and common method bias issues in the analysis.

Collaboration network construction and variables. The collaboration network of firms is constructed from the alliance records in the SDC Platinum database. Extant studies suggest the average longevity of inter-firm alliances and joint ventures in the US technology-driven industries to be 5 years (Dovev Lavie & Drori, 2011; Schilling, 2015; Schilling & Phelps, 2007), therefore, I pool all alliances and joint ventures recorded annually in SDC Platinum in the observation period using a 5-year moving window to construct the collaboration network. Specifically, I follow the common operationalization of network construction: if two firms have at least 1 alliance or joint venture record(s) from years t-4 to t, then these firms have a collaboration network tie in year t, and the tie strength is reflected in the number of records within the time window.

I use the construct *collaboration network betweenness* to describe how well a firm can connect other partners, such that it can receive and control the network flows (e.g. information, knowledge, and resources) between multiple, distal collaboration network actors. I use Freeman's betweenness centrality score to operationalize *collaboration network betweenness* to capture network hub occupancy of the firms (Freeman, 1977; Gilsing et al., 2008). Freeman betweenness measures the probability of a given node occurring on a geodesic (i.e. the shortest path between two other network nodes) in the whole network (Freeman, 1977, 1978):

$$g(v) = \sum_{s \neq v \neq t} \frac{\sigma_{st}(v)}{\sigma_{st}}$$

Equation 4.4

where σ_{st} is the total number of geodesics connecting nodes s and t, and $\sigma_{st}(v)$ is the number of those geodesics that intersect with node v.

In my conceptual development, *collaboration structural hole spanning* reflects a firm's role in spanning the gaps between multiple collaboration partners that are otherwise disconnected. Burt's constraint measure is essentially a metric that captures how much social capital a given firm invests in the other network entities who are invested in the partners of the focal firm (Burt, 1992). Burt's constraint is commonly used as the proxy for structural holes in organizational network studies that investigate the impact of boundary-spanning network positions (Ahuja, 2000a; Burt, 1992; Wal et al., 2016). Therefore, I operationalize *collaboration structural hole spanning* by subtracting Burt's constraint measure from a constant,1, congruent with the common practice in the organizational network literature (Burt, 2004):

$$c_{ij} = (p_{ij} + \sum_{q} p_{iq} p_{qj})^2, \quad i \neq q \neq j$$

Equation 4.5

where c_{ij} denotes the dyadic constraint between node i and node j. The dyadic constraints of i are summed to give the following:

$$C_i = \sum_j c_{ij}$$

Equation 4.6

and the structural hole spanning of firm i, S_i, is given in:

$$\mathbf{S_i = 1 - C_i}$$

Equation 4.7

Knowledge network construction and variables. The knowledge network is constructed from firm patent stock records from the USPTO. Specifically, I invest the overlaps in firm knowledge bases, therefore, I operationalize knowledge network ties as co-classification between patents from two firms in the same technological classes within the same patent application year (Guan & Liu, 2016; Wang et al., 2014). Since the knowledge bases of technology-driven firms are dynamic with a high pace of changes in the technological trajectories (Dovev Lavie, 2006), I analyze knowledge network embeddedness in a yearly basis. Specifically, I operationalize inter-firm knowledge network following the convention in the existing literature by counting the numbers of patent co-classifications in the same USPTO technological classes in a given patent

application year (Guan & Liu, 2016). Due to varied time lags between patent filing and issue, I chose patent application years to closely approximate the time at which knowledge elements are generated to account for the potential noise caused by expedited or delayed patenting processes (Henderson et al., 2005).

I use eigenvector centrality to reflect the *knowledge network centrality* of firms to capture knowledge influences. Eigenvector centrality accounts for the number of ties in a network and the influences of the connected actors (Bonacich, 1987, 2007). Thus, eigenvector centrality provides a more accurate measure of the influences of a network node than alternative measures, such as degree centrality (Bonacich, 2007). In a given network graph G := (V, E) with a number of nodes |V|, define the adjacency matrix of network nodes as A = ($a_{v,t}$); then the eigenvector centrality score of node v is defined as:

$$x_v = \frac{1}{\lambda} \sum_{t \in M(v)} x_t = \frac{1}{\lambda} \sum_{t \in G} a_{v,t} x_t$$

Equation 4.8

where M(v) is the set of neighbors of node v, and λ is a constant. Eigenvector is given in the following equation:

$$\lambda x_i = \sum_{j=1}^{n} a_{ij} x_j, \quad i = 1, \ldots, n$$

Equation 4.9

Technological overlaps are reflected in the *knowledge structural hole spanning*. Similar to the operationalization of collaboration structural hole spanning, I calculate Burt's constraint measures of firm knowledge bases in the knowledge network and subtract the scores from a constant 1 to construct the independent variable *knowledge structural hole spanning*. This operationalization is congruent with existing practice in the knowledge network literature (C. Wang et al., 2014). This measure captures the extent to which a knowledge network position spans across disconnected technological competence bases of different innovating firms (i.e. technological overlaps between the focal firm and other innovation firms), which reflect the focal firm's cross-boundary knowledge recombination potential.

4.4.4 Econometric Model Specification

I fit my data to a linear ordinary least square (OLS) model to test the hypotheses. The model is specified as a panel data model on the firm-year level with firm- and time-variant errors. To reduce simultaneity issues, a 1-year time lag is implemented in the independent variables. Specifically, the observations of firm predictors in year t-1 are correlated with those of firm outcomes in year t. Year fixed effects are included to reduce time-specific endogeneity issues. The econometrics model is specified in the equation below.

$$INNOVATION\_PERFORMANCE_{ijt} = \beta_0 + \beta_1 X_{ijt-1} + \beta_2 C_{ijt-1} + \alpha_j + v_t + \mu_{ijt-1}$$

Equation 4.10

A vector C_{ijt-1} of control variables is included in the regression model, namely, firm size (i.e. employee number, total asset), resource thickness (i.e. cash, intangible asset), and financial health (i.e. capital expenditure, R&D expense, operation expense, advertising expense) to reduce firm-specific endogeneity issues. These variables may cause potential confounding effects on firm innovation performance, as elucidated by studies in the existing literature (Bhaskarabhatla & Hegde, 2014). The vector X_{ijt-1} represents the key independent variables and the interaction terms. β_0 is a constant that represents the intercept of the regression model. β_1 is a vector of coefficients that reflect the correlations between predictors, interaction terms and the outcomes. β_2 is a vector of coefficients that reflect the correlations between the control variables and the outcomes. α_j represents the industry fixed effects, v_t represents the year-fixed effects, and μ_{ijt-1} represents the firm- and time-variant errors. All coefficient parameters are estimated with robust standard errors that are clustered at the firm level to account for heteroscedasticity and correlated disturbance terms at the firm level (Greene, 2003; White, 1980).

4.5 RESULTS

Table 4.1 and Table 4.2 below show the summary statistics and Pearson correlation coefficients. With the exclusion of the control variables, no independent variable demonstrates a variance inflation factor (VIF) greater than 2 (i.e. ranging from 1.06 to 1.83, and the full model shows a mean VIF of 6.42. The VIFs of the key independent variables and the mean VIF of the full model are well below the recommended threshold VIF (i.e.

10), multicollinearity in the data set is unlikely a concern in my analysis (Greene, 2003). The pairwise correlation coefficients of the independent variables are well below 0.5, which further show that analysis of the data set is unlikely to be plagued by multicollinearity.

Table 4.1 Summary Statistics of Controls, Independent, and Dependent Variables

Variable	Obs	Mean	Std. Dev.	Min	Max
1. Innovation performance	1217	6.570E-10	1.00	-0.31	18.28
2. Total asset	1217	7.283	2.21	1.89	12.53
3. Capital expenditure	1217	4.303	2.29	0.00	9.92
4. Cash	1217	5.005	2.05	0.00	9.68
5. Firm size	1217	1.913	1.52	0.01	5.74
6. Intangible asset	1217	4.352	2.93	0.00	11.82
7. Advertisement expense	1217	2.442	2.09	0.00	8.16
8. Operation expense	1217	6.686	2.15	0.99	11.30
9. R&D expense	1217	4.722	1.91	0.22	9.41
10. Coopetition pursuit	1217	1.430E-08	1.00	-0.92	7.04
11. Collaboration network betweenness centrality	1217	1.820E-09	1.00	-0.45	6.40
12. Collaboration network structural hole	1217	1.200E-08	1.00	-2.04	1.11
13. Knowledge network eigenvector centrality	1217	1.520E-10	1.00	-0.34	8.46
14. Knowledge network structural hole	1217	1.060E-09	1.00	-7.99	1.85

Table 4.2 Pearson Correlation Coefficients

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1. Innovation performance	1.000													
2. Total asset	0.361	1.000												
3. Capital expenditure	0.370	0.947	1.000											
4. Cash	0.360	0.886	0.818	1.000										
5. Firm size	0.376	0.909	0.896	0.780	1.000									
6. Intangible asset	0.213	0.756	0.658	0.620	0.675	1.000								
7. Advertisement expense	0.437	0.595	0.599	0.584	0.541	0.418	1.000							
8. Operation expense	0.362	0.964	0.921	0.857	0.935	0.710	0.575	1.000						
9. R&D expense	0.430	0.833	0.762	0.819	0.753	0.616	0.551	0.822	1.000					
10. Coopetition pursuit	0.190	0.249	0.249	0.221	0.211	0.194	0.205	0.219	0.207	1.000				
11. Collaboration network betweenness centrality	0.511	0.399	0.399	0.384	0.423	0.225	0.464	0.399	0.480	0.167	1.000			
12. Collaboration network structural hole	0.239	0.414	0.410	0.373	0.385	0.203	0.307	0.407	0.435	0.102	0.433	1.000		
13. Knowledge network eigenvector centrality	0.347	0.285	0.355	0.330	0.270	0.031	0.251	0.271	0.330	0.124	0.249	0.212	1.000	
14. Knowledge network structural hole	0.066	0.052	0.021	0.006	0.042	0.099	-0.003	0.008	0.080	-0.019	0.100	0.087	-0.088	1.000

Note: Correlations larger than |.066| are significant at $p < .05$, and those larger than |.088| are significant at $p < .01$.

The results of the panel regression models are reported in Table 4.3. In Model 1, only the control variables are included in the regression to establish the starting model. In Model 2 through Model 5, coopetition pursuit is added to demonstrate the baseline effect, and each of the collaboration network and knowledge network variables and the interaction terms are added stepwise to test Hypotheses 1 – 4. In Models 2 – 5, the coefficient estimates of coopetition pursuit are statistically insignificant ($p > 0.1$). The null result for the baseline effect is as expected in my conceptual model, based on the theoretical and empirical insights from the existing literature, namely, coopetition pursuits may yield positive or negative effects on firm innovation. My analytical goal is to tease out the contingency effects of collaboration and knowledge network embeddedness in Models 2 – 5.

Table 4.3 Panel OLS Regression with Lagged IV, Industry- and Year-Fixed Effects, Firm-Level Clustered Robust SE

	Model 1	**Model 2**	**Model 3**	**Model 4**	**Model 5**
Dependent variable	Firm Innovation Economic Value				
Independent variables					
Coopetition pursuit		-0.0128	-0.00686	-0.0118	-0.0153
		(0.0337)	(0.0313)	(0.0249)	(0.0253)
Collaboration network betweenness		0.183**	0.179**	0.190***	0.189***
		(0.0712)	(0.0729)	(0.0697)	(0.0697)
Coopetition X collaboration network betweenness		0.233**	0.260**	0.178***	0.176***
		(0.109)	(0.115)	(0.0652)	(0.0639)
Collaboration structural holes			-0.00882	-0.0216	-0.0205
			(0.0225)	(0.0214)	(0.0209)
Coopetition X collaboration structural holes			-0.0803**	-0.0848***	-0.0839***
			(0.0345)	(0.0285)	(0.0288)
Knowledge network eigenvector centrality				0.0395	0.0385
				(0.0528)	(0.0520)
Coopetition X knowledge network eigenvector centrality				0.198***	0.201***
				(0.0631)	(0.0628)
Knowledge network structural holes					0.0254
					(0.0193)
Coopetition X knowledge network structural holes					0.0397
					(0.0439)

Control variables					
Total asset	-0.0687	-0.117*	-0.118*	-0.0720	-0.0768
	(0.0599)	(0.0641)	(0.0622)	(0.0540)	(0.0541)
Capital expenditure	0.0759*	0.0999**	0.0973**	0.0367	0.0408
	(0.0456)	(0.0441)	(0.0430)	(0.0321)	(0.0318)
Cash	0.00434	0.0120	0.0149	0.00335	0.00539
	(0.0419)	(0.0312)	(0.0316)	(0.0330)	(0.0341)
Firm size	0.183**	0.0771	0.0882*	0.0848	0.0854
	(0.0726)	(0.0552)	(0.0530)	(0.0534)	(0.0536)
Intangible asset	-0.0189	-0.0144	-0.0138	-0.0146	-0.0160
	(0.0146)	(0.0148)	(0.0149)	(0.0158)	(0.0154)
Advertisement expense	0.177***	0.120***	0.118***	0.117***	0.117***
	(0.0622)	(0.0386)	(0.0387)	(0.0380)	(0.0379)
Operation expense	-0.134	-0.0583	-0.0619	-0.0187	-0.0204
	(0.108)	(0.0530)	(0.0527)	(0.0423)	(0.0419)
R&D expense	0.169***	0.130***	0.130***	0.106***	0.106***
	(0.0504)	(0.0338)	(0.0326)	(0.0298)	(0.0299)

Clustered robust standard errors in parentheses;

* p<0.1; ** p<0.05; *** p<0.01

In Model 2, the interaction term of coopetition pursuit and collaboration network betweenness shows a significant, positive effect on firm innovation economic value ($\beta = 0.233$, $p < 0.05$), providing supports for Hypothesis 1. In Model 3, the interaction term of coopetition pursuit and collaboration network structural hole measure shows a significant, negative effect on firm innovation economic value ($\beta = -0.0803$, $p < 0.05$), providing supports for Hypothesis 2. Also shown in Model 3, the interaction effect between collaboration network betweenness and coopetition pursuit ($\beta = 0.260$, $p < 0.05$) on firm innovation economic value remain stable, further supporting Hypothesis 1.

In Model 4, the interaction effect between knowledge network centrality and coopetition pursuit are added to test Hypothesis 3. The interaction term of coopetition pursuit and knowledge network centrality shows a significant, positive effect on firm innovation economic value ($\beta = 0.198$, $p < 0.001$), providing strong supports for Hypothesis 3. Also shown in Model 4, the interaction effect between collaboration network betweenness and coopetition pursuit ($\beta = 0.178$, $p < 0.001$), and the interaction effect between collaboration network structural hole spanning and coopetition pursuit ($\beta = -0.0848$, $p < 0.001$) remain stable in direction, magnitude, and statistical significance, which lend further supports for Hypotheses 1 and 2.

In Model 5, the interaction effect between knowledge network structural hole spanning and coopetition pursuit are added to test Hypothesis 4. No significant effect is demonstrated in the interaction term between knowledge network structural hole spanning and coopetition pursuit ($p \geq 0.1$). Hence, Hypothesis 4 is not supported in the empirical

analysis here. Model 5 represents the full model with all contingency effects hypothesized above. In the full model, the interaction effects of collaboration network betweenness ($\beta = 0.176$, $p < 0.01$), collaboration network structural hole spanning ($\beta = -0.0839$, $p < 0.01$), and knowledge network centrality ($\beta = 0.201$, $p < 0.01$) on the baseline correlation between coopetition pursuit and innovation performance remain stable in directions, magnitudes, and statistical significance. Therefore, Hypotheses 1 – 3 are supported by the full model.

4.6 DISCUSSION AND CONCLUDING REMARKS

4.6.1 Theoretical Contribution

In this study, I sought answers to the research question: How does collaboration network and knowledge network embeddedness influence firm coopetition and innovation? I zero in on the unresolved controversy over potential value creation and value destruction in firm technological innovation as a result of coopetition pursuit. Specifically, I construct a contingency model using seminal insights in multiple network embeddedness (i.e. network pluralism) to clarify the structural conditions that augment value creation and mitigate value destruction effects of coopetition pursuits on the economic value of firm innovation. The contingency model illustrates the moderation effects of firm network position attributes on innovation outcome, namely, collaboration network betweenness, collaboration structural hole spanning, knowledge network centrality, and knowledge structural hole spanning.

The analysis makes several contributions to the existing literature of coopetition and innovation, and network pluralism research. First, the study contributes to the coopetition and firm innovation literature. Prior research in firm coopetition and innovation seldom emphasizes network contextual factors, and in particular glosses over the impacts of firm network positions on the relationship between firm coopetition pursuit and the economic value of firm innovation. Exemplary studies establish the significance of firm network embeddedness on innovation strategies and performances (Ahuja, 2000a; Burt, 1987; Singh et al., 2015) which suggest the lack of conceptualization of network embeddedness as contextual conditions may have clouded existing knowledge on the influence of coopetition on innovation with a controversy over the direct impact of coopetition on firm innovation. The contingency model clarifies the network structural conditions that regulate value creation and value destruction effects of coopetition on innovation, hence providing insights into the controversy whether coopetition impacts firm innovation economic value positively or negatively (Gnyawali & Park, 2011; Park, Srivastava, & Gnyawali, 2014).

Second, I synthesize seminal insights from two parallel streams of research in the organizational network literature, namely, collaboration network and knowledge network, and contribute to the network pluralism literature by depicting the direct and moderation effects of network positions on coopetition and innovation in doubly embedded firms (Shipilov et al., 2014). I posit that collaboration network betweenness centrality augments the positive impact and mitigates the negative effect of coopetition pursuit on innovation (i.e. a positive moderation effect). The moderation effect of collaboration network

betweenness is supported empirically. On the other hand, collaboration structural hole spanning is expected to dampen the positive impact and exacerbate the negative impact of coopetition pursuit on innovation (i.e. a negative moderation effect). The moderation effect of collaboration structural hole spanning is supported empirically.

Furthermore, I hone in on the moderation effects caused by firm structural embeddedness in a firm-level knowledge network, which captures the interdependencies between firm knowledge bases (Phelps et al., 2012). I hypothesize that knowledge network centrality mitigates the negative impact and augments the positive impact of coopetition pursuit on innovation (i.e. a positive moderation effect). The moderation effect of knowledge network centrality is supported empirically. Finally, I argue that knowledge structural hole spanning enhances the positive impact and diminishes the negative impact of coopetition pursuit on innovation (i.e. a positive moderation effect). The moderation effect of knowledge structural hole spanning is not supported empirically.

My contingency model contributes to research in network pluralism (Shipilov et al., 2014) by integrating insights from organization network research and knowledge network research. I juxtapose, compare, and contrast two firm-level networks, namely, a collaboration network resulting from formal partnership (e.g. strategic alliances and joint ventures), and a knowledge network resulting from overlaps in codified knowledge bases of different firms (e.g. patent portfolio technological class co-assignments). In doing so, I demonstrate the conceptual distinctions between firm embeddedness in these two types of networks, and how different positions in the collaboration network and the knowledge

network may influence the relationship between firm strategies (e.g. coopetition pursuit) and firm performances (e.g. economic values of innovation) in distinguishable ways.

4.6.2 Limitation and Future Research

The analysis here is limited in a number of respects that can spur future research. First, I have just begun to explore the direct and indirect influences of inter-firm collaboration network and firm-level knowledge network in juxtaposition. Technology-driven firms are often embedded in both of these inter-organizational networks simultaneously, and their behaviors and performances are subject to inter-firm relational interdependence (i.e. reflected in inter-firm collaboration network embeddedness) and knowledge interdependence (i.e. reflected in inter-firm knowledge network embeddedness). In this study, I investigate how relational and knowledge interdependencies moderate the impacts of coopetition on innovation in parallel, and how these network-based factors directly contribute to innovation value. However, I have yet to examine how relational and knowledge interdependencies may interact concurrently in determining the effectiveness and efficiency in value creation. Future research may be conducted to explicate the interplay between collaboration network embeddedness and knowledge network embeddedness on the firm level.

Second, I use within-industry M&A pursuits as a proxy for coopetition. My operationalization approach is designed to reduce endogeneity issues since my collaboration network is constructed from strategic alliance and joint venture records. However, within-industry M&A pursuits is a highly conservative proxy for coopetition,

namely, an M&A tends to manifest after repeated interactions between the merger partners (e.g. acquirer and target), and it entails fully integration between two competitors' technological competencies (Makri et al., 2010). Technology-driven firms also pursue coopetition without full integration, which is excluded in my independent variable operationalization. Future research can distinguish coopetition pursuits that involves full and partial knowledge integration and expound any similar or different impact on firm innovation value creation.

Third, I use patent stock technological classes to construct firm-level knowledge network. While co-classification in patent stocks of the firms reflect technological overlaps accurately (Wang et al., 2014), this operationalization only approximates inter-firm knowledge influence. For example, patent citations may more closely reflect knowledge flows between the firms (Henderson et al., 2005; Sorenson et al., 2006). Future research can utilize citations on the firm patent stock level to construct firm knowledge network to investigate inter-firm knowledge influences. In addition, future research may leverage text mining techniques to investigate patent documents in full. For example, inter-firm knowledge ties can be operationalized as keyword co-occurrence (Tseng, Lin, & Lin, 2007), bibliometric coupling (Hummon & Dereian, 1989), or similar technological footprints (Aharonson & Schilling, 2016). Future research on firm learning, knowledge and innovation may leverage these newly developed techniques to operationalize inter-firm knowledge networks in more details and higher resolution.

4.6.3 Managerial Implications

This study contributes to managerial practice in technology-driven industries in several aspects. Firms in technology-driven industries are subject to high environmental turbulence and competitive threats, therefore, technology firms rely on innovation to gain and sustain competitive advantage (Levine & Prietula, 2012; Roberts & Eisenhardt, 2003; Thornhill, 2006). Coopetition is a key strategy for innovation-driven firms to create value and improve their innovation efficiency (Brandenburger & Nalebuff, 2011; Chen & Miller, 2015; Lado et al., 1997). However, partnering with competitors requires effective mechanisms to prevent value destruction from exacerbating competitive tension. The contingency model suggests collaboration network positions and knowledge network positions that can enhance the value creation effect of coopetition and mitigate its value destruction effect on firm innovation.

Corporate and business-level managers in technological firms may leverage the insights here when strategizing inter-firm relations. Firms that occupy a well-connected position that bridge other collaboration partners tend to achieve greater value creation both directly and indirectly through coopetition. On the other hand, firms that span across the boundaries of disconnected collaboration partners gain less profound value creation by pursuing coopetition, suggesting that firms in a close community network benefit more from coopetition than firms in an open network configuration. Corporate and business unit decision makers may strategically forge inter-firm partnerships to increase the firm's

network bridging ties and position the firm in a close-knit collaboration network, when seeking innovation efficiency enhancement and value creation through coopetition.

In addition, managers may consider the contingency effects attributed to the overlaps between firm knowledge bases when strategizing coopetition. I identify a significant, augmenting effect of knowledge network centrality on value creation via coopetition. Therefore, corporate and business unit decision makers may strategically pursue two modes of knowledge absorption in parallel, namely, independently absorbing codified knowledge from the technological leaders in the industry by patent-based searches and pursuing coopetition to access competitors' tacit knowledge. This approach can amplify the efficiency of competence development and further enhance the innovation value of the firm.

5 CONCLUSION

Coopetition is a crucial firm strategy to gain competitiveness by forging win-win relationships with competitors. A central theme in the coopetition strategy is to leverage complementarity between competing firms, which enhances organization learning efficiency and firm innovation effectiveness. In the modern knowledge economy, competitive advantage hinges on incessant growth and renewal of firm competencies through learning and innovation. Hence, coopetition continues to garner interests from strategic management scholars and practitioners.

However, coopetition is a double-edged sword that may either bring in benefits or inflict harms to the focal firm. For example, partnering with competitors can facilitate competency specialization and reduce cognitive burden on decision makers by providing a clear trajectory for firm capability development. On the other hand, coopetition may exacerbate the "Icarus paradox"[7]: prior success from coopetition augments managerial attention to partnership, limiting the scope of firm competency development and escalating firm commitment. When competitive conditions change, the focal firm may not be able to adapt.

Given the tension and tradeoff associated with coopetition, strategic formulation and ramification can be distinct. My dissertation research investigates the motivation and hindrance involved in the firm decision to balance competition and cooperation and to

[7] The Icarus paradox refers to the loss of competitiveness attributed to prior success, such as excessive commitment to specialization, routinization, relational shackles (see Miller, 1990 for a detailed account).

pursue coopetition, and the benefits and harms attributed to coopetition. To achieve this goal, I conceptualize how firms balance competition and cooperation from a socio-cognitive perspective; I then empirically study how firm learning influences coopetition, and how coopetition influences firm innovation. I select the empirical context of technologically intensive industries, where firms have high incentives to synergize with their competitors through cooperative innovation (Bouncken & Kraus, 2013; Teece, 1992).

In Chapter 2, theoretical development elucidates that a balance between competition and cooperation emerges from the interplay between emotionality and rationality on the firm level in the inter-firm interaction context. The causal connections between firm perceptions of the actions and motivations of their competitors, firm emotional responses, and firm action proclivities explain the shifts in inter-firm interaction modes in competitive dynamics hybridism with different degrees of competition and cooperation. These insights inform managers about the confounding effects of emotion-driven action proclivities. Inferring from the findings here, managers should acknowledge the impact of firm-level emotions elicited by competitive perception, and recalibrate their strategic focus on value-based interdependence with competitors when strategizing inter-firm relations.

In Chapter 3, I apply the theoretical lens of organization learning to explain the effects of firm learning experiences on their strategic decisions regarding coopetition. The results suggest a motivating effect of past strategic alliances and a hindering effect of firm patent searches on its coopetition pursuit, depicting path dependency in organization

learning and relationship building. These results inform strategic managers about the connection between learning experiences, firm capabilities, and the tradeoff in coopetition. The insights from this chapter provide guidance to strategize collaboration with competitors by evaluating the match between firm learning proficiency and the competency development opportunity through coopetition.

In Chapter 4, I apply the theoretical lens of network pluralism to tease out the contingency effects of alliance network and knowledge network embeddedness on the relation between coopetition and innovation. The results suggest augmenting effects of alliance and knowledge network centrality and a dampening effect of alliance network structural hole on the impact of horizontal integration on firm innovation performance. Focusing on the coopetition tensions and tradeoffs, I clarify logic behind these network-based contingency effects. This investigation demonstrates the differential impacts of firm positions in multiple networks to inform managerial decision regarding leveraging coopetition to improve innovation. Specifically, when strategizing coopetition, innovation-driven firm managers should consider not only the interfirm social power interdependence, but also the influence of the focal firm's knowledge base in the technological domain.

In combination, the investigation on the balancing, learning, and innovating aspects of coopetition leads to new insights on how firms can strategize coopetition to gain competitiveness, while avoiding the caveats associated with this approach. Although the empirical work in this dissertation is grounded in the technology-driven sectors, managerial guidance is applicable to a wide range of firms in the modern knowledge economy, in

which organization learning and innovation constitute the linchpin of firm competitive advantage.

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