BUSINESS VALUE OF INFORMATION TECHNOLOGY IN NETWORK ENVIRONMENTS

BY

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Abstract

Information Technology (IT) business value research is suggested as fundamental to the contribution of the IS discipline. The IS research community has accumulated a critical mass of IT business value studies, but only limited or mixed results have been found on the direct relationship between IT and firm performance. Extant studies mostly focus on whether IT creates business value and demonstrate indirect relationships between IT and *some* aspects of firm value; however, the question of why and how IT can do so remains understudied. These limitations lead to the challenge where existing IT business value studies have not done enough on providing feasible, practical guidance for IT practitioners and have had lacking relevance to the business world. In this study I propose the concept of dynamic IT capability (DIC), defined as the ability of a firm to build, integrate, and upgrade IT resources to improve, enhance, and reengineer business processes as responses to rapidly changing environments, and apply it in network environments. Using data of 26 companies over a span of 8 years from a number of secondary sources, I examined the direct link between DIC and firm performance and the indirect link through the mediation of firm innovation, both moderated by network structures. The results of data analysis indicate that DIC is an important indicator of IT business value in network environments. DIC contributes to firm performance directly or indirectly through firm innovation. Also, DIC complements network structures to positively influence firm performance. These findings have important implications for both researchers and practitioners.

Keywords*: IT business value, dynamic IT capability, network structure, firm innovation, firm performance*

To My Parents

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CHAPTER 1

INTRODUCTION

Information Technology (IT) business value research is suggested as fundamental to the contribution of the IS discipline (Agarwal & Lucas, 2005), based on the logic that: "if IT is not valuable, then we (the IS research community) are engaging in research on something that is not valuable, and hence we are not valuable !" (Kohli & Grover, 2008, p24). The IS research community has accumulated a critical mass of IT business value studies (e.g., Devaraj & Kohli, 2000; Santhanam & Hartono, 2003; Shaft, Zmud, & Dao, 2007; Stoel & Muhanna, 2009), but only limited or mixed results have been found on the direct relationship between IT and firm performance (Joshi, Chi, Datta, & Han, 2010). To some extent, the lack of evidence on the direct link between IT and firm performance is against intuition, as it is implied in the term "productivity paradox"(Kraemer & Dedrick, 2001b). As a result, these inconsistent and incomplete findings instigate dissenting voices on IT business value, such as "IT doesn't matter" (Carr, 2003) and the blames on the IT failure to deliver innovation (Martin, 2007). Thus, the weak or missing link between IT and firm performance has still been an important issue and concern for IS researchers.

While past studies provide valuable insights on different aspects of IT business value, this stream of research still suffers from considerable limitations. First, existing IT business studies have not demonstrated a clear, strong direct link between IT and firm performance and the lack of such empirical evidence has made some researchers believe that there is no significantly direct link existing (Joshi et al., 2010). Second, extant studies mostly focus on whether IT creates business value and demonstrate indirect relationships between IT and *some* aspects of firm value;

however, the question of why and how IT can do so remains understudied (Kohli & Grover, 2008). These two aforementioned limitations lead to the challenge where existing IT business studies have not done enough on providing feasible, practicable guide for IT practitioners and lack relevance to the business world. Third, organizations in today's networked economy rely on not only themselves but also other connected entities to operate and be successful. Therefore, IT business value research needs to be further investigated in the network environment to provide a complete and realistic understanding.

One of the obvious problems for IT business value research is what "IT" should be defined and used for contributing to firm performance. For example, two pioneering IT business studies (i.e., Bharadwaj 2000 and Santhanam & Hartono 2003) have clearly demonstrated the differences between IT-leaders[1] and non IT-leaders on firm performance. Despite the significance of their findings, there are still two important questions left for practitioners. First, how can firms become IT leaders? Second, as implied by the term of "leaders", only a handful of firms can become IT leaders. Does this fact imply that IT business value is achievable only for a set of firms? These questions can significantly hurt the contribution of existing IT business value studies.

Past studies have defined IT from different perspectives (e.g., complementary perspective, alignment perspective, process-oriented perspective, and capability perspective). Most popularly, IT resources are used for this stream of research. For example, Shaft and her colleagues (2007) divided IT resources into three categories (i.e., automate, informate, and transform) and argue that different categories induce distinct performance effects through their differential impacts on

[1] IT leaders are defined as the "leaders" of technology and are determined by a select group of industry analysis, IT executive, IS researchers, and other practitioners (Bharadwaj, 2000).

organizational process, product-markets and capabilities. Stoel and Muhanna (2009) divided IT resources as internal and external and proposed that IT resources' impact was contingent on the "fit" between the type of IT resources a firm possesses and the demands of the industry in which it competes. Bhatt and Grover (2005) distinguished IT infrastructure, IT business experience, and relationship infrastructure and argued that by demarcating specific types of IT resources, we can better understand the sources of IT-based competitive advantages. However, these studies not only struggle to discover consistently and directly whether IT resources create business value but also fail to answer the question of why and how IT resources create business value. Without knowing how, IT practitioners cannot use the results of research to gain benefits of IT. One plausible reason for this problem is that existing IT business value studies heavily rely on resource-based view (RBV) (e.g., Bharadwaj, 2000; Santhanam & Hartono, 2003). Despite its significance, RBV has been realized as conceptually vague and tautological and not adequately explained how and why certain firms have competitive advantage. It also pays no attention to mechanisms by which resources (e.g., IT resources) actually contribute to competitive advantage and firm performance (Eisenhardt & Martin, 2000).

I believe that a theoretically based and comprehensive representation of IT for studying IT business value can be a key solution for the first two aforementioned limitations. From a perspective of organizational literature, cost and differentiation are two basic factors directly related to company competitive advantage[2] and then firm performance (Porter, 1985). IT emerges as a strategic differentiator (Sambamurthy, Bharadwaj, & Grover, 2003) and its impact on cost reduction has long been argued and examined in IS literature (Mitra & Chaya, 1996).

[2] Competitive advantage and firm performance are two different but closely connected concepts. The former is frequently used in organizational literature and the later is usually the focus of IS studies. Following existing studies (e.g., Bhatt & Grover 2005), this study treats firm performance as an indicator of competitive advantage.

One of the promising hints is illustrated in the value chain literature where the role of IT on cost reduction and differentiation is that IT can be embodied in every primary and support business activities and dramatically shape and reengineer business processes (Porter & Milar, 1985). This is in line with the dynamic capabilities (DC) perspective, which is defined as the ability of a firm to "integrate, build, and reconfigure internal and external competencies to address rapidly changing environments (Teece, Pisano, & Shuen, 1997, p516)." Therefore, this study assumes the organizational and empirical lens to study how IT resources are used to create competitive advantages rather than merely looking at whether IT resources create competitive advantages directly (Eisenhardt & Martin, 2000). By doing so, I first strive to provide empirical evidences for the direct link between dynamic IT capability and firm performance. As DC consists of specific strategic and organizational processes, it not only can be used to demonstrate whether DC directly creates business value, but also provides opportunities to observe how IT resources create business value through integrated business processes. By demonstrating how firms actively use IT resources to shape and improve business processes and eventually contribute to firm performance, this study help practitioners gain useful insights on the relationship between IT and firm performance and follow what is called 'best practice' to build and use IT resources effectively and boost firm performance.

Specifically, I define the concept, *dynamic IT capability*[3] (DIC), as the ability of a firm to build, integrate, and upgrade IT resources to improve, enhance, and reengineer business processes as responses to rapidly changing environments. That is, DIC is the combination and integration of IT resources and business process. First, DIC focuses on IT resources rather than

[3] Organizational literature tends to distinguish between resources and capabilities, and refer capabilities to the ability to assemble, integrate, and deploy valued resources (Bharadwaj, 2000). Even though in IS literature resources are understood broadly and include capabilities, in this study I distinguish DIC from IT resources.

the whole resources or so-called IT-enabled resources[4] owned by a firm since that IT resources are also in a dynamic process of building, integrating, and upgrading continuously. Second, DIC focuses on business processes and explains the impact of IT resources as demonstrated in improved or enhanced business processes, rather than treat IT resources as rare, inimitable, and non-substitutable (from the RBV perspective suggesting that IT resources can create business value alone, without concerning how and where to use them).

The concept of DIC can be clearly demonstrated in the examples of IT practice. First, in October 2006, Yahoo! Inc (NASDAQ: YHOO) built an IT application to support a service that includes sponsored text links from a select group of advertisers on the Yahoo Mobile Web in the United States and the United Kingdom (Malykhina, 2007). In this example, DIC is demonstrated as the firm *built* new IT resources (the new IT application) to support business processes (operation process[5]). Second, in 2001, Qualcomm (NASDAQ: QCM) used TIBCO Software Inc.'s Business Works stack to integrate several internal customer relationship management (CRM) to provide better supports to mobile sales force (Petersen, 2004). In this example, DIC is demonstrated as the firm *integrates* existing IT resources to improve business process (marketing/sales process). Third, in 2000, Bristol-Myers Squibb Co. (NYSE: BMY) re-engineered their enterprise resource planning network and provide general supports for business activities, such as order entry and production sourcing (Ferrarini, 2000). In this example, DIC is demonstrated as the firm *upgraded* their existing IT resources to support business process (firm infrastructure process).

[4] IT-enabled resources refer to systems that are formed through relationships between IT assets and organizational resources (Nevo & Wade, 2010).
[5] The categories of business process come from Porter (1980) and will be described more clearly in Chapter 2.

The benefits of employing DIC for studying IT business value are manifest. First, DIC is theoretically based on DC which has been intensively referred to and tested. Second, from past studies and as discussed above, IT can be used to support any business processes. The term IT-enabled resources as used in many IT business value research deems to be too broad and abstract because it may include every resource a firm owns. Even if we find significant relationship between IT-enabled resources (e.g., customer orientation, knowledge assets, and synergy) and firm performance, there still are important questions left to practitioners (e.g., how can we use IT to obtain these IT-enabled resources). By focusing on IT resources themselves, DIC demonstrates clearly how companies dynamically organize IT resources and gain benefits and provides operable guides for practitioners. Third, the process to build DIC is easily understandable. As demonstrated in the three examples above, DIC is embedded in normal IT practice, such as building new IT resources or integrating and upgrading existing IT resources to improve business processes. Thus, firms can follow 'best practice' in the industry they reside by benchmarking or other techniques to explore new opportunities for dynamically using IT resources (either by building, integrating, or upgrading) to improve, enhance, and reengineer business processes. Finally, DC perspective has been used as the core concept of studies for net-enabled organizations in a network environment (Barua, Konana, Whinston, & Yin, 2004; Straub & Klein, 2001; Wheeler, 2002). Therefore, DIC deems to be a more appropriate construct to study IT business value in a network environment.

The second focus of this study is the interaction between DIC and network structures (e.g., centrality, structure hole, and Simmelian tie). Even though the two concepts of IT and network could be totally independent, as indicated that we can have network without IT and we

can use IT in areas far beyond network, they are related almost intuitively as demonstrated in company networks (Piore, 1992) and personal networks (e.g., Facebook and LinkedIn). But studies on the impact of interaction between IT and network on IT implementation, competitive action, and firm innovation found negative or mixed results. An early study described the failure of an interorganizational information system (IOS) in a network environment and argued that relationship among companies is an important concern for implementation of IOS (Kumar, Dissel, & Bielli, 1998). Recent studies examined the effects of interaction between IT and network structures (structure hole and network density) on competitive action and firm innovation from a perspective of IT-enabled capabilities and found mixed results. They argued that different type of IT-enabled capabilities may interact with different network structures in different ways (Chi, Liao, Han, & Joshi, 2010; Chi, Ravichandran, & Andrevski, 2010).

This study approaches the IT-network interaction issue from the perspective of flexible specialization. The term flexible specialization describes a network phenomenon in which companies develop highly interdependence with their business partners in networks and flexibly organize internal and external resources to respond to rapidly changing markets (Piore, 1992). It provides explanations as to why companies choose to enter into networks and the expectations of their network activities. Both flexible specialization and DC are proposed as solutions for firms to effectively compete in dynamic environments. Flexible specialization focuses on the external environments and argues that there exists a performance network consisting of stakeholders' capabilities that influences individual firm performance (Buytendijk, 2009). DC focuses on the internal capabilities that a firm integrates, builds and reconfigures internal and external resources to address rapidly changing environments (Teece et al., 1997) and claims itself as a necessary

condition of competition in dynamic environments. Thus, flexible specialization and DC can be used as complementary theoretical bases to address the issue of firm performance in network environments and provide theoretical guidelines for the effects of the interaction between DIC and network structures on firm performance.

Therefore, the research questions of this study are:

(1) *Can dynamic IT capability of a firm contribute directly and indirectly to firm performance? What is the mediating factor for which dynamic IT capability contributes to performance?*

(2) *What are the effects of network structures of a firm on the direct and indirect link between dynamic IT capability and firm performance?*

This study has several major contributions. First, it addresses the direct relationship between IT and firm performance from a perspective of DIC. Unlike exiting studies, this study explicitly points out that to obtain expected business value of IT, firms should rely on DIC by continuously exploring how to build new IT resource and integrate and upgrade existing IT resources to improve business processes. This emphasis is important because it explicitly considers the combination and integration of IT resources and business processes of a firm as the dynamic IT capability. It also challenges an implied perspective of existing studies where the effects of IT resources are simply cumulative (e.g., the effects of an IT application launched in 10 years ago are equal to those of a new one launched this year; the effects of two separate IT applications are equal to those of two connected IT applications). By proposing a new definition of DIC, this study demonstrates that IT capabilities are not static, but in a dynamically, continuously building, integrating, and upgrading process.

Second, this study provides empirical evidences to support the direct and indirect links between DIC and firm performance. Although the idea of DIC sounds rather straightforward, scientific studies with empirical evidences are absolutely needed to provide guidelines for organizations to follow. In practice, firms seem to still hesitate to invest in IT and doubt IT business values. There are several possible reasons. First, the advance of information technology is kind of vender-push, other than customer-pull. For example, most software venders, such as Microsoft, Oracle, and Adobe, continue to release new versions of products. From the side of customers, however, they may think what they already have are good enough and try to avoid new spending on seemingly-unnecessary new versions. Second, firms may lack competence in exploring opportunities to build new IT resources and integrate and upgrade existing IT resources. Third, tight budget may significantly hurt the enthusiasm of a firm to build new IT resources and integrate and upgrade existing IT resources. Thus, the findings of empirical evidences in this study on the direct/indirect links between DIC and firm performance can significantly encourage firms to overcome the obstacles and actively pursue DIC.

Third, this study found significant, positive interaction between DIC and network structures. In existing studies, only a few of them focus on the effects of the relationships between IT and network on firm performance. Early studies approached this issue from a perspective of IOS (Bakos, 1991; Chi, Holsapple, & Srinivasan, 2007; Gallivan & Depledge, 2003). But as some researchers have pointed out, the benefits of IOS in network environments will be very limited if firms are only connected by IOS without integrating their IT resources (Iacovou, Benbasat, & Dexter, 1995). This study takes a DIC perspective and demonstrates that

the business value of IT will be more manifest in network environments and provides guidance such as where to use IT for practitioners.

The rest of this study is organized as follows:

· Chapter 2**.** Literature Review and Theoretical Bases: Relevant studies and theories related to IT business value and network structure are reviewed and summarized. Several important issues such as different perspectives on IT business value, debate upon network definition, and properties of network will be discussed.

· Chapter 3**.** Research Model and Hypotheses: Research model used in this study is introduced and hypotheses are developed for model testing.

· Chapter 4**.** Methodologies: Research method and data collection process are discussed. Measures of constructs are developed. Data analysis method is proposed and results of data analysis are presented.

· Chapter 5**.** Discussion, Implications, Limitations, and Conclusions: Results of data analysis are discussed. The implications of the findings are discussed and limitations of this study are stated. Conclusions of this study are provided.

CHAPTER 2

LITERATURE REVIEW AND THEORETICAL BASES

2.1. IT business value research

Traditionally, IT business value research focuses on the economic value such as reducing costs or differentiating products or services that are derived from IT (Mata, Fuerst, & Barney, 1995). Numerous case studies demonstrate the value of IT on reducing inventory costs – Wal-Mart (Stalk, Evans, & Shulman, 1992), differentiating service support - General Electric (Benjamin, Rockart, Scott Morton, & Wyman, 1984), improving customer service and increasing switching costs - McKesson (T. C. Powell & Dent-Micallef, 1997), and differentiating service operations - Otis Elevator (Balaguer, 1990). The general conclusion is that IT can add value to firms in a wide variety of circumstances (Mata et al., 1995).

Despite the general conclusion of IT value, it was challenged on a specific performance measure - productivity. During 1990s, Nobel Prize winning economist, Robert Solow observed that "you can see the computer age everywhere but in the productivity statistics" (so called "productivity paradox") (Kraemer & Dedrick, 2001b). This observation motivated a surge of IT value research on productivity. A lot of studies were conducted at firm level (Brynjolfsson & Hitt, 1996; Tallon, 2000), industry level (Melville, 2001), and country level (Dewan & Kraemer, 2000; Kraemer & Dedrick, 2001a). The reasons for the equivocal results of IT payoff had been attributed to inadequate measurement and analysis methodologies and time lags in measuring payoff (Kohli & Devaraj, 2003). Despite the existence of counterexamples, the results of these studies generally indicated that IT investment was correlated with better firm performance and

that IT value was significant in wealthier industrialized countries but not in developing countries (Kraemer & Dedrick, 2001b).

The debate on productivity paradox seemed to fade away when the U.S. economy experienced a surge of productivity growth in the late 1990s (Kraemer & Dedrick, 2001b). However, other issues still exist concerning the linkage between IT and firm performance. One important focus has been transferred to sustainable competitive advantage, a popular term widely used in strategy literature. IT researchers advocated tight IT-sustainable advantage linkages and examined conditions where IT produces sustainable advantages, such as obtaining first-mover advantages by binding customers with high switching cost (Porter, 1985) and relying on scale economies, managerial expertise and efficiencies (Clemons, 1986). Basically, IT literature reflected a general optimism that IT creates competitive advantages (T. C. Powell & Dent-Micallef, 1997).

However, counter empirical evidences, though scant, exist. Researchers found little or no significant connection between IT and firm performance in retail banking industry (Banker & Kauffman, 1988). During 1970s and 1980s, 21 of the 30 firms had experienced competitive declines within 5 years of IT implementation (Kettinger, Grover, Guha, & Segars, 1994). IT also was found to have no or even negative impact on entry barriers (Mahmood & Soon, 1991). Based on these evidences, researchers argued that IT-based advantages eventually vanish because of competitive imitation of competitors (Clemons & Row, 1991) and IT cannot produce sustainable advantages because most IT is readily available to all firms (T. C. Powell & Dent-Micallef, 1997). This view has been well reflected in the widely cited article of Nicholas G. Carr (2003), an editor of Harvard Business Review, “IT doesn’t Matter.” Carr argued that IT cannot

provide differential advantage to any firms because they are ubiquitous, increasingly inexpensive, and accessible to all firms. He noted that IT just likes other replicable, standardized infrastructural technologies, such as railroads and telegraphs, create benefits to all firms and cannot provide competitive advantages for just some of them.

IS researchers respond to this challenge by pointing out that Carr confused undifferentiated IT assets like infrastructure, and the ability to manage these assets (so called IT capabilities) (Bhatt & Grover, 2005). Based on a resource-based analysis, IS scholars argue that while proprietary technology and technical IT skills cannot create sustainable competitive advantages, IT managerial skills are likely to be a source of sustained competitive advantages because they need long time to develop through an accumulating process of trial and error learning (Mata et al., 1995). Recent research has identified a batch of IT capabilities that are related to competitive advantages, such as IT business experience ("extent to which IT group understand business"), relationship infrastructure ("extent to which there are positive relationships between IT and business managers"), intensity of organizational learning (Bhatt & Grover, 2005), IT-enabled business intelligence competence (L.-B. Oh, 2009), IS integration ("the extent to which the IS applications of a focal firm work as a functional whole in conjunction with the IS applications of its business partners") (Saraf, Langdon, & Gosain, 2007), and IT project barrier (technology characteristics, such as visibility, uniqueness, and complexity, and implementation process complexity and change) (Piccoli & Ives, 2005).

Certainly, other issues still exist, such as whether IT leverages competence directly or indirectly causing competitive advantage (Pavlou & Sawy, 2006), whether IT strategy is an independent source or it needs to align with business strategy to create competitive advantages

(W. Oh & Pinsonneault, 2007), and whether IT needs to be embedded in organizations to produce valuable, sustainable resource complementarity (T. C. Powell & Dent-Micallef, 1997). More of these issues will be discussed in Section 2.1.1. A review of recent IT business value research is provided in Table 1.

Table 1. IT business value literature review

Studies	Theoretical bases	Method	Key findings
Barua, Konana, Whinston, & Yin, 2004	Resource-based theory	The data collection involved traditional manufacturing firms, distributors, wholesalers, and retailers engaged in net-enabled transformation that had the ability to interact with customers over the web. Respondents included owners and principals of smaller organizations, and IT or business process specialists in larger companies. The response rate was about 25%.	1. While most firms are lagging in their supplier-side initiatives relative to the customer-side, supplier-side digitization has a strong positive impact on customer-side digitization, which, in turn, leads to better financial performance. 2. Both customer and supplier readiness to engage in digital interactions are shown to be as important as firm's internal digitization initiatives, implying that a firm's transformation-related decisions should include its customers' and suppliers' resources and incentives.
Bharadwaj, 2000	Resource-based view	Data were collected from secondary resources.	Firms with high IT capability tend to outperform a control sample of firms on a variety of profit and cost-based performance measures.
Bhatt & Grover, 2005	Resource-based view and dynamic capabilities	Data were collected from senior IT executives (CIO, vice president of IT, director of IT) randomly selected from a directory of 3000 manufacturing firms.	1. While IT infrastructure did not have any significant effects on competitive advantage, the quality of IT business expertise and the relationship infrastructure did. 2. The intensity of organizational learning was significantly related to IT infrastructure quality, IT business expertise, and relationship infrastructure
Chi et al., 2007	Theory of creative destruction	Data were collected from multiple secondary data sources.	There is a strong link between interorganizational system (IOS) and competitive actions.
Chi, Liao et al., 2010	Absorptive capacity theory	Secondary data for 20 pharmaceutical companies over the period of 2000-2006	Three types of IT enabled knowledge capabilities (IT-potential, IT-realized, and IT-socializing) differentially interact with structural

			holes to affect firms' patent innovations.
Chi, Ravichandran et al., 2010	Awareness-motivation-capability (AMC)	Secondary data for 12 automakers over 16 years from 1988 to 2003	Network structure rich in structural holes has a positive direct effect on firms' ability to introduce a great number and a wider range of competitive actions.
Dehning, Richardson, & Zmud, 2003	IT strategic role	Data of IT investment announcements and cumulative abnormal return were collected from secondary data resources.	The authors found positive, abnormal returns to announcements of IT investments by firms making transformative IT investments, and with membership in industries with transform IT strategic roles.
Joshi et al., 2010	Absorptive Capability	Secondary data resources	1. Knowledge capabilities that are enhanced through the use of IT contribute to firm innovation. 2. Different types of IT-enabled knowledge capabilities have differential effects on firm innovation.
Kohli & Devaraj, 2003	Not explicitly specified	Meta-analysis	1. The sample size, data source, and industry influence the likelihood of finding greater improvements on firm performance. 2. The choice of the dependent variables, the type of statistical analysis, and cross-sectional or longitudinal design also appears to influence the outcome.
D. H. Lee, 2006	Resource-based view and coalignment theory	Use a case study as preliminary investigation and collect data of IT announcement event , business environments , and firm performance from archival secondary resources	1. Environmental dynamism negatively moderates the linkage between IT capabilities and firm performance. 2. Competitive pressure and IT intensity positively moderate this linkage.
W. Oh & Pinsonneault, 2007	Resource-centered and contingency-based approach	Data were collected from CEOs and CIOs respectively from small- and medium-size enterprises in the manufacturing industry, with a response rate of 32%.	1. The contingency-based approach is better at explaining the impact of cost-related IT applications on firm performance; the resource-centered perspective has a stronger predictive ability of IT impact on firm revenue and profitability. 2. Investments in growth-oriented applications were directly and positively related to firm revenue. 3. The nonlinear approaches provide additional insights that help to better understand the relationship between alignment and performance.
Pavlou & Sawy, 2006	Dynamic capabilities and	Data were collected from new product development	1. IT leveraging competence (the ability to effectively use IT

	resource-based review	(NPD) managers at two conferences. 39% and 43% response rate for two samples, respectively.	functionalities) indirectly influence competitive advantage in NPD through functional competencies (the ability to effectively execute operational NPD processes) and dynamic capabilities. 2 The strategic effect of IT leveraging competence is more pronounced in higher levels of environmental turbulence.
T. C. Powell & Dent-Micallef, 1997	Resource-based review	Data were collected from CEOs or other senior executive in retail industries, with a response rate of 26%.	ITs alone have not produced sustainable performance advantages in the retail industry, but that some firms have gained advantages by using ITs to leverage intangible, complementary human and business resources such as flexible culture, strategic planning-IT integration, and supplier relationships.
Ravichandran & Lertwongsatien, 2005	Resource-based theory	Survey from Fortune 1000 firms (18.2% response rate)	1. Variation in firm performance is explained by the extent to which IT is used to support and enhance a firm's core competencies. 2. An organization's ability to use IT to support its core competencies is dependent on IS functional capabilities, which, in turn, are dependent on the nature of human, technology, and relationship resources of the IS department.
Santhanam & Hartono, 2003	Resource-based view	Data were collected from secondary resources.	Firms with superior IT capability indeed exhibit superior current and sustained firm performance when compared to average industry performance, even after adjusting for effects of prior firm performance
Saraf et al., 2007	Relationship network	Data were collected from business units of enterprises mainly in the high-tech (computing) and the financial services sector. Respondents include director of marketing, vice present of marketing, sales executives, sales managers, and new product development manager. The response rate was 27%, 18%, and 24% for three waves.	1. IS integration with channel partners and customers contributes to both knowledge sharing and process coupling with both types of enterprise partners. 2. IS flexibility indirectly contributes to value creation in interfirm relationships by enabling greater IS integration with partner firms. 3. Knowledge sharing with channel partners and process coupling with customers are significantly associated with business performance.
Shaft et al., 2007	Not explicitly specified	Data of IT investment initiatives were collected from these firms' annual reports from 1996 to 2000	1. Automate IT investments demonstrate the most evident impacts on firm performance. Transform IT investments

			performance impacts are most evident with profitability. 2. For accounting-based performance metrics, transform IT investments exhibit a longer time-lag than automate IT investments; for market-based performance metrics, the reverse was observed. 3. Informate IT investments may be the most challenging type of IT investment to link to firm performance.
Sircar, Turnbow, & Bordoloi, 2000	Not explicitly specified	Data were collected from secondary resources and consisted of over 2000 observations of 624 firms.	1. Both IT and corporate investments have a strong positive relationship with sales, assets, and equity, but not with net income. 2. Spending on IS staff and staff training is positively correlated with firm performance, even more so than computer capital.
Stoel & Muhanna, 2009	Contingency perspective	Secondary data resources	IT capabilities' impact on firm resources was continent on the "fit" between the type of IT capability/resource a firm possesses and the demands of the industry in which it competes.
Tafti, Mithas, & Krishnan, 2008	Dynamic capabilities and transaction cost theory	Data were collected from 375 firms that are publicly listed in the U.S. and that span multiple industries.	1. The contribution of joint ventures to firm value increases with investment in IT and in service-oriented architectures (SOA). 2. The impacts of IT and SOA are greater in the case of joint ventures than in non-equity alliances.
Xiao & Dasgupta, 2009	Resource-based view, dynamic capabilities, theory, complementarity theory, and organizational culture theories.	Population was firms in the IT related industries in the US. The surveys were addressed to senior IT executives, other senior executives, or IT managers identified through public databases.	1. Dynamic IT capability is a valid and reliable measure of IT that may explain firm performance within the selected samples. 2. Dynamic IT capability does interact with certain organizational culture values in influencing market firm performance.

2.1.1. Four major perspectives of IT business value

In most recent IT business value research, two basic concepts used frequently are IT resource and IT capability. There is some confusion about the meanings of the two concepts. Some authors include IT capability as a type of IT resource (e.g., Aral & Weill, 2007) but others

explicitly distinguish IT capability from IT resource (e.g., Bharadwaj, 2000; Eisenhardt & Martin, 2000). In this study, I adopt the second perspective and treat IT resource and IT capability as two distinct concepts according to the definitions from Helfat and Peteraf (2003):

> "A resource refers to an asset or input to production (tangible or intangible) that an organization owns, controls, or has access to on a semi-permanent basis. An organizational capability refers to the ability of an organization to perform a coordinated set of tasks, utilizing organizational resources, for the purpose of achieving a particular end result" (p. 999).

Indeed, for the concept of DIC, IT capability and IT resource are indivisible. A firm cannot possess DIC without owning IT resources. IT capability is not treated as a potential that can exist alone and will exhibit automatically in the future. I argue DIC as an ability to effectively use IT resources to support business processes. In other words, DIC will be found in enhanced business processes boosted by effective use of IT resources. I will discuss this concept further in detail below.

Based on the literature review provided earlier, I summarize perspectives on IT business value into four categories, namely complementary perspective, alignment perspective, process-oriented perspective, and capability perspective [6]. I further elaborate their arguments and limitations below.

Complementary perspective of IT business value

The complementary perspective argues that IT alone has not produced sustainable advantages, but firms can gain advantages by using IT to leverage intangible, complementary human and business resources such as flexible culture, strategic planning-IT integration, and supplier relationships (T. C. Powell & Dent-Micallef, 1997). Here the term "complementary"

[6] Some authors also propose a perspective of IT-related resources (e.g., IT skills, IT human resources, IT knowledge, and IT capability) to explain IT business value. Because this perspective do not distinguish IT resources from IT capability, it is not treated as a separate category in this study.

indicates synergies between IT and other firm resources, or contingency of IT business value on other resources. Based on the resources-based view (RBV), the complementary perspective contends that IT contributes to firm performance by leveraging the complementary organizational resources that are rare, firm-specific, and inimitable (Melville, Kraemer, & Gurbaxani, 2004).

The complementary perspective obtains some empirical supports. For example, in their widely cited paper, Powell and Dent-Micallef (1997) found that IT resources, such as systems used for inventory management, administration, human resources management, and marketing, have no influence on firm overall performance but that IT intensity magnifies the effects of human and business resources on firm performance. It is worth to note that in their study, IT resources were constrained to technological systems and did not include other important IT-related resources, such as infrastructure and human capital. Moreover, they did not really demonstrate how IT intensity leverages others complementary resources, but rather showed that IT intensity makes some originally insignificant factors become significant. These results simply suggest that intensive use of IT can support a different set of complementary resources. One interesting result from their study is that top executives' commitment to IT *alone*, which even does not need to depend on technology resources, significantly influences firm overall performance. This finding provides support to the idea that companies should embraces IT with enthusiasm, explore opportunities brought by new IT advance, and actively use new technologies to create value to customers and such IT enthusiasm will be rewarded (Wheeler, 2002).

The complementary perspective is rooted in organizational literature, which treats IT as a magnifier of other organizational resources. From the IS field, however, while it is true that IT

needs to integrate with and support other organizational resources, IT should not be only a magnifier of other resources. IS scholars believe and have demonstrated that IT resources such as the quality of IT business expertise and the relationship infrastructure (Bhatt & Grover, 2005), do contribute to firm performance. The divergence between organizational literature and IS field is on the role of IT playing in the synergies with other firm resources. Organizational literature implies a minor role of IT in firm performance, but IS scholars assert a major influence of IT on firm performance.

Alignment perspective of IT business value

The alignment perspective also emphasizes the importance of complementary resources, such as unique skills or knowledge-based assets (Tallon, 2000). Unlike the complementary perspective, however, the alignment perspective does not treat IT only as a magnifier of other organizational resources, but as an important resource for pursuing business strategies. This perspective argues that IT should be aligned with business core strategies to obtain competitive advantages. Underlying this argument is the fact that effectiveness and efficiency of IT is contingent on other organizational factors, such as top management support and training (T. C. Powell & Dent-Micallef, 1997). By aligning IT with business core strategies, companies can invest more resources on IT application in order to achieve effective and efficient use of IT. In essential, the alignment perspective emphasizes both roles of IT as a magnifier and an important resource and argues that companies should embrace IT and use IT to support their core business strategies.

The alignment perspective obtained empirical supports from different angles. For example, Tallon (2000) examined the alignments of IT with business strategies at the process

level and found that IT alignments with product and service enhancement, sales and marketing support, and customer relations significantly contribute firm performance in term of customer intimacy and product leadership. Chen and his colleges (2008) examined IT and business strategy alignment in a longitudinal study of a Taiwanese semiconductor company and found that unaligned strategic information system (with an implemented IT strategy that varies from the intended IT strategy) impedes the development of IT competency. Ray, Wu, & Konana (2009) found that IT can support vertical integration or disaggregation strategy, depending on which one is used as an core strategy for companies.

The major limitation of the alignment perspective is that it does not examine the underlying reasons why IT alignment with core business strategies contributes to firm performance. As I mentioned above, there may be different reasons for improvement on firm performance, such as IT leveraging valuable resources or organizational resources supporting IT applications. In other words, it is unclear to which extent that IT is indispensable for firm performance. Although the reasons seem not to make difference on final results of IT alignment with core business strategies, they are necessary for theoretical understanding of IT business value.

Moreover, the underlying assumption of the alignment perspective is that companies have not succeeded in effectively and efficiently using IT to support their strategies. This argument may be true in the early ages when companies were over-optimistic about the effects of IT. But as companies are gaining more and more experiences on use of IT and most of them are facing a tight budge on IT investments since the burst of dot-com bubble, the misalignment between IT investments and firm strategies should not be arbitrarily assumed. Actually, as IT continues

becoming prevalent, it could be expected that most use of IT needs to and should be aligned with firm strategies.

Process-oriented perspective of IT business value

The process-oriented perspective believes that IT creates business value by improving individual business processes (Tallon, Kraemer, & Gurbaxani, 2000). It argues that the impacts of IT should be measured at lower operational process (e.g., administrative cost reduction, productivity improvement, and customer service enhancement) because of the disparate nature of an organization's IT investments (Barua, Kriebel, & Mukhopadhyay, 1995). According to this perspective, there are some benefits associated with process-level measures. First, process measures may provide more insights into how IT creates business value within business processes. Second, process measures are easier to obtain than firm-level measures (Tallon & Kraemer, 1998).

There are several ways to depict business processes within an organization. The most widely known one perhaps is the value chain (Porter, 1985). Because the value chain process description is developed for classifying organizational activities, however, it may not fit perfectly with IT-related activities. Some IS scholars have proposed a two-major-category model (i.e., operational process and management process) for distinguishing IT impacts on different business process (Mooney, Gurbaxani, & Kraemer, 1996). Still others think the two-major-category model as incomplete and propose the third model to classify process-level IT impacts (Tallon & Kraemer, 2006). Table 2 summarizes the three process models.

Table 2. Business processes categories (extracted from Tallon and Kraemer 2006)

Moony et al. (1996)	Porter (1985)	Tallon and Kraemer (2006)
<u>Operational Process</u> Procurement & Logistics	<u>Primary Activities</u> Inbound Logistics	Supplier Relations Production & Operations

Production Marketing and Intelligence Product/Service Delivery	Operations Outbound Logistics Marketing & Sales Service	Sales & Marketing Support Customer Relations Process Planning & Support Product & Service Enhancement Competitive Dynamics
Management process Information Handling Communications Coordination Knowledge Control Design & Development	Secondary Activities Firm Infrastructure Human Resource Management Technology Development Procurement	

The process-oriented perspective is based on numerous studies related to process-level IT impacts, such as enabling closer monitoring of quality and improved delivery techniques (Kraemer, Dedrick, & Yamashiro, 2000) and offering improved levels of customer service (Ray, Barney, & Muhanna, 2004). The problem for this perspective is that it has no intention to provide a comprehensive view of IT business value. By only focusing on process-level IT business value, it just shows the trees, but fails to see the forest. In the early days, companies might think about IT applications for supporting single business process. But today they have to consider IT applications in a big picture, as demonstrated by emergence of enterprise information systems. Moreover, because IT can be applied to any business processes, measuring the whole IT impact on the firm-level is possible and also necessary.

Capability perspective of IT business value

IT capability has become one of the most popular perspectives to explain IT business value since 2000 when Anandhi Bharadwaj's widely cited paper was published. Although there seems different understanding of what should be counted as IT capabilities, this perspective provides a complementary explanation of IT business value. Capability is the ability to use resources. Although it cannot contribute to competitive advantages alone (Eisenhardt & Martin, 2000), the ability to use resources should be as important as owning resources. Moreover,

dynamic capability theory indicates that companies should renew, combine, and integrate their resources in a dynamic process to adapt to changes in environment. Thus, capability involves both using and generating resources and plays a critical role in firm performance.

IS scholars have identified a variety of IT capabilities and demonstrated their effects in different scenarios. For example, Pavlou and Sawy (2006) introduced the construct of IT leveraging competency (the ability to effectively use IT functionalities) and showed that the effective use of IT functionalities can help build a competitive advantage. Bhatt and Grover (2005) indentified four specific capabilities (IT infrastructure, IT business experience, relationship infrastructure, and intensity of organizational learning) and found that IT business experience and relationship infrastructure have significant effect on competitive advantage. Barua and his colleagues (2004) proposed online informational capabilities (the ability of a firm to exchange strategic and tactical information with customers and suppliers on demand) and demonstrated its effect on financial performance of net-enabled companies.

The major limitation of the IT capability perspective is that this term is not precisely identified. There are several similar terms used in existing literature, such as IT-related capability (Bhatt & Grover, 2005), IT-enabled capability (Joshi et al., 2010), and dynamic IT capability (Xiao & Dasgupta, 2009). Moreover, some authors just treat IT capability as a type of IT resources (e.g., Aral & Weill, 2007). In her pioneering work, however, Anandhi Bharadwaj (2000) explicitly distinguished resources from capabilities. According to her, resources include tangible (e.g., financial capital, plant and equipment), intangible (e.g., reputation, brand image, and product quality), and personnel-based resources (e.g., technical know-how); on the other

hand, capabilities refer to the ability to assemble, integrate and deploy resources. In short, capabilities represent the ability of an organization to use resources.

This study adopts the capability perspective of IT business value and focuses on dynamic IT capability. As a type of capability, DIC emphasizes on the use of IT resources (such as IT applications, IT infrastructure, and IT human capital) to support business processes. The concept of DIC can also be understood as process-oriented. It means that the business value of IT has to be presented in improved or enhanced business processes, rather in the form of pure IT resources. In other words, the ownership of IT resources by itself cannot be a sufficient driver of business value. IT resources have to be used and cause improved or enhanced business processes and then contribute business value to firms. For example, if an IT application is not accepted and appropriately used by its users, or the targeted business processes have not be improved after the use of the IT application, then this IT application does not have business value at all.

2.1.2. Synergy of perspectives on IT business value

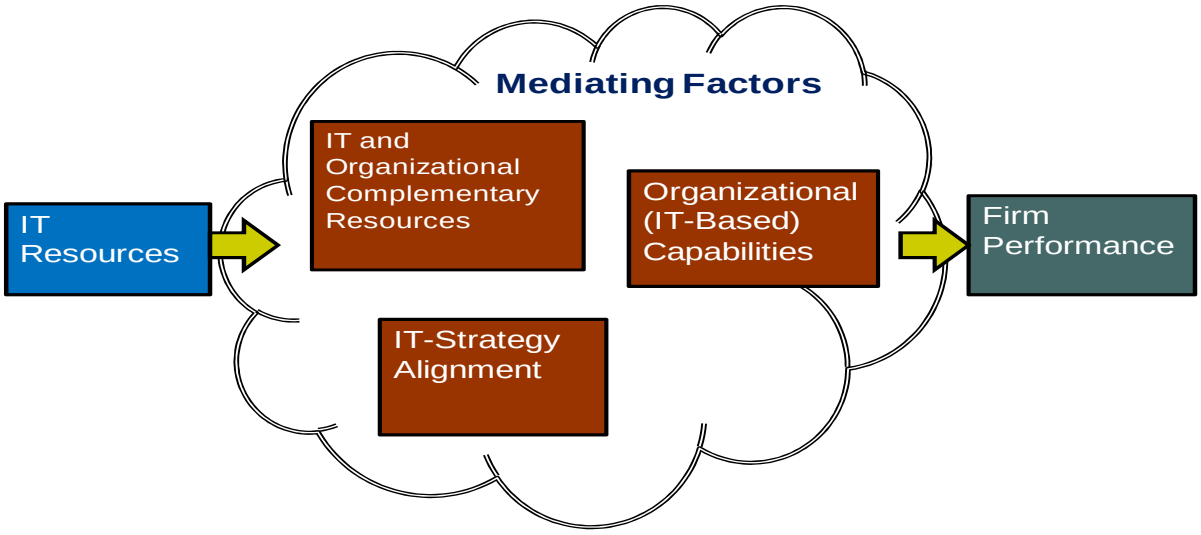

Figure 1. Synergy of perspectives on IT business value (extracted from Rajiv Kohli & Grover, 2008)

In this section I try to further clarify the different perspectives on IT business value and then provide a more synergistic view. Figure 1 above is directly extracted from Kohli & Grover (2008) which provides an excellent review for the terms and the perspectives frequently used in IT business value research. Several things in this figure worth paying special attention to. First, it distinguishes capabilities from resources. Second, it points out a mediated perspective between IT resources and firm performance. Third, it indicates that the mechanisms through which IT resources contribute to firm performance are elusory (in the cloud). Fourth, it proposes IT complementary perspective, IT alignment perspective, and IT capabilities perspective as the potential mechanisms as the mediating factors between IT resources and firm performance.

Although Figure 1 provides an excellent review over different perspectives on IT business value, its description on IT capabilities is not very precise. Most studies based on the IT capabilities perspective usually argue a direct relationship between IT capabilities and firm business value (e.g., Bhatt & Grover, 2005; Stoel & Muhanna, 2009; Xiao & Dasgupta, 2009). Moreover, the IT capabilities perspective not only includes traditional IT resources (e.g., IT infrastructure and human IT resources) but also is related to IT-enabled resources (e.g., knowledge assets, customer orientation, and synergy) (Bharadwaj, 2000). In addition, IT capabilities are supposed to combine or copresent with other resources and capabilities (Bharadwaj, 2000). Thus, the IT capabilities perspective needs to be separated out and further illustrated.

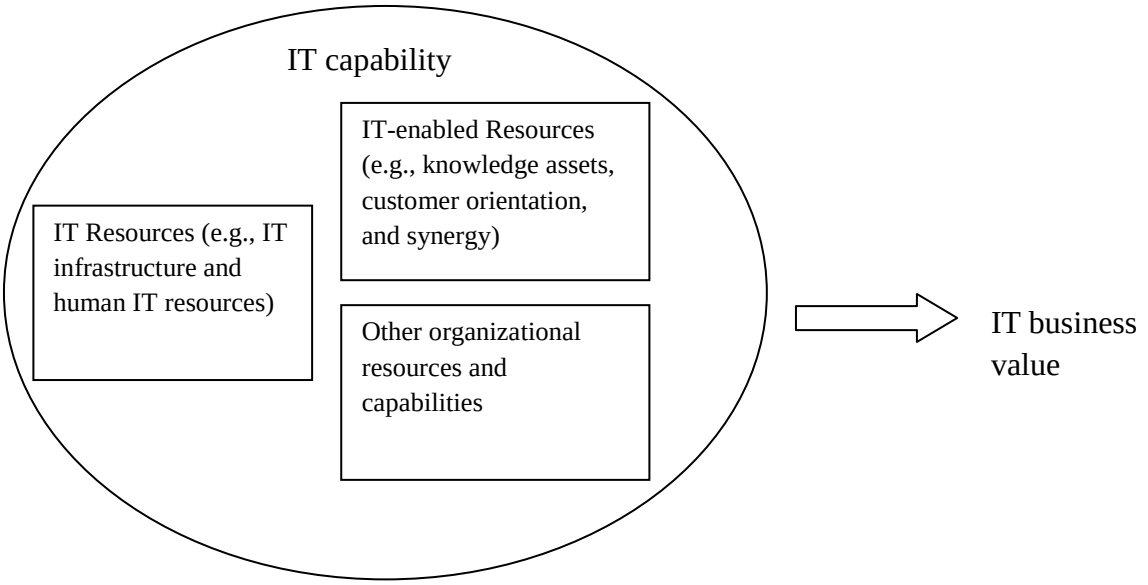

Figure 2. IT capability

Figure 2 demonstrates the concept of IT capability proposed in Bharadwaj (2000). According to her definition, IT capability should not be understood as a separate type of IT resources. Rather, IT capability is inseparable from IT resources, IT-enabled resources, and even other organizational resources. It can be understood as effective use of IT-based resources (both IT resources and IT-enabled resources) in combination with other organizational resources. For example, in her paper, Bharadwaj (2000) demonstrates IT leaders have superior performance than non-IT leaders and IT leaders are judged not by how many IT resources they own, but by how they effectively use IT resources.

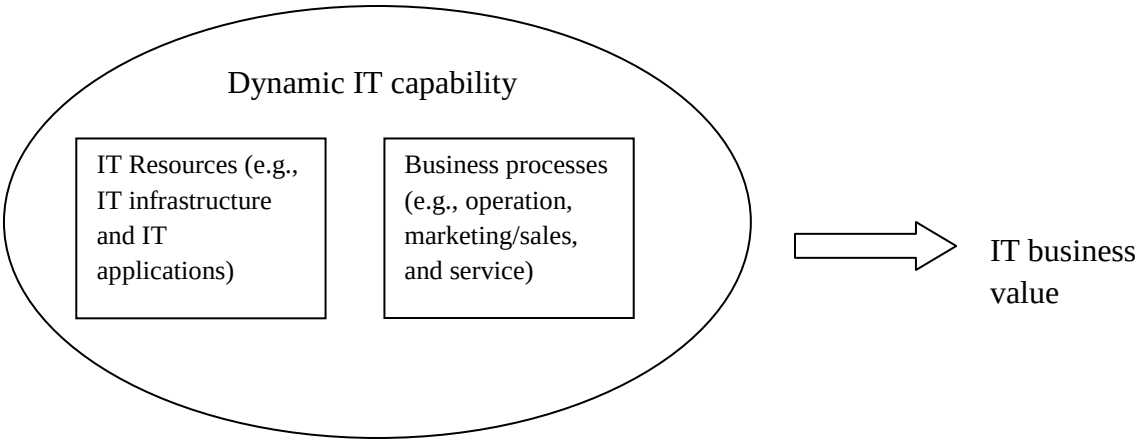

Figure 3. Dynamic IT capability

Based on abovementioned arguments, I define DIC in Figure 3 for this study. There are several things that needed to be emphasized. First, IT resources should be understood as part of business processes, rather than IT-enabled or IT-based processes. In other words, IT resources are inseparable from business processes. Second, DIC means the ability to continuously refresh IT resources, such as IT infrastructure and IT applications to improve business processes. Third, because DIC is process-oriented, rather than resource-oriented, human IT resources are not separated out as a type of IT resources. That is, using IT resources and relying on human IT resources are inseparable part of integrating and improving business processes for creating business value for a firm.

Comparing Figure 2 with Figure 3, one can see the major difference between DIC and IT capability is that DIC is process-oriented and IT capability is resource-based. DIC emphasizes that IT resources must be used in business processes to create business value; IT capability highlights that IT resources have to be combined with other IT-enabled resources (e.g., knowledge assets and synergy) and organizational resources to generate business value. This

difference reflects the theoretical divergence between the perspective of dynamic capabilities and RBV. Readers who feel interested in this topic can refer to the seminal work of Eisenhardt and Martin (2000). I also provide a review of the perspective of dynamic capabilities in the next section.

2.1.3. Theories of IT and Firm Performance

Literature of IT value on firm performance is mostly based on four theoretical perspectives: position perspective (Porter, 1980, 2001), transaction cost perspective (Williamson, 1985), resource-based view (Barney, 1991), and dynamic capabilities perspective (Eisenhardt & Martin, 2000; Teece et al., 1997). Position perspective asserts that firms should develop their strategies around an integrated system of activities that give them an attractive position relative to competitors (Bhatt & Grover, 2005). Here the position not only establishes the uniqueness and value of firms' products and services (Porter, 2001), but also locks-in firms and constrains their strategic mobility (Ghemawat, 1991). The role of IT is in facilitating the superior position by supporting strategic activities such as pricing (Beath & Ives, 1986) and customer relationship management (Porter & Milar, 1985). But this perspective has several limitations. First, it assumes firm structure as static and firms as homogeneous in their abilities (Bhatt & Grover, 2005) and provides weak explanation of strategic activities in dynamic environment (Sambamurthy et al., 2003). Second, it uses industry as the unit of analysis and does not focus on individual firms (Bhatt & Grover, 2005; Teece et al., 1997). Finally, it does not explain how firms can keep their strategic activities from inimitable (Sambamurthy et al., 2003).

The core of transaction cost perspective is asset specificity, such as physical proximity, transaction-specific capital investments, and transaction-specific know-how accumulated by

transactors (Williamson, 1985). This perspective argues that firms must do specialized strategic investment to develop a competitive advantage (Amit & Schoemaker, 1993) and is frequently used to explain institutional governance. It works through a discriminating alignment hypothesis that transactions with different asset attributes (generic versus specialized) should be aligned with different governance structures (markets versus hierarchies) to economize on particular attributes of transactions costs (Wareham, 2003). In strategy literature this perspective has been used to explain the relationship between relation-specific investments and performance and has obtained empirical supports (Dyer, 1996; Parkhe, 1993). The roles of IT in transaction cost perspective include reducing product complexity, lowering external search costs, and reducing asset specificity (Robey, Im, & Wareham, 2008). However, the transaction cost perspective also suffers from several criticisms. First, transaction-based theories (i.e., agency theory, incomplete contracting theory, and transaction cost theory) have dominated managerial academic community for several decades but their intrinsic assumption and scope are too narrow to justify the continued, all-encompassing application in the broader areas of managerial and social studies (Wareham, 2003). Second, this perspective provides little insight on how the asset-specific investment cannot be imitated (Bhatt & Grover, 2005).

The resource-based view (RBV) has been used in numerous studies to explain the relationship between IT and competitive advantages/firm performance (Bhatt & Grover, 2005; Rai, Patnayakuni, & Seth, 2006; Ravichandran & Lertwongsatien, 2005; Ray, Muhanna, & Barney, 2005; Zhu, 2004). This perspective looks at firms as bundles of resources and assumes that those resources are heterogeneously distributed across firms and that resource differences persist over time (Eisenhardt & Martin, 2000). When firms own resources that are valuable, rare,

inimitable, and nonsubstitutable (so called VRIN attributes), they can implement a value creating strategy that cannot be easily duplicated by competitors and achieve sustainable competitive advantage (Barney, 1991). Despite its popularity, this perspective is also suffered from some limitations. First, it provides a set of necessary conditions for achieving sustainable competitive advantages, but says little about how resources actually contribute to these advantages (Melville et al., 2004). Second, in dynamic business environment, sustainable competitive advantages have been seen as unlikely in the long run (Eisenhardt & Martin, 2000). Finally, it c cover issues such as skill acquisition, management of knowledge and know-how, and learning that are underlying the scarce resources (Teece et al., 1997).

The dynamic capabilities perspective can be seen as an extension of resource-based view (Eisenhardt & Martin, 2000). Unlike RBV, which focuses on an economic and formal modeling lens (Barney, 1991) and is criticized as "conceptually vague and tautological" (Priem & Butler, 2000), this perspective relies on organizational and empirical base and focuses on specific strategic and organizational processes, such as product development, alliancing, and strategic decision making that have extensive empirical research streams associated with them (Eisenhardt & Martin, 2000). The dynamic capabilities perspective asserts that competitive advantage comes from resource configurations, or the ability of firms to integrate, build, and reconfigure internal and external resources to adapt to rapidly changing environments (Teece et al., 1997). The effective patterns of dynamic capabilities vary with market dynamism and evolve through specific learning paths (Eisenhardt & Martin, 2000). This perspective is particularly important to this study for two main reasons. First, IT has been argued as an enabler of two critical dynamic capabilities for firm performance: agility (the ability to detect and seize market opportunities

with speed and surprise) and digital options (a set of IT-enabled capabilities in the form of digitized enterprise work processes and knowledge systems) (Sambamurthy et al., 2003). Therefore, considering DIC is an appropriate means to investigate its direct effect on firm performance in rapidly changing environments. Second, unlike RBV, which focuses on organizational internal resources, dynamic capability perspective implicitly and explicitly considers both internal and external resources for firms to adapt to today's inter-connected environments. Therefore, this perspective is the core of studies for net-enabled organizations in a network environment (Barua et al., 2004; Straub & Klein, 2001; Wheeler, 2002).

I summarize those four perspectives in Table 3 below.

Table 3. Summary of theories used for IT business value research

	Position	Transaction cost	Resource-based view	Dynamic capabilities
Unit of analysis	Industry	Transaction	Firm	Firm
Major constructs	Competitive forces and corresponding strategies	Asset specificity (such as physical proximity, transaction-specific capital investments, and transaction-specific know-how)	Valuable, rare, inimitable, and nonsubstitutable resources (VRIN attributes)	Specific strategic and organizational processes, such as product development, alliancing, and decision making
Core arguments	Firms should develop strategies around activities that lock them in a position with uniqueness and value	Firms must do specialized strategic investment to develop a competitive advantage	When firms own VRIN resources, they can implement a value creating strategy that cannot be easily duplicated by competitor and achieve sustainable competitive advantage	Competitive advantages come from resource configurations. Dynamic capabilities are necessary, but not sufficient, conditions for competitive advantage.
Role of IT	IT provides supports for strategic activities and facilitate the superior position	The roles of IT include reducing product complexity, lowering external search costs, and reducing asset specificity	IT can provide some categories of VRIN resources. IT also can enable other VRIN resources	IT is an enabler of dynamic capabilities. Such capabilities are reflected in business processes.
Limitations	1. It assumes firm structure as static and firms as homogeneous in their abilities. 2. It uses industry as unit of analysis and doesn't focus on performance of individual firms. 3. It doesn't explain how firms can keep their strategic activities as inimitable.	1. Its intrinsic assumption and scope are too narrow to justify their continued, all-encompassing application. 2. It provides little insight on how firms can pursue differentiation and how their asset-specific investment cannot be imitated.	1. It provides necessary conditions for achieving sustainable competitive advantages, but says little about how resources actually contribute these advantages. 2. Sustainable competitive advantages may be unlikely in dynamic business environment. 3. It doesn't indicate how to obtain and renew resources.	1. It totally separates capabilities from resources. 2. This perspective argues that resources configurations contribute to competitive advantages, but doesn't explicitly define the relationships among resources configurations, capabilities, and resources.

2.2. Network research

The roles of network in economic activities attract much attention from both researchers and practitioners over the past two decades (Smith-Doerr & Powell, 2003). In practice, "networking among companies is now in fashion all over the world" (Harrison, 1994). Correspondingly, there is a exponential increase in network research (Borgatti & Foster, 2003). As Nohria (1992) points out,

> "The term 'network' has become the vogue in describing contemporary organization, from large multinationals to small entrepreneurial firms, from manufacturing to service firms, from emerging industries such as biotechnology to traditional industries such as automobiles, from regional districts such as Silicon Valley and Italy's Prato district to national economies such as those of Japan and Korea, more and more organizations are being described as networks" (p.1).

Researchers have pointed out three major reasons for the increased interest in the concept of network: the emergence of the "New Competition", the emergence of new information technologies, and the maturing of network analysis as an academic discipline and also a legitimate mainstream perspective (Nohria, 1992; Piore, 1992). The "New Competition" refers to the competitive rise of small entrepreneurial firms, of regional districts, of new industries such as computers and biotechnology, and of Asian economies such as Japan, Korea, and Taiwan, and is supposed to use a lateral and horizontal network as a model of organizations (Best, 1990; Nohria, 1992). Information technology provides a platform and makes it possible for firms to achieve disaggregated, distributed, and flexible production arrangements, as well as organize their internal operations in different ways (Nohria, 1992; Piore, 1992; Venkatraman & Henderson, 1998).

In this section, I will discuss the definition of network, properties of network, main research streams based on characteristics of network, and major theories used in network research. Each of them will be elaborated in a subsection.

2.2.1. Definition of network

A network can be defined as a set of actors connected by a set of ties (Borgatti & Foster, 2003). The actors may be roles, individuals, groups, organizations, industries, or even nation states (Fombrun, 1982). The ties may be based on anything that causes a relation, such as friendship, kinship, economic exchange, or information exchange (Nohria & Eccles, 1992). According to this definition, any form of social organization can be thought as a network. Thus, this term is used in a variety of sciences, such as neuro-sciences, operational research, communication theory, small group theory, and certainly organization theory (Grandori & Soda, 1995). In this study I refer network to the mode of coordinating economic activities in the context of organization.

There is some debate on whether network refers to a new ideal type of organization characterized by relations with unique logics of exchange that are based on neither hierarchical authority nor market transactions (W. W. Powell, 1990), or network just represents a hybrid form that combines institutional features of both markets and hierarchies (Hennart, 1993). If we take the broad definition of network as connections among actors, it seems that there is no need for a new organizational form because every organization has to be embedded in some kind of networks of economic and social relations (Borgatti & Foster, 2003). For this study, however, network is treated as a distinct form with some unique characteristics that cannot be acquired in markets or firm hierarchies. I speculate that those unique characteristics provide a better

explanation of the rise of networking both in practice and in theory than a hybrid of markets and hierarchies because a hybrid seems not to be able to obtain characteristics that do not belong to any of their parents (see Ebers 1997 for a review of characteristics of market, network and firm). It is clear that a network does not just combine characteristics of markets and firms (though it is true for some characteristics); instead, it owns distinct characteristics different from both market and firms, such as coordination mechanisms and distribution of property rights over resources.

2.2.2. Properties of network

Early network research has distinguished two major types of network: attribute network and transactional network (Fombrun, 1982). Attribute network is based on some common attributes, such as goals, gender, status, or memberships. Examples of an attribute network include group and association, where there is some form of social boundary indicating insiders and outsiders, which implies that the existence of relationship does not depend on direct contact among members (Smith-Doerr & Powell, 2003). In contrast, transactional network focuses on exchanges that occur among a set of units, such as individuals, groups, or organizations (Fombrun, 1982). Significant research focuses on transactional (or exchange) network, which is also the focus of this study.

The important set of properties of network include transactional content (what is changed), nature of ties (strength and qualitative nature), and structural characteristics (pattern of relationships) (Tichy, Tushman, & Forbrun, 1979). Based on the flows through a network, we can distinguish four types of transactional contents: expressive (affect), instrumental (influence or power), cognitive (information), and objective (goods or services) (Fombrun, 1982) (see Tichy et al. 1979 for a review of properties of network). According to Formbrun (1982), network

research can be conducted at three levels: individual nodes (NODAL), all possible pairwise combination of the nodes (DYADIC), or an inventory of all possible triads of nodes (TRIADIC).

At the firm level, recent network research usually focuses on structural characteristics, such as centrality (e.g., Owen-Smith & Powell, 2004; Raz & Gloor, 2007; Tsai, 2001), structural hole (e.g., Lin, Peng, Yang, & Sun, 2007; Paruchuri, 2010; Shipilov, 2009), and network density (e.g., Chi, Ravichandran et al., 2010; Pan, Pan, & Leidner, 2012; Reagans & Zuckerman, 2001). Although network density has been used in studies at firm level, it describes a characteristic of a network (actual links in a network as a ratio of possible links), rather than a characteristic of a firm in that network. Moreover, a firm may have multiple connections with one firm and may also be involved in one connection with multiple firms (TRIADIC). These conditions make the concept of network density difficult to understand in the scenario of this study. Thus, I only focus on centrality and structural hole, as well as Simmelian tie – an important moderator of innovation (Tortoriello & Krackhardt, 2010).

Centrality

The idea of centrality was introduced by Bavelas in 1948 for solving human communication problems (Freeman, 1979). An actor's (participant) position is called centralized "to the extent that all relations in the network involve him" (Burt, 1980, p92). This term is used to describe the inequality in actors' relations in a network (Burt, 1982). According to Freeman (1979), there are three types of centrality. Degree centrality indicates the extent to which an actor is directly connected to other actors in a network. An actor with high degree centrality has the visibility or the potential for communication activities in a network. Betweenness centrality measures the extent to which an actor falls on the shortest paths of pairs of other actors in a

network. An actor in such a position can withhold or distort information in transmission and usually take a role of maintenance of communication, or coordinator of group processes. Closeness centrality denotes the extent to which an actor is close to all other actors in a network. An actor with high closeness centrality can avoid the control potential of others. Table 4 provides a summary of different centrality types.

Table 4. Summary of centrality (Freeman 1979)

Degree centrality	The extent to which an actor is directly connected to other actors in a network
Betweenness centrality	The extent to which an actor falls on the shortest paths of pairs of other actors in a network
Closeness centrality	The extent to which an actor is close to all other actors in a network

Although positions with high centrality usually indicate power in a network (Bonacich, 1987) and are related to advantages of information access and control (Freeman, 1979), the perspective of centrality significantly focuses on the structure of a network and miss two important points. First, it assumes that all information makes similar contributions to the actors and ignores the context included in that information (Burt, 1992). In other words, all information receives the same weights even though it may be redundant or unimportant. Second, it assumes that all connections take the same weights and ignores the differences such as strong tie and weak tie (Granovetter, 1973). The differences on the strength of ties will significantly influence information access and also the cost of maintenance on relations.

Despite these limitations, centrality as a structural property plays a very important role in network research. Degree centrality clearly indicates the number of possible resources that a firm may directly access in a network. Betweenness centrality depicts the ability of a firm to control the flow of information via the position in a network and is related to another important concept in network research: structural hole. Closeness centrality not only measures the ability of a firm

to be independent of the control of other firms in a network, but also indicates the efficiency of information transmission for that firm. Aforementioned limitations just remind researchers that the concept of centrality does not include everything in a network and only can be used to describe some aspect of a network, such as position.

Recent research explores the effects of centrality on a variety of topics, such as innovation, knowledge acquisition, venture performance, firm survival, and system use. For example, Owen-Smith & Powell (2004) found betweenness centrality in a geographically dispersed network will positively affect innovation. Stam & Elfring (2008) detected negative effects of closeness centrality on new venture performance. Tsai (2001) revealed positive effects of centrality and absorptive capability on business unit innovation. Hansen (2002) found that the combination of knowledge relatedness and closeness centrality explained knowledge acquisition, but any of them could not provide explanation individually. Raz & Gloor (2007) reported that betweenness centrality has positive effects on the survival of start-ups. Sykes, Venkatesh, & Gosain (2009) reveal that degree centrality is positively related to system use.

Structural hole

The term structural hole was introduced by Burt (1992). According to the author, a structural hole "is a relationship of nonredundancy between two contacts…As a result of the hole between them, the two contacts provide network benefits that are in some degree additive rather than overlapping" (p18). The core concept proposed in the structural hole argument is brokerage, which indicates the opportunity provided by a structural hole to broker the flow of information between two or more disconnected contacts and also control the projects that bring them together (Burt, 2000). The role of control in structural hole is similar to the concept of betweenness

centrality (Freeman, 1979) introduced above. The structural hole provides a bridge to connect contacts otherwise disconnected with each other. Another function of a structural hole is to separate nonredundant sources of information. In other words, a structural hole connects contacts with different information and provides access to additive information, rather than overlapping information.

The opposite of the concept of structural hole is network closure. Networks with closure refer to networks in which everyone is connected (Coleman, 1988). Such networks are also called as dense or closed networks. The focuses of the network closure perspective is to avoid risks associates with incomplete information (Burt, 2000). According to Coleman (1988), network closure has two benefits. First, it facilitates information circulation. Because everyone in the closed network is connected, information obtained by one person can easily circulate in the network and save the time of other members to obtain the information. Second, it facilitates sanctions because everyone is visible in the network and inappropriate behaviors will show up to the whole network.

Because the two concepts, structural hole (brokerage) and network closure, are contradictory network forms, there is a debate on which mechanisms can generate social capital in a network (Martin Gargiulo & Benassi, 2000). An explanation provide by Burt (2000) seems to serve as a good solution. According to Burt, structural hole (brokerage) and network closure have different focuses and should be used in different situations. Network closure is "about stasis while brokerage is about change. Closure is about advantages that go to people in a cohesive group…the hole argument is about advantages that go to people who build bridges across

cohesive groups" (p12). Because the world is changing, however, the structure hole argument stands apart from the closure argument (Burt, 2000).

Scholars have provided examples on the different focuses of brokerage and closure. A group of authors argue that brokerage is more important than closure for idea generation and innovation, but less important for the execution and implementation of innovations (Burt, 2005; Cowan & Jonard, 2008; Obstfeld, 2005). Still, other scholars believe that the benefits related to brokerage are short-lived and immediate, but these related to closure tend to be longer-lived and more enduring (Baum, McEvily, & Rowley, 2010; Soda, Usai, & Zaheer, 2004). In addition, empirical evidence also demonstrates that brokerage and closure can be compatible and complementary in a network for both knowledge seeking and knowledge transfer (Reagans & McEvily, 2008).

Recent research frequently relates the concept of structural hole to firm performance, innovation, and merger and acquisition. For example, Zaheer and Soda (2009) demonstrate that structural holes are positively associated with superior team performance. Shipilov (2009) reports that strucural holes interact with the scope of experience of a firm and significantly contribute to performance improvements. Lin, Yang, & Demirkan (2007) find that structural holes are positively related to firm perofmrance but interact with alliance ambidexterity to negatively influence firm performance. Lin, Peng, Yang, & Sun (2009) reveal that structure holes contribute to firm mergers and acquisition, with institutional development as a moderator.

Simmelian Tie

Although the concept of Simmelian tie is not so frequently used as the centrality or the structural hole in organizational research, its history is not shorter than any of them. While the

concepts of centrality and strucural hole can be used to describe both dyadic and triadic (or more) relationships in a network, Simmelian tie explictly focuses on triadic (or more) relationships. The change to add a thiry-party into a dyadic relationsip is not minor, but “has the potential to substantially change their character and quality” (Tortoriello & Krackhardt, 2010, p170). As emperical evidences have revealed, Simmelian tie offers important insights on some fundamental characteristics of social networks and can privide critical complements to the concept of centrality or the structural hole (Tortoriello & Krackhardt, 2010).

According to Krackhardt (1998), “a tie is Simmelian when the parties involved are reciprocally and strongly tied to each other and they are both reciprocally and strongly tied to at least one common third party” (p24). Although Simmel (1950) did not use the term Simmelian tie, he provided the first and most theoretical foundation to distingiush connected triads from dyads (Krackhardt, 1999). According to Simmel, dyads usually preserve the individuality of both players, retain their bargaining power, and escalate conflicts. In a triad, however, because of the presnece of a third party, an individual can be outvoted or isolated by the other group members and thus loses part of his/her individuality and bargaining power. The third party can also act as a moderater to reduce conflicts and contribute to the stability of the social relations. Moreover, Simmel argues that while the differencens between dyads and triads are substantial, there are just minimal differences between triads and large cliques (more than three parties).

The core idea of Simmelian tie is role constrains. While a dyad may not develop strong group norms, a triad can be treated as a clique and usually own norms that explicitly contrain the behaviors of its members (Krackhardt, 1999). Following this idea, one can reason that a person who occupies a position as a bridge between two cliques has to assume more constrains derived

from the norms in the two cliques and has fewer permissible behaviors than a person who is a member of just one clique. This reasoning indicates that what is perceived as advantages in the structural hole theory may be regarded as constrains in the Simmelian tie theory (see Krackhardt 1999 for a demonstration of differences between the two concepts).

Recent research relates Simmelian ties to the generation of innovations (Tortoriello & Krackhardt, 2010). Combining the concpets of structural hole and Simmelian tie, these scholars argue that bridging structural holes with Simmelian ties is strongly associated the the generation of innovation. In their view, Simmelian ties can reduce dissension and moderate conflict, and thus increase the statility of cliques. The increased stability can faciliates the formation of common language and shared understandings, and encourage cooperation and reciprocity. Common knowledge and the willingness to cooperate by sharing knowledge with each other are critical to generate innovation (Tortoriello & Krackhardt, 2010).

2.2.3. Main network research streams

Many forms of network exist, such as joint-ventures, franchising, consortia, commercial agreements, sub-contracting, interlocking directorates, and personal networks (Grandori & Soda, 1995). Some researchers distinguish network research based on existing research streams into different categories, such as social capital, embeddedness, network organizations, board interlocks, joint ventures and inter-firm alliance, knowledge management, social cognition, and group processes (Borgatti & Foster, 2003). Others organize network forms along three dimensions: whether they are formalized or not; whether they are centralized or parity-based; and their characteristic mix of coordination mechanisms (Grandori & Soda, 1995). In this subsection I first provide a literature review of recent network research in Table 5 and then

specially introduce an important research stream: strategic alliance, which is the focus of this study.

Table 5. Literature review of recent network research

Study	Theoretical bases	Constructs	Measures	Key findings
Borgatti & Cross, 2003	Social network theory, information processing, organizational learning	Knowing, value, access, cost, physical proximity, information seeking	Measures are developed by the authors.	Knowing, value, and access are positively related to information seeking, and also mediate the relationship between physical proximity and information seeking.
Gargiulo, Ertug, & Galunic, 2009	Social network theory	Network size, density of ties, performance	Network size is the number of people evaluated or evaluating geo. Network density is the ratio of existing ties to the maximum number of possible ties between alters in the network.	Network density increase performance of acquirer of information, and decrease performance of provider.
Grewal, Lilien, & Mallapragada, 2006	Network embeddedness	Degree centrality, betweenness centrality, eigenvector centrality	See the appendix of this paper for details.	Network embeddedness has strong and significant effects on both technical and commercial success of project, but some effects are positive under some regimes and negative under others.
Hansen, 1999	Social network theory	Weak tie, complex knowledge	Weakness of tie is measured by the average of the frequency and closeness.	Weak ties help transferring codified, independent knowledge and strong ties help transferring noncodified, dependent knowledge.
Hansen, 2002*	Network theory	Path length, number of direct relation, codified and noncodified knowledge, project completion time	Path length was measured by closeness centrality (Freeman, 1979) with UCINET IV (Borgatti, Everett, & Freeman, 2002).	1. Combination of knowledge relatedness and path lengths explained project completion time and knowledge obtained from others, but any of them alone couldn't provide explanation. 2. Direct relations were helpful for transferring noncodified knowledge, but harmful with

				codified knowledge.
Lin, Peng, Yang, & Sun, 2007	Resource dependence	Closeness centrality, structural hole, exploitation learning tendency, institutional development	UCINET 6 was used to calculate closeness centrality. Structural hole is captured by constraint (Burt, 1992).	Both closeness centrality and structural hole contribute to mergers and acquisition, with institutional development as a moderator.
Lin, Yang, & Demirkan, 2007	Social networks, Ambidexterity hypothesis	Performance, alliance ambidexterity, centrality, structural hole	Performance (ROA), alliance ambidexterity = # of new alliance / # of total alliance, weighted degree centrality, structural hole (Burt 1992)	1. Centrality and structural hole are positively related to firm performance. 2. Alliance ambidexterity interacts positively with centrality and negatively with structural hole to influence firm performance.
McFadyen, Semadeni, & Cannella, 2009	Knowledge creation and network structure	Average tie strength, network density, knowledge creation	Average tie strength is measured by the mean number of publications per coauthor that a given scientist achieved during the previous three years. Network density is equal to the actual ties divided by the maximum number of pairs.	1. Knowledge creation depends on both network density and average tie strength. 2. Strong ties with sparse network have the highest levels of net knowledge creation.
Moran, 2005	Social capital	Number of tie, density of tie, closeness, relational trust, performance	Density is the ratio of indirect ties among contacts to all possible ties. Closeness is measured by asking respondents how close their relationship is with each contact. Relational trust includes perceptions of honesty and truthfulness in exchange, perceptions of competence in ongoing interactions, and alignment of goals and values.	Number of tie and tie density plays a stronger role in explaining more routine, execution-oriented tasks, whereas closeness and relational trust plays a stronger role in explaining new, innovation-oriented tasks.
Owen-Smith & Powell, 2004*	Geographic propinquity, institutional demography	Innovation, centrality, collocated and dispersed network	Centrality is measured by betweenness (Freeman, 1979)	1. Membership in a geographically collocated network will positively affect innovation, but centrality does not. 2. Centrality in a geographically

				dispersed network will positively affect innovation, but membership does not.
Paruchuri, 2010	Network structure and innovation	Structural centrality, innovation, structural hole, impact	Structural centrality of an inventor is calculated with the power measure of Bonacich (1987). Structural holes measure is adopted from (Borgatti et al. 2002, Burt 1992). Innovation is measured by the number of patents. Impact is measured by the number of citations	Structural centrality of an inventor in the network is associated with her impact on her firm's innovation activities in an inverted-U-shape relation. This relationship is moderated by the firm's centrality and span of structural holes in the interfirm network
Perry-Smith, 2006	Creativity and social network theories	Tie strength, network centrality, external tie	Tie strength was measured by assessing the closeness, duration, and frequency of each relationship. Closeness centrality was measured as a respondent's average distance to other members of the network.	1. Weak ties are generally beneficial for creativity, whereas strong ties have neutral effects. 2. Centrality is more positively associated with creativity when individuals have few ties outside of their organization and combination of centrality and many outside ties is not optimal.
Raz & Gloor, 2007	Social embeddedness	Size of network, betweenness, firm survival	Size of network is the number of ties that a company has to other firms. Betweenness is calculated as the fraction of shortest paths between node pairs that pass through the node of interest.	Start-ups that have larger informal communication networks increased their chance to survive external shock.
Reagans, 2005	Demographic characteristic, social network theory	Tie strength, preferences, identity, competition	Tie strength is measured by emotional closeness and communication frequency.	Having the same tenure predicts strength of tie.
Reagans & McEvily, 2003	Social network theory	Tie strength, network density, network diversity, knowledge transfer	Tie strength is measured by the intensity of the relationship. Network density is the overall strength of the third-party connections around the focal relationship. Network diversity is the combination of both	Both network density and diversity ease knowledge transfer, over and above the effect for the strength of the tie between people.

			network connections across expertise areas and strength of the network connections.	
Reagans & Zuckerman, 2001	Social network theory	Network density, network heterogeneity, productivity	Network density is the average level of communication between any two members of team. Network heterogeneity measures the extent that scientists allocate a large proportion of their network time to colleagues far removed in the team's tenure distribution.	Both network density and network heterogeneity help account for team productivity.
Rhee, 2004	Structural hole	Network size, network closure, exploratory learning environment	Exploratory learning environment: does your task environment keep you learning new things. Network size is measured as the total number of direct ties. Network closure is measured as the total number of indirect ties between others in the network.	Effects of network size and network closure are significant only with new or updated network ties.
Robert, Dennis, & Ahuja, 2008	Social capital	Knowledge integration, team decision quality, relational capital, network structure, cognitive capital	Relational capital was measured from norms, identification, trust, and obligation dimensions. The structural capital was measured by network decentralization and tie intensity. Cognitive capital was measured by using a repertory grid analysis technique called sociogrid.	Relational capital and cognitive capital facilitate knowledge integration. Structural capital is important for knowledge integration with a lean digital network.
Ruef, 2002	Embeddedness of economic action	Network tie strength, network diversity, directed (unilateral) tie, innovation	Tie: discussion with family members or friends (strong tie); discussion with business associates (customers or suppliers) (weak ties); discussion in the general media or specialized trade press (directed ties toward discourse); observation of existing competitors in an industry (directed ties toward a set of concrete others). Network	1. Weak ties, directed ties toward discourse, and network diversity positive contribute to subjective perception of innovation. 2. Directed ties toward discourse positively contribute to patent/trademark application.

			diversity: proportion of different categories of tie (Shannon & Weaver, 1963). Innovation: nine categories defined by (Schumpeter, 1934); Patent and trademark applications.	
Schilling & Phelps, 2007	Recombinatory search perspective, network structure	Clustering, reach	Measures (Borgatti et al., 2002)	Both high clustering and high reach are positively related innovative output.
Shipilov, 2009	Interfirm networks, structural holes	Market share (performance), historic multimarket contact (MMC), centrality, structural hole	Betweenness centrality (Freeman 1979); structural hole is measured by effective size (Burt 1992)	1. Firms with a wide scope of experience will be able to extract performance improvements from network positions rich in structural holes. 2. Firms with a high level of historic multimarket contact (MMC) are able to augment their performance. 3. firms of low centrality will extract performance benefits from enhancing bargaining power as a result of exploiting brokerage opportunities in open networks
Stam & Elfring, 2008*	Social network theory	Centrality, bridging ties, entrepreneurial orientation, performance	Closeness centrality is measured with UCINET VI (Borgatti et al., 2002). Bridging ties are measured by counting ties with different kinds of organizations.	While bridging ties positively influence performance, centrality is negatively related to performance.
Sykes, Venkatesh, & Gosain, 2009	Social network theory, knowledge transfer	Network density, centrality, system	Density is measured by the number of ties divided by the number of possible pairs. Centrality measure is adopted from (Bonacich, 1987).	Both network density and centrality are positively related to system use.
Tortoriello & Krackhardt, 2010	Knowledge transfer	Strength of tie, Simmelian tie, innovation	Strength of tie is measure by frequency. Simmelian tie is measured by formulation provided in(Krackhardt, 1998).	In the context of cross boundary relationships, the positive effects of bridging on innovation reflect the specific features of a subset of network ties: Simmelian ties.

Tsai, 2001	Organizational learning, network theory	Centrality, absorptive capacity, innovation, performance	Innovation: the number of new products introduced in a unit in a particular year divided by the unit's target number in that year. Performance: a unit's return on investment in a particular year divided by its target return in that year. Centrality: the total number of units from which a focal unit has received knowledge.	1. Centrality and absorptive capacity have significant, positive effects on business unit innovation. And 2. Centrality works together with absorptive capacity to influence unit performance.
Uzzi & Gillespie, 2002	Social embeddedness theory	Duration of relationship, degree of multiplexity in relationship, size of network	Duration: the log of the number of years of the longest relationship. Multiplexity: the number of business and services used by the entrepreneur. Network size: a log of the count of the number of banks a firm uses.	Small-to medium-sized firms with embedded ties (duration, multiplexity, and size) were more likely to take lucrative early-payment trade discounts and avoid costly late-payment penalties than were similar firms that lacked embedded ties.
Vanhaverbeke, Duysters, & Noorderhaven, 2002	Transaction-cost theory	Prior ties, network distance, network centrality, alliance history	Prior tie is the number of prior strategic alliances. Network distance stands for the shortest path between two firms in the network. Network centrality is operationalized as betweenness centrality.	Previous ties and network distance increase the probability of acquisition. Centrality is positively related to being an acquirer.
Wong & Boh, 2010*	Social exchange and network structure theory	Network size, density, heterogeneity, nonoverlapping contacts, peer reputation	Network size is standardized by dividing the number of tie with the total possible tie. Density is measured by the ratio of the number of ties among contacts to the maximum possible number of ties. Heterogeneity is measured by heterogeneity index (Blau 1977)	Advocate network heterogeneity and nonoverlapping contacts are positively and significantly related to a focal manager's peer reputation.
Wuyts & Geyskens, 2005	Governance structure	Uncertainty avoidance, detailed contract drafting, close partner selection (strong tie), power distance, opportunism,	Close partner selection: our firm work very intensively and had a very close relationship with this supplier; we had a very collaborative relationship, like a real	1. Collectivism is positively related to use of strong tie. 2. There is a U-shaped relationship between strong tie and opportunism.

		network embeddedness	team. Network embeddedness: our firm worked very intensively and had a very close relationship with one or more partners of this supplier; we had a very collaborative relationship with one or more partners of this supplier, like a real team.	
Wuyts, Stremersch, Van Den Bulte, & Franses, 2004*	Transaction cost, trust, complex knowledge transfer	Tie intensity and tie valence, number of ties (centrality)	Intensity and frequency of interaction, and cooperative character of interaction	For complex products, buyers value sequences of strong ties as well as sequences of more numerous weak ties
Zagenczyk, Gibney, Murrell, & Boss, 2008	Social network theory	Strength of advice ties and friendship ties, and organization citizenship behavior (OCB)	Weekly interaction constituted a strong tie.	Strong advice ties between employees were significantly related to similarity in OCB, where weak advice ties and strong and weak friendship ties between employees were not.
Zaheer & Soda, 2009	Structural hole	Content homogeneity, structural hole, status, number of structural holes, team cohesion, performance	Structural hole measure (Burt, 1992), Cohesion is measured by the valued density of ties	Structural holes originate from the prior status and centrality of teams and are associated with superior team performance.
*: Findings with negative effects of network structures				

Summaries:

1. Social networks of firms can bring up both opportunities and constrains (Zaheer & Soda, 2009). For example, strong network ties typified by close and frequent interactions between firms promote the transfer of tacit knowledge, but impede transfer of codified knowledge. Firms with central position in their networks have more opportunities to access new information and resources, but have constrains on changing their position because of inertia.

2. To date, literature on inter-firm relationship has typically stressed the positive effects of embeddedness within networks, but over-embeddedness may generate decreasing returns and impede firms' activities, such as searching for new partners and dissolution of extant partnerships (Hagedoorn & Frankort, 2008).

3. There is a trend that researchers are developing contingencies on effects of networks, such as knowledge relatedness (Hansen, 2002), bridging ties (Stam & Elfring, 2008), clustering (Schilling & Phelps, 2007), digital communication network (Robert et al., 2008), geographic propinquity (Owen-Smith & Powell, 2004), and Simmelian tie (Tortoriello & Krackhardt, 2010). Thus, effects of networks in a specific environment are related to characteristics of that environment.

4. Some links between networks and knowledge transfer have been established (Argote, McEvily, & Reagans, 2003). New research focuses on knowledge creation (McFadyen et al., 2009) and knowledge integration (Robert et al., 2008; Tortoriello & Krackhardt, 2010).

Strategic Alliance

Strategic alliances are defined as "voluntary arrangements between firms involving exchange, sharing, or co-development of products, technologies, or services" (Gulati, 1998, p293). A strategic alliance involves at least two firms, which remain legally independent, share benefits and managerial control over the assigned tasks of the alliance, and make continuing contributions in strategic areas (Todeva & Knoke, 2005). Strategic alliances are presented in many different forms, which are considered "hybrids" that combine varying degree of hierarchical relations (one firm acquires or mergers another firm) and market relations (arm's-

length transactions coordinated only through the price mechanism) (Todeva & Knoke, 2005). There exist a variety of forms of strategic alliance, such as joint ventures, equity investments, R&D consortia, franchising, and licensing (see Todeva and Knoke 2005 for a comprehensive view of basic forms of strategic alliance).

Organizational literature on strategic alliance mostly focuses on explaining why firms enter into alliances, what are the outcomes of alliances, and what factors influencing alliance success. The reasons to enter alliances include reduced uncertainty, risk and opportunism, access to resources and legitimacy, and opportunities for learning and innovation (Borgatti & Foster, 2003; Gulati, 1998). Research on the outcomes of strategic alliances takes a variety of forms. Some researchers focus on the stock market effects of alliance announcements and found mixed results (Balakrishnan & Koza, 1993; Koh & Venkatraman, 1991). Others look at the effects of alliances on the likelihood of firm survival and generally suggest a beneficial impact (Baum & Oliver, 1992; Brian Uzzi, 1996). There are also studies that focus on other forms of outcomes, such as performance of startups and new firms, firm valuations, organizational learning, and innovation (Borgatti & Foster, 2003).

Research on factors influencing alliance success is also proliferated. For example, Lei and his colleagues suggest a group of factors related to the outcomes of organizational alliance learning, including "the nature of the shared business activity, the type of knowledge jointly developed, and the firm's reward system" (Lei, Slocum, & Pitts, 1997, p210). Kale et al. (2000) found that strong relations and effective conflict resolution mechanisms can significantly increase the opportunities of corporate learning and avoid loss of proprietary assets. Gulati (1988) summarizes a set of general rules for alliance success, including "flexibility in management of

the alliance, building trust with partners, regular information exchange with the partners, constructive management of conflict, continuity of boundary personnel responsible for the interface between the firm and the alliance, managing partner expectations, and so on" (p306) .

This study focuses on strategic alliance because over the last twenty years researchers have accumulated a mass of studies on this topic (see Gulati, 1998 for a review). Moreover, organizational researchers have reached some level of consensus on the significant impacts of strategic alliance on firm-level outcomes (Borgatti & Foster, 2003; Todeva & Knoke, 2005). In IS field, however, researchers have just started to explore in this area. Recent IS studies focus on how IT investments interact with types of strategic alliance to influence firm value (Tafti et al., 2008), how the use of IOS influences the structuring network position of companies (such as structural similarity and centrality) (Chi, Holsapple, & Srinivasan, 2008), how IT-enabled knowledge capabilities interact with alliance network structure (structural holes) to influence firm innovation (Chi, Liao et al., 2010), and how IT-enabled capability interacts with alliance network structures (structural holes and network density) to influence firm competitive actions (Chi, Ravichandran et al., 2010).

2.2.4. Theories of network research

As I discussed above, researchers have proposed dynamic capabilities that integrate, build, and reconfigure internal and external resources (Teece et al., 1997), and net-enabled organizations that embrace digital networks to create customer value (Wheeler, 2002). To advance in this direction and to investigate IT business value in a network environment, two theories of network are particularly relevant to this study: flexible specialization (Piore, 1992; Piore & Sabel, 1984) and social network theory (W. W. Powell, 1990).

Flexible Specialization

At firm level, flexible specialization is also called craft production and defined as "the manufacture of a wide and changing array of customized products using flexible, general-purpose machinery and skilled, adaptable works" (Hirst & Zeitlin, 1991, p3). Its opposite is mass production, namely "the manufacture of standardized products in high volumes using special-purpose machinery and predominately unskilled labor" (Hirst & Zeitlin, 1991, p3). However, this concept is suitably used at network level and describes a form of industrial organization where production is organized around the interactions of a network of small firms, such as 'industrial districts' and large, decentralized companies or groups (Stroper & Christopherson, 1987). In a flexible specialization network, each firm or productive unit is specialized on some small area, but the whole production system is flexible because there are many possible combinations of specialized input-providing firms (Piore & Sabel, 1984). The characteristics of flexible specialization include "the production of a wide range of products for highly differentiated markets and the constant adaptation of goods/services in response to changing tastes and in order to expand markets" (Starkey & Barnatt, 1997, p272). Although the research stream of flexible specialization has been rarely cited in IS research, its concepts have been argued to underlie the current popular organizational forms such as network (Piore, 1992) or virtual organizing (Venkatraman & Henderson, 1998).

There are important values to apply flexible specialization to this study. First, its interpretation of industrial progress provides leads for researchers to understand how to pursue competitive advantages through IT.

"Technology is the embodiment of certain concepts or conceptual frameworks in terms of which we think about transforming resources. Each of the frameworks can be

> thought of as involving a set of abstract principles that tell us how resources can be organized and deployed. The ultimate foundation for technological progress involves the reorganization of our understandings in new, more revealing-hence more powerful-conceptual frameworks" (Piore 1992, p.440).

Originally the resources are understood at some physical level and technology includes know-how to transform resources. Accordingly, this definition explains IT value as providing new, and more powerful conceptual frameworks to transform resources. Second, flexible specialization is cognition-oriented. It argues that specialization contributes to economic growth by three ways: deepening knowledge, transferring conceptual frame, and inventing new conceptual frame (Piore, 1992). Thus, it supports the argument that network learning is a source of competitive advantages (Gulati, 1999; Kogut, 2000). Finally, flexible specialization argues that innovation also comes from integration among operations. It provides a reasoning why IT can cause innovation by facilitating cooperation and coordination in a network. However, the limitation of flexible specialization is that it tends to only provide a suggestive guideline at some macro-level to broad trends in industrial reorganization, rather than testable hypotheses at the micro-level (Hirst & Zeitlin, 1991).

Social Network Theory

The perspective of social network theory argues that a network form of organizations is a viable pattern of economic arrangement with unique logics of communication and exchange (Borgatti & Foster, 2003). Compared with market and hierarchy form, the network form is more dependent on relationships, mutual interests, and reputations, and is especially useful for the exchange of intangible commodities, such as know-how, technological capability, or a spirit of innovation or experimentation (W. W. Powell, 1990). The perspective of social network theory acknowledges the existence of opportunism behaviors; however, unlike transaction cost

perspective, which regards opportunism as the determinant of form of organization, this perspective treats the opportunism behaviors as nonomnipotent (Wareham, 2003) and emphasizes on shared benefits and burdens (W. W. Powell, 1990) . The basic assumption here is that "one party is dependent on resources controlled by another, and that there are gains to be had by the pooling of resources" (Powell 1990, p.302).

The perspective of social network theory is important for this study for several reasons. First, it offers a mechanism to pursue competitive advantage in a network environment. Here reputation, friendship, interdependence, and altruism become the cornerstones of a successful network. Second, it identifies a network as a locus of resources (Chi et al., 2007; Gnyawali & Madhavan, 2001), and also a locus of innovation through learning (W. W. Powell, Koput, & Smith-Doerr, 1996). Finally, IS research has slowly begun to embrace this perspective (Wareham, 2003) and there is a need to examine IS phenomenon with it (Kumar et al., 1998). There are criticisms of social network theory. First, it focuses on relationships at the expense of other concerns, such as politics and institutions (Smith-Doerr & Powell, 2003). Second, the definition of reciprocity, one of the core concepts of social network theory, is rather ambiguous (W. W. Powell, 1990). Finally, the focus on the structure of relationships treats all ties as comparable, without regard to their content or context (Goodwin & Emirbayer, 1994). Table 6 provides a summary for flexible specialization and social network theory.

Table 6. Summary for flexible specialization and social network theory

	Flexible specialization	Social network theory
Thesis	Firms gain growth by specialization and embeddedness of networks which support production of a wide range of products by flexibly combing input-providing firms inside it.	Network form is a viable pattern of economic organization with unique logics of communication and exchange, such as relationships, mutual interests, and reputation
Role of IT	IT provides new and powerful conceptual frameworks to transform resources and supports	IT expands and enrich social network by facilitating communication and

	both specialization and network embeddedness	collaboration.
Limitations	It only provides a conceptual framework. No operations or specific constructs are available.	1. It focuses on relationships at the expense of other concerns. 2. Its core concept of reciprocity is ambiguously defined. 3. It treats all ties as comparable.
Implications for this study	1. It clarifies the role of IT as providing conceptual frameworks to transform resources. 2. It suggests network learning as are source of competitive advantages. 3. It points out that innovation comes from integration among operations inside a network.	1. It offers mechanisms, such as reputation, friendship, interdependence, and altruism, to explain competitive advantages in a network environment. 2. It proposes network as a locus of resources and emphasizes on network learning.

CHAPTER 3

RESEARCH MODEL AND HYPOTHESES

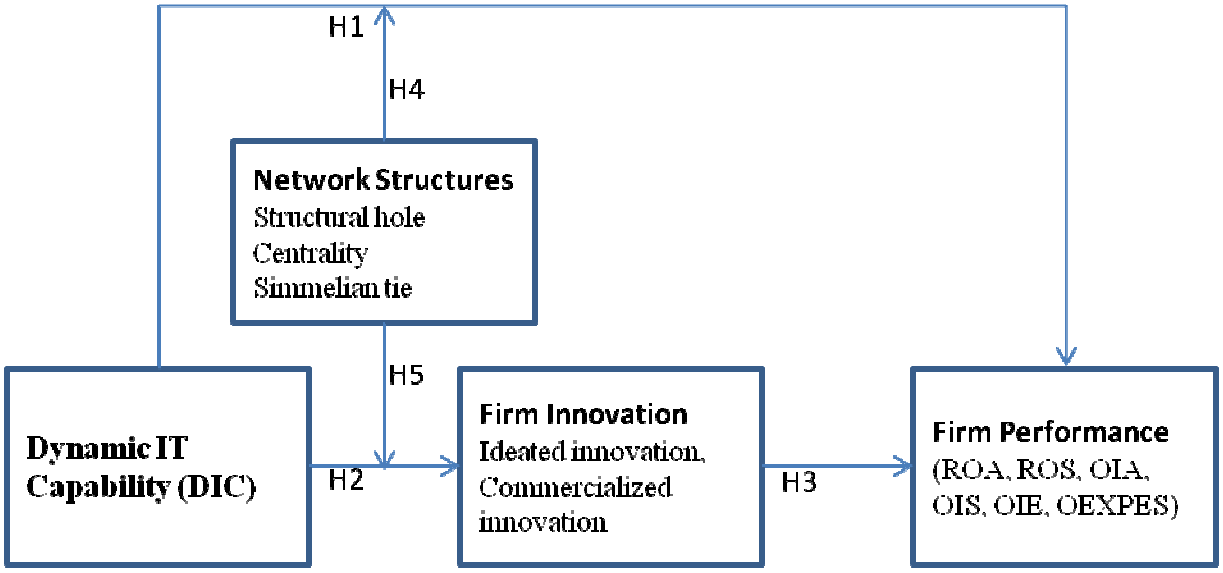

Figure 4. Research model

Figure 4 describes the research model. The core of this study is the concept of dynamic IT capability (DIC). I conjecture that DIC of a firm directly contributes to firm performance. At the same time, DIC can also indirectly contribute to firm performance through the mediation of firm innovation. The second focus of this study is the interaction between DIC and network structures related to a firm in a network environment. Based on organizational and IS theories (i.e., dynamic capabilities theory and flexibility specialization theory), I argue that the interaction between DIC and network structures is positively associated with firm performance and firm innovation. I will elaborate these arguments further below.

3.1. DIC, Firm Innovation, and Firm Performance

As discussed early, DIC indicates the ability of a firm to build and refresh its IT resources to support business processes. In essence, DIC is a type of IT capability. The link between IT capability and firm performance can be found in some studies. For example, Bharadwaj (2000) demonstrates that firms with high IT capability can gain superior financial performance. In her study, Bharadwaj used the term "IT leaders" to indicate superior IT capability. As she stated,

> While the IT leader are not ranked on specific IT resources or skills, firms are peer-ranked on the basis of the overall IT strengths. Thus, firms that are known to have successfully launched innovationative or strategic applications or who have a strong reputation for being a technology leader tend to be randed as the leaders (p177).

Based on this description, one can see that the concept of IT capability indicates the superior ability of firms to use IT resources, other than merely owning IT resouces. IT leaders are judged by having "successfully launched innovationative or strategic applicaitons". This point is reflected in the the definition of DIC as dynamically building and refreshing IT resources to support business processes.

Other researchers also have built a link between IT capabilities and firm competitive advantages. For example, Bhatt and Grover (2005) found that IT business experience and relationship infrastructure have significant effect on competitive advantage (perception of relative performance with respect to the competitors). Pavlou and Sawy (2006) introduced the construct of IT leveraging competency (the ability to effectively use IT functionalities) and showed that the effective use of IT functionalities can help build a competitive advantage (new product development). Barua and his colleagues (2004) proposed online informational capabilities (the ability of a firm to exchange strategic and tactical information with customers

and suppliers on demand) and demonstrated its effect on financial performance of net-enabled companies. But those studies either did not focus on using *IT resources* themselves, or did not directly targeted on firm performance in essence.

DIC also is a type of dynamic capability. Dynamic capabilities theory (Eisenhardt & Martin, 2000; Teece et al., 1997) argues that firms have to continously integrate, build, and reconfigure internal and external resources to address rapidly changing environments. This is specially true for IT resources. As IT continosouly advances, we are obtaining more and more powerful computing capability and seeing the emergence of all kinds of new technologies, such as Web 3.0, virtualization, and cloud computing. Moreover, today firms need to serve customers born in what is called generation V (Generation Virtual or Virtual Generation) (Sarner, 2008). It is hard to imagine that a firm can satisfy these customers' needs without making use of new technologies.

Although DIC is process-oriented, it should not be equated to a measure of IT impact on process-level, as argued in one IT business value research stream (Tallon, 2008; Tallon & Kraemer, 2006). What is concerned in the concept of DIC is the ability to use new and/or existing IT resources to improve all business processes, rather than a specific, or separate business process. For example, Rajiv Kohli & Hoadley (2006) recorded three cases in which three firms use IT resources to redesign business process (so called IT-enabled BPR). Only one firm achieved its designed purpose and two firms failed because of ambiguous focus. In this example, the firm with successful IT-enabled BRP demonstrates superior DIC.

The idea of DIC is to use IT resources to support business processes. Owning a technology is not the purpose, no matter it is a new or old technology. Certainly, a firm not only

can make use of new technologies to improve business processes, but also can integrate existing IT resources, such as developing middleware to connect old mainframe-based applications with new web-based applications. If the consequences of using technologies are not associated with improvements on business processes, a firm does not possess superior DIC, no matter how many new technologies are used. In other words, DIC contributes to firm performance with improved or enhanced business processes, rather than by just owning or using new technologies as IT resources. Therefore, I hypothesize that:

Hypothesis 1. DIC is positively related to firm performance.

As cited in Joshi et al. (2010), innovation is defined as "the design, invention, development and/or implementation of new or altered products, services, processes, systems, organizational structures, or business models for the purpose of creating new value for customers and financial returns for the firm" (Advisory Report to the Secretary of Commerce of the United States 2008, pi). It is frequently used as an important weapon for firms to compete in a rapidly changing environment (Danneels, 2002). The outcomes of innovation, such as patents and new product and service introductions, indicate the aggressive actions that firms launch to gain market share and/or achieve profitability (Ferrier, Smith, & Grimm, 1999; Smith, Ferrier, & Ndofor, 2001). They can dramatically change the competitive landscape in a market by disrupting existing markets and creating new opportunities (Aboulnasr, Narasimhan, Blair, & Chandy, 2008).

Recently, scholars have started to establish the link between IT and innovation from different perspectives. For example, based on absorptive capability theory, a group of scholars introduce and develop the concept of IT-enabled knowledge capability, which is defined as the

ability that “IT enables the creation, dissemination, and use of knowledge, thus greatly augmenting and enabling firms’ knowledge capabilities” (Joshi et al., 2010, p473), and demonstrate that this capability contributes to firm innovation (Chi, Liao et al., 2010). Others focus on the business process level of analysis and introduce the concept of IT leveraging competence, which is defined as the ability to effectively use IT functionalities, and argue that the effective use of IT functionalities in new product development processes can help firms build a competitive advantage (Pavlou & Sawy, 2006). Another research stream focuses on the relationship between IT and organizational learning and argues that the extent to which a firm effectively utilizes IT to manage information is positively related to organization learning (Tippins & Sohi, 2003).

This study explores the relationship between IT and firm innovation from a perspective of DIC. Existing studies have demonstrated that IT can contribute to firm innovation through supporting knowledge acquisition, assimilation, transformation, and exploitation (Chi, Liao et al., 2010; Joshi et al., 2010). Examples of IT supporting knowledge acquisition and assimilation include applications such as enterprise resource planning systems, customer relationship management systems, supply chain management systems, and databases. Examples of IT supporting knowledge transformation and exploitation include applications such as business intelligence, data analytics, data mining, decision support systems, and online analytical processing (Joshi et al., 2010). The argument of the DIC perspective is that IT resources used in supporting firm innovation are in a dynamic building and refreshing process. The underlying logic is that firms should not be limited by what IT resources they already own, but should

continuously pursue opportunities to build new IT resources or to use existing IT resources in new ways such as integrating and improving business processes for firm innovation.

For example, Pfizer, a pharmaceutical company, was continuously looking for opportunities to use IT to facilitate its innovation processes. It was an active member in the Globus Alliance, a consortium formed by IBM, Sun Microsystems, Hewlett-Packard and Intel for improving the Globus Tooklit, the open-source development project and a pioneer to use grid computing in drug research in 2001(Thibodeau, 2005). It also used data-grid software to give its researchers a centralized view of distributed data and facilitate data-sharing in 2002 (Thibodeau, 2004). When IBM released a new version of DataStage 7.5, a data integration and management application in 2005, Pfizer almost immediate decided to use it to enable data integration (Songini, 2005). In the three examples above, Pfizer not only actively embraced new technology, such as grid computing, but also looked for opportunities to integrate existing database and enable data sharing in order to facilitate innovation. Those examples indicate that Pfizer had superior DIC for pursuing innovation and developing new products. Based on these discussions, I propose that:

Hypothesis 2. DIC is positively related to firm innovation.

Organizational literature has long concluded that in general innovation is positively related to firm performance and especially to firm survival (Brown & Eisenhardt, 1995; Christensen & Bower, 1996; Clark & Fujimoto, 1991; O'Reilly & Tushman, 2004; Teece et al., 1997). The emergence of innovation in the form of new ideas, patents, products and services can significantly disrupt existing markets and create vast new market opportunities (Aboulnasr et al., 2008). In fact, managing innovation to survive and grow has been widely investigated for

decades and empirical evidences have indicated that it has a positive impact on firm performance (Burns & Stalker, 1961; Chandler, Keller, & Lyon, 2000; Zahra & Neubaum, 1998).

Innovation is especially important in a rapidly changing environment (Danneels, 2002). According to RBV, when firms own resources that are valuable, rare, inimitable, and nonsubstitutable, they can achieve sustainable competitive advantages (Barney, 1991). But in a rapidly changing environment, sustained competitive advantages have been seen as unlikely (D'Aveni & Gunther, 1994) and innovation has been argued as needed to survive and maintain profitability (Hamel, 2000; Hult, Jr, & Slater, 2005). Moreover, researchers have suggested that innovation should be included as the antecedents of financial performance in any relevant studies (McWilliams & Siegel, 2000). Thus, I propose that:

Hypothesis 3. Firm innovation is positively related to firm performance.

3.2. Interaction between DIC and network structures

Literature on the effects of interaction between IT and network structures on firm performance and firm innovation so far has been very limited. But the two concepts are almost institutively related from several aspects. First, they have important focuses in common. Firm performance and firm innovation are two of the most important dependent variables in both IS literature (e.g., Barua et al., 2004; Dehning et al., 2003; Ravichandran & Lertwongsatien, 2005; Ray et al., 2005) and network study literature (e.g., Lin, Yang et al., 2007; Paruchuri, 2010a; A. V. Shipilov, 2009; Tsai, 2001). Second, both concepts are frequently used to address rapidly changing environments (Gulati, 1998; Sambamurthy et al., 2003). Third, both concepts are resources based and related. The basic logic underlying strategic alliance networks is resource-interdependence (Gulati, 1995). One of the most important theories for IT business research is

resource-based view (RBV). Thus, the interaction between IT and network structures should be an intriguing topic for IS researchers.

The interaction effects between IT and network structures can be investigated from different perspectives. An early case study recorded the failure of an IOS implementation in a dense network (Kumar et al., 1998). Based on that case, Kumar and his colleagues argued that there should be a third rationality (i.e., that of relationships and trust) of information systems to explain the IT phenomena in networks. In that study IT negatively interacted with network structures because the purpose of using IT was to facilitate collaboration but collaboration is already a basic characteristic in a dense network (W. W. Powell, 1990). A recent study took a perspective of IT-enabled capability to investigate the effects between IT and network structures on firm competitive actions (Chi, Ravichandran et al., 2010). Based on the awareness motivation-capability theory, Chi and her colleagues argued that IT-enabled sensing and responding capability moderates the relationship between network structures and competitive actions. They concluded that IT-enabled capability can substitute the effects of structural hole or complement these of network density.

In this study, I take a perspective of DIC. As discussed early, DIC is a type of dynamic capability, which indicates the ability to mobilize and deploy resources for intended purposes. Thus, DIC is one of the internal properties of a firm and indicates its ability to use resources. Network structures indicate the opportunities of a firm in a network to access resources. Hence, they represent the external environments around a firm. Combining these two aspects, I argue that the interaction between DIC and network structures can be understood as the interaction between the internal properties of a firm and the external environments around it. There are three

interesting scenarios. First, a firm with strong internal capabilities develops weak dependence on its external environments. Second, a firm with weak capabilities has to strongly depend on its external environments. Third, a firm with strong capabilities actively explores and exploits its external environments. In this study I focus on the third scenario and argue that a firm with strong DIC can effectively mobilize, deploy, and reconfigure its internal and external resources to support its business processes, and in turn pursue firm innovation and improve firm performance.

According to flexible specialization theory (Piore, 1992), the major reason why firms enter into networks is to obtain access to resources. It means that firms do not want or cannot own all resources they need and have to develop some level of dependence on their networks. But obtaining access to resources is not the purpose. The purpose should be utilizing these external resources with internal resources to support business processes. In addition, the core of DIC is the use of IT resources to integrate and improve business processes. Therefore, DIC should not be simply understood as automating business processes, but should cover business process reengineering (BPR) (Kohli & Hoadley, 2006), such as making business processes more compatible with partners' and providing opportunities for high level process interdependence (Venkatraman & Henderson, 1998). Thus, both obtaining access to partners' resources and effectively using them for business processes are important focuses for firms to enter into networks.

In this study I focus on the interaction between DIC and two types of network structure: centrality and structural hole. Network centrality indicates the position a firm occupies in a network. A straight measure of network centrality is the number of strategic alliances that a firm

has in a network (i.e., degree centrality). Strategic alliances are voluntary agreements for exchange, sharing or codevelopment of capital, technology, or firm-specific assets (Gulati, 1995). It can be understood as the efforts of a firm to occupy a competitive position or obtain market power (Kogut, 1988). A position with higher centrality in a network makes the firm more visible for other members and provides more opportunities for access to partner's resources.

Certainly a firm may choose to own all resources it needs and eliminate its dependence on others' resources. In a rapidly changing environment, however, firms may never be able to predict and secure all resources they needs. Thus, a position with high centrality in a network provides more options for a firm to mobilize and deploy its internal and external resources. Existing studies also provide empirical evidences for the benefits of network centrality. For example, Powell et al. (1996) found that network centrality increase the growth rate of biotechnology start-ups. Baum, Calabrese, & Siverman (2000) reported that biotechnology start-ups with high network centrality obtained access to diverse information and achieved high revenue growth. Thus, I propose that:

Hypothesis 4(a). The interaction between DIC and network centrality is positively related to firm performance.

Unlike network centrality, the concept of structural hole does not rely too much on the number of direct connected partners in a network, but focuses on nonredundant connections (Burt, 1992). According to Burt, nonredundant connections create benefits of nonredundant information and control over unconnected partners. In the context of strategic alliance, nonredundant connections provide opportunities for access to diverse resources and control over the flow of resources. In other words, resources flow not only between dyads, but also flow over

a network. Firms who occupy a position with rich structural holes can obtain access to diverse resources and also control over the flow of these resources to other members who do not have direct access to those resources. Empirical studies also provide evidences that firms are able to extract performance improvements from network positions rich in structural holes (Shipilov, 2009). Thus, I propose that:

Hypothesis 4(b). The interaction between DIC and structural holes is positively related to firm performance.

One of the most important motivations for firms to enter networks is knowledge learning and innovation (Brass, Galaskiewicz, Greve, & Tsai, 2004; Gulati, 1998; Kogut, 1988). The massive network research has reached some level of consensus on this topic. Networks have been treated as locations of resources (Gulati, 1999; Whittington, Owen-Smith, & Powell, 2009), channels and conduits for knowledge spillovers and knowledge transfer (Owen-Smith & Powell, 2004; Tsai, 2001), and loci for knowledge creation (Lavie, 2007; McFadyen et al., 2009). It has been realized that the locus of innovation has to be found in networks, rather than in individual firms (W. W. Powell et al., 1996). With no doubt about the roles that networks play in firm innovation, researchers are interested in questions about how firms can obtain beneficial consequences from their network activities, such as how the tension between cooperation and competition affects the dynamics of learning in networks (Khanna, Gulati, & Nohria, 1998), why firms choose different governance structures across their networks (Gulati & Singh, 1998), and how the portfolios of partners influence value creation in networks (Lavie, 2007).

Recent network research has started to pay more attention to the relationships between network structures and firm innovations. For example, Tsai (2001) analyzed data collected from

24 business units in a petrochemical company and 36 business units in a food-manufacturing company and found that organizational units can produce more innovation if they occupy central network positions. Whittington, Owen-Smith, & Powell (2009) used negative binomial count models of patenting activity for U.S.-based life science firms to examine the joint effects of geographic propinquity and network position on organizational innovation and found that regional agglomeration and network centrality complementarily influence organizational innovation. Schilling & Phelps (2007) conducted a longitudinal study of 1106 firms in 11 industry-level alliance networks and found that the structure of alliance networks influences their potential for knowledge creation and innovation.

This study mainly focuses on the interaction between DIC and network centrality as well as between DIC and structural holes. Early research has points out that firms who occupy a position with higher centrality in a network can obtain more access to resources than firms with lower centrality (Freeman, 1979). But the chances to access resources are not automatically transformed into increased firm innovation and there must be some capabilities through which firms can effectively acquire, assimilate, transform, and exploit knowledge embedded in these resources (Joshi et al., 2010). DIC can contribute to this process by building and refreshing IT resources that support knowledge management initiatives and nurture firm innovation (Alavi & Leidner, 2001).

Literature has reported the functions of IT resources to enable the creation, dissemination, and usage of knowledge and help leverage synergies among disparate knowledge (Chi, Liao et al., 2010; Tanriverdi, 2005). The perspective of DIC specially points out that such IT resources are in dynamic building and refreshing processes. For example, the emergence of social media,

such as Blogs, Wikipedia, and Second Life provides both opportunities and challenges for knowledge learning and collaboration (Bruns, 2008). It is the choice of firms to decide whether, when and how to accommodate such trends, but winners should be those firms who actively explore the opportunities brought by new technologies and effectively use new technologies to build new applications or refresh existing applications to nurture innovation in a favorable network position. Thus, I propose that:

Hypothesis 5(a). The interaction between DIC and network centrality is positively related to firm innovation.

While the concept of network centrality focuses the amount of information a firm may receive in a network, the structural hole emphasizes on the heterogeneity of information and the control of information flow in the network (Burt, 1992). As I have discussed early, structural holes provide external opportunities for firms to obtain benefits from networks, but did not insure that such opportunities will automatically be transformed into benefits. Actually, firms located in position rich in structural holes are facing challenges, such as handling with heterogeneous information and collaborating with partners in different groups (Shipilov, 2009). I argue that DIC can help firms handle those challenges through effective use of IT resources. IS literature has demonstrated that IT resources can support knowledge and facilitate knowledge absorption (Alavi & Leidner, 2001). IT resources also can leverage synergies among disparate, heterogeneous knowledge (Tanriverdi, 2005). With the embedded process-oriented nature, DIC contributes to these aspects by dynamically mobilizing and deploying related IT resources for achieving intended goals.

Existing research found mixed results on the interaction between IT capability and structural holes. Chi and her colleagues (2010) found negative effects on competitive actions and argued that IT capability plays a substitutive role when firm do not have advantageous access to brokerage opportunities (lack of structural holes). They explained that without benefits brought by structural holes, firms still can increase their ability to initiate competitive actions by developing a strong IT capability. In a following-up study, Chi, Liao et al. (2010) found positive interaction between IT-enabled socializing knowledge capability (e.g., e-mail, message boards, and e-community of practice) and structural holes on firm innovation. In this study I argue that structural holes provide access to external resources and at the same time DIC ensures the effective use of these resources. Thus, I propose that:

Hypothesis 5(b). The interaction between DIC and structural holes is positively related to firm innovation.

Besides network centrality and structural holes, in this study I am also interested in exploring the effects of interaction between DIC and another network structure, Simmelian tie, on firm innovation. By definition, two people are involved in a Simmelian tie if both of them are connected at least one third party in common (Krackhardt, 1999). As a dense network structure, Simmelian tie provides benefits such as reduced dissension and moderated conflicts among parties and thus increase stability of network structure (Krackhardt, 1998). In addition, Simmelian tie can facilitate the formation of common languages and shared understanding and promote cooperation among involved parties (Tortoriello & Krackhardt, 2010). Common knowledge and close cooperation are critical for applying knowledge in an across-domain setting and nurturing firm innovation (Carlile & Rebentisch, 2003).

Compared with structural hole and centrality, Simmelian tie is not so popular using in network studies, but a recent study has showed that it plays an important role in activating cross-boundary knowledge transformation and generation of innovation (Tortoriello & Krackhardt, 2010). For the purpose of innovation in the context of strategic alliance network, two roles that Simmelian tie plays in group social networks may have positive effects. First, Simmelian tie can enhance group norms against partner noncooperation (Krackhardt & Kilduff, 2002). Second, Simmelian tie can promote the formation of shared understanding and facilitate knowledge transformation (Tortoriello & Krackhardt, 2010). In addition, DIC facilitates the deployment and reconfiguration of IT resources that support knowledge management and nurture innovation (Alavi & Leidner, 2001). Thus, I propose that:

Hypothesis 5(c). The interaction between DIC and Simmelian tie is positively related to firm innovation.

CHAPTER 4

METHODOLOGIES

I collected secondary data for DIC from multiple data sources. As argued by IS scholars, although primary data collection through survey is valuable for assessing IT initiatives, it suffers from common method bias (Joshi et al., 2010). For example, it significantly depends on respondents' perceptions. Researchers have pointed out that perceptions of IT initiatives may not be consistent with actual implementation and launch of IT initiatives because of the difficulty of respondents to recall past events (Devaraj & Kohli, 2003) and also because of the biased selection of perceptions due to respondents' individual preferences (Joshi et al., 2010). Moreover, as widely realized, the impact of most IT initiatives is usually suffered from time lags (Kohli & Devaraj, 2003). It is not feasible to ask respondents to evaluate firm performance this year and recall IT initiatives last year or the year before last year. In addition, this study is designed as a longitudinal study with a span over 15 years. It is unrealistic to expect that respondents could provide accurate information of IT initiatives over so many years.

Although using secondary data is perhaps the most feasible method for this study, I recognize the limitation of secondary data collection due to media bias derived from unbalanced media attention and reports about different companies across different industries. I address this limitation with two approaches. First, I carefully selected the sample companies so that they are comparable as much as possible. Second, I carefully selected the range of data sources from existing literature to ensure a reasonable and balanced coverage of targeted companies. The details about selection of sample companies and data sources will be described in the following subsections.

4.1. Sample selection

This study focuses on IT business value in network environments. There are several important concerns for the sample selection process. First, these companies should be actively involved in network environments, such as having at least five[7] strategic alliances in all recent years (2007, 2008, and 2009) in the targeted study timeframe. Second, to avoid unbalanced media attention, these companies should be leaders in their industry or included in Fortune 500 or S&P 500, and should be public companies in the U.S. Third, these companies should not lose their identity through acquisition or merger during the 15-year time span (1994 – 2008). Fourth, because firm innovation is included as an important mediator in this study, the sample companies should be located in industries that report some level of R&D spending in their annual statements. Fifth, because this is a cross-industry study, there should be a balanced representation of companies from different industries; that is, companies in some industries should not be over-represented. Based on these criteria, I obtained a sample of 26 companies across 19 industries as presented in Table 7.

Table 7. Sample companies

Industry SIC	Industry description	Number of companies	Name of companies
2531	Public Building and Related Furniture	1	Johnson Controls Inc
2820	Plastic material, synth resin/rubber, cellulos (no glass)	1	DuPont
2834	Pharmaceutical Preparations	4	Bristol-Myers Squibb Co , Merck & Co Inc, Eli Lilly & Co, Pfizer Inc
2836	Biological Products, Except Diagnostic Substances	1	Sigma-Aldrich Corp
3571	Electronic Computers	1	Dell Inc
3572	Computer Storage Devices	1	EMC Corp
3579	Office Machines, NEC	1	Pitney Bowes Inc
3663	Radio and Television Broadcasting and Communications Equipment	2	Harris Corp, QUALCOMM Inc
3674	Semiconductors and Related Devices	1	Advanced Micro Devices Inc

[7] The number of five is an empirical choice with the sample size concern.

3760	Guided Missiles and Space Vehicles	1	Lockheed Martin Corp
3812	Search, Detection, Navigation, Guidance, Aeronautical, and Nautical Systems and Instruments	1	Raytheon Co
3944	Games, Toys, and Children's Vehicles, Except Dolls and Bicycles	1	Hasbro Inc
4841	Cable and Other Pay Television Services	1	Comcast Corp
5045	Computers and Computer Peripheral Equipment and Software	2	Tech Data Corp , Ingram Micro Inc
6199	Finance services	1	American Express Co
7370	Services-computer programming, data processing, etc.	1	Yahoo! Inc
7372	Prepackaged Software	3	Autodesk Inc, Electronic Arts Inc , McAfee Inc
7373	Computer Integrated Systems Design	1	Unisys Corp
7374	Computer Processing and Data Preparation and Processing Services	1	Acxiom Corp

4.2. Construct operationalization/measurements

Table 8 summarizes the operationalizations of constructs in the proposed model. DIC is measured with data collected from leading news sources of Lexis-Nexis. Network structures are measured by data collected from the SDC database. Firm innovation is measured with data collected from Espacenet and FACTIVA database. Firm performance and control variables are measured with data collected from COMPUSTAT. I will elaborate each of them in the follow subsections.

Table 8. Construct operationalization

Construct operationalization		
Variables	Definition	Measurements
Dynamic IT capability	The ability to build, integrate, and upgrade IT resources to improve, enhance, and reengineer business processes as responses to rapidly changing environments	The number of IT initiatives launched to improve business processes
Structure Hole	Bridging ties that link network actors otherwise not connected to one another (Burt, 1992)	The number of ties a firm owns that do not cross with other ties within 2 network levels
Centrality	The extent to which the focal actor occupies a strategic position in the network by virtue of being involved in many significant ties" (Gnyawali & Madhavan 2001, p.434).	Degree centrality: the total number of ties that a firm owns

Simmelian Tie		A tie is Simmelian when the parties involved are reciprocally and strongly tied to each other and they are both reciprocally and strongly tied to at least one common third party (Krackhardt, 1998)	The number of ties that cross at the first network level
Firm Innovation	Ideated innovation	Knowledge that is created through firms' innovation efforts and embodied in forms such as inventions, discoveries, developed ideas, and/or solutions of technical problems.(Joshi et al., 2010)	The number of patens that a firm filed in that year
	Commercialized innovation	Brings ideated innovation to market (Joshi et al., 2010)	The number of new product & service announcements.
Firm profitability		Return on assets (ROA)	Net income / total assets
		Return on sales (ROS)	Net income / sales
		Operating income to assets (OI/A)	Operating income / total assets
		Operating income to sales (OI/S)	Operating income / sales
Employee profitability		Operating income to employees (OI/E)	Operating income / number of employees
Cost of operations		Operating expenses to sales (OPEXP/S)	Operating expense / sales

4.2.1. Dynamic IT capability

Table 9 below provides a summary of the operationalization of IT capabilities in a set of recent IS studies. A number of prior studies have suggested that collecting secondary data to assess IT capabilities is a feasible approach (e.g., Chi et al., 2007; Chi, Ravichandran et al., 2010; Joshi et al., 2010; Sabherwal & Sabherwal, 2007). Especially, two major popular computer journals, Computerworld (CW) and InformationWeek (IW) have been argued to cover 80%-90% of the news about various IT practices in the U.S. (Bharadwaj, 2000) and have been used as the major data sources in a number of other studies (e.g., Bharadwaj, Bharadwaj, & Konsynski, 1999; Brynjolfsson & Hitt, 1996; Lichtenberg, 1995). Following these prior studies, I adopted LexisNexis database, which includes major computer journals, such as CW, IW, and eWeek, as the data resource for this study. To measure DIC, I counted the number of IT initiatives launched

by a firm in each year for different business processes. The categories of business processes are adopted from Porter's (1985) value chain activities, with combining inbound, outbound and procurement into a single category as supply chain (see Table 10).

Table 9. IT capabilities operationalization

Studies	Term	Definition	Measures	Methodology	DV
Bharadwaj (2000)	IT capability	The ability to mobilize and deploy IT-based resources in combination or copresent with other resources and capabilities	IT leader	Data from InformationWeek	Financial performance: return on assets, return on sales, total operating expenses to sales, cost of goods sold to sales, and selling and general administrative expenses to sales.
	IT-based resources	(1)the tangible resource comprising the physical IT infrastructure components,(2) the human IT resources comprising the technical and managerial IT skills, (3) the intangible IT-enabled resources, such as knowledge assets, customer orientation, and synergy			
	IT infrastructure	A shared information delivery base, the business functionality of which has been defined in terms of its reach and range. While the reach determines			

		the locations that the platform can access and to which it can link, its range defines the kind of information that can be seamlessly and automatically shared across systems and services.			
	Human IT resources	IT comprises the training, experience, relationships, and insights of its employees. (1) technical IT skills, such as programming, systems analysis and design, and competencies in emerging technologies, and (2) the managerial IT skills, which include abilities such as the effective management of IS functions, coordination and interaction with user community, and project management and leadership skills.			
Bhatt & Grover (2005)	IT capabilities	The ability to mobilize and deploy IT-based resources in combination or copresent with	Include IT infrastructure, IT business experience, and relationship infrastructure	11200 senior IT executives (CIO, vice president of IT, and director of IT) randomly selected from a	Competitive advantage of the firm: relative performance with respect to the competitors

		other resources and capabilities		directory of 3000 manufacturing firms supplied by a marketing vendor. 17% response rate.	for the past three years (financial performance and sales growth), and performance for the past three years (profitability, financial performance, and sales growth)
	IT infrastructure	Extent to which systems are compatible, are modular, are scalable, are transparent	The extent to which systems are compatible, are modular, are scalable, are transparent, are the extent to which systems can handle multiple applications, and use commonly agreed IT standards		
	IT business experience	Extent to which IT groups understand business	The extent to which IT groups are knowledgeable about business strategy, competitive priorities, business policies, business opportunities, and initiate change in the organization		
	Relationship infrastructure	Extent to which there are positive relationships between IT and business managers	The extent to which IT groups and line management trust, appreciate, consult with, account for, and respect each other in setting business and IT strategy		
	Intensity of organizational	It is an organizational	Knowledge exploration: the		

	learning (dynamic capabilities)	capability and involves accumulation, sharing, and application of knowledge.	ability of the firm to search and acquire new and relevant knowledge. Knowledge exploitation: the ability of the firm to assimilate and apply relevant knowledge. Focus: the extent of concerted efforts for the exploitation of existing competences and exploration of new knowledge		
Lei Chi, Liao et al.(2010)	IT-enabled capability	Enhances firms' ability to sense their environment and respond to opportunities and threats speedily	IT-enabled sensing capability: knowledge-oriented IT applications and partner scope; IT responding capability: process-oriented IT applications and business function scope	Data collected from a number of popular computer journals, such as Computerworld, Networkworld, eWeek, ITweek, Inforworld, and InformationWeek	Competitive action
Dehning et al. (2003)	IT investment		IT investments announcements	Data collected from prior researchers	Three-day cumulative abnormal returns
Joshi et al. (2010)	IT-enabled potential absorptive capability	Information technologies help support knowledge acquisition and assimilation	Analytical software; business intelligence; data analytics; data mining; simulation	Data collected from a number of popular computer journals, such as Computerworld, eWeek and InformationWeek	Firm innovation

			software; decision support system; digital dashboard; online analytical processing; visualization.		
	IT-enabled realized absorptive capability	Information technologies help support knowledge transformation and exploitation	Enterprise resource planning system; Customer relationship management system; Supply chain management system; Database; Content management system; Repository; Information retrieval or search software; Data reading system.		
	IT-enabled realized social integration capability	Enables the development of social capital through direct human interactions and discourse	Collaboration technology; e-community of practice, Web 2.0, groupware; messaging service; computer conferencing; video conferencing; Web conferencing.		
Pavlou & Sawy (2006)	IT leveraging competence	The ability to effectively use IT functionalities to support IT-	Please rate effectiveness by which your NPD work unit	554 participants at the 2002 PDMA (product development and	NPD competitive advantage: product

		related activities in new product development (NPD)	uses the following IT functionalities in the NPD process: 1.overall effectiveness of using IT functionality in the NPD process, 2. Overall adequacy of utilizing IT tools in the NPD group	management association) conference and 161 participants of the 2003 roundtable management conference. Key respondents were NPD managers. 39% and 43% response rate.	effectiveness (quality and innovativeness) and process efficiency (time to market and low cost)
	Dynamic capabilities	The ability to integrate, build, and reconfigure existing functional competencies to address turbulent environments	Please rate the effectiveness of your NPD work unit in the following activities relative to your major competitors: 1. Reconfigurability: we can successfully reconfigure our resources to come up with new productive assets; we can effectively integrate and combine existing resources into novel" combinations. 2. Market orientation. 3. Absorptive capacity. 4. Coordination capability. 5.		

			Collective mind		
Ravichandran & Lertwongsa-tien (2005)	IS human resource capital	IS personnel skill IS human resource specificity: the extent to which IS personnel had firm-specific knowledge.	Four items such as our IS staff has very good technical knowledge. Six items such as our IS staff has excellent business knowledge.	Mail survey of Fortune 1000 firms (directory of top computer executives). 18.2% response rate	Firm performance: Operating performance Market-based performance
	IT infrastructure flexibility	Network and platform sophistication Data and core application sophistication	Six items such as the technology infrastructure needed to electronically link our business units is present and in place today. Four items such as the speed of our network infrastructure adequately meets our current business needs		
	Partnership quality	Internal partnership quality: the quality of the	Six items such as critical information and knowledge that		

		relationships between the IS department and other business units. External partnership quality: the relationships the IS department has with vendors and IT service providers.	affect IT projects are shared freely between our business units and IS department. Six items such as we seldom have conflicts with our IT vendors and service providers.		
	IS capabilities	IS planning sophistication: characteristics of the IS planning process, such as the participation of key stakeholders in the planning process. Systems development capability: the quality of the system delivery process and the routines that lead to a reliable and controlled systems delivery process. IS support maturity: the attributes of the support process, such as its responsiveness and service orientation. IS operations capability: the sophistication of	Four-items such as IS planning is an ongoing process in our organization. Six-items such as our systems development process can be easily adapted to different types of development projects. Five items such as we have a mature systems development process, the process is well defined and documented. Six items such as we have automated most systems operation tasks		

		the operations process, such as emergency planning and backup recovery.			
	IS support for core competencies	The extent to which IT is used to support and enhance the development of a firm's market access, integrity-related and functionality-related competencies. IT support for market-access competencies IT support for integrity-related competencies IT support for functionality-related competencies	Four items such as the extent of use of IT including the Internet and the World Wide Web in enhancing the responsiveness to customer service requests. Five items such as reengineering business process. Seven items such as developing new products/ services		
Xiao & Dasgupta (2009)	Dynamic IT capability	IT infrastructure (ITF), Human IT resources (ITH), Intangible IT resources (ITI), IT reconfigurability (ITR)	See below	Senior IT executives, other senior executives, or IT managers were identified through public databases, including Hoover's Company Records, Mergent and Compustat. Incentive is an executive summary of the research findings. Include industry NAICS code 334, 517, 518, 5415, and 5416 (1574	Performance: perceived firm performance (financial and market), and objective firm performance (Tobin's Q and ROA)
	IT infrastructure	An organizations' physical IT assets, including computer hardware, software, communication technologies, and sharable technical platforms and	ITF1. The systems in our IT infrastructure are compatible with each other. ITF2. The systems in our IT infrastructure are modular. ITF3. The systems in our IT infrastructure		

		databases	are scalable. ITF4. The systems in our IT infrastructure are transparent to users. ITF5. The systems in our IT infrastructure can handle multiple applications. ITF6. The systems in our IT infrastructure use agreed upon IT standards.	firms). 183 responses from 134 companies.	
	Human IT resources	IT related skills, including technical skills such as programming skills, and managerial skills such as project management and leadership skills in IT functions.	ITH1. Our employees have strong technical IT skills. ITH2. The technical IT skills of our employees are better than those of our competitors. ITH3. Our employees have strong managerial IT skills (e.g. communications, coordination and interaction with users, and project management, etc). ITH4. The managerial IT skills of our employees are better than those of our competitors.		

	Intangible IT resources	Invisible benefits of IT that indirectly impact organizational effectiveness, such as customer orientation, knowledge assets, and synergy.	ITI1. Our IT resources assist in putting our customers' interests first. ITI2. Our IT resources assist in managing our organization's knowledge assets. ITI3. Our IT resources assist in sharing assets and capabilities across divisions.		
	IT reconfigure-ability	An organization's ability to adjust its IT resources to the fast changing environment	ITR1. We can reconfigure our IT resources to come up with new assets as technology and markets change. ITR2. We often examine and adjust IT resources to better match our product and market areas. ITR3. We can integrate and combine existing IT resources into innovative combinations.		

Table 10. Business processes (extracted from Porter 1985)

Name of process	Description	Examples of IT applications
Operations	Activities associated with transforming inputs into the final product form	Manufacturing system, production scheduling system, equipment-performance optimization
Supply chain	Activities associated with receiving, storing, and disseminating inputs to the product, with collecting, storing, and physically distributing the product to buyers, and with purchasing inputs used in processes	Web-based procurement systems, parts-supply database, warehouse management system
Marketing & Sales	Activities associated with providing a means by which buyers can purchase the product and inducing them to do so	Mobile sale-force applications, sales-force automation, demand management and simulation
Service	Activities associated with providing service to enhance or maintain the value of the product	Answer center/call center, help desk, web-based services
Human resource	Activities involved in the recruiting, hiring, training, development, and compensation of all types of personnel	Virtual web-based training program, employee self-service, human resources systems
Technology development	Activities that can be broadly grouped into efforts to improve the product and the process	Knowledge-management application, data analysis tool with integrates online analytical processing (OLAP), Web-based computational models
Firm infrastructure	Activities used to support the entire chain, including general management, planning, finance, accounting, government affairs, and quality management	Intranet/portal, email system, financial system, accounting system

4.2.2. Network Structures

Data about strategic alliance are collected from the SDC Platinum dataset, which is regarded as one of the most comprehensive sources of data on alliances (Schilling, 2008; Tafti et al., 2008) and widely used for strategic alliance network studies (e.g., Anand & Khanna, 2000; Lavie, 2007; Lin, Yang et al., 2007). For this study, I first identified alliances formed by the 26 companies in each year (first level), and then searched for the alliances formed by their partners (second level). The total numbers of alliances vary each year, but the range for the first level is about 300-400 alliances and for the second level is about 6000-7000 alliances. Because the (third-level) alliances formed by these second-level partners will be a much bigger number, I only conducted analysis based on the first two levels of alliances.

There are several ways to calculate network structures, such as the ones proposed by Freeman (1979) and Bonacich (1987). There are also several software available, such as UCINET (Borgatti et al., 2002) and EgoNet (an open source software). But these methods miss some important information. For example, the calculation of structural hole mostly focuses on the idea of redundant information and ignores the role of the bridge. In this study I followed the definitions of the original authors, Freeman (1979) and Burt (1992), and used a straightforward method to calculate network centrality, structural hole, and Simmelian ties with Visual Basic for Applications (VBA).

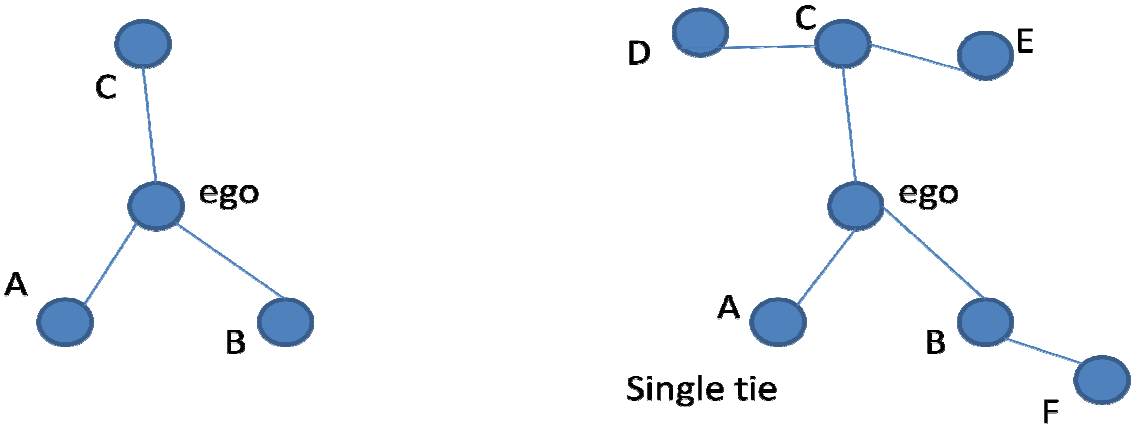

Figure 5. Single tie

First, I introduced the concept of single tie. In both illustrations in Figure 5, the ego (focal company) is involved in alliances with A, B, and C. From the left, the ego only works as a bridge for three connections, AB, AC, and BC. From the right, the ego acts as a bridge for 11 connects, AB, A(B)F, AC, A(C)D, A(C)E, BC, B(C)D, B(C)E, C(B)F, D(CB)F, and E(CB)F (this idea is called betweenness centrality in Freeman 1979). The diffidence between these two illustrations is whether the partners at the first level (e.g., A, B, and C) are involved in alliances with partners in

the second level (e.g., D, E, and F). Thus, to be in an effective position in a network, single tie should be avoided. In this study I adjusted the degree centrality (the number of direct alliances) and structural holes (the number of unconnected partners at the both level 1 and level 2) by using the ratio of them with the number of single tie.

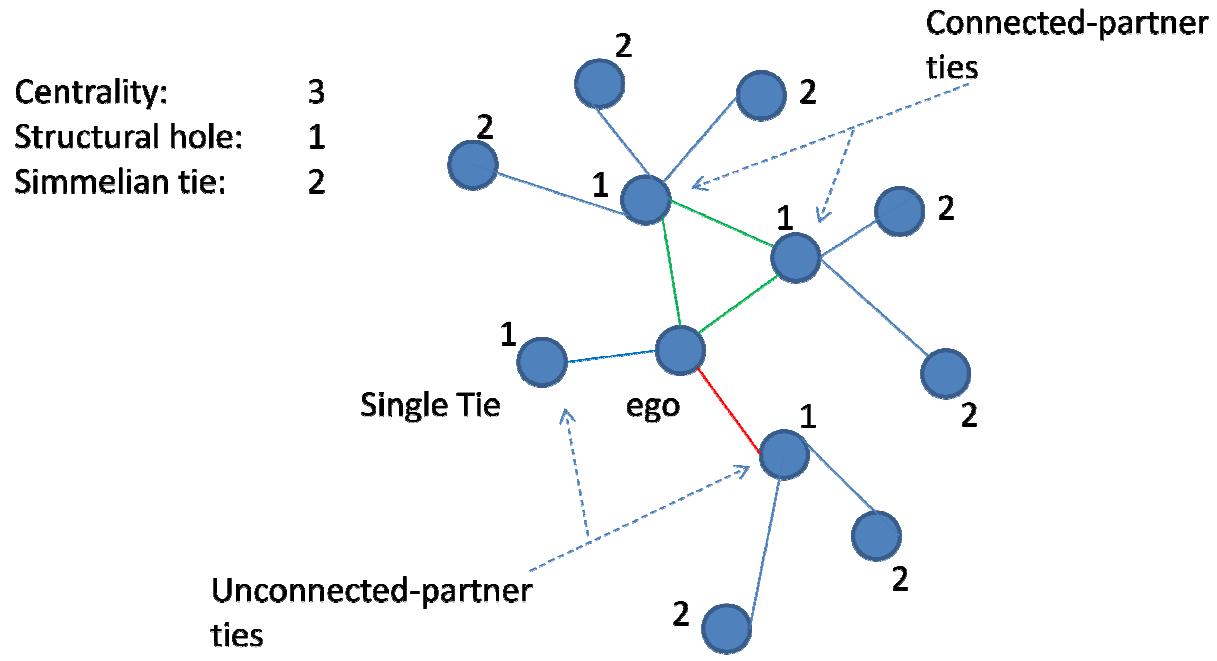

Figure 6. Centrality, structural hole, and Simmelian tie

Figure 6 illustrates an example of calculations of centrality, structural hole, and Simmelian tie in this study. It is a two-level network. The ego has four direct partners and one of them is single tie (no connection at the second level). The centrality (i.e., 3) is calculated using the number of direct non-single ties (i.e., 3) divided by the number of the single tie (i.e., 1). There are two direct partners that are not connected to other direct partners. The number of structural holes is counted using the number of unconnected-partner, non-single ties (i.e., 1) divided by the number of single ties (i.e., 1). The number of Simmelian tie is counted for the number of connected-partner ties that are directly connected at the first level (i.e., 2).

4.2.3. Firm performance

Table 11 provides a review of firm performance operationalization in both recent organizational and IS literature. Basically, there are several ways for operationalizing firm performance: financial profitability (e.g., return on assets and sales growth), stock market value (e.g., stock prices and Tobin's q), and perceptions. There seems to be a trend that non-perceptive measurements are preferred more in organizational literature than in IS literature. In this study I focus on financial performance for several reasons. First, the term "IT business value" implies the profitability measurement of firm performance. Financial performance is widely accepted across different disciplines. Second, even though perceptions of firm performance are also used in existing literature as a reasonable proxy of objective performance, many different sets of perceptions exist, which causes difficulty to compare different studies. Third, even though profitability measurement has been criticized as past-oriented and does not include intangible assets, such as reputations, this study is designed as a longitudinal study and focuses on the past-performance of firms. Moreover, in the long run, intangible assets should be reflected in profitability measurement.

Thus, following prior IT business value studies (e.g., Bharadwaj 2000 and Santhanam & Hartono 2003), in this study I focus on a set of profitability and financial performance measurements, including return on sales (ROS), return on assets (ROA), operating income to assets (OIA), operating income to sales (OIS), operating income to employees (OIE), and operating expenses to sales (OEXPES).

Table 11. Firm performance

Studies	IVs	Firm performance	Operationalization
Ravichandran & Lertwongsatien(2005)	IS human capital, IT infrastructure	Market-based performance	1. We have entered new markets very quickly. 2. We have brought new products

	flexibility, IS partnership quality, IS capabilities, IT support for core competencies		and services to the market faster than out competitors. 3. The success rates of our new products and services have been very high.
		Operating performance	1. Our productivity has exceeded that of our competitors. 2 Our profit has exceeded that of our competitors. 3. Our financial performance has been outstanding. 4. Our financial performance has exceeded that of our competitors
Tallon (2008)	Strategic alignment between business strategy and IT strategy	IT business value in process	How much impact has IT had on your firm's performance in each of the following areas? Please limit your appraisal to value already realized rather than value expected in the future
Dehning et al.(2003)	Announced IT investments	Market value	Stock prices
Santhanam & Hartono (2003); Bharadwaj (2000)	IT leader	Profit ratios Cost ratios	Return on sales, return on assets, operating income to assets, operating income to sales, and operating income to employees Cost of goods sold to sales, selling and general administration expenses to sales, and operating expenses to sales
Ray et al.(2005)	IT spending, flexible IT infrastructure, technical IT skills, generic technologies, and shared knowledge	Relative performance of customer service process	1. The customer service unit gives customers prompt service. 2. Customer service representatives are never too busy to respond to customers. 3. Customer service representatives are empowered to solve customers' problems. 4. When the customer service unit promises to do something for a customer by a certain time, it does so. 5. When a customer has a problem, the customer service unit shows sincere interest in solving it. 6. The customer service unit performs the service accurately the first time. 7. Customer service representatives understand customers' specific needs
Barua et al.(2004)	System integration, process alignment, partner readiness, online informational capabilities, digitization level,	Financial performance	1. Has your company experienced an increase in revenue per employee since it began its electronic business initiatives? What is the percentage increase in revenue per employee? 2. Has your company experienced an increase in gross profit margin since it began its electronic

			business initiatives? What is the percentage increase in gross profit margin? 3. Has your company experienced an increase in return on assets since it began its electronic business initiatives? What is the percentage increase in return on assets? 4. Has your company experienced an increase in return on invested capital since it began its electronic business initiatives? What is the percentage increase in return on invested capital?
Powell et al.(1996)*	Human resources, business resources, technology resources	Information technology performance	1. New information technologies have dramatically increased our productivity. 2. New information technologies have improved our competitive position. 3. New information technologies have dramatically increased our sales. 4. New information technologies have dramatically increased our profitability. 5. New information technologies have improved our overall performance
		Overall company performance	1. Over the past 3 years, our financial performance has been outstanding. 2. Over the past 3 years, our financial performance has exceeded our competitors'. 3. Over the past 3 years, our sales growth has been outstanding. 4. Over the past 3 years, we have been more profitable than our competitors. 5. Over the past 3 years, our sales growth has exceeded our competitors'
Tippins & Sohi (2003) *	IT competency and organizational learning	Firm performance	Perception on customer retention, sales growth, profitability, and return on investment
Stoel & Muhanna (2009)	Internal IT capability and external IT capability	Firm performance	Return on sales, return on assets, operating income to assets, operating income to sales, and operating income to employees Cost of goods sold to sales, selling and general administration expenses to sales
Shaft et al.(2007)	IT investment initiatives	Production costs, operating profit, and market performance	Cost of goods sold divided by sales for production costs, operating profit for profitability, and market value divided by book value for market performance
Bhatt & Grover (2005)	Intensity of	Competitive	Perceptions: relative performance with

	organizational learning, IT infrastructure quality, IT business expertise, and relationship infrastructure	advantages	respect to the competitors for the past three years; performance for the past three years
Sarv Devaraj & Kohli (2000)	IT labor, IT support, IT capital	Financial & quality outcomes	Net patient revenue per day, net patient revenue per admission
Tanriverdi (2005)	IT relatedness, knowledge management capability	Corporate performance	Tobin's q and return on assets (ROA)
Saraf et al.(2007)	Process coupling, knowledge sharing, IS integration	Business performance	Perceptions: 1. Over the past 3 years, our BU's financial performance has exceeded our competitors. 2. The past 3 years have been more profitable than our competitors'. 3. Over the past 3 years, our BU's sales growth has exceeded our competitors'.
Tanriverdi (2006)	Cross-unit IT synergy	Firm performance	Tobin's q, return on assets, and return on sales
Ordanini (2010)	Business resources and IT resources	Firm performance	Return on assets, return on sales, and operating income/net assets
Shipilov (2009)*	Firm scope experience, centrality, structural hole	Performance	Market share
Lin, Yang et al.(2007)*	Centrality, structural hole	Firm performance	Net sales over current asset
Tanriverdi & Venkatraman (2004)*	Knowledge relatedness	Firm performance	Return on assets, return on equity, and Tobin's Q (the ratio of the market value of a firm to the replacement cost of its assets)
Tsai (2001)*	Absorptive capacity, network position	Performance	Return on investment
Tafti et al.(2008)	IT intensity, Service-oriented architectures capability	Performance	Tobin's q
Stuart (2000)*	Technological capabilities	Sales growth	Sales volume
Lavie (2007)*	Network resources, relative partner	Market performance	The annual change in the market value of the firm's common shares (expectations

	profitability, relative partner alternatives		about the future performance of the firm)
*: published in organizational journal			

4.2.4. Firm Innovation

In most existing studies, firm innovation is measured by the number of patents that a firm files (e.g., Paruchuri, 2010; Schilling & Phelps, 2007; Tortoriello & Krackhardt, 2010; Whittington et al., 2009). Still, some scholars used the number of patent citation (Stuart, 2000), and others used the number of new products introduced (Tsai, 2001). IS scholars have distinguished two types of innovation: ideated innovation and commercialized innovation (Joshi et al., 2010). According to these scholars, ideated innovation is "knowledge that is created through firms' innovation efforts and embodied in forms such as inventions, discoveries, developed ideas, and /or solutions of technical problems" and commercialized innovation "brings ideated innovation to market" (Joshi et al., 2010, p476). Ideated innovation is measured by the number of patents filed and commercialized innovation by the number of announcements of new product and services. In this study I followed this existing practice.

Data of patents were obtained through the online services supported by the European Patent Office in November 2011. The services provide access to more than 70 million patent documents worldwide[8]. Data of new product and service introductions were obtained from FACTIVA database. FACTIVA is owned by Dow Jones & Company. It provides access to more than 28,500 sources[9] and covers subjects such as new products/services and corporate actions.

[8] www.epo.org/serching/free/espacenet.html
[9] http://www.dowjones.com/factiva/index.asp

4.2.5. Control variables

This study compares firm performance among different companies across different industries. To make these companies comparable, I controlled the major differences among companies and industries: firm size and industry dynamism. Firm size is widely used as an important control variable in firm innovation and performance studies (Bharadwaj, 2000; Santhanam & Hartono, 2003; Tanriverdi, 2005) as large firms can enjoy advantages such as economies of scale and scope that might not be available for smaller firms (Bhatt & Grover, 2005). Industry dynamism describes a basic characteristic of industries. Firms located in highly dynamic industries are facing constant changes and forced to compete in different ways such as continuously innovating (Joshi et al., 2010). Control variable data were obtained from COMPUSTAT. I used the number of employees to measure firm size and use the average industry R&D spending to measure industry dynamics.

4.3. Data coding

Data coding was conducted with careful endeavors. After the first round coding, I went through the results again and corrected any possible mistakes. Part of the data coding came from the help of four research assistants. All of them received a 30 minutes training at the beginning and then were given a sample of 100 news items for practice. After that each of them worked independently on different data of companies. I further used 10% of the news items overlapped for coding reliability test (Perreault & Leigh, 1989) and the interrater reliability was 0.85 which is considered acceptable.

4.4. Statistical Method

In this study, I collected data for 26 companies over a span of 15 years from 1994 to 2008. These data were clustered, or nested, around companies. It means that observations within companies are typically more similar than observations between companies. In two recent similar studies published in top-tier IS journals, the authors addressed this issued by adding dummy variables for each period to correct for the effects of nestedness (Chi, Liao et al., 2010; Chi, Ravichandran et al., 2010). This approach assumes a fixed slope across companies. I adopted multilevel modeling (MLM) for data analysis in this study. Compared with other approaches, MLM treats clusters as if they are sampled from a larger population of clusters and enhances the generalizability of results (Snijders & Bosker, 1999). In other words, cluster–level effects are not estimated separately for each cluster and regression weights area assumed to have a particular distribution across clusters (Raudenbush & Bryk, 2002). The statistical models used in this study are listed below.

Main effect models:

$$y_{ij} = \beta_{0j} + \beta_{1j} Year_{ij} + \beta_{2j} FirmSize_{ij} + \beta_{3j} IndustryDynamism_{ij} + \beta_{4j} DynamicITCapability_{ij} + e_{ij}$$

$$y_{ij} = \beta_{0j} + \beta_{1j} Year_{ij} + \beta_{2j} FirmSize_{ij} + \beta_{3j} IndustryDynamism_{ij} + \beta_{4j} IdeatedInnovation_{ij} + e_{ij}$$

$$y_{ij} = \beta_{0j} + \beta_{1j} Year_{ij} + \beta_{2j} FirmSize_{ij} + \beta_{3j} IndustryDynamism_{ij} + \beta_{4j} CommercializedInnovation_{ij} + e_{ij}$$

$$\begin{aligned} \beta_{0j} &= \gamma_{00} + \mu_{0j} \\ \beta_{1j} &= \gamma_{10} + \mu_{1j} \\ \beta_{2j} &= \gamma_{20} + \mu_{2j} \\ \beta_{3j} &= \gamma_{30} + \mu_{3j} \\ \beta_{4j} &= \gamma_{40} + \mu_{4j} \end{aligned} \qquad e_{ij} \sim N\left(0, \sigma_e^2\right) \qquad \begin{bmatrix} \mu_{0j} \\ \mu_{1j} \\ \mu_{2j} \\ \mu_{3j} \\ \mu_{4j} \end{bmatrix} \sim N\left(\begin{bmatrix} 0 \\ 0 \\ 0 \\ 0 \\ 0 \end{bmatrix}, \begin{bmatrix} \tau_{00} & & & & \\ \tau_{10} & \tau_{11} & & & \\ \tau_{20} & \tau_{21} & \tau_{22} & & \\ \tau_{30} & \tau_{31} & \tau_{32} & \tau_{33} & \\ \tau_{40} & \tau_{41} & \tau_{42} & \tau_{43} & \tau_{44} \end{bmatrix} \right)$$

Interaction effect models:

$$y_{ij} = \beta_{0j} + \beta_{1j} Year_{ij} + \beta_{2j} FirmSize_{ij} + \beta_{3j} IndustryDynamism_{ij} + \beta_{4j} DynamicITCapability_{ij} + \beta_{5j} StructureHole_{ij} + \beta_{6j} DynamicITCapability_{ij} * StructureHole_{ij} + e_{ij}$$

$$y_{ij} = \beta_{0j} + \beta_{1j} Year_{ij} + \beta_{2j} FirmSize_{ij} + \beta_{3j} IndustryDynamism_{ij} + \beta_{4j} DynamicITCapability_{ij} + \beta_{5j} Centrality_{ij} + \beta_{6j} DynamicITCapability_{ij} * Centrality_{ij} + e_{ij}$$

$$y_{ij} = \beta_{0j} + \beta_{1j} Year_{ij} + \beta_{2j} FirmSize_{ij} + \beta_{3j} IndustryDynamism_{ij} + \beta_{4j} DynamicITCapability_{ij} + \beta_{5j} SimmelinaTie_{ij} + \beta_{6j} DynamicITCapability_{ij} * SimmelinaTie_{ij} + e_{ij}$$

$$\begin{aligned} \beta_{0j} &= \gamma_{00} + \mu_{0j} \\ \beta_{1j} &= \gamma_{10} + \mu_{1j} \\ \beta_{2j} &= \gamma_{20} + \mu_{2j} \\ \beta_{3j} &= \gamma_{30} + \mu_{3j} \\ \beta_{4j} &= \gamma_{40} + \mu_{4j} \\ \beta_{5j} &= \gamma_{50} + \mu_{5j} \\ \beta_{6j} &= \gamma_{60} + \mu_{6j} \end{aligned} \qquad e_{ij} \sim N\left(0, \sigma_e^2\right)$$

$$\begin{bmatrix} \mu_{0j} \\ \mu_{1j} \\ \mu_{2j} \\ \mu_{3j} \\ \mu_{4j} \\ \mu_{5j} \\ \mu_{6j} \end{bmatrix} \sim N\left(\begin{bmatrix} 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \end{bmatrix}, \begin{bmatrix} \tau_{00} & & & & & & \\ \tau_{10} & \tau_{11} & & & & & \\ \tau_{20} & \tau_{21} & \tau_{22} & & & & \\ \tau_{30} & \tau_{31} & \tau_{32} & \tau_{33} & & & \\ \tau_{40} & \tau_{41} & \tau_{42} & \tau_{43} & \tau_{44} & & \\ \tau_{50} & \tau_{51} & \tau_{52} & \tau_{53} & \tau_{54} & \tau_{55} & \\ \tau_{60} & \tau_{61} & \tau_{62} & \tau_{63} & \tau_{64} & \tau_{65} & \tau_{66} \end{bmatrix} \right)$$

Subscript *i* represents firms (*i* = 1 to 26) and *j* represents years (*j* =1 to 15), respectively. β is the coefficient (slope) of the independent variables and β_0 is the intercept at the level-one. μ is the coefficient (slope) and γ is the intercept at the level-two. σ is the variance at the level-one and τ is the covariance at the level-two.

4.4.1. Multicollinearity

Because the regression models include a cross-product between predictors, the issue of multicollinearity may exist. To address this issue, I used the residual centering technique (Lance, 1988) for data analysis of the interaction effects. I first conducted regression analysis for the equations:

$$DynamicITCapability*Centrality = c1 \times DynamicITCapability + c2 \times Centrality + d1$$

$$DynamicITCapability*StructuralHole = c3 \times DynamicITCapability + c4 \times StructuralHole + d2$$

$$DynamicITCapability*SimmelianTie = c5 \times DynamicITCapability + c6 \times SimmelianTie + d3$$

Where *c* represents the coefficients and *d* represents the unstandardized residuals, respectively. Then I used these unstandardized residuals to replace the cross-product terms in the MLM equations for data analysis of the interaction effects.

4.4.2. Validity

Because this study involves 26 companies in 19 industries, some industries are represented by more than one company. To address the uneven distribution issue, I conducted a sensitivity analysis and chose only one company every time in these industries and tested how sensitively these changes will influence the results. The results show that there are not major differences by including different companies from these industries.

4.5. Results

During the process of data analysis, I found that although the results from the whole data set (1994 – 2008) already indicate some levels of positive results, the data subset from 2001 to 2008 provides even more significant results. Thus, in the following data analysis I used the results from the small data set and will further elaborate the use of the small data set in the discussion section. Also, to correct the lag effects and skewness of IT initiatives, DIC is transformed into the log value with one year lag[10].

Table 12 below shows the intraclass correlation (ICC) between the two levels[11]. ICC is the proportion of observed variance that is between cases. It can be used to decide if MLM

[10] Empirical evidence indicates that the impacts of IT initiatives were observed to be characterized mostly by a one-year lag (Shaft et al., 2007).

[11] In this study, the level one is the observations in each year. The level two is the companies.

would be worthwhile. High values of ICC indicate that the observed variances are explained in a high proportion by between-cluster variances. Based the table below, about 36% to 87% of the observed variation is due to differences among companies, so the use of MLM is appropriate for this study. Table 13 provides the descriptive statistics and Table 14 describes the correlation matrix[12].

Table 12. Intraclass correlation (ICC) reports

	ROA	ROS	OIA	OIS	OIE	OEXPS	Ideated Innovation	Commercialized Innovation
σ^2	0.00439	0.00824	0.00178	0.00287	728.98469	0.00287	137201.58783	6425.04774
τ_{00}	0.00246	0.00709	0.00263	0.01090	2275.08821	0.01090	887267.16897	15216.74889
ICC	0.359124	0.462492	0.596372	0.791576	0.757335	0.791576	0.866075	0.703119

[12] I found that OIS and OEXPS are perfectly corrected. After careful data checking, there is no data mistake found.

Table 13. Descriptive Statistics

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	DIC	CENT	SH	ST	ROA	ROS	OIA	OIS	OIE	OEXPS	II	CI	FZ	ID	Year
Mean	.798	.456	.086	1.730	.044	.057	.126	.190	77.525	.810	554.580	135.770	96.728	136.450	5.5
Std. dev	.849	.736	.729	3.20	.088	.168	.077	.140	88.776	.140	1181.805	156.549	312.269	111.973	2.882
Note: CENT: Centrality, SH: Structural Hole, ST: Simmelian Tie, II: Ideated Innovation, CI: Commercialized Innovation, FZ: Firm Size, ID: Industry Dynamism															

Table 14. Correlation Matrix

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	1														
2	.207**	1													
3	-.020	.805**	1												
4	.314**	.314**	-.158**	1											
5	-.007	-.016	.011	0.14	1										
6	.009	.031	.014	.005	.757**	1									
7	-.066	.020	.081	-.017	.716**	.499**	1								
8	-.083	.080	.074	-.038	.420**	.562**	.482**	1							
9	.054	.034	.001	.027	.314**	.431**	.263**	.788**	1						
10	.085	-.081	-.077	.043	-.421	-.561**	-.482**	-1**	-.788**	1					
11	.133*	-.019	-.098	.029	.198**	.297**	.188**	.378**	.554**	-.379**	1				
12	.214**	.171**	.030	.143*	.042	.103+	.047	.226**	.414**	-.225**	.282**	1			
13	.172**	-.146*	-.093	-.069	.069	-.039	.059	-.166**	-.130*	.166**	.068	.110+	1		
14	.120+	.160*	.097	.166**	.249**	.243**	.283**	.198**	.147*	-.198**	.415**	.342**	.399**	1	
15	-.380**	-.210**	-.110+	-.257**	.035	.044	-.004	.029	.067	-.032	.039	.260**	.032	.256**	1
Note: + Significant at 10%; * significant at 5%; ** significant at 1%															

4.5.1. Effects at firm-level

Because DIC is process-oriented, data are collected at process-level and aggregated to the firm-level. With this approach, this study provides insights of the effects of DIC at both firm level and process level. Table 15 describes the main effects of DIC on both firm performance and firm innovation. DIC has positive effects on ROA, ROS, OIS, and OIE, and negative effect on OEXPS. DIC is also positively related to both ideated innovation and commercialized innovation. Thus, Hypothesis 1 is supported for most dependent variables and Hypothesis 2 is supported for all dependent variables.

Table 15. DIC effects

Variables	ROA	ROS	OIA	OIS	OIE	OEXPS	II	CI
DIC	0.01358+	0.02836*	0.00809	0.0193**	9.4572**	-0.019**	97.9248*	26.545**
	(0.00796)	(0.01126)	(0.00522)	(0.00675)	(3.42642)	(0.00675)	(48.7698)	(9.91247)
Firm Size	-0.00040	-0.00018	-0.00011	0.00031	-0.21512	-0.00031	5.57254+	0.75322
	(0.00049)	(0.00041)	(0.00023)	(0.00038)	(0.18312)	(0.00038)	(2.99680)	(0.51026)
Industry Dynamism	0.00022	0.00018	0.00003	0.00005	0.07940+	-0.00005	0.63818	0.11184
	(0.00024)	(0.00012)	(0.00006)	(0.00009)	(0.04374)	(0.00009)	(0.64655)	(0.12509)
Year	0.00052	0.00423	0.00237	0.00475*	4.5477**	-0.0047*	13.89592	19.764**
	(0.00246)	(0.00347)	(0.00161)	(0.00211)	(1.06551)	(0.00211)	(15.2992)	(3.07680)
Intercept	0.02397	0.01918	0.1201**	0.1358**	43.880**	0.8641**	194.6220	23.24007
	(0.01935)	(0.02896)	(0.01605)	(0.02724)	(12.7826)	(0.02724)	(226.87)8	(35.2706)
Deviance -2Log (likelihood)	-473.501	-331.386	-633.149	-513.367	1998.822	-513.367	3085.39	2425.128
Observations	202	202	202	202	202	202	202	202
Number of *i*	26	26	26	26	26	26	26	26

Note: Standard errors are in parentheses.
+ Significant at 10%; * significant at 5%; ** significant at 1%
II: Ideated Innovation; CI: Commercialized Innovation

To examine the indirect effects of DIC on firm performance through the mediation of firm innovation, I calculated the products of DIC and firm innovation (ideated innovation and commercialized innovation, respectively) and examine their effects on firm performance. Table 16 and 17 show the results of data analysis. The product of DIC and ideated innovation is significantly related to ROA, ROS and ROE; the product of DIC and commercialized innovation

is significantly related to ROA, ROS, OIA, OIS, OIE, and OEXPS. Thus, the argument that DIC has indirect effects through the mediation of firm innovation is supported for most of the dependent variables.

Table 16. Indirect effects (DIC x Ideated Innovation)

Variables	ROA	ROS	OIA	OIS	OIE	OEXPS
DIC x Ideated Innovation	0.00001+	0.00002**	0.00000	0.00000	0.00392*	0.00000
	(0.00000)	(0.00001)	(0.00000)	(0.00000)	(0.00175)	(0.00000)
Firm Size	-0.00002	-0.00018	-0.00006	0.00044	-0.19926	-0.00044
	(0.00026)	(0.00023)	(0.00023)	(0.00037)	(0.17564)	(0.00037)
Industry Dynamism	0.00011	0.00027**	0.00001	0.00003	0.06677	-0.00003
	(0.00008)	(0.00009)	(0.00006)	(0.00009)	(0.04286)	(0.00009)
Year	-0.00050*	0.00078	0.00127	0.00257	3.57306**	-0.00257
	(0.00207)	(0.00342)	(0.00139)	(0.00184)	(0.93156)	(0.00184)
Intercept	0.03692	0.02835	0.12973**	0.15409**	53.24941**	0.84591**
	(0.01690)	(0.02000)	(0.01482)	(0.02614)	(11.83746)	(0.02614)
Deviance -2Log (likelihood)	-496.727	442.610	-656.389	-529.666	2068.991	-529.666
Observations	202	202	202	202	202	202
Number of *i*	26	26	26	26	26	26
Note: Standard errors are in parentheses. + Significant at 10%; * significant at 5%; ** significant at 1%						

Table 17. Indirect effects (DIC x Commercialized Innovation)

Variables	ROA	ROS	OIA	OIS	OIE	OEXPS
DIC x Commercialized Innovation	0.00007**	0.00013**	0.00003+	0.00006**	0.04204**	-0.00006**
	(0.00002)	(0.00003)	(0.00002)	(0.00002)	(0.01026)	(0.00002)
Firm Size	0.00001	-0.00014	-0.00009	0.00035	-0.21720	-0.00035
	(0.00027)	(0.00042)	(0.00024)	(0.00038)	(0.17873)	(0.00038)
Industry Dynamism	0.00011	0.00015	0.00002	0.00005	0.07767+	-0.00005
	(0.00008)	(0.00012)	(0.00006)	(0.00009)	(0.04278)	(0.00009)
Year	-0.00154	-0.00005	0.00121	0.00197	3.08886**	-0.00197
	(0.00222)	(0.00311)	(0.00148)	(0.00195)	(0.96741)	(0.00195)
Intercept	0.03499*	0.04381	0.12739**	0.15364**	52.29637**	0.84636**
	(0.01778)	(0.02728)	(0.01530)	(0.02639)	(12.11730)	(0.02639)
Deviance -2Log (likelihood)	-479.337	-340.217	-634.437	-513.941	1990.170	-513.941
Observations	202	202	202	202	202	202
Number of *i*	26	26	26	26	26	26
Note: Standard errors are in parentheses. + Significant at 10%; * significant at 5%; ** significant at 1%						

Table 18 and 19 indicate the effects of ideated innovation and commercialized innovation on firm performance. Ideated Innovation (lag 2 years)[13] is positively related to ROA, ROS, and OIE. Thus, Hypothesis 3(a) is supported for three among six dependent variables. Commercialized innovation is positively related to OIE. But it is found negatively related to ROA, ROS, OIA, OIS, and positively related to OEXPS with two-year lag. Thus, Hypothesis 3(b) is supported only for OIE and some opposite effects are found two-year lag.

Table 18. Ideated Innovation effects

Variables	ROA	ROS	OIA	OIS	OIE	OEXPS
Ideated Innovation (lag 2 years)	0.00001+	0.00004**	0.00000	0.00000	0.01051*	0.00000
	(0.00001)	(0.00001)	(0.00001)	(0.00001)	(0.00431)	(0.00001)
Firm Size	-0.00020	-0.00030	-0.00028	0.00048	-0.31157+	-0.00048
	(0.00025)	(0.00036)	(0.00023)	(0.00034)	(0.16498)	(0.00034)
Industry Dynamism	0.00003	0.00003	0.00003	0.00006	0.09230*	-0.00006
	(0.00008)	(0.00011)	(0.00006)	(0.00007)	(0.03952)	(0.00007)
Year	-0.00010	0.00212	-0.00090	0.00104	2.45970**	-0.00104
	(0.00165)	(0.00231)	(0.00126)	(0.00141)	(0.77253)	(0.00141)
Intercept	0.05360**	0.05423*	0.15424**	0.16280**	57.40897**	0.83720
	(0.01579)	(0.02332)	(0.01478)	(0.02582)	(11.38551)	(0.02582)
Deviance -2Log (likelihood)	-613.583	-439.931	-752.082	-681.196	2590.116	-681.196
Observations	260	260	260	260	260	260
Number of *i*	26	26	26	26	26	26
Note: Standard errors are in parentheses. + Significant at 10%; * significant at 5%; ** significant at 1%						

Table 19. Commercialized Innovation effects

Variables	OIE	ROA	ROS	OIA	OIS	OIE	OEXPS
CI	0.06095**						
	(0.02239)						
CI (lag 2 years)		-0.0002**	-0.00017*	-0.00009**	-0.00010*	-0.00476	0.00010*
		(0.00005)	(0.00007)	(0.00003)	(0.00004)	(0.02377)	(0.00004)
Firm Size	-0.35322*	-0.00011	-0.00014	-0.00020	0.00060+	-0.26364	-0.00060+
	(0.17073)	(0.00023)	(0.00036)	(0.00021)	(0.00034)	(0.17340)	(0.00034)
Industry Dynamism	0.09190*	0.00016*	0.00022	0.00007	0.00010	0.10495**	-0.00010
	(0.03886)	(0.00007)	(0.00011*)	(0.00006)	(0.00007)	(0.04053)	(0.00007)
Year	1.87461*	0.00195	0.00389	0.00137	0.00231	2.70131**	-0.00231
	(0.82281)	(0.00175)	(0.00254)	(0.00124)	(0.00153)	(0.84355)	(0.00153)
Intercept	58.16953**	0.04311**	0.05059*	0.13925**	0.15152**	56.58424**	0.84848**
	(11.82352)	(0.01492)	(0.01021)	(0.01358)	(0.02647)	(12.49052)	(0.02647)

[13] The two-year lag was used in existing studies (e.g., Joshi et al. 2010).

Deviance -2Log (likelihood)	2508.781	-600.263	-413.873	-771.532	-655.092	2496.191	-655.092
Observations	252	252	252	252	252	252	252
Number of *i*	26	26	26	26	26	26	26
Note: Standard errors are in parentheses. + Significant at 10%; * significant at 5%; ** significant at 1% II: Ideated Innovation; CI: Commercialized Innovation							

Table 20 indicates the effects of interaction between DIC and centrality. The interaction has positive effects on ROA, OIA, OIS, and negatively affects OEXPS. Thus, Hypothesis 4(a) is supported for four among six dependent variables. However, no significant effects of this interaction are found on ideated innovation and commercialized innovation. Thus, Hypothesis 5(a) is not supported.

Table 20. Interaction between DIC and centrality

Variables	ROA	ROS	OIA	OIS	OIE	OEXPS	II	CI
Model 1= DIC + Centrality + DIC x Centrality								
DIC	0.01377+	0.02951*	0.00800	0.0194**	9.2319**	-0.019**	95.5996+	26.910**
	(0.00808)	(0.01149)	(0.00525)	(0.00681)	(3.46450)	(0.00681)	(49.5990)	(10.0309)
Centrality	-0.00036	-0.00194	0.00402	0.00291	-2.05294	-0.00291	42.45797	4.26658
	(0.00777)	(0.01108)	(0.00507)	(0.00658)	(3.35025)	(0.00658)	(47.8861)	(9.70293)
DIC x Centrality	0.01781+	0.01699	0.01607*	0.01682+	3.84538	-0.0168+	-47.3539	-3.63468
	(0.01044)	(0.01477)	(0.00668)	(0.00860)	(4.38319)	(0.00860)	(62.4659)	(12.7104)
Firm Size	0.00001	-0.00018	-0.00004	0.00045	-0.11125	-0.00045	6.53893*	0.54672
	(0.00027)	(0.00042)	(0.00024)	(0.00041)	(0.19313)	(0.00041)	(3.25184)	(0.53134)
Industry Dynamism	0.00015+	0.00020	0.00004	0.00007	0.09234*	-0.00007	0.67222	0.11981
	(0.00009)	(0.00013)	(0.00006)	(0.00009)	(0.04495)	(0.00009)	(0.66899)	(0.12833)
Year	0.00020	0.00373	0.00235	0.00462*	4.4373**	-0.0046*	13.38915	19.480**
	(0.00253)	(0.00359)	(0.00164)	(0.00215)	(1.08947)	(0.00215)	(15.7149)	(3.14853)
Intercept	0.02117	0.01852	0.1128**	0.1262**	38.980**	0.8737**	169.8567	-15.8046
	(0.01980)	(0.02988)	(0.01632)	(0.02851)	(13.2876)	(0.02851)	(237.152)	(36.3220)
Deviance -2Log (likelihood)	-463.572	-321.974	-623.287	-502.650	1959.995	-502.650	3027.416	2377.571
Observations	198	198	198	198	198	198	198	198
Number of *i*	26	26	26	26	26	26	26	26
Note: Standard errors are in parentheses. + Significant at 10%; * significant at 5%; ** significant at 1% II: Ideated Innovation; CI: Commercialized Innovation								

Table 21 indicates the effects of interaction between DIC and structural hole. The interaction has positive effects on ROA, OIA, OIS, OIE, and negatively affects OEXPS. Thus,

Hypothesis 4(b) is supported for five among six dependent variables. However, no significant effects from this interaction are found on ideated innovation and commercialized innovation. Thus, Hypothesis 5(b) is not supported. Also, no significant effects from the interaction of DIC and Simmelian tie are found on ideated innovation and commercialized innovation. Thus, Hypothesis 5(c) is not supported.

Table 21. Interaction between DIC and structural hole

Variables	ROA	ROS	OIA	OIS	OIE	OEXPS	II	CI
Model 2 = DIC + Structural Hole + DIC x Structural Hole								
DIC	0.01224	0.02670*	0.00698	0.0181**	9.0469**	-0.018**	101.527*	26.229**
	(0.00783)	(0.01112)	(0.00509)	(0.00663)	(3.40351)	(0.00663)	(48.6258)	(9.88498)
Structural Hole	0.00325	0.00761	0.00586	0.00530	1.54826	-0.00530	-31.3810	11.54624
	(0.00705)	(0.01000)	(0.00457)	(0.00592)	(3.04330)	(0.00592)	(43.3779)	(8.84414)
DIC x Structural Hole	0.0236**	0.02899*	0.0184**	0.0206**	6.85952*	-0.022**	-61.1997	0.54850
	(0.00889)	(0.01256)	(0.00570)	(0.00735)	(3.78318)	(0.00735)	(53.8149)	(11.0013)
Firm Size	-0.00003	-0.00020	-0.00013	0.00029	-0.22278	-0.00029	5.69903+	0.74918
	(0.00026)	(0.00041)	(0.00023)	(0.00037)	(0.18209)	(0.00037)	(2.99303)	(0.50981)
Industry Dynamism	0.00015+	0.00020	0.00005	0.00008	0.09008*	-0.00008	0.53598	0.10127
	(0.00008)	(0.00012)	(0.00006)	(0.00009)	(0.04396)	(0.00009)	(0.65278)	(0.12626)
Year	0.00011	0.00382	0.00206	0.00432*	4.4011**	-0.0043*	14.75744	20.154**
	(0.00244)	(0.00345)	(0.00158)	(0.00208)	(1.06644)	(0.00208)	(15.3769)	(3.09147)
Intercept	0.02343	0.01788	0.1186**	0.1340**	43.392**	0.8659**	201.4942	-24.5572
	(0.01922)	(0.02887)	(0.01558)	(0.02676)	(12.7224)	(0.02676)	(227.204)	(35.2734)
Observations	202	202	202	202	202	202	202	202
Number of *i*	26	26	26	26	26	26	26	26

Note: Standard errors are in parentheses.
+ Significant at 10%; * significant at 5%; ** significant at 1%
II: Ideated Innovation; CI: Commercialized Innovation

4.5.2. Effects at process level

Table 22 provides a summary of the main effects of process DICs on corresponding dependents variables. Supply Chain DIC, Technology Development DIC, and Firm Infrastructure DIC are positively related to multiple indicators of firm performance. Technology

Development DIC and Firm Infrastructure DIC are positively related to Ideated Innovation. Operation DIC is positively related to Commercialized Innovation.

Table 22. Process DIC main effects

	ROS	OIA	OIS	OIE	OEXPS	II	CI
Operation DIC							59.17618**
							(17.46486)
Supply Chain DIC	0.04087+	0.02141*	0.04346**	16.51142**	-0.04346**		
	(0.02166)	(0.0097)	(0.01237)	(6.40415)	(0.01237)		
Technology development DIC	0.04819+		0.02736 +	13.91736+	-0.02736+	272.3345*	
	(0.02602)		(0.01543)	(7.83973)	(0.01543)	(109.3645)	
Firm Infrastructure DIC	0.04034*		0.02463*	11.98248*	-0.02463*	150.6430+	
	(0.01836)		(0.01090)	(5.54152)	(0.01090)	(78.10269)	
**: p<0.01 *: p<0.05 +:p<0.1 # of level one units: 202; # of level two units: 26 Blank indicates non-significant effects II: Ideated Innovation; CI: Commercialized Innovation							

Table 23 describes the interaction effects of process DICs with network structures. As presented earlier, interactions between network structures and DIC are not significantly related to firm innovation at firm level. However, I found that interactions between network structures and DICs at process level show some significant relationships with firm innovation. While Simmelian tie does not interact with DIC to have significant effects on innovation at the firm level, it interacts with Operation DIC and Supply Chain DIC for contributing to Ideated Innovation. In addition, Supply Chain DIC interacts with Centrality and Structural Hole to influence multiple indicators of firm performance. I also found that Service DIC interacts with Centrality and Structural Hole to influence Commercialized Innovation. Technology Development DIC and Firm Infrastructure DIC interact with Structural Hole to influence two indicators of firm performance.

Table 23. Process DIC interaction effects

	ROA	OIA	OIS	OIE	OEXPS	II	CI
Operation DIC * Structural Hole			0.02664+		-0.02664+	-215.0409+	
			(0.01573)		(0.01573)	(111.2329)	
Operation DIC * Simmelian Tie						38.78836 *	-13.15907**
						(15.64667)	(2.98440)
Supply Chain DIC * Centrality		0.03107*	0.03554*	19.1444*	-0.0355*		
		(0.0138)	(0.01752)	(8.99907)	(0.01752)		
Supply Chain DIC * Structural Hole		0.0317**	0.03235*	13.54583+	-0.03235*		
		(0.0122)	(0.01566)	(8.13799)	(0.01566)		
Supply Chain DIC * Simmelian Tie				2.09153+		36.0781*	
				(1.11896)		(16.28202)	
Service DIC * Centrality							75.3076*
							(33.28133)
Service DIC *Structural Hole							71.67324**
							(25.86738)
Technology Development DIC * Structure Hole	0.0397+	0.03099*					
	(0.0239)	(0.0153)					
Firm Infrastructure DIC * Centrality		0.02194*					
		(0.0103)					
Firm Infrastructure DIC * Structural Hole	0.02597+	0.01838*					-39.98628*
	(0.0138)	(0.0088)					(16.59406)

**: p<0.01 *: p<0.05 +:p<0.1
# of level one units: 202; # of level two units: 26
Blank indicates non-significant effects
II: Ideated Innovation; Commercialized Innovation

CHAPTER 5

DISCUSSION, IMPLICATION, AND CONCLUSIONS

Table 24. Summary of results

	Description	Supported DV	Non-supported DV
Hypothesis 1	DIC→firm performance	ROA, ROS, OIS, OIE, and OEXPS	OIA
Hypothesis 2	DIC→firm innovation	II, and CI	
Hypothesis 3(a)	Ideated Innovation→ firm performance	ROA, ROS, and OIE	OIA, OIS and OEXPS
Hypothesis 3(b)	Commercialized Innovation → firm performance	OIE	ROA, ROS, OIA, OIS, and OEXPS[14]
Hypothesis 4(a)	DIC x Centrality →firm performance	ROA, OIA, OIS and OEXPS	ROS and OIE
Hypothesis 4(b)	DIC x Structural Hole →firm performance	ROA, ROS, OIA, OIS, OIE and OEXPS	
Hypothesis 5	DIC x Centrality, Structural hole, and Simmelian Tie →firm innovation		II, and CI

In this study I propose DIC as an important determinant for achieving IT business value. DIC describes the ability of a firm to dynamically build, organize, and re-shape their IT resources to effectively support their business processes. I also explicitly investigate this aspect in network environments and argue that in such environments IT can complement with network structures (i.e., centrality, structural hole, and Simmelian tie) to contribute to firm innovation and performance. Especially, I propose that DIC can contribute to firm performance directly and also indirectly through firm innovation.

The results of data analysis provide strong supports for most of my major arguments (i.e., Hypotheses 1, 2, 3, and 4) except Hypothesis 5 (at firm level) (Table 24). First, DIC has an important impact on firm innovation and firm performance. DIC is significantly related to five indicators of firm performance (i.e., ROA, ROS, OIS, OIE, and OEXPS). Also, DIC is positively

[14] The opposite effects are found with two year lag.

related to both indicators of firm innovations (i.e., ideated innovation and commercialized innovation). These findings provide evidences that DIC is an appropriate direct and indirect determinant of firm performance for advancing IT business value research.

Second, DIC significantly interacts with network centrality and structural holes to influence most of indicators of firm performance (i.e., ROA, OIA, OIS, OIE, and OEXPS), but does not significantly interact with any network structures on improving firm innovation at firm level. This finding implies that the mechanisms underlying the two interactions are different. DIC indicates the collective ability of a firm to use IT resources to support all kinds of business processes. Network structure indicates the position of a firm in a network to access resources. While the two factors can complement on improving firm performance, the effects of their interaction on firm innovation may be too broad to capture. In other words, such effects may be easier to capture at the process level than at the firm level because not all business processes can contribute to innovation.

In light of this, I further investigated the interaction effects of DIC and network structures at the process level and the findings provide important insights. That is, while this study failed to find the effects of interaction between DIC and network structures on firm innovation, it captured some such effects at the process level. Several process-level DICs, such as Operation DIC and Supply Chain DIC, interact with Simmelian tie and structural hole to influence ideated innovation. Others DICs, such as Service DIC and Firm Infrastructure DIC interact with structural hole and centrality to influence commercialized innovation. These findings indicate that even though Hypothesis 5 is not significantly supported at the firm level, it obtains supports at the process-level. Also, it makes sense to find that Service DIC contributes to commercialized

innovation by prompting new service introduction. In addition, there are several findings related to negative effects. For example, Operation DIC interacts with structural hole to negatively influence ideated innovation; Operation DIC interacts with Simmelian tie to negatively influence commercialized innovation; and Firm Infrastructure DIC interacts with structure hole to negatively influence commercialized innovation. These findings provide plenty of opportunities for future research.

Again from the process-level analysis, I also found interesting results of direct relationship between DIC and firm performance. Supply Chain DIC, Technology Development DIC, and Firm Infrastructure DIC are found to be significantly associated to firm performance (i.e., ROS, OIA, OIS, OIE, and OEXPS), but Operation DIC, Marketing/Sales DIC, Service DIC, and Human resource DIC are not. These findings imply that after many years of initiation and deployment of IT, the focuses for competitive advantage from IT have shifted from traditional IT applications, such as operation, marketing, and service, to newer applications, such as supply chain, technology development, and firm infrastructure. It also means that IT applications on operation, marketing, and service have been commonly developed and utilized, and could not be used directly for competitive advantages any more. This finding provides reasonable explanation for the argument of "IT doesn't matter" (Carr, 2003) because if firms still focus on only using IT to support these so-called major business processes, they have less opportunities to gain competitive advantages.

In addition, among these process-level DICs, Supply Chain DIC stands out by directly influence five indicators of firm performance (i.e., ROS, OIA, OIS, OIE, and OEXPS). It also interacts with centrality and structural hole to influence four indicators of firm performance (e.g.,

OIA, OIS, OIE, and OEXPS). Such findings are consistent with literature on firm performance from the perspective of IT-enabled supply chain integration capability (Rai et al., 2006). It also provides directions for IT practitioners to avoid risks related to IT investments and increase the opportunities to obtain expected returns on their IT investments. The finding on the effects of interaction between Supply Chain DIC and network structures on firm performance is very important for network research. Network research significantly focuses on innovation and firm performance and does not put enough attention on the interaction between network structures and supply chain capability. This finding also provides new opportunities for future network research with a focus on supply chain integration with favorable network structures.

Third, this study found that ideated innovation (patents) with two-year lag has positive influence on three firm performance indicators (i.e., ROA, ROS, and OIE), but not all of them. Also, commercialized innovation is found to be positively associated only with OIE, not with other five indicators of firm performance. Moreover, commercialized innovation with two-year lag is negatively associated with most of the indicators of firm performance, except ROS. These findings are consistent with the argument that innovation alone is not enough for improving performance (Baer & frese, 2003). Actually, the relationship between innovation and firm performance is complex. Although literature has generally suggested that innovation should be included as the antecedents of financial performance in any relevant studies (McWilliams & Siegel, 2000), innovation should not be understood as a sufficient condition, but rather a necessary condition. Similarly, literature has pointed out that innovation, such as product-diversification, is not necessary related to firm financial performance (Hitt, Hoskisson, & Kim, 1997).

In the original design of this study, I collected and analyzed a data set over a span of 15 years. After conducting numerous data analyses, I discovered that a data subset from 2001 to 2008 can more significantly and suitably capture the effects of IT (DIC) on firm performance. During the process of data collection, I noticed that there was a shift on company IT budget policy after the 911 event and the burst of dot-com bubble. For example, according to the InformationWeek Research's third-quarter Priorities survey of IT spending, in less than one month after September 11, more than a third of companies have stopped or suspended their IT projects (Sweat, 2001). It means that CIOs were facing tight IT budgets and needed to well justify their projects. According to the IT-strategy alignment perspective in IS literature, IT resources need to align with firm strategies to influence firm performance (Chen et al., 2008). It is reasonable to argue that firms did a better job on IT-strategy alignment after 2001 than before. When facing a tight IT budget, where CIOs can use their budget if they do not use it in projects that support firm strategies? Also, using IT resources to support business strategies is on a learning curve. The burst of dot-com bubble should also give CEOs a hard lesson on how to use IT resources effectively. Even though data analyses by using the 15-year data set showed similar results, I believe the choice of the smaller data set is appropriate for main data analyses of this study.

5.1. Implications

The findings of this study have important implications for IS research. First, the lack of empirical evidence for the direct link between IT and firm performance has made some IS researchers believe there is no such direct link exists (Joshi et al., 2010). This study demonstrates that IT can have direct impact on both firm innovation and performance. This finding is

especially important for the IS community because it means existing studies have not fully appreciated the potential of IT and there is still plenty of room for IS researchers to make important contributes to the business world. Second, although the perspective of dynamic capabilities has been used in IS research (e.g., Wheeler, 2002; Xiao & Dasgupta, 2009), RBV is still the main theoretical base for most IT business value research. To some extent, such narrow theoretical base can significantly confine IT business value research because RBV breaks down in dynamic environments (Eisenhardt & Martin, 2000). This study indicates that the perspective of dynamic capabilities deserves more attention and IT business value research should be based on diverse theoretical bases.

Third, the impact of IT on business processes has been widely realized (Sambamurthy et al., 2003), but researchers used to separate IT from business processes and did not realize that IT cannot exist alone without supporting business processes. By explicitly including IT and business processes in the definition of DIC, this study provides a new angle for researchers to re-examine the relationship between IT and business processes. Fourth, existing IT business research significantly ignores the impact of external environments on firm performance. By exploring the impact of network structures on IT business value, this study demonstrates that IT business value research should benefit from a network perspective.

The findings of this study also have important implications for both IS researchers and practitioners. Although IS scholars believe and are dedicated to justify that IT can produce tremendous values for businesses, the argument that "IT doesn't matter" is based on observations, not based on suppositions. Carr (2003) presents this opinion for a group people, rather than just himself. There are plenty of cases indicating that a number of companies failed to receive

expected benefits from their IT investments. Even though IS scholars can argue that these companies did not use IT appropriately, but the answer to "what are the appropriate ways to use IT" still remains open. I believe that we (IS researchers) have not done enough on this topic to help practitioners. To respond to Carr's argument, IS researchers need to conduct scientific research with strong theoretical base and clear empirical evidences, rather than just providing perspectives or opinions of a different group of people. Especially, such evidences need be consistent and comparable across different studies and in different disciplines. IT practitioners need both clear evidences indicating IT does contribute to competitive advantages and feasible guidance on why and how to use IT to obtain business values.

This study provides such an opportunity. By measuring DIC of companies from IT initiatives used to support business processes from a set of popular computer journals, this study helps practitioners gain knowledge on how and why some companies possess high DIC and obtain superior returns. After companies understand why DIC is an important contributor for firm performance, they can selectively invest on IT initiatives for best fitting their process needs and improvements. In other words, the method used in this study for DIC operationalization has important practical meanings. Findings derived from this way are more objective and realistic which cannot be easily obtained from IS studies based on perceptions of survey respondents. For example, in the popular research stream of TAM studies, one important concept is usefulness. A large numbers of studies have indicated that IT actual usage is based on user's perception of usefulness. But they did not really stand in the shoes of companies. Think about this scenario: a company just implemented an IT application and is seeking for advice to promote its use. Then the answer they may get from the TAM research stream is: make the users feel the application

useful. Does this answer really help solve the problem of the company or explain why and how? I do not think so.

This study focuses on firm performance measured with profitability, rather than perceptions of firm performance. Such focus also has important implications for practitioners. I did not intend to deny the values of studies based on perceptions but believe that practitioners can benefit more with objective, standardized, and understandable results of academic research. They may not trust others' perceptions. Thus, the use of popular financial performance indicators, such as ROA, ROS, OIA, and OIS, can help practitioners understand the results of studies and improve relevance. The use of objective measures for firm performance is also widely accepted in organizational and IS literature.

In addition, this study defines DIC as process-oriented and classifies IT initiatives into categories of various business processes. I argue that such classification has an advantage over other classification, such as automate IT, informate IT, and transform IT (e.g., Shaft et al., 2007) because business process is a common language and also one of the focuses of companies. Practitioners may have problem with understanding the meaning of automate IT or transform IT, but they certainly do not have problem with knowing business processes. I argue that a process-oriented perspective of IT business value can improve relevance of IS research than other perspectives, such as RBV, which does not explain how to use IT resources but just argues that resources by themselves can produce values.

This study also provides guidance on where to use IT resources to improve firm performance and explain why some companies failed to do so. Traditionally, IT is used to support some major business processes, such as operation, marketing, and service. There are a

number of existing studies which indicate how companies can benefit from the use of IT in those processes. Thus, some people (like Carr) assumed that IT business value should be also derived from these major business processes. But the results of this study show that companies should explore using IT resources in new areas, such as supply chain and technology development. These findings can provide straightforward insight and help practitioners effectively use IT resources to obtain competitive advantages.

Finally, this study provides guidance for companies to participate in network practice. First, research on the interaction between IT capability and network structures is still limited. This study confirms that two important factors, DIC and network structure, can complement each other to improve firm performance. Second, the interaction between IT capability and network structures at the process-level is still understudied. This study provides guides for how IT can be used to support specific business processes, such as supply chain and firm infrastructure, interact with network structures and contribute to firm performance. Third, I applied the concept of Simmelian tie to firm-level studies and found significant effects of Simmelian tie on firm innovation at process-level. I believe these findings are important because of the lack of similar studies on this topic.

5.2. Limitation and Future Research

This study suffers from some limitations. First, it is well-known that organizational studies significantly suffer from the difficulty of data collection. In this study, I carefully followed existing studies and tried to avoid data collection bias. But no data collection is perfect. There is a possibility that some level of data collection bias exists. Second, in this study I only used 26 companies across 19 industries over 8 years for our main data analysis. Although the

sample size is totally comparable with existing studies, such as Chi, Ravichandran et al.(2010) with 12 companies over 16 years and Chi, Liao et al. (2010) with 20 companies over 7 years, it is possible that this study fails to capture some significant effects due to relatively small sample size. Finally, I referred to the original definitions of network structures and calculated them by myself. This method needs to be confirmed and tested further in future studies.

This study introduces (or re-defines) a new concept: dynamic IT capability. Although I found strong and significant supports for my arguments, follow-up studies are considerably needed. Future studies can focus on using this concept in difference context or measuring it with different operationalization. Also, this study has some interesting findings on the interaction between processes-level DICs and network structures, such as some negative effects of the interaction between Operation DIC and structural hole on ideated innovation. Future studies can follow this direction and systematically explore the mechanisms under the phenomena and ask the question: what factors cause the negative results and how we can obtain the positive results.

5.3. Conclusions

The quest of IT business value has been a big concern in both IS and organizational research. While some scholars in other fields have argued that IT does not matter, in the IS field some scholars start to believe that no direct link exists between IT and firm performance measured by profitability. The consequences of such opinions are troublesome because they can significantly discourage the enthusiasm of practitioners to embrace and invest in IT resources for pursuing competitive advantages.

The results of this study clearly indicate that IT can both directly and indirectly contribute to firm performance. It is just a matter of how and where to use IT resources for business

processes in order to obtain business value. Based on the data collected for 26 companies across 19 industries, this study found that DIC, the ability of a firm to dynamically build, integrate, and redesign IT resources to support business processes, significantly contributes to firm performance (measured by profitability) and firm innovation (measured by patents and new product and services). It also reveals that DIC can complement network structures, such as network centrality and structural hole, to improve firm performance. Moreover, this study provides valuable insights on the contributions of process-level DICs to firm performance and firm innovations. All these findings contribute to current IT business value research and provide guides for practitioners to effectively use IT and achieve competitive advantages.

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