Mechanisms Underlying IT-enabled Business Innovation: Review, Theoretical Framework, and Empirical Analyses

by

Terence Joseph V. Saldanha

A dissertation submitted in partial fulfillment
of the requirements for the degree of
Doctor of Philosophy
(Business Administration)
in The University of Michigan
2012

Doctoral Committee:

Professor M.S. Krishnan, Chair
Professor Gerald F. Davis
Professor Robert J. Franzese Jr
Assistant Professor Nigel P. Melville

Dedication

To my mother (Lolita M. Saldanha, 1946-2008) and my father (Sylverius A. Saldanha, 1941-1996)

Acknowledgements

This dissertation would not be possible without the help and support of a number of persons. First, my dissertation advisor (chair) Dr. M.S. Krishnan has been a constant source of help and support to me right from the day I first arrived in Michigan. Dr. Krishnan’s guidance has immensely improved this dissertation. Dr. Krishnan has been and will always be a role model for me. He has been a great advisor and guide for me in multiple aspects of research, teaching, academic life, and life in general. I will forever remain indebted to Dr. Krishnan for his guidance, help, and support. Second, Dr. Nigel Melville has been of great support and help to me in strengthening this dissertation and in improving my research in general. He has been a guiding light to me right from my first year in the program and has taught me many invaluable and practical lessons in research, writing, teaching, and academic life. Third, Dr. Gerald Davis has been a great help and guide to me in the dissertation. His guidance and insights on many theoretical and empirical aspects of the dissertation has strengthened the dissertation significantly. Fourth, Dr. Robert Franzese has imparted important guidance to me in this dissertation as well as in his Econometrics class. His guidance and insights in the overall dissertation and the empirical approaches in particular has strengthened the dissertation immensely. In sum, this dissertation has greatly benefitted from the comments, inputs, and suggestions of all my committee members. I thank each one of them for their guidance and support.

Next, I acknowledge the help and support of the Business Information Technology (BIT) department faculty at the Stephen Ross School of Business at the University of Michigan. Dr. Scott Moore, Dr. Michael Gordon, Dr. Dennis Severance, Dr. Hila Etzion, Dr. Thomas Schriber, Dr. Jerry Peterson, and Dr. Joe Walls have contributed to my academic journey at University of Michigan in various ways. This dissertation and my academic experience here at Ross have been enriched by their inputs on my research, my presentations, and my teaching; I thank each of them.

Next, I acknowledge my fellow colleagues, students, and graduates in the BIT department at the Ross School of Business. Dr. Sanjeev Kumar has been a particularly helpful source of guidance to me professionally especially when I first reached Ann Arbor. Similarly, Dr. Ali Tafti, Dr. Min-seok Pang, Sajeev Cherian, Mark Madrilejo, Dr. Li Wang, and Vijay Dakshinamoorthy, and have been helpful as seniors in the program to me at various stages of my academic experience at Ross. Similarly, Sanghee Lim, Suresh Malladi, Andrea Walrath, Daniel Rush, and Ajit Sharma have been great colleagues and friends to have in the program.

I also acknowledge the support of many other recent graduates of the BIT Ph.D. program at Ross. In addition to those named earlier, Dr. Sunil Mithas, Dr. Jonathan Whitaker, Dr. Ramanath Subramanyam, and Dr. Narayan Ramasubbu have all been helpful in providing professional and research guidance. I thank them for being always willing and taking time to help and advise me in my research and academic endeavors.

I next acknowledge the support of the faculty of the Ross School of Business outside the BIT department, and the University of Michigan faculty outside Ross. Dr. Anne Harrington and Professor Karen Bird went out of their way to help me with regard to training in teaching, and I am grateful to them for supporting my academic endeavors. Similarly and in particular, Dr. Gautam Ahuja (Strategy department at Ross) and Dr. Jeff Smith (Department of Economics) have enriched my academic journey and research learnings in Michigan in various ways through their classes I have taken and/or individual feedback on earlier drafts of the chapters.

I next thank the staff at the Doctoral Studies Office of Ross School. Brian Jones, Roberta Perry, Kelsey Zill, Pam Russell, Karen Lewis, Paula Kopka, Christopher Gale, Martha Boron, Judith Sachs, and Linda Veltri have been of great help to me in providing administrative and logistical support to me at various stages of my doctoral program.

I acknowledge the support of InformationWeek who provided the data used for the empirical chapters in this dissertation. I thank the ten Chief Information Officers (CIOs) who took time to share their insights with me through my discussions with them. Because I had assured these ten CIOs of complete anonymity of their views, comments, and inputs, I refrain from naming them or their companies.

I acknowledge the financial support and tuition waivers provided by the Doctoral Studies Office at the Ross School of Business to fund my education at the University of Michigan from 2007-2012. Additionally, I thank Information Systems Education Foundation (ISEF) for providing me with financial scholarships from 2007-2011. Needless to say, it would have been financially impossible for me to take up the Ph.D. program without these sources of financial support. I also thank Mr. and Mrs. Robert Neary, and Mr. Charles Gessner for the scholarships I received (via the Doctoral Studies Office) in 2010 and 2011-2012 respectively. I thank the Horace Rackham Graduate

School, ISEF, and the BIT department for financially supporting my travel to various academic conferences and doctoral consortia for my research presentations.

I acknowledge the support of my colleagues and friends in the Information Systems discipline outside the Ross School of Business. The comments and suggestions of the participants and the anonymous reviewers of International Conference on Information Systems (ICIS) 2011 (where Chapter 2 was presented) , and the INFORMS Conference on Information Systems and Technology (CIST) 2009 (where an early version of Chapter 3 was presented) proved invaluable in improving the quality of the research. Similarly, I thank all the faculty mentors and participants at the ICIS 2011 doctoral consortium, the Americas Conference on Information Systems (AMCIS) 2011 doctoral consortium, the Academy of Management (AOM) Organizational Communications and Information Systems (OCIS) 2011 doctoral consortium, the Decision Sciences Institute (DSI) 2011 doctoral consortium, the Interdisciplinary Committee of Organizational Studies (ICOS, at University of Michigan) Dissertation poster session 2011, and the Big-Ten Information Systems Research Symposium 2010 who provided feedback on early drafts of the chapters in this dissertation.

I thank my Professors at the prior educational institutes where I studied [S.P. Jain Institute of Management & Research, and University of Mumbai]. In particular, Dr. Debasis Mallik, Professor Jiban Mukhopadhyay, Dr. Shrikant Parikh, and Dr. Sunil Rai supported my endeavor to take up the Ph.D. program.

Next, I thank my family and friends. My mother (Lolita Saldanha, 1946-2008) was a significant inspirational influence on me in taking up the Ph.D. program and was a great support to me during the first year of my program. Her untiring support and encouragement to me during our innumerable phone and GoogleTalk conversations kept me going even when I found the going tough. No words can express my gratitude to my mother and my father (Sylverius Saldanha, 1941-1996) for being sources of inspiration to me. I thank my brothers Carl Saldanha and Dr. Ian Saldanha who have constantly supported and encouraged me in my academic endeavors and personal life. Similarly, I thank my uncles, aunts, cousins, other family members, and friends who have been a support to or encouraged me in various ways especially after I lost my parents. I specially thank my uncle Dr. Melvyn Menezes who has been a great source of professional and personal advice, guidance, encouragement, and support to me throughout the Ph.D. program. I also specially thank my cousin Valerie Doshi, her husband Mehul Doshi, and their child Pranay Doshi who have been of great help to me here in Michigan especially during my early years in Ann Arbor. Finally, I thank God Almighty. At all times through the Ph.D. program, it was His guidance that has been instrumental and without which this dissertation would have been impossible.

In conclusion, I am grateful to everyone who has been a part of or encouraged me during my academic journey here at University of Michigan. There are so many people (professors, colleagues, family, and friends) who have contributed to, encouraged, or supported me in various ways during my program; and it would simply take up too much space to name everyone here. If I have missed mentioning someone who deserves mention, this oversight is completely unintentional.

While I thank all of the aforementioned individuals for their contribution, encouragement or support, I emphasize that any errors, omissions, inaccuracies, oversights, and deficiencies that remain in this dissertation are solely my own.

Table of Contents

List of Figures

List of Tables

Abstract

The role of Information Technology (IT) in business innovation is important, yet relatively understudied in the extant Information Systems (IS) literature. This dissertation focuses on mechanisms underlying IT-enabled Business Innovation. Consistent with prior research, I use the definition of IT-enabled business innovation as ‘new products, services, or processes developed by a firm through the application of IT’.

In Chapter 1, I conceptually explore the role of IT in business innovation. I review the literature at the nexus of IT and business innovation, categorizing the related literature into four broad themes. Drawing on the literature review and on theory, I then propose a theoretical framework linking aspects of a firm’s technical architecture and social architecture and IT-enabled business innovation. The framework explicates the role of the technical architecture and social architecture in IT-enabled business innovation. Furthermore, the framework identifies five underlying mechanisms linking the technical architecture and social architecture to IT-enabled business innovation. Subsequently, I identify and suggest research directions to explore the role of IT in business innovation.

In Chapter 2, from a social perspective of IT-enabled business innovation and drawing on organizational theory of boundary-spanning leadership, I examine the role of the leader of the IT organization, the Chief Information Officer (CIO) in IT-enabled

business innovation. I empirically examine how the CIO's role pertaining to entities and functions outside the IT organization explains the firm's propensity for IT-enabled business innovation. The empirical analysis of a large dataset of U.S. firms suggests that IT-enabled business innovation is more likely when the CIO reports to the Chief Executive Officer, has greater interaction with the firm's customers, and is more involved in product development.

In Chapter 3, from a technology perspective of IT-enabled business innovation and drawing on organizational knowledge creation theory, I conceptualize Web 2.0 technologies as facilitators of knowledge creation, improving firms' propensity for IT-enabled business innovation. I further posit that the use of Web 2.0 technologies improves firms' propensity for IT-enabled customer- centricity. I contend that these relationships are reinforced by a flexible interoperable IT architecture, Services-Oriented Architecture (SOA) and are mediated by improved information integration across the firm. The empirical findings using a large dataset of U.S. firms generally support the theoretical predictions.

Chapter 4 concludes the dissertation by tying back the findings from the empirical studies to the theory in Chapter 1. This chapter also suggests future research in the area of IT-enabled business innovation.

Taken together, this dissertation sheds light on selected mechanisms linking IT and business innovation, with specific focus on the CIO role and IT architecture (Web 2.0, SOA, and integration).

Introduction

The topic of innovation has proven interesting to academicians and practitioners alike (Ahuja et al. 2008). In today's highly competitive marketplace, a growing number of firms view innovation as a means of achieving growth and profitability. Recent years have also seen a paradigm shift in how companies innovate. Innovation has shifted from introduction of new ideas and product development through heavy investment in a firm's own resources (e.g., Research and Development [R&D]) to a model where firms innovate jointly in collaboration with other firms and entities (Huston and Sakkab 2006). Innovation has been transformed into an open innovation model rather than a closed innovation model (Chesbrough 2003). At the same time, the role of Information Technology (IT) in business has evolved from one that was just focused on efficiency and cost-reduction, to one that is enabling new business models and strategic capabilities.

Despite recognition of innovation as a source of competitive advantage and the evolving role of IT in business, there has been limited attention in the extant literature to the role of IT in business innovation. Notable recent exceptions include Cherian et al. (2009), Chi et al. (2010), Han and Ravichandran (2006), Joshi et al. (2010), and Kleis et al. (2012). Motivated by this relative paucity of research on innovation as a performance outcome of IT, though this research stream is growing, my dissertation examines specific mechanisms driving the relationship between IT and business innovation.

In Chapter 1, I conceptually explore the role of IT in business innovation. I review the literature at the nexus of IT and business innovation. Drawing on prior literature and theory, I then propose a framework linking aspects of a firm's technical and social architecture (Prahalad and Krishnan 2008) to IT-enabled business innovation. I subsequently identify potential future research opportunities to explore the role of IT in business innovation. I conclude the chapter by scoping my dissertation under the broad umbrella of the framework. Taken together, this chapter lays the conceptual grounding for the empirical studies in the dissertation, and provides a framework and foundation for future research on the role of IT in business innovation.

Chapter 2 examines IT-enabled business innovation from the perspective of top management, i.e., more specifically, from the viewpoint of the role of the leader of the IT organization in the firm, the Chief Information Officer (CIO). Drawing on organizational theory of boundary spanning leadership, I posit that the CIO's cross-functional role interfacing with functions and entities outside the IT organization help explain the firm's propensity for IT-enabled business innovation. Our empirical analysis of U.S. firms largely supports the theoretical predictions. The findings indicate that IT-enabled business innovation is more likely when the CIO reports to the Chief Executive Officer (CEO), has more interactions with the firm's customers, and is more involved in new product development. The chapter concludes with implications for research and practice.

In Chapter 3, I examine the link between the firm's use of Web 2.0 technologies and the firm's IT-enabled business innovation. I draw on knowledge creation theory which posits that organizational knowledge creation takes place through iterative progressions of knowledge and conversions from explicit to tacit knowledge and vice-versa (Nonaka 1994). The underlying mechanism guiding the hypotheses is that by being better connected to each other through Web 2.0 technologies, employees in an organization are better equipped to be more successful in innovation. Specific theory-grounded hypotheses are presented first proposing that the use of Web 2.0 technologies is associated with firms' propensity for IT-enabled business innovation and IT-enabled customer-centricity. Next, hypotheses are proposed positing a positive moderating role of a flexible IT infrastructure (Services-Oriented Architecture [SOA]) on the Web 2.0 – innovation and Web 2.0-customer-centricity relationships. Finally, a mediating role of improved information integration is hypothesized. Findings indicate that use of Web 2.0 technologies is associated with firms' propensity for IT-enabled business innovation and IT-enabled customer-centricity. SOA is found to positively moderate the Web 2.0-customer-centricity link but not the Web 2.0-innovation link. Finally, improved information integration is found to fully mediate the Web 2.0 –customer centricity relationship, and partially mediate the Web 2.0-innovation relationship. This chapter concludes by providing potential implications of the findings for research and practice.

Chapter 4 ties back the empirical findings of the previous two chapters to Chapter 1, and concludes the dissertation with further suggestions for future research.

Chapter 1

IT-enabled Business Innovation: A Review, Theoretical Framework, and Research Directions

1.1. Introduction and Motivation

> *"Because the purpose of business is to create and keep a customer, the business enterprise has two - and only two - basic functions: marketing and innovation. Marketing and innovation produce results; all the rest are costs."*
>
> - Peter Drucker (1909-2005) in *The Practice of Management (1954)*

The above quote by the eminent management scholar Peter Drucker epitomizes the importance of innovation in business. Innovation has been widely recognized as a mechanism for wealth creation (Dougherty 1992; Dougherty and Heller 1994) and as a means for firms to gain profitability, competitive advantage, growth, and market share (Acs and Audretsch 1990; Banbury and Mitchell 1995; Cho and Pucik 2005; Giarratana 2004). Innovation has also been regarded as critical for the survival of firms (Hurley and Hult 1998).

'Business innovation' has had varied definitions in the literature. One perspective, drawing on organizational literature (Daft 1978; Damanpour 1991) and put succinctly by Gordon and Tarafdar (2007, p. 356), defines business innovation as "an idea, practice, behavior or artifact that is perceived as being new by the adopting unit". This definition is consistent with the diffusion of innovations perspective (Rogers 1996), and is in line with arguments that organizations can benefit by adopting innovations. An important consideration in this definition is that the innovation is new to the adopting organization without necessarily being new to the population of organizations (Damanpour 1987; Hage 1999). A second common definition of business innovation takes the perspective of the output of the innovation process and defines innovation as new products, processes, or services developed by a firm (Ahuja et al. 2008; Thompson 1965). In this dissertation, I employ this perspective of innovation, i.e., as characterized by new products, processes or services developed by a firm.

The process by which firms innovate has gradually changed during the past several decades. In the traditional approach to innovation, new ideas would be spurned by heavy investments in R&D (Chesbrough 2007). In the modern era, innovation is often a result of actions by a variety of stakeholders and actors who interact with each other to collaborate in the process of knowledge creation (Landry et al. 2002). Innovation is increasingly transitioning from a closed paradigm to an 'open innovation' paradigm where innovations are generated collaboratively by firms with their customers, partners, and employees (Chesbrough 2003; Prahalad and Krishnan 2008; von Hippel 1998).

During the past few years, the role of information technology (IT) in business has evolved. IT is no longer simply the back-office unit of organizations, but has instead moved into the forefront of business to provide strategic value, innovation value, and competitive advantage (Dehning and Stratopoulos 2003; Joshi et al. 2010; Sambamurthy et al. 2003). For example, the online IT system by Dell has transformed its supply chain process capabilities. IT plays a pivotal role at Ducati Motors, aiding their design of new motorcycles (Gino and McAfee 2006). IT is critical to Amazon's ability to personalize their customers' experiences and improve sales. Advanced technologies such as Product

Lifecycle Management (PLM) systems and automated design systems facilitate innovation among product development teams. IT can help in drug discovery at pharmaceutical companies such as Biogen Inc. (Joshi et al. 2010; Kleis et al. 2012; Narayanan et al. 2004). Technologies such as social computing have changed the way how people collaborate online (Cook 2008), potentially driving fruitful collaboration among employees, and between firms and customers in an open innovation paradigm. Many such examples pervade the business landscape, suggesting that IT is fundamentally transforming business, processes, products, and services. IT has become central to the innovation success of businesses by enabling dynamic, flexible, and aligned business processes. With the increasing role of IT in enabling strategic capabilities, IT organizations and IT managers are looked up to by firms and CEOs to support and drive business innovation.

The Information Systems (IS) literature has long emphasized that the use of IT has digitized the business process operations of firms with substantial improvements in productivity and operational efficiency (e.g., Brynjolfsson and Hitt 1996). Recent discourses in the literature recognize that IT advances have enhanced new product development and process design capabilities, helping firms increase the value proposition of their product and service offerings to customers (Banker et al. 2006; Kohli and Melville 2009; Pavlou and Sawy 2006). Researchers have also showed that IT has evolved from merely enhancing efficiency to providing strategic value (Bardhan et al. 2008; Kearns and Lederer 2000; Oh and Pinsonneault 2007; Pavlou and Sawy 2006; Sambamurthy et al. 2003). Despite these advances in the literature regarding the strategic role of IT in business, there is limited academic research linking IT to business innovation, barring few recent studies in this area (e.g., Cherian et al. 2009; Chi et al. 2010; Han and Ravichandran 2006; Joshi et al. 2010; Kleis et al. 2012). This is also recognized by prior research (Gordon and Tarafdar 2007; Joshi et al. 2010; Kleis et al. 2012). In this chapter and dissertation, I propose to address this gap in the literature. My dissertation seeks to explore an overarching fundamental research question: *How can IS resources drive IT-enabled business innovation?*[1]

The rest of this chapter proceeds as follows. In the next section, I define IT-enabled business innovation as referred to in this chapter and dissertation. In section 1.3, I review the literature at the nexus of IT and business innovation. Section 1.4 draws on theory and on the literature to posit a framework of IT-enabled business innovation. In section 1.5, I suggest opportunities for future research to explore the role of IT in business innovation. Section 1.6 includes discussion and contributions. In Section 1.7, I discuss the limitations. Section 1.8 concludes the chapter and bridges the connection to the ensuing empirical studies in this dissertation.

1.2. Defining IT-enabled Business Innovation

Before proceeding, it is important to clarify what we refer to as innovation because, as discussed earlier, innovation can potentially have multiple definitions (Wineman et al. 2009). For example, innovation is varyingly referred to as a structural reorganization of the firm (e.g., Mohr 1969), the introduction of a new administrative or production process (e.g., Kimberly and Evanisko 1981), the creation of a new product, process, or service (e.g., Miller and Friesen 1982), or is defined on the basis of the type of change it causes in the firm (e.g., Dewar and Dutton 1986).

[1] The term "IT-enabled business innovation" is defined in the ensuing sub-section.

In this dissertation, I use the definition of IT-enabled business innovation by prior research (Agarwal and Sambamurthy 2002; Joshi et al. 2010; Teo et al. 2007; Ye and Agarwal 2003) as 'new products, services, or processes developed by a firm through the application of IT'. For example, IT competences were critical to the product innovation capabilities of a large glass-manufacturing company in Ohio (Gordon and Tarafdar 2007). YCH Group, a logistics and supply chain company, used an IT-based analytics system to design a new process of scheduling trucks (Teo et al. 2007). An example of an IT-enabled service innovation is the new check-depositing service capability via an iPhone application that Chase Bank offered to its customers.[2] Thus, I focus on innovation as outputs (i.e., new products, processes, or services), not inputs, although innovation can refer to both (Ahuja et al. 2008; Cohen and Levin 1989).

Our adopted definition of IT- enabled business innovation differs from the definition of 'IS innovation' used in seminal works in the IS literature, which refer to IS innovation as "innovation in the application of digital computer and communications technologies" (Fichman 2004; Swanson 1994, p. 1078; Swanson and Ramiller 2004) and "the pursuit of IT applications new to an organization" (Swanson and Ramiller 2004, p. 556). These alternate definitions view the IT innovation as the information technology perceived as new by the adopting organization (Wang and Ramiller 2009). Our definition can be mapped to, and builds off the outcome of what Swanson (1994) defines as Type III IS innovations which are "inherent to or imbedded in a product … or … incorporated within a service" or process (Grover et al. 1997; Swanson 1994, p. 1078).

[2] I thank Dr. M.S. Krishnan for providing this and other useful examples of IT-enabled business innovation.

While our definition of innovation is in line with prior literature (Agarwal and Sambamurthy 2002; Joshi et al. 2010; Teo et al. 2007; Ye and Agarwal 2003), it is pertinent to note that this perspective of innovation (in terms of patenting activity of new products, processes, or services), like most measures of innovation, has not gone unchallenged (Ahuja et al. 2008; Griliches 1990).[3] Some of the criticisms stem from arguments that patenting may be indicative of a firm's corporate strategy or may be used by firms to prevent litigation. Despite such arguments, patenting activity is considered to be a useful measure of innovation. More specifically, as argued by Griliches (1990, p. 299), patenting activity can be expected to correlate well with the level of "inventive output" or the "additions to economically valuable knowledge" resulting from inputs to the innovation process. Thus, patenting activity is considered as a good measure of innovation and is widely used in the literature (e.g., Ahuja et al. 2008; Joshi et al. 2010; Scherer 1965; Schilling and Phelps 2007).

In employing this definition of IT-enabled business innovation, it is instructive to distinguish between IT-enabled business innovation and innovation that is not IT-enabled. To illustrate this distinction in contrast to the earlier described examples of IT-enabled business innovation, as an example of a business innovation that is not IT-enabled, consider a chemical company which patents a new formula that was created by mixing two existing formulas without the aid of IT. Or consider an automobile equipment manufacturer that patents a three-button in-vehicle appliance which is driven by mechanical equipment and not driven by IT.[4] Alternately, consider a patent of a

[3] I thank Dr. Gerald Davis for motivating this discussion.
[4] I thank an anonymous CIO for providing me this example during my discussion with him.

mechanically driven apparatus to score book covers. In these examples, IT is unlikely to have played a big role in the innovation.

1.3. Literature Review

1.3.1. Management Literature on Innovation

The management literature on innovation is vast, and we refer the reader to recent reviews provided by Ahuja et al. (2008) and Gilbert (2006), among others. These reviews broadly characterize innovation output as a production function with several input determinants including firm, industry, and institutional factors. As noted in Ahuja et al. (2008, p. 5), factors influencing innovation can be broadly characterized into four categories: "industry structure, firm characteristics, intra-organizational attributes, and institutional influences."[5]

First, industry structure is identified as an important factor influencing innovation, beginning from the seminal work of Schumpeter (1942) who argued that industry concentration can promote innovation by monopolistic or oligopolistic firms because such firms can derive more benefit from innovation compared to firms in competitive industries. A counter-argument to this perspective is the X-efficiency argument which posits that less competition may cause firms to waste resources and hence be less innovative (Kamien and Schwartz 1982). Recent literature (e.g., Ahuja 2000) has broadened the view of industry structure to examine how collaboration of networks of firms in industries may influence firms' innovation productivity by serving as conduits for sharing resources and information (e.g., Freeman 1991). Other studies of the role of industry structure on innovation include those that examine user innovations (e.g., von

---

[5] The following four paragraphs in this subsection draw heavily on a detailed review of the management literature on innovation by Ahuja et al. (2008). To avoid excess verbosity, I refrain from repetitive citation of Ahuja et al. (2008).

Hippel 1998), innovations by suppliers (Harhoff 1996), and the conditions under which users and suppliers may invest in innovation activities of the focal firm.

Second, firm characteristics play an important role in innovation (Ahuja et al. 2008). One of the most common arguments is that firm size is important for innovation because large firms have scale economies in the R&D process, and are likely to have an abundance of resources that complement R&D (Cohen and Levin 1989; Schumpeter 1942). The scope of firms, more specifically the extent of diversification, can impact innovation by facilitating knowledge transfer and cross-pollination of ideas across businesses (Miller et al. 2007). As with industry, the notion of "the firm" itself has broadened, and researchers have adopted the perspective that the characteristics of networks of alliances of firms with other firms can influence innovation (e.g., Sampson 2005). Such characteristics include the position of the firm in the network (Rogers and Larsen 1984), the network structure, and nature of alliances (Kotabe and Swan 1995). The underlying theory behind arguments of network characteristics as predictors of innovation is that networks can serve as "information conduits" (Ahuja et al. 2008, p. 42). Next, organizational performance is identified as an important factor for innovation because high-performing firms have the ability to invest in resources required for successful innovation (Greve 2003).

Third, intra-organizational attributes such as "structure and processes, governance and incentives, manager backgrounds and search processes" are important for innovation (Ahuja et al. 2008, p. 5). For example, structures that are mechanistic or bureaucratic may hinder innovation, compared to organic organization structures (Aiken and Hage 1971). Similarly, decentralization, complexity, and formalization can influence innovation by impacting the fertilization of ideas (Aiken and Hage 1971), the involvement of employees, and the extent of openness in the organization (Pierce and Delbecq 1977). Researchers have also addressed how incentive structures, monitoring mechanisms (Hill and Snell 1988), characteristics and background of managers (Wu et al. 2005), and organizational search processes influence innovation (Kogut and Zander 1992).

Fourth, institutional factors such as the extent of scientific progress and appropriability conditions in the firm's environment can influence innovation by providing conditions that increase the likelihood of successful innovation (Ahuja et al. 2008). For example, advances in science can help firms detect new opportunities for innovation by uncovering potential new cause-effect relationships. Appropriability conditions refer to environmental factors that can include complementary assets in industries and legal protection mechanisms that can enhance innovation.

A common view in many of the extant studies on innovation is consideration of the economics of innovation from the perspective of R&D investments and processes. Despite the literature on organizational capabilities in innovation, it is evident from the reviews of the innovation literature (Ahuja et al. 2008; Gilbert 2006) that IS capabilities have not been extensively studied as drivers of business innovation. This has also been noted by prior researchers (Banker et al. 2006; Dewett and Jones 2001; Gordon and Tarafdar 2007; Joshi et al. 2010). Moreover, whereas the business value of IT literature includes much research on the role of IT in operational efficiency, the role of IT in business innovation has received scant attention and is relatively understudied (Gordon and Tarafdar 2007; Joshi et al. 2010; Kleis et al. 2012).

1.3.2. Literature on Role of IT in Business Innovation

IS capabilities have significant potential and capacity to shape the business processes, products, and services of firms (Fichman 2004; Swanson 1994). In the IS literature, the effect of IT on business innovation has been captured more recently in some studies. It has been found that IT investments complement firms' investments in R&D (Han and Ravichandran 2006; Kleis et al. 2012) and can directly contribute to business innovation (Cherian et al. 2009). IT-enabled absorptive capacity has been found to have a positive effect on firm innovation (Joshi et al. 2010). Ahituv et al. (1998) find that firms that are highly successful with new products possess more IS applications than firms that are less successful. Prior IS research has also suggested mechanisms by which IT can facilitate business innovation such as through improved knowledge management capabilities (Alavi and Leidner 2001; Chi et al. 2010), co-ordination and collaboration (Nambisan 2003), greater IS-business linkages (Gordon and Tarafdar 2007), and a greater ability to manage new product development (Nambisan 2003; Pavlou and Sawy 2006). IT enhances the ability for concurrent design and engineering capabilities, facilitating innovation (Dewett and Jones 2001). IT can also lessen the cost of product development by reducing product cycle time and improving product quality (Banker et al. 2006).

In this review, I limit the scope to papers which relate to the similar definition of innovation (or IT-enabled business innovation) that I have adopted, as discussed earlier. I synthesize the literature at the nexus of IT and business innovation into four broad themes, based on the underlying mechanisms or conceptual arguments made in the literature for how IT may potentially influence innovation. The four themes are:

Theme A: Knowledge-related capabilities.

Theme B: Collaboration, cross-functional teamwork, cross-functional integration.

Theme C: Information-processing and coordination.

Theme D: Creativity and individual-level stimuli.

The key focal mechanisms and representative studies in each theme are depicted in a birds-eye view of the literature (Figure 1).

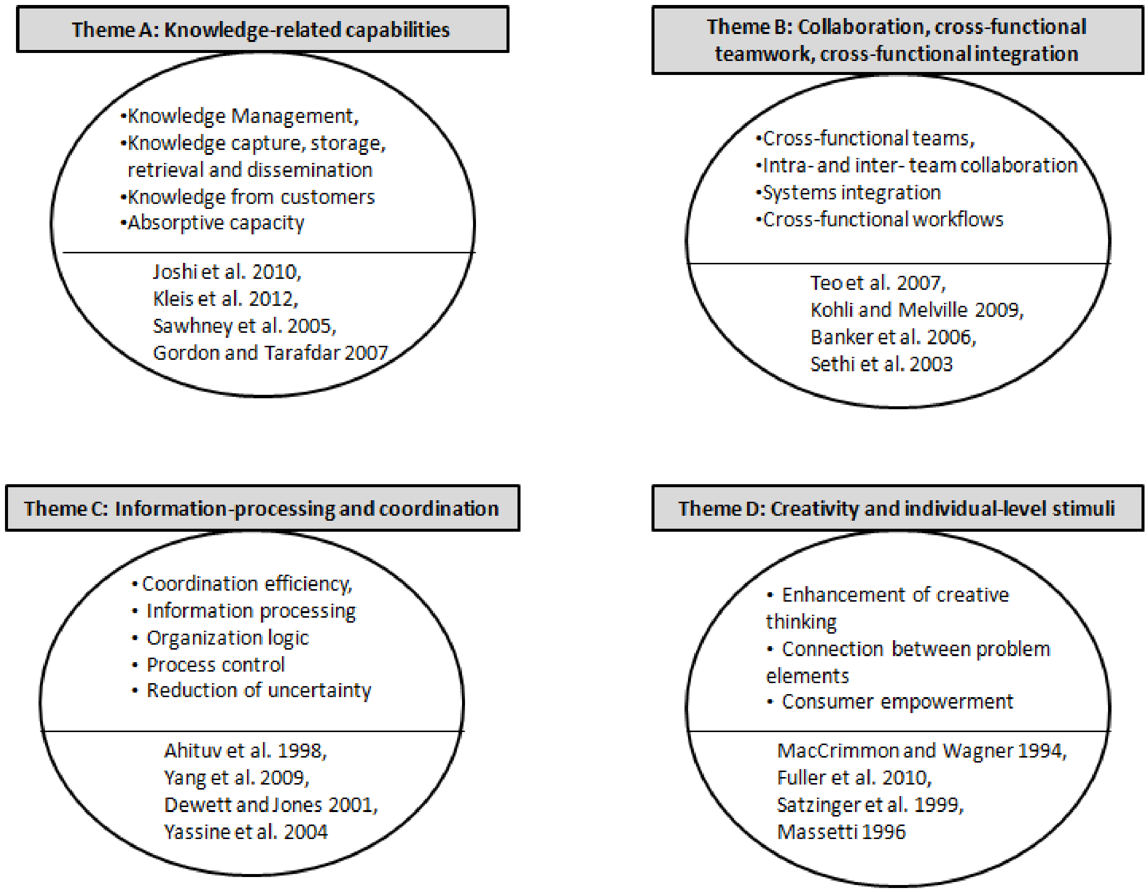

Figure 1: Birds-eye View of Literature related to IT and Business Innovation (Themes, Focal Mechanisms, and Representative Literature)

First, studies suggest that knowledge capabilities driven by IT are an important enabler of innovation (Theme A, Table 1). Studies in this theme draw on the notion that IT can help firms capture, store, retrieve, and disseminate knowledge. Knowledge capabilities can facilitate organizational learning (Henderson and Lentz 1995), helping firms leverage their resources for innovation. The knowledge perspective also argues that firms can draw on external sources of knowledge for innovation, and IT can play an important role in facilitating this phenomenon. For example, Sawhney et al. (2005) contend that the Internet can serve as a platform for incorporating customer knowledge into innovation. Dong (2010) posits that new knowledge created through IT-based information exchange with suppliers can be an important mechanism leading to IT-enabled innovation in supply chains. The absorptive capacity theoretical perspective has also been applied by researchers (Chi et al. 2010; Joshi et al. 2010; Srivardhana and Pawlowski 2007) to argue that by increasing knowledge capabilities, firms' absorptive capacity can be enhanced, resulting in improved innovation capabilities.

The second broad theme underlying the literature suggests that collaboration, cross-functional integration, and teamwork enabled by IT can drive innovation (Theme B, Table 1). For instance, IT-enabled integration of diverse functional information can mitigate conflict across departments and increase the potential of finding novel linkages (Sethi et al. 2003). Banker et al. (2006) examine how IT can promote collaboration among design teams, thus improving product quality and reducing product cycle time and development cost. IT can also promote collaboration between cross-functional teams in the firm (Kohli and Melville 2009; Teo et al. 2007).

Third, research suggests that IT can improve information processing and coordination capabilities to drive innovation (Theme C, Table 1). Studies in this theme support the view that IT can help in the organization of tasks and in the processing of data to support decision making by providing information about the organization and its competitive environment (Ahituv et al. 1998; Yoo et al. 2010). IT can also enhance coordination efficiency and communication by facilitating organizational routines in the innovation process (Han and Ravichandran 2006). Dewett and Jones (2001) argue that information processing and information integration enabled by IT help innovation by "enhancing the creative and coordinated behaviors both inside and between organizations" (p. 327). This view of IT promoting information processing and coordination across organizations is also supported by Yang et al. (2009), who posit that the quality of information from IS can help firms in coordinating with their upstream and downstream partners, and in leveraging their capabilities in the innovation process.

Finally, the fourth theme underlying the literature suggests that IT can act as a stimulus for enhancing individual-level mechanisms (such as creativity) that can influence innovation (Theme D, Table 1). Literature in this stream has examined how specific computer programs can improve the creativity of individuals (MacCrimmon and Wagner 1994; Massetti 1996). Group-Support Systems (GSS) have also been identified as improving employee creativity by serving as a stimulus for idea generation (Satzinger et al. 1999). Another mechanism identified by Füller et al. (2010) is the empowerment of consumers through IT. Specifically, the authors found that the Internet triggers consumer empowerment which stimulates their participation in innovation co-creation activities of firms. In sum, studies in this theme focus on individual-level mechanisms by which IT can enhance the creativity or innovation of individuals.

It is evident from the literature review that while several studies *suggest* a link between IT and business innovation, empirical evidence is limited (Cherian et al. 2009; Chi et al. 2010; Han and Ravichandran 2006; Joshi et al. 2010; Kleis et al. 2012).

Table 1 summarizes key literature in the four identified themes related to IT and business innovation.

Study	Journal/ Outlet	Research Question/Focus	Research Finding	Type of study	Social or Technical Architecture	Key Focal Mechanisms
Theme A: Knowledge-related capabilities						
Cherian et al. 2009	Working Paper	What is the effect of IT investment on innovation in high-tech firms?	IT expenditure is positively associated with firm patenting. Innovation returns to IT investments are higher for firms with lower R&D investments.	Empirical	Technical, Social	Knowledge capabilities
Chi et al. 2010	ICIS	How do IT-enabled knowledge capabilities interact with network characteristics to influence firm innovation?	IT-enabled socializing capability positively interacts with access to structural holes to influence firm innovation.	Empirical	Technical	Knowledge capability
Dong 2010	ICIS	How do IT resources for SCM enable product and process innovations in conjunction with supply chain partners?	IT enables product and process innovations through e-business capability in the supply chain.	Empirical	Technical, Social	KM, collaboration
Gordon and Tarafdar 2007	JEIM	How do an organization's IT competences affect its innovation processes?	IT competences in KM, collaboration and communication, and business involvement positively affect an organization's ability to innovate.	Case-study	Technical, Social	Knowledge capabilities, IT-business linkages, communication and coordination
Henderson and Lentz 1995	JMIS	What are the ways in which the bridge between working and innovation can be built?	Organizational learning is a mechanism that mediates the link between working of IS organization and innovation.	Case study	Social	Organizational learning
Joshi et al. 2010	ISR	Does IT-enabled absorptive capacity influence innovation?	Knowledge capabilities that are enhanced through the use of IT contribute to firm innovation.	Empirical	Technical	Knowledge capabilities and absorptive capacity
Kleis et al. 2012	ISR	Can IT investment facilitate the innovation process?	IT capital has a positive and significant effect on innovation output.	Empirical	Technical	Knowledge management (KM), opportunity identification, inter-organizational coordination
Lee and Choi 2003	JMIS	How can knowledge enablers impact organizational performance?	IT support can enable organizational creativity through knowledge combination capability.	Empirical	Technical	Knowledge capability
Liberatore and Stylianou 1995	Management Science	Framework for expert systems and decision support systems with management methods	Expert systems provide flexibility and benefits for new product development decision making, which can accelerate product development cycle time.	Descriptive	Technical	Knowledge capabilities, capture of expert knowledge, understanding of decision-making process
Malladi and Krishnan 2012	AMCIS	Is cloud computing an important factor for IT-enabled innovation?	Software as a Service (SaaS) is positively associated with IT-enabled innovation. Organizational learning, architecture maturity and process maturity complement this relationship.	Empirical	Technical	Organizational learning, organizational capabilities
Nambisan 2003	MIS Quarterly	What is the potential for IS to contribute to New Product Development (NPD) research?	Process management, project management, information and KM, and collaboration and communication are important in NPD research.	Descriptive	Technical, Social	Process management, project management, information management, KM, collaboration and communication
Pavlou and El Sawy 2006	ISR	How can IT help NPD? and how does environmental turbulence affect this relationship?	IT leveraging competence is positively associated with NPD dynamic capabilities which is associated with NPD competency and competitive advantage.	Empirical	Technical	Organization of tasks, knowledge capabilities

Ramesh and Tiwana 1999	DSS	Identification of problems with KM in NPD teams and how IT system can meet these needs.	Lack of shared understanding, inconsistency in multiple versions of information, and loss of tacit knowledge are among the identified problems.	Case study	Technical	KM, overcoming problems of lack of shared understanding and inconsistency of information.
Sawhney et al. 2005	Journal of Interactive Marketing	How does the Internet as a platform facilitate collaborative innovation with customers?	Internet promotes customer engagement, interactivity, reach persistence, speed and flexibility. These facilitate collaborative innovation.	Case study	Social	Knowledge from customers, customer engagement, interactivity, reach persistence, speed and flexibility
Srivardhana and Pawlowski 2007	JSIS	In what ways does ERP affect business process innovation?	ERP can enable business process innovation through exposure to knowledge and enhanced organizational memory, which increase absorptive capacity.	Descriptive	Technical	Knowledge impacts, absorptive capacity
Tarafdar and Gordon 2007	JSIS	How can IS competences affect process innovations?	KM, Collaboration, Project Management, Ambidexterity, IT/Innovation Governance, Business-IS Linkages can affect process innovations.	Case-study	Technical, Social	KM, Collaboration, Project Management, Ambidexterity, IT/Innovation Governance, Business-IS linkages
Theme B: Collaboration, cross-functional teamwork, and cross-functional integration						
Banker et al. 2006	ISR	Role of Collaborative Product Commerce (CPC) in product development	CPC facilitates collaboration among design teams which positively impacts product quality and reduces cycle time and product development cost.	Empirical	Technical	Intra-team and inter-team collaboration, improved efficiency of workflows
Kohli and Melville 2009	CACM	What separates successful IT innovators from others?	Untapped value of IT lies at the intersection of business needs and IT capabilities.	Case-study	Technical, Social	Cross-functional teamwork, creative processes, integration, alignment, adaptation of processes
Sethi et al. 2003	JPIM	How web-based NPD systems integration influences NPD outcomes; and impact of contextual factors	Framework specifying importance of integration of systems for NPD outcomes.	Conceptual	Technical, Social	Cross-functional integration, systems integration
Teo et al. 2007	MIS Quarterly - Executive	How can IT-enabled innovation be fostered?	Importance of an innovation mindset, cross-learning from alliances and flexible risk ethic for innovation.	Case-study	Technical, Social	Cross-functional teams, open culture, entrepreneurial structure, partnership with customers
Theme C: Information processing and coordination						
Ahituv et al. 1998	I&M	What is relationship between pattern of environmental scanning, use of IS and success in introducing new products?	Firms with more success in introducing new products possess more computer applications than firms that have less success with new products.	Empirical	Technical	Information processing, process control
Dewett and Jones 2001	Journal of Management	Review and assess role of IT in organizations	Role of IT in innovation is understudied.	Review	Technical	Information storage and retrieval, knowledge optimization, employee interaction
Han and Ravichandran 2006	AMCIS	Can IT have direct and complementary effects on innovation?	IT investment complements R&D investment. No direct effect of IT investment on innovation.	Empirical	Technical	Coordination efficiency, strengthening weak ties, external sourcing
Yang et al. 2009	Technovation	Is the effect of quality of IS information on innovation performance contingent on the level of budgetary slack?	The influence of IS information quality on innovation performance is contingent on budget slack. In low budget slack, the influence is positive and significant.	Empirical	Technical	Information from IS reduces uncertainty
Yassine et al. 2004	PPC	What is the role of IT capability in product customization capability?	Information processing, knowledge sharing increases customization capability.	Empirical	Technical	Information processing, knowledge sharing

Yoo et al. 2010	ISR	Framework and agenda for emerging organizing logic of digital innovation	A modular flexible architecture is critical for the new organizing logic for digital innovation.	Descriptive	Technical	Modularity, flexibility in IT architecture improves organizing logic for innovation.
Theme D: Creativity and individual-level stimuli						
Fuller et al. 2010	JMIS	How are consumers empowered through Internet-based co-creation activities?	Experienced IT tool support impacts intention of future participation via perceived consumer empowerment.	Empirical	Technical, Social	Consumer empowerment, perceived enjoyment
MacCrimmon and Wagner 1994	Management Science	Can computer software provide better creativity support than Word processor?	A portfolio of methods implemented through computer software can help individuals generate creative ideas for managerial problems.	Experiment	Technical	Creative processes, connections among problem elements and between problem elements and the environment
Massetti 1996	MIS Quarterly	Do creativity support IT applications enhance the creative performance of individual users?	Responses generated with software support are significantly more novel and valuable than responses generated by pen and paper.	Experiment	Technical	Enhancement of creative thinking
Satzinger et al. 1999	JMIS	How do the contents of group memory in a Group-support system (GSS) influence the ideas generated by individuals?	GSS-based idea generation process provides stimuli. Individuals tend to generate ideas that match the paradigm-relatedness of ideas provided by GSS.	Empirical	Technical	Stimuli provided by system-generated ideas
Journal/Outlet Abbreviations: AMCIS: Proceedings of Americas Conference on Information Systems; CACM: Communications of the Association for Information Systems; DSS: Decision Support Systems; I&M: Information & Management; ICIS: Proceedings of International Conference on Information Systems; ISR: Information Systems Research; JEIM: Journal of Enterprise Information Management; JMIS: Journal of Management Information Systems; JSIS: Journal of Strategic Information Systems; JPIM: Journal of Product Innovation Management; PPC: Production Planning and Control						

Table 1: Synthesis of Literature Related to IT and Business Innovation

1.4. Framework of IT-enabled Business Innovation

In this section, I draw on theoretical underpinnings in the IS/innovation literature and business literature (Prahalad and Krishnan 2008) to propose a conceptual framework of IT-enabled business innovation (Figure 2).[6]

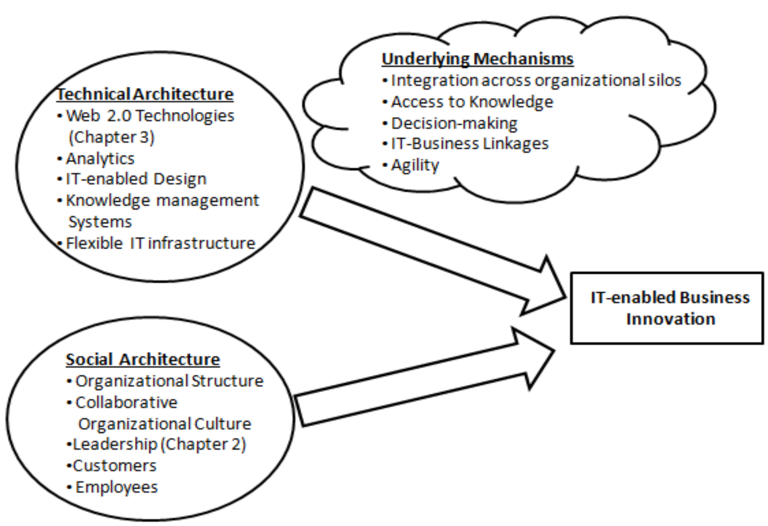

Figure 2: Conceptual Framework of IT-enabled Business Innovation

[6] I thank Dr. M.S. Krishnan for providing motivation and insights related to leveraging the concepts of "technical architecture" and "social architecture".

The review of the literature (Table 1) reveals that IT-enabled business innovation can be fostered by IT (technological) components and organizational components in the firm. For example, while some studies focus on technology capabilities (e.g., study of ERP by Srivardhana and Pawlowski 2007), others emphasize organizational artifacts such as team-level processes, organizational learning processes, and individual-level stimuli (e.g., Hendersen and Lentz 1995). I draw upon the technological and organizational components evident from the literature to derive a framework of IT-enabled business innovation. The technology capabilities and the organizational artifacts can be respectively broadly characterized as the "technical architecture" and "social architecture" of the firm, concepts introduced by Prahalad and Krishnan (2008).[7] I build on these concepts and the literature to propose a framework (Figure 2) linking the social and technical components of the firm's architecture to IT-enabled business innovation. The technical dimension includes among others, IT-enabled design (or computer-aided design [CAD]), analytics (business intelligence), Web 2.0 technologies, knowledge management systems, and other information technologies that foster advanced design capabilities, collaboration, information availability, and knowledge sharing. Further, the firm's social architecture such as organizational structure, collaborative organizational culture, leadership, customers, and employees can play an important role in IT-enabled business innovation.

Furthermore, the literature alludes to mechanisms that are enabled by the technical and social architecture of the firm. In line with prior literature which posits that IT improves organizational performance through its impact on organizational business capabilities (Melville et al. 2004), I build on the IT and innovation literature to identify

[7] I discuss the definitions of technical architecture and social architecture in the ensuing subsections.

underlying mechanisms facilitating IT-enabled business innovation. In sum, the framework posits that IT-enabled business innovation is fostered by mechanisms which are driven by the technical and social dimensions of the firm's architecture.

I now discuss each component of the framework.

1.4.1. Technical Architecture

The "technical architecture" is defined by Prahalad and Krishnan (2008, p. 6) as the "Information Technology backbone", comprising applications that enable business processes in the firm.

Technologies such as design systems, knowledge management systems, and business intelligence systems provide the infrastructure for innovation by directly facilitating the creation of new products, processes, or services (as in the case of design systems), or by facilitating the process of knowledge generation and knowledge access (as in the case of knowledge management systems and Web 2.0 technologies). Collaborative technologies can enhance the ability to synthesize knowledge and generate new knowledge required for innovation. Similarly, IT-enabled analytics capabilities (e.g., business intelligence systems) streamline decision-making and provide firms with insights in the innovation process (Prahalad and Krishnan 2008).

While specific technology capabilities can potentially drive IT-enabled business innovation, as argued by Prahalad and Krishnan (2008), flexibility in the technological architecture facilitates adaptation to change which is important for innovation. IT can enhance the ability of firms to dynamically adapt to changing needs (Pavlou and El Sawy 2006). This adaptability is important for innovation because innovation requires the ability to sense and respond to the changing needs of customers for new products and services. The firm's technical architecture needs to be flexible to respond to change and support the innovation needs. A rigid legacy IT architecture is often an impediment in the path to innovation, whereas flexible IT infrastructures facilitate synergy with organizational resources (Allen and Boynton 1991) and can boost the firm's innovation capacity.

IT departments can help with important enablers of innovation such as service-oriented architecture (SOA) that enhances flexibility, and knowledge management systems and applications that foster end-user collaboration, for example. IT can also help with Web 2.0 technologies, which can facilitate the streamlining and consolidation of information and knowledge sharing. The ability to find and integrate information using information technologies can enhance innovation. These arguments lead to the following proposition:

Proposition 1: The firm's technical architecture comprising (i) Web 2.0 technologies, (ii) analytics, (iii) IT-enabled design, (iv) knowledge management systems, and (v) flexible IT infrastructure can drive IT-enabled business innovation.

1.4.2. Social Architecture

The second component of the framework (Figure 2) is the social architecture of the firm. Prahalad and Krishnan (2008) define "social architecture" of the firm to include the "organizational structure, performance measurement, social norms, training, skills, decision rights, values of the organization, systems, processes, beliefs and reward systems" (p.6, p. 75, p. 148, p. 177).

The social architecture is important for IT-enabled business innovation because IT must be supported by the social fabric of the organization (Prahalad and Krishnan 2008).

It is here that the "social architecture" can play its part in IT-enabled business innovation. For example, incentives to employees to pursue innovation-oriented initiatives are more likely to result in innovation compared to a culture where employees are restrained from pursuing such goals. Google is a fitting example of such a social architecture. Google encourages its employees to spend 20 percent of their time working on ideas that interest them personally. Another example of the social architecture is the training programs conducted by human-resource division of the companies. By incorporating innovation related principles and skill-sets into training programs, firms can train their workforce to be more innovation-oriented so as to complement the IT infrastructure for innovation.

While, as discussed above, there are undoubtedly multiple components of the social architecture that can be potentially important for IT-enabled business innovation, in this dissertation, I focus my theoretical model on factors that I believe to be more relevant in the scope of this dissertation. More specifically, I consider organizational structure, collaborative organizational culture, and the role of leaders, customers, and employees.[8]

First, the management literature argues that structures that are organic (rather than mechanistic) are conducive to innovation because they support interaction and exchange of ideas (Damanpour 1991). Other characteristics of the organizational structure that can influence innovation include formalization (Pierce and Delbecq 1977) and decentralization (Tsai 2002). In the context of IT-enabled business innovation, such characteristics can potentially play a part by promoting improved and less bureaucratic IS-business linkages and faster decision-making. For example, lower formalization can

[8] In doing so, I do not deny the potential importance of other components of the social architecture for IT-enabled business innovation. For example, training programs and human resource skill-sets can be important in developing capabilities for IT-enabled innovation.

enable IS and business personnel to more freely share knowledge on IT and business ideas to drive IT-enabled business innovation.[9]

Second, a collaborative organizational culture can also enhance innovation. For instance, the extent to which departments within an organization are cohesive and collaborate with each other is identified as critical for innovation (Dougherty 1992). A closely-knit organization can promote shared understanding and collective action that is required for innovation. A culture of collaboration can create an environment where new IT-enabled ideas can be fostered and allowed to take shape (Lee and Choi 2003). Applied to the context of IT-enabled business innovation, a collaborative culture is likely to play a role in IT-enabled innovation by promoting knowledge sharing. These arguments lead to the following proposition: [10]

Proposition 2a: The characteristics of the firm's social architecture such as, for example, (i) organizational structure, and (ii) collaborative organizational culture can drive IT-enabled business innovation.

The second aspect related to the social architecture comprises the key stakeholders of the firm. Along this dimension, I consider the role of leadership, customers, and employees. Although Prahalad and Krishnan (2008) do not explicitly include leaders, customers, and employees in their definition of the social architecture, the authors implicitly refer to these stakeholders during their discussions of managerial behavior, organizational legacies, and co-creation. I argue that these sub-components

---

[9] It can be argued that low formalization may also hinder innovation by causing governance problems. However, IT capabilities can mitigate such challenges by providing improved control and monitoring mechanisms.

[10] In this dissertation, I limit the scope to a *conceptual discussion* of the role of the factors of organizational structure and collaborative culture in IT-enabled business innovation. Nevertheless, future research (outside this dissertation) can empirically explore these factors by leveraging several well-developed scales in the literature, such as for instance, the measurement of centralization and formalization (Galbraith and Merrill 1991; Lee and Choi 2003), and collaboration (Lee and Choi 2003).

(leaders, customers, and employees) of the social architecture need to be leveraged appropriately in the drive to IT-enabled business innovation.

First, leadership is of importance to innovation because leaders can establish the conditions needed for innovation and can garner support for innovation teams. The leadership literature is vast, and scholars have argued for a critical role of leadership in the innovation process (e.g., Amabile 1988).[11] For instance, researchers have studied the effect of leaders' persuasion skills (Dudeck and Hall 1991) and influence behaviors (McGourty et al. 1996) on the creativity of employees. However, as pointed out by Jung et al. (2003, p. 526), empirical studies on leadership and innovation have "tended to examine its effects [of leadership] at the individual level, rather than the organizational level". Innovation research has, in general "not taken into account the role and significance of leadership in the equation that drives innovation" (Papadakis and Bourantas 1998, p. 90).

In a study of innovation at the organizational level, Jung et al. (2003) found that transformational leadership can influence innovation through employees' perception of empowerment and support for innovation. Other scholars have linked various aspects of leadership (CXOs) to innovation.[12] For example, the CEO's personality characteristics (e.g., need for achievement) and demographic characteristics (e.g., tenure and formal education) have been linked to the extent of technological innovation (Papadakis and Bourantas 1998). Lefebvre and Lefebvre (1992) also found that personal characteristics, personality traits and attitudes, and characteristics of the decision-making process of

[11] For a detailed meta-analytic review of the literature on leadership and innovation, refer Mumford et al. (2002).

[12] I thank Dr. Nigel Melville for providing motivation to incorporate literature related to other CXOs to innovation.

CEOs are related to the innovativeness of the firm, in terms of adoption of new technologies. Roberts and Hauptman (1986) showed that founders' characteristics such as their professional background and experience were associated with the technological sophistication of a firm's products. It has also been found that firms with CEOs who have more future-focused and external-focused attention spans are more innovative (Yadav et al. 2007). Similarly, the accounting literature finds that CFOs who are younger, less tenured, and more business-oriented more likely to drive accounting innovation (Naranjo-Gil et al. 2009).

In sum, the literature suggests that leaders can be the embodiment of change and innovation in the organization (Mumford et al. 2002). Strong leadership can overcome barriers to innovation and help garner support for innovation initiatives (Keller 2006). Strong leadership can also help gather information and communicate effectively with various stakeholders to guide innovation. Sustainable innovation requires strategic guidance from top executives of the firm. Notwithstanding the leadership literature, as Karahanna and Watson (2006, p. 172) note, the business dependence on IS poses "unique challenges for CIOs" and "idiosyncratic challenges that require studies that examine IS leadership in its own right".

In the context of IT-enabled business innovation, business leaders and IT leaders can both play a part. While IT leaders can provide guidance in how to apply IT to business innovation, business leaders' understanding of IT can help them support IT initiatives in line with the business needs. Similarly, the characteristics of the CIO (such as demographics, leadership styles, etc.) can promote the generation of IT-enabled business ideas by encouraging creativity and innovation through the provision of resources.

Second, firms can drive IT-enabled business innovation by involving customers in the innovation process. The management and marketing literatures recognize the potential role of customers in innovation (e.g., Chesbrough 2003; Desouza et al. 2008; von Hippel 1998). The increasingly digitally enabled nature of innovation (Prahalad and Krishnan 2008) magnifies the potential role of customers in innovation. IT plays a major role in enabling capabilities of customer-orientation and collaborative development of products and services. For example, firms such as Adidas, BMW, and Proctor and Gamble (P&G) use IT-based platforms to imbibe customer insights into product development (Ogawa and Piller 2006). Starbucks (MyStarbucksIdea) uses IT-enabled engagement platforms to involve customers in product and service development (Ramaswamy and Gouillart 2010). IT can also promote customer involvement in design, ideation, and innovation processes (Nambisan 2003).

Finally, for IT-enabled business innovation to succeed, the employees of the firm play a crucial role. IT-enabled innovation is generally knowledge intensive in nature. How employees interact socially through the exchange of ideas and sharing of knowledge is important for IT-enabled innovation. The social ties and connections among employees facilitate the generation and implementation of innovative ideas (Tsai 2002; Tsai and Ghoshal 1998). The use of IT can facilitate this socialization process by promoting the sharing of knowledge and exchange of ideas by employees online.

The preceding arguments lead us to the following proposition:

Proposition 2b: The characteristics and role of the firm's (i) leadership, (ii) customers, and (iii) employees can drive IT-enabled business innovation.

Table 2 provides examples of the components of the framework.

Model Component	Examples	Representative Literature (if found)
Technical Architecture		
Web 2.0 technologies	Wikis, blogs, social networks	Chi et al. 2010; Joshi et al. 2010
Analytics	Business intelligence systems	Prahalad and Krishnan 2008
IT-enabled design	Computer-aided design systems	
Knowledge management systems	Customer-knowledge systems, document management systems, other knowledge management systems	Joshi et al. 2010
Flexible IT infrastructure	Service-oriented architecture (SOA), cloud computing infrastructure	Malladi and Krishnan 2012; Yoo et al. 2010
Social Architecture		
Organization structure	Formalization, centralization	Pierce and Delbecq 1977; Tsai 2002
Organization culture	Collaborative organizational cultures	Dougherty 1992; Lee and Choi 2003
Leadership	CEO characteristics, CIO characteristics, CIO role, CIO-CEO interface	Jung et al. 2003
Customers	Customer co-creation	Fuller et al. 2010; Prahalad and Krishnan 2008; Prahalad and Ramaswamy 2004
Employees	Social ties and connections among employees	Tsai 2002; Tsai and Ghoshal 1998
IT-enabled business innovation	IT-enabled automatic check-deposit system; computer-implemented systems for matching paint on a vehicle; analytics-based system for scheduling trucks	Gordon and Tarafdar 2007; Teo et al. 2007

Table 2: Examples of Components of the Framework

1.4.3. Mechanisms Underlying IT-enabled Business Innovation

In this sub-section, I discuss specific underlying mechanisms to IT-enabled business innovation, drawing on prior literature and theory.

- *Integration across organizational silos through information exchange*

  Innovation requires the sharing of information and the ability to mobilize action towards problem solving (Dewett and Jones 2001). Organizational researchers posit that interdepartmental separation and lack of co-ordination results in poor understanding and low synchronization for developing new products (Dougherty 1992; Dougherty and Heller 1994). It has been argued that if knowledge within a firm is isolated within sub-unit boundaries, it hinders the capacity to recombine various sources of knowledge in the quest for innovation (Henderson and Clark 1990). Integration across organizational silos helps to overcome barriers to interdepartmental co-ordination, facilitating interactive learning and continuous expansion of knowledge. Knowledge accumulated from across silos facilitates the generation of novel ideas and combination of various types of knowledge (Hurley and Hult 1998).

By making it easier to capture, store, retrieve, and disseminate knowledge, IT has the capacity to reduce or break down organizational silos of knowledge. IT provides the ability to transcend invisible barriers within a company and provide greater access to knowledge sources. Access to greater number of knowledge sources improves the likelihood of obtaining knowledge that leads to valuable innovations (Leiponen and Helfat 2010). IT can also facilitate the sharing of values and norms between people in different subunits of the organization (Dewett and Jones 2001), which can enhance innovation (Scott and Bruce 1994).

We draw on two theoretical perspectives to propose integration across organizational silos as a mechanism facilitating IT-enabled business innovation. First, IT can help develop strong ties and leverage weak ties in an organization, thus supporting the development of ideas. This is in line with weak-tie theory which argues for the importance of weak ties to facilitate the diffusion of information among groups (Granovetter 1973). Organizational scholars have argued that access to weak ties is important for innovation and overcoming problems due to organizational silos (Constant et al. 1996; Wineman et al. 2009). IT facilitates access to distant acquaintances through information exchange, enhancing employee's abilities to leverage on the expertise of weak ties in the organization. In particular, technologies such as Web 2.0 technologies provide significant potential to access weak ties. For example, online social networks facilitate access to co-workers who might not have otherwise connected with each other. Similarly, blogs promote the ability for employees to get feedback on ideas from socially distant or geographically distant acquaintances. Second, IT can promote organizational learning by enhancing the ability of the organization to scan for data, interpret the data, and learn from the interpretations; IT can facilitate each of the key components of organizational learning identified in the organizational learning literature: knowledge acquisition, information distribution, information interpretation, and organizational memory (Huber 1991). Improved organizational learning can, in turn facilitate adaptation in the innovation process. Business intelligence systems are prime examples of such technological capabilities that can promote organizational learning.

The social components of the framework can also help reduce silos in the organization. For example, a culture of knowledge sharing helps transcend silos among employees in different units of the firm. Interaction with customers helps break down communication barriers with customers and helps understand their needs and incorporate them into IT-enabled innovation. Leaders of the organization can establish the conditions needed for increased collaboration across organizational silos. When employees access broader sources of knowledge across silos, it allows them to widen their perspective, fostering greater innovation (Gordon and Tarafdar 2007).

- *Access to Knowledge*

The importance of knowledge for innovation is well recognized in the literature (e.g., Brown and Eisenhardt 1997; Nonaka 1994). Access to knowledge refers to the greater availability of more sources of knowledge to workers in the firm. If workers have more access to knowledge and information, their potential to generate new knowledge for innovation is likely to improve (Earl 2001). Thus, through improved access to knowledge, firms can enhance their ability to introduce new products, services, and processes.

Two theoretical perspectives help establish the importance of access to knowledge as a key mechanism in the framework. First, the weak-tie theory (Granovetter 1973) discussed earlier is consistent with the view that weak ties can provide access to expertise and knowledge in the organization. IT can be a significant facilitator of access to knowledge by enabling access to weak ties. For example, Web 2.0 technologies such as social networks help facilitate access to expertise which might have been otherwise difficult to achieve. Second, organizational knowledge creation theory (Nonaka 1994) argues that knowledge creation takes place through the inter-conversions of explicit to tacit knowledge and vice-versa. IT capabilities can be a significant enabler of these conversions.

IT enhances the knowledge base available in the firm (Dewett and Jones 2001; Joshi et al. 2010). The organizational ability to effectively capture, store, and retrieve knowledge can facilitate the initiation of innovative ideas by helping employees to access knowledge more easily, and to combine explicit with tacit knowledge. Improved knowledge access enabled by IT can also enhance the development of the generated ideas by helping employees learn from past knowledge. Information technologies increase the range of sources from which knowledge can be captured. With IT, recombination of knowledge can occur by using knowledge sources not just from within the firm, but also from across firm boundaries. Thus, IT can increase the capability of firms to make innovations which require building upon existing knowledge, as well as innovations which require new knowledge (Benner and Tushman 2003). IT makes it easier to connect employees that would otherwise be unlikely to communicate with each other, either because of geographical, departmental, or social separation. This can help leverage weak ties in the organization, with concomitant benefits for new knowledge generation (Constant et al. 1996). For example, collaboration technologies and computer networks help link people who may be geographically dispersed or unacquainted with each other. In sum, IT can increase the innovation capability of the firm via its ability to improve access to knowledge.

Similarly, access to knowledge can also be a mechanism linking components of the firm's social architecture and IT-enabled business innovation. Through IT-enabled involvement of customers, leaders, and employees in innovation processes, firms can leverage on these internal and external sources of knowledge to drive business innovation.

- *Decision-making*

Co-ordination theory suggests that IT can improve decision-making capability by reducing co-ordination costs (Crowston 1997). Because of the inherently risky nature of innovation (Ahuja et al. 2008), decision-making is critical in the innovation process, to help identify which ideas and innovations to pursue and which ones to abandon. The use of IT helps managers at all levels of the firm to be better informed about the current situation, problems, and issues so as to make better decisions related to innovation (Argyres 1999). By promoting the free flow of information within the firm, IT can improve coordination and provide flexibility and effectiveness in decision-making (Dewett and Jones 2001).

- *IT-Business Linkages*

The next important mechanism is the linkage between IT and the business. The theory of organizational alignment (Semler 1997) serves as a theoretical base for explicating the importance of IT-business linkages for IT-enabled business innovation. This theory argues that "systematic agreement between strategy, structure, and culture within an organization creates an internal environment that facilitates achievement of the organization's strategic goals by removing internal barriers to cooperation and performance that would otherwise reduce the efficiency and effectiveness of work toward those goals" (Semler 1997, p.28). Alignment is potentially important for IT-enabled business innovation because it can speed up the development of IT-driven business ideas by ensuring that IT and the business are in sync. Thus, IT-business linkages can be a key mechanism to IT-enabled business innovation.

Prior research has recognized that IT-business alignment is critical for the strategic impact of IT (e.g., Tallon and Pinsonneault 2011). IT-business linkages help IT leaders to understand the business needs, as well as help business leaders understand how IT can be assimilated into business innovation. While the technology evaluation for innovation can be done by IT, IT-enabled business innovation can be fostered by including business leaders for the assessment of fit and evaluation of impact of the IT-driven innovation, and to weigh the business benefits and costs of the IT-driven innovation.

The social components of the framework can also play a significant role in facilitating the organizational alignment for innovation by IT-business linkages. For example, an organizational culture of knowledge sharing and flat organizational structures can make it easier for IT and business personnel to strengthen their linkages. Similarly, technical components of the framework such as wikis and blogs (Web 2.0 technologies) can facilitate greater communication between IT and the business.

- *Agility*

Dynamic capabilities theory (Teece et al. 1997) is an appropriate theoretical lens for understanding the role of agility as a mechanism for IT-enabled innovation. This theory posits that dynamic capabilities are important factors for providing organizations with the ability to change and adapt. IT can facilitate innovation by providing dynamic capabilities via, for example a flexible IT architecture. Cloud computing and modular service-oriented architecture (SOA) are some examples of IT infrastructures that can provide agility through dynamic capabilities. These technology infrastructures provide flexibility to upscale or downscale the IT infrastructure as well as to easily re-use components (Prahalad and Krishnan 2008).

An important capability for innovation is the ability to adapt to changing conditions. This requires business agility as well as agility in the IT architecture (Prahalad and Krishnan 2008). If the IT architecture of the firm is rigid, it will not be able to support the innovation needs of the firm. Hence the agility provided by flexible IT architectures such as cloud computing (Malladi and Krishnan 2012) and flexible business strategies (Sambamurthy et al. 2003) is critical for contemporary firms to compete on innovation.

The preceding arguments lead to the following proposition:[13]

Proposition 3: Underlying mechanisms linking the technical and social architecture to IT-enabled business innovation are (i) integration across organizational silos through information exchange, (ii) improved access to knowledge, (iii) improved decision-making (iv) IT-business linkages, and (v) improved agility.

Table 3 summarizes the underlying mechanisms identified and the associated descriptions, theoretical bases, and representative studies suggesting the mechanisms.

Mechanism	**Description**	**Theoretical Base**	**Representative studies suggesting the mechanism**
Integration across organizational silos	IT facilitates ability to transcend barriers within an organization.	Weak-tie theory (Granovetter 1973), Organizational learning theory (Huber 1991)	Banker et al. 2006; Henderson and Lentz 1995; Sethi et al. 2003
Access to knowledge	IT improves ability to capture, store, retrieve and disseminate knowledge.	Organizational knowledge creation theory (Nonaka 1994), Weak-tie theory (Granovetter 1973)	Joshi et al. 2010; Kleis et al. 2012; Srivardhana and Pawlowski 2007
Decision-making	IT improves decision-making by improving decision flow.	Co-ordination theory (Crowston 1997)	Han and Ravichandran 2006; Kleis et al. 2012
IT-business linkages	IT and social components of the framework can facilitate IT-business linkages resulting in improved understanding between IT and business.	Theory of organizational alignment (Semler 1997)	Gordon and Tarafdar 2007; Kohli and Melville 2009
Agility	Flexible IT architectures promote ability to adapt to change.	Dynamic capabilities theory (Teece et al. 1997)	Pavlou and Sawy 2006; Yoo et al. 2010

Table 3: Underlying Mechanisms, Theoretical Bases, and Representative Studies

1.5. Research Directions for IS Research

In this section, I draw on the preceding framework (Figure 2) to suggest three broad future research opportunities for IS research to explore the role of IT in business innovation, a subset of which are addressed in the subsequent chapters in this

[13] While this chapter limits the discussion to a conceptual level, measurement of these mechanisms can be obtained by using or adapting those found in the literature. These include, for instance, cross-functional integration (Pavlou and El Sawy 2003), knowledge accessibility (Bennett and Gabriel 1999), IT-business linkages (Tian et al. 2010), and agility (Tallon and Pinsonneault 2011).

dissertation.[14] First, the myriad of IT applications raises the potential for examining complementarities between IT applications and infrastructure. Second, the paucity of empirical research related to IT leadership and innovation (discussed at length in Chapter 2) raises the question of how the leadership of the IT function can drive IT-enabled business innovation. Third, while the framework discusses about IT-enabled business innovation in terms of extent, it is possible to extend the framework by examining the types of innovation efforts driven by IT. The research questions can provide a starting point for future conceptual, theoretical, or empirical examination of the impacts of IT on business innovation. These identified areas of inquiry have potential to yield insights with important implications for practice and research, warranting deeper exploration.

The first question pertains to one aspect of the social architecture of the firm, leadership (Figure 2). Top management support is crucial for sustained innovation capabilities of firms (Dougherty and Hardy 1996) because it helps create a culture and "mindset for innovation", and makes innovation "meaningful for the entire firm" and "part of the strategic conversation" (Ahuja et al. 2008, p. 57). The role of leadership in organizational innovation has received attention in the management literature (Jung et al. 2003; Mumford et al. 2002; Paulsen et al. 2009). From an IT perspective, the IT leadership, the Chief Information Officer (CIO) can play an important role in the extent to which IT can drive business innovation. For example, the CIO can serve as a channel between IT and the business to garner resources and support needed for innovation (Carter et al. 2011). Similarly, the influence of CEO characteristics (e.g., demographics, age, etc.) on organizational performance has been a subject of research in the strategy

[14] While several important research questions can potentially be derived from the framework, I limit the scope to those questions that I partly address in this dissertation.

literature. It may be pertinent to examine whether the characteristics, role, leadership style, and/or demographics of the top management of IT (the CIO) can play a part in IT-enabled innovation. Relevant demographics of the CIO can include his educational background, age, business background, and personality, among others. Therefore, I ask:

RQ1: How do the role and characteristics of the CIO influence IT-enabled business innovation?

The second question pertains to the technical architecture of the firm (Figure 2). Specifically, elements of the IT infrastructure can be complements of each other in facilitating business innovation. For example, flexible IT systems can potentially complement IT analytics in allowing firms to adapt and build on the information gained from analytics systems to facilitate innovation. Customer-management systems and business intelligence (BI) systems may complement each other's capabilities by providing customer knowledge and analytics capabilities respectively. The complementarities between organizational and IT resources are well-studied (Melville et al. 2004). Prior research also suggests that synergies between IT applications and infrastructure may have implications for IT business value (Zhu 2004). Yet, the complementarities between IT components to facilitate business innovation have, to the best of my knowledge, not been empirically explored in the extant literature. This leads to a second potential research question:

RQ2: How do IT infrastructure elements complement each other in influencing IT-enabled business innovation?

As an extension of the framework beyond the extent of IT-enabled business innovation, it is also relevant to consider whether IT may influence the type of innovation, i.e., the kinds of innovation activity that IT supports. It is conceivable that certain types of IT systems can influence the innovation efforts of firms, in terms of involving different stakeholders in the innovation process. For example, customer relationship management (CRM) systems, supply chain management (SCM) systems, and business analytics solutions enable firms to respectively understand their customers, suppliers, and the business environment better. Therefore, it might be reasonable to expect firms that leverage these systems to have a greater tendency to pursue innovation efforts in partnership with their customers, suppliers, and business partners. For example, BI and CRM systems can help firms involve customers in product and service development. Likewise, social technologies that facilitate online interactions may foster innovation through collaboration among the firms' employees. IT can also enhance customer-centric innovation by transcending organizational silos and overcoming barriers to customer-centricity. Examining how different types of IT systems impact the *mode* of innovation would also help explaining why certain firms differ in the way that the innovation process is managed (Ahuja et al. 2008; Henderson and Cockburn 1994). Hence, I ask:

RQ3: How do different types of IT systems affect the kinds (or mode) of innovation efforts by firms?

1.6. Discussion and Contributions

The importance of IT for business innovation is gaining traction in practice. Several practitioner outlets reinforce how it is important for IT to drive business innovation (e.g., Tansley et al. 2008). Yet, academic research has, in my opinion, not sufficiently explored this phenomenon.

Our analysis in this chapter has revealed several insights contributing to scholarly and practitioner understanding of how IT can facilitate innovation capabilities. First, building on recent empirical literature on IT and business innovation (Chi et al. 2010; Han and Ravichandran 2006; Joshi et al. 2010; Kleis et al. 2012; Prahalad and Krishnan 2008), this chapter presents an integrative framework linking aspects of the firms technical architecture and social architecture to IT-enabled business innovation.

Second, the study suggests that the technical components of the framework are essential for providing the innovation infrastructure. IT lies at the core of managing knowledge capabilities which are essential for innovation. The variety of technological advances in recent times (Web 2.0 technologies, cloud computing, analytics, etc.) expand the possibilities for managing knowledge and innovation in the organization. This can inform practitioners of the possibilities that IT provides for innovation. IS research can build on this framework (Figure 2) to inform practice by exploring how these technologies can, by themselves, and in combination with other technologies drive innovation. Third, the social components of the framework suggest that organizational actors and non-technological factors also need to play their part in IT-enabled business innovation. Factors such as organizational structure, organizational culture, leadership, customers, and employees are critical components of the social fabric of an organization (Prahalad and Krishnan 2008); and our framework has exposited their potential role in IT-enabled business innovation. Fourth, the framework sheds light on specific mechanisms and their theoretical underpinnings linking (Table 3) the social and technical components of the firm’s architecture to IT-enabled business innovation. Finally, our framework based on the literature review led us to propositions and research questions.

While I address some of these questions in this dissertation, the propositions and questions can be built on by future theoretical and empirical research.

1.7. Limitations and Future Research

We now explicate the key limitations of this study, which can be starting points for future research. First, in our theoretical framework, we have focused largely on internal factors (internal to the organization). As noted in prior research, IT business value is shaped by external factors such as the competitive context, industry characteristics, and trading partner resources (Melville et al. 2004). Future research on IT-enabled business innovation can theorize the role of external factors in IT-enabled business innovation. Second, I have restricted the theoretical framework to factors and mechanisms that I believe to be among the more important ones for IT-enabled business innovation. It certainly does not represent the entire gamut of social and technical architecture of the firm, nor does it represent the entire gamut of mechanisms that could potentially influence IT-enabled business innovation. Future research can extend the framework by theorizing more factors and mechanisms. Finally, the framework does not theorize potential complementarities between the social and technical components of the model. Future work can explore such relationships to further enrich our understanding of IT-enabled business innovation.

1.8. Conclusion

In this chapter, I first reviewed the literature at the confluence of IT and business innovation. My literature review revealed limited research attention to the role of IT in business innovation. More pertinently, I found that empirical studies connecting IT and business innovation are scant, barring few exceptions (e.g., Cherian et al. 2009; Chi et al.

2010; Han and Ravichandran 2006; Joshi et al. 2010; Kleis et al. 2012). To help address these knowledge gaps, drawing on theory and the literature and on concepts discussed in Prahalad and Krishnan (2008), this chapter proposed a conceptual framework linking the firm's social architecture and technical architecture to IT-enabled business innovation, facilitated via specific underlying mechanisms. I then suggested potential research directions in this stream by proposing research questions that can be addressed by future research. In the ensuing empirical studies in the dissertation, I examine the role of one specific type of IT systems (Web 2.0 technologies) that is encapsulated in the technical architecture of the firm; and I examine one specific aspect of the social architecture (role of the CIO). I intend to pursue some of the other aspects of the framework and questions in future research outside this dissertation.

In sum, this chapter reviews the literature, lays the conceptual grounding and theory for the empirical studies in the dissertation, and offers a framework and foundation for future studies to explore the role of IT in business innovation.

References

Acs, Z., and D. Audretsch. "The Determinants of Small-Firm Growth in US Manufacturing," *Applied Economics* (22:2), 1990, pp. 143-153.

Agarwal, R., and V. Sambamurthy. "Principles and Models for Organizing the IT Function," *MIS Quarterly* (26:1), 2002, pp. 1-16.

Ahituv, N., J. Zif, and I. Machlin. "Environmental Scanning and Information Systems in Relation to Success in Introducing New Products," *Information & Management* (33:4), 1998, pp. 201-211.

Ahuja, G., C. Lampert, and V. Tandon. "Moving Beyond Schumpeter: Management Research on the Determinants of Technological Innovation," *Academy of Management Annals* (2:1), 2008, pp. 1-98.

Ahuja, G. "Collaboration Networks, Structural Holes, and Innovation: A Longitudinal Study," *Administrative Science Quarterly* (45:3), 2000, pp. 425-455.

Aiken, M., and J. Hage. "Organic Organization and Innovation," *Sociology - the Journal of the British Sociological Association* (5:1), 1971, pp. 63-82.

Alavi, M., and D. Leidner. "Review: Knowledge Management and Knowledge Management Systems: Conceptual Foundations and Research Issues," *MIS Quarterly* (25:1), 2001, .
Allen, B., and A. Boynton. "Information Architecture: In Search of Efficient Flexibility," *MIS Quarterly* (15:4), 1991, pp. 435-445.
Amabile, T. M. "A Model of Creativity and Innovation in Organizations ," *Research in Organizational Behavior* (10:1988, pp. 123-167.
Argyres, N. S. "The Impact of Information Technology on Coordination: Evidence from the B-2 "Stealth" Bomber," *Organization Science* (10:2), 1999, pp. 162-180.
Banbury, C. M., and W. Mitchell. "The Effect of Introducing Important Incremental Innovations on Market Share and Business Survival," *Strategic Management Journal* (16:1995, pp. 161-182.
Banker, R., I. Bardhan, and O. Asdemir. "Understanding the Impact of Collaboration Software on Product Design and Development," *Information Systems Research* (17:4), 2006, pp. 352-373.
Bardhan, I., A. Gupta, and P. Tallon. "Research Perspectives on Innovation through Information Technology Management in a Networked World," *Information Technology Management* (9:3), 2008, pp. 148.
Benner, M., and M. Tushman. "Exploitation, Exploration, and Process Management: The Productivity Dilemma Revisited," *The Academy of Management Review* (28:2), 2003, pp. 238.
Bennett, R., and H. Gabriel. "Organisational Factors and Knowledge Management within Large Marketing Departments: An Empirical Study," *Journal of Knowledge Management* (3:3), 1999, pp. 212-225.
Bharadwaj, A., S. Bharadwaj, and B. Konsynski. "Information Technology Effects on Firm Performance as Measured by Tobin's q," *Management Science* (45:7), 1999, pp. 1008.
Brown, S., and K. Eisenhardt. "The Art of Continuous Change: Linking Complexity Theory and Time-Paced Evolution in Relentlessly Shifting Organizations," *Administrative Science Quarterly* (42:1), 1997, pp. 1.
Brynjolfsson, E., and L. Hitt. "Paradox Lost? Firm-Level Evidence on the Returns to Information Systems Spending," *Management Science* (42:4), 1996, pp. 541-558.
Carter, M., V. Grover, and J. Bennett. "The Emerging CIO Role of Business Technology Strategist," *MIS Quarterly Executive* (10:1), 2011, pp. 19-29.
Cherian, S. P., J. W. Whitaker, and M. S. Krishnan. "Do IT Investments Enable Business Innovation in High-Tech Firms? an Empirical Analysis," *Ross School of Business Working Paper,* 2009.
Chesbrough, H. "Business Model Innovation: It's Not just about Technology Anymore," *Strategy & Leadership* (35:6), 2007, pp. 12-17.
Chesbrough, H. W. *Open Innovation: The New Imperative for Creating and Profiting from Technology*, Harvard Business School Press, Boston, MA, 2003.
Chi, L., Y. Liao, S. Han, and K. Joshi. "Alliance Network, Information Technology, and Firm Innovation: Findings from Pharmaceutical Industry," *International Conference on Information Systems*2010, pp. 1-16.

Cho, H., and V. Pucik. "Relationship between Innovativeness, Quality, Growth, Profitability, and Market Value." *Strategic Management Journal* (26:6), 2005, pp. 555.

Cohen, W., and R. Levin. *"Empirical Studies of Innovation and Market Structure ," Handbook of Industrial Organization,* R. Schmalensee and R. Willig (eds.), Amsterdam, 1989, pp. 1107.

Constant, D., L. Sproull, and S. Kiesler. "The Kindness of Strangers: The Usefulness of Electronic Weak Ties for Technical Advice," *Organization Science* (7:2), 1996, pp. 119.

Cook, N. *Enterprise 2.0: How Social Software Will Change the Future of Work*, Gower Publishing2008.

Crowston, K. "A Coordination Theory Approach to Organizational Process Design," *Organization Science* (8:2), 1997, pp. 157.

Daft, R. L. "A Dual-Core Model of Organizational Innovation," *Academy of Management Journal* (21:2), 1978, pp. 193-210.

Damanpour, F. "The Adoption of Technological, Administrative, and Ancillary Innovations: Impact of Organizational Factors," *Journal of Management* (13:4), 1987, pp. 675-688.

Damanpour, F."Organizational Innovation: A Meta-Analysis of Effects of Determinants and Moderators." *The Academy of Management Journal* (34:3), 1991, pp. 555.

Dehning, B., and T. Stratopoulos. "Determinants of a Sustainable Competitive Advantage due to an IT-Enabled Strategy," *Journal of Strategic Information Systems* (12:1), 2003, pp. 7.

Desouza, K., Y. Awazu, S. Jha, C. Dombrowski, S. Papagari, P. Baloh, and J. Kim. "Customer-Driven Innovation: To be a Marketplace Leader, Let Your Customers Drive." *Research Technology Management* (51:3), 2008, pp. 35.

Dewar, R. D., and J. E. Dutton. "The Adoption of Radical and Incremental Innovations: An Empirical Analysis," *Management Science* (32:11), Nov., 1986, pp. pp. 1422-1433.

Dewett, T., and G. Jones. "The Role of Information Technology in the Organization: A Review, Model, and Assessment," *Journal of Management* (27:3), 2001, pp. 313.

Dong, J. Q. "How does Information Technology Enable Innovation in Supply Chains," *Proceedings of the International Conference on Information Systems*2010, pp. 1-17.

Dougherty, D. "Interpretive Barriers to Successful Product Innovation in Large Firms," *Organization Science* (3:2), 1992, pp. 179-202.

Dougherty, D., and T. Heller. "The Illegitimacy of Successful Product Innovation in Established Firms," *Organization Science* (5:2), 1994, pp. 200.

Drucker, P. *The Practice of Management / P.F. Drucker.*, Londres, Inglaterra : Mercury Books1954.

Dudeck, S. Z., and W. B. Hall. "Personality Consistency: Eminent Architects 25 Years Later." *Creativity Research Journal* (4:1991, pp. 213-232.

Earl, M. "Knowledge Management Strategies: Towards a Taxonomy," *Journal of Management Information Systems* (18:1), 2001, pp. 215-233.

Fichman, R. G. "Going Beyond the Dominant Paradigm for Information Technology Innovation Research: Emerging Concepts and Methods," *Journal of the Association for Information Systems* (5:8), 2004, pp. 314.

Freeman, C. "Networks of Innovators: A Synthesis of Research Issues," *Research Policy* (20:5), 1991, pp. 499-514.

Füller, J., H. Mühlbacher, K. Matzler, and G. Jawecki. "Consumer Empowerment through Internet-Based Co-Creation," *Journal of Management Information Systems* (26:3), 2010, pp. 71-102.

Galbraith, C. S., and G. B. Merrill. "The Effect of Compensation Program and Structure on SBU Competitive Strategy: A Study of Technology-Intensive Firms," *Strategic Management Journal* (5:12), 1991, pp. 353.

Giarratana, M. "The Birth of a New Industry: Entry by Start-Ups and the Drivers of Firm Growth - the Case of Encryption Software," *Research Policy* (33:5), 2004, pp. 787.

Gilbert, R. "Looking for Mr. Schumpeter: Where are we in the Competition-Innovation Debate?," *Innovation Policy and the Economy*2006, pp. 159.

Gino, F., and A. P. McAfee. "Ducati Corse," *Harvard Business School Case 605-091,* 2006.

Gordon, S., and M. Tarafdar. "How do a company's Information Technology Competences influence its Ability to Innovate?" *Journal of Enterprise Information Management* (20:3), 2007, pp. 271-290.

Granovetter, M. S. "The Strength of Weak Ties," *American Journal of Sociology* (78:6), 1973, pp. 1360.

Greve, H. "A Behavioral Theory of R&D Expenditures and Innovations: Evidence from Shipbuilding," *Academy of Management Journal* (46:6), 2003, pp. 685-702.

Griliches, Z. "Patent Statistics as Economic Indicators: A Survey," *Journal of Economic Literature* (28:4), 1990, pp. 1661.

Grover, V., K. Fiedler, and J. Teng. "Empirical Evidence on Swanson's Tri-Core Model of Information Systems Innovation," *Information Systems Research* (8:3), 1997, pp. 273.

Hage, J. T. "Organizational Innovation and Organizational Change," *Annual Review of Sociology* (25:1999, pp. 597.

Han, S., and T. Ravichandran. "Does IT Impact Firm Innovativeness ? : An Empirical Examination of Complementary and Direct Effects," *Proceedings of the Twelfth Americas Conference on Information Systems,*2006, pp. 704-715.

Harhoff, D. "Strategic Spillovers and Incentives for Research and Development," *Management Science* (42:6), 1996, pp. 907-925.

Henderson, J., and C. M. A. Lentz. "Learning, Working, and Innovation: A Case Study in the Insurance Industry," *Journal of Management Information Systems* (12:3), 1995, pp. 43-64.

Henderson, R., and K. Clark. "Architectural Innovation: The Reconfiguration of Existing Product Technologies and the Failure of Established Firms," *Administrative Science Quarterly* (35:1), 1990, pp. 9.

Hill, C. W. L., and S. A. Snell. "External Control, Corporate Strategy, and Firm Performance in Research-Intensive Industries," *Strategic Management Journal* (9:6), 1988, pp. 577-590.

Hoskisson, R., M. Hitt, and C. Hill. "Managerial Risk Taking in Diversified Firms: An Evolutionary Perspective," *Organization Science* (2:3), pp. 296-314.

Huber, G. P. "Organizational Learning: The Contributing Processes and the Literatures," *Organization Science* (2:1), 1991, pp. 88.

Hurley, R., and G. T. M. Hult. "Innovation, Market Orientation, and Organizational Learning: An Integration and Empirical Examination," *Journal of Marketing* (62:3), 1998, pp. 42.
Huston, L., and N. Sakkab. "Connect and Develop: Inside Procter Gamble's New Model for Innovation." *Harvard Business Review* (84:3), 2006, pp. 58.
Joshi, K., L. Chi, A. Datta, and S. Han. "Changing the Competitive Landscape: Continuous Innovation through IT-Enabled Knowledge Capabilities," *Information Systems Research* (21:3), 2010, pp. 472.
Jung, D., C. Chow, and A. Wu. "The Role of Transformational Leadership in Enhancing Organizational Innovation: Hypotheses and some Preliminary Findings," *The Leadership Quarterly* (14:4), 2003, pp. 525-544.
Kamien, M. I., and N. L. Schwartz. *Market Structure and Innovation*, Cambridge University Press, Cambridge, U.K., 1982.
Karahanna, E., and R. Watson. "Information Systems Leadership," *IEEE Transactions on Engineering Management* (53:2), 2006, pp. 171-176.
Katila, R., and G. Ahuja. "Something Old, Something New: A Longitudinal Study of Search Behavior and New Product Introduction," *The Academy of Management Journal* (45:6), 2002, pp. 1183.
Keller, R. T. "Transformational Leadership, Initiating Structure, and Substitutes for Leadership: A Longitudinal Study of Research and Development Project Team Performance," *Journal of Applied Psychology* (91:1), 2006, pp. 202.
Kimberly, J., and M. Evanesco. "Organizational Innovation: The Influence of Individual, Organizational, and Contextual Factors on Hospital Adoption of Technological and Administrative Innovations." *Academy of Management Journal* (24:1981, pp. 689.
Kleis, L., P. Chwelos, R. Ramirez, and I. Cockburn. "Information Technology and Intangible Output: The Impact of IT Investment on Innovation Productivity," *Information Systems Research* (23:1), 2012, pp. 42-59.
Kogut, B., and U. Zander. "Knowledge of the Firm, Combinative Capabilities and the Replication of Technology," *Organization Science* (3:3), 1992, pp. 383.
Kohli, R., and N. P. Melville. "Learning to Build an IT Innovation Platform," *Communications of the ACM* (52:8), 2009, pp. 122-126.
Kotabe, M., and K. S. Swan. "The Role of Strategic Alliances in High-Technology New Product Development," *Strategic Management Journal* (16:8), 1995, pp. 621.
Landry, R., N. Amara, and M. Lamari. "Does Social Capital Determine Innovation? to what Extent?" *Technological Forecasting Social Change* (69:7), 2002, pp. 681.
Lee, H., and B. Choi. "Knowledge Management Enablers, Processes, and Organizational Performance: An Integrative View and Empirical Examination," *Journal of Management Information Systems* (20:1), 2003, pp. 179-228.
Lefebvre, L. A., and E. Lefebvre. "Firm Innovativeness and CEO Characteristics in Small Manufacturing Firms," *Journal of Engineering and Technology Management* (9:3), 1992, pp. 243-277.
Leiponen, A., and C. Helfat. "Innovation Objectives, Knowledge Sources, and the Benefits of Breadth," *Strategic Management Journal* (31:2), 2010, pp. 224-236.
Liberatore, M., and A. Stylianou. "Expert Support Systems for New Product Development Decision Making: A Modeling Framework and Applications," *Management Science* (41:8), 1995, pp. 1296.

MacCrimmon, K., and C. Wagner. "Stimulating Ideas through Creativity Software." *Management Science* (40:11), 1994, pp. 1514.
Malladi, S., and M.S. Krishnan. "Does Software-as-a-Service (SaaS) have a role in IT-enabled Innovation? – An Empirical Analysis" *Proceedings of the Americas Conference on Information Systems*, 2012.
Massetti, B. ""an Empirical Examination of the Value of Creativity Support Systems on Idea Generation"," *MIS Quarterly* (20:1), 1996, pp. 83.
McGourty, J., L. A. Tarshis, and P. Dominick. "Managing Innovation: Lessons from World Class Organizations," *International Journal of Technology Management* (11:3-4), 1996, pp. 354-368.
Melville, N., K. Kraemer, and V. Gurbaxani. "Review: Information Technology and Organizational Performance: An Integrative Model of IT Business Value," *MIS Quarterly* (28:2), 2004, pp. 283.
Miller, D., and P. H. Friesen. "Innovation in Conservative and Entrepreneurial Firms: Two Models of Strategic Momentum," *Strategic Management Journal* (3:1), 1982, pp. 1.
Miller, D., M. Fern, and L. Cardinal. "The use of Knowledge for Technological Innovation within Diversified Firms," *Academy of Management Journal* (50:2), 2007, pp. 308-326.
Mohr, L. B. "Determinants of Innovation in Organizations," *The American Political Science Review* (63:1), Mar., 1969, pp. pp. 111-126.
Mumford, M. D., G. M. Scott, B. Gaddis, and J. M. Strange. "Leading Creative People: Orchestrating Expertise and Relationships," *The Leadership Quarterly* (13:6), 2002, pp. 705-750.
Nambisan, S. "Information Systems as a Reference Discipline for New Product Development," *MIS Quarterly* (27:1), 2003, pp. 1-18.
Naranjo-Gil, D., V. Maas, and F. Hartmann. "How CFOs Determine Management Accounting Innovation: An Examination of Direct and Indirect Effects," *European Accounting Review* (18:4), 2009, pp. 667-695.
Narayanan, V., F. Douglas, D. Schirlin, G. Wess, and D. Geising. "Virtual Communities as an Organizational Mechanism for Embedding Knowledge in Drug Discovery: The Case of Chemical Biology Plattform," *Journal of Business Chemistry* (1:2), 2004, .
Nonaka, I. "A Dynamic Theory of Organizational Knowledge Creation," *Organization Science* (5:1), 1994, pp. 14-37.
Ogawa, S., and F. Piller. "Reducing the Risks of New Product Development," *MIT Sloan Management Review* (47:2), 2006, pp. 65.
Oh, W., and A. Pinsonneault. "On the Assessment of the Strategic Value of Information Technologies: Conceptual and Analytical Approaches." *MIS Quarterly* (31:2), 2007, pp. 239.
Papadakis, V., and D. Bourantas. "The Chief Executive Officer as Corporate Champion of Technological Innovation: An Empirical Investigation," *Technology Analysis & Strategic Management* (10:1), 1998, pp. 89.
Paulsen, N., D. Maldonado, V. Callan, and O. Ayoko. "Charismatic Leadership, Change and Innovation in an R Amp D Organization," *Journal of Organizational Change Management* (22:5), 2009, pp. 511-523.

Pavlou, P., and O. El Sawy. "From IT Leveraging Competence to Competitive Advantage in Turbulent Environments: The Case of New Product Development," *Information Systems Research* (17:3), 2006, pp. 198-227.

Pierce, J., and A. Delbecq. "Organization Structure, Individual Attitudes and Innovation," *The Academy of Management Review* (2:1), 1977, pp. 27-37.

Prahalad, C., and M. S. Krishnan. *The New Age of Innovation- Driving Co-Created Value through Global Networks*, McGraw-Hill, New York, 2008.

Prahalad, C. K., and V. Ramaswamy. *The Future of Competition: Co-Creating Unique Value with Customers*, Harvard Business School Pub., Boston, Mass., 2004.

Ramaswamy, V., and F. Gouillart. *The Power of Co-Creation*, Free Press, New York, NY, 2010.

Ramesh, B., and A. Tiwana. "Supporting Collaborative Process Knowledge Management in New Product Development Teams," *Decision Support Systems* (27:1), 1999, pp. 213-235.

Roberts, E., and O. Hauptman. "The Process of Technology Transfer to the New Biomedical and Pharmaceutical Firm," *Research Policy* (15:3), 1986, pp. 107.

Rogers, E. "Diffusion of Innovations, (4th Edition)," *Rural Sociology* (61:2), 1996, pp. 381.

Rogers, E. M., and J. K. Larsen. *Silicon Valley Fever: Growth of High-Technology Culture*, New York, 1984.

Sambamurthy, V., V. Grover, and A. Bharadwaj. "Shaping Agility through Digital Options: Reconceptualizing the Role of Information Technology in Contemporary Firms," *MIS Quarterly* (27:2), 2003, pp. 237.

Sampson, R. C. "Experience Effects and Collaborative Returns in R&D Alliances," *Strategic Management Journal* (26:11), 2005, pp. 1009-1031.

Satzinger, J., M. Garfield, and M. Nagasundaram. "The Creative Process: The Effects of and Group Memory on Individual Idea Generation," *Journal of Management Information Systems* (15:4), 1999, pp. 143.

Sawhney, M., G. Verona, and E. Prandelli. "Collaborating to Create: The Internet as a Platform for Customer Engagement in Product Innovation," *Journal of Interactive Marketing* (19:4), 2005, pp. 4.

Scherer, F. M. "Firm Size, Market Structure, Opportunity, and the Output of Patented Inventions," *The American Economic Review* (55:5), 1965, pp. 1097.

Schilling, M., and C. Phelps. "Interfirm Collaboration Networks: The Impact of Large-Scale Network Structure on Firm Innovation," *Management Science* (53:7), 2007, pp. 1113.

Schumpeter, J. A. *Capitalism, Socialism, and Democracy*, Harper & Brothers, New York, 1942.

Scott, S., and R. Bruce. "Determinants of Innovative Behavior: A Path Model of Individual Innovation in the Workplace." *The Academy of Management Journal* (37:3), 1994, pp. 580-607.

Semler, S. "Systematic Agreement: A Theory of Organizational Alignment," *Human Resource Development Quarterly* (8:1), 1997, pp. 23.

Sethi, R., S. Pant, and A. Sethi. "Web-Based Product Development Systems Integration and New Product Outcomes: A Conceptual Framework," *The Journal of Product Innovation Management* (20:1), 2003, pp. 37-56.

Srivardhana, T., and S. Pawlowski. "ERP Systems as an Enabler of Sustained Business Process Innovation: A Knowledge-Based View," *Journal of Strategic Information Systems* (16:1), 2007, pp. 51-69.

Swanson, E. B., and N. Ramiller. "Innovating Mindfully with Information Technology," *MIS Quarterly* (28:4), 2004, pp. 553.

Swanson, E. B. "Information Systems Innovation among Organizations." *Management Science* (40:9), 1994, pp. 1069.

Tallon, P., and A. Pinsonneault. "Competing Perspectives on the Link between Strategic Information Technology Alignment and Organizational Agility: Insights from a Mediation Model," *MIS Quarterly* (35:2), 2011, pp. 463-486.

Tanriverdi, H. "Performance Effects of Information Technology Synergies in Multibusiness Firms," *MIS Quarterly* (30:1), 2006, pp. 57-77.

Tansley, D., C. Loughran, C. Edwards, R. Lambert, and J. Peppard. "Realizing Value from a CIO: Navigating the Silicon Ceiling," *Deloitte LLP and Cranfield University Report*2008, pp. 1-16.

Tarafdar, M., and S. Gordon. "Understanding the influence of Information Systems Competencies on Process Innovation: A Resource-Based View," *Journal of Strategic Information Systems* (16:2007, pp. 353-392.

Teece, D., G. Pisano, and A. Shuen. "Dynamic Capabilities and Strategic Management," *Strategic Management Journal* (18:7), 1997, pp. 509-533.

Teo, T., C. Ranganathan, S. Srivastava, and J. Loo. "Fostering IT-Enabled Business Innovation at YCH Group," *MIS Quarterly Executive* (6:4), 2007, pp. 211-223.

Thompson, V. A. "Bureaucracy and Innovation," *Administrative Science Quarterly*1), 1965, .

Tian, J., K. Wang, Y. Chen, and B. Johansson. "From IT Deployment Capabilities to Competitive Advantage: An Exploratory Study in China," *Information Systems Frontiers* (12:3), 2010, pp. 239-255.

Tsai, W. "Social Structure of "Coopetition" within a Multiunit Organization: Coordination, Competition, and Intraorganizational Knowledge Sharing," *Organization Science* (13:2), 2002, pp. 179.

Tsai, W., and S. Ghoshal. "Social Capital and Value Creation: The Role of Intrafirm Networks." *Academy of Management Journal* (41:4), 1998, pp. 464-476.

VanderWerf, P. "Explaining Downstream Innovation by Commodity Suppliers with Expected Innovation Benefit." *Research Policy* (21:4), 1992, pp. 315-334.

von Hippel, E. "Economics of Product Development by Users: The Impact of "Sticky" Local Information," *Management Science* (44:5), 1998, pp. 629.

Wang, P., and N. Ramiller. "Community Learning in Information Technology Innovation." *MIS Quarterly* (33:4), 2009, pp. 709.

Wineman, J. D., F. W. Kabo, and G. F. Davis. "Spatial and Social Networks in Organizational Innovation," *Environment and Behavior* (41:3), 2009, pp. 427.

Wu, S., E. Levitas, and R. Priem. "CEO Tenure and Company Invention Under Differing Levels of Technological Dynamism," *Academy of Management Journal* (48:5), 2005, pp. 859-873.

Yadav, M., J. Prabhu, and R. Chandy. "Managing the Future: CEO Attention and Innovation Outcomes," *Journal of Marketing* (71:4), 2007, pp. 84-101.

Yang, M., A. Wang, and K. Cheng. "The Impact of Quality of IS Information and Budget Slack on Innovation Performance," *Technovation* (29:8), 2009, pp. 527.
Yassine, A., K. Kim, T. Roemer, and M. Holweg. "Investigating the Role of IT in Customized Product Design," *Production Planning Control* (15:4), 2004, pp. 422-434.
Ye, F., and R. Agarwal. "Strategic Information Technology Partnerships in Outsourcing as a Distinctive Source of Information Technology Value: A Social Capital Perspective," *Proceedings of the International Conference on Information Systems,*2003, .
Yoo, Y., O. Henfridsson, and K. Lyytinen. "The New Organizing Logic of Digital Innovation: An Agenda for Information Systems Research." *Information Systems Research* (21:4), 2010, pp. 724.
Zhu, K. "The Complementarity of Information Technology Infrastructure and E-Commerce Capability: A Resource-Based Assessment of their Business Value," *Journal of Management Information Systems* (21:1), 2004, pp. 167-202.

Chapter 2

Leveraging IT for Business Innovation: Does the Role of the CIO Matter?

2.1. Introduction

Information Technology (IT) is employed by business managers to digitize business processes and operations of firms with substantial improvements in productivity and operational efficiency (Brynjolfsson and Hitt 1996). IT advances have also enhanced new product development (Bakos and Treacy 1986; Pavlou and El Sawy 2006) and process design capabilities, helping firms increase the value propositions of products and services to customers. For example, IT plays a pivotal role at Ducati Motors, aiding their design of new motorcycles (Gino and McAfee 2006). IT is a critical part of Amazon's ability to personalize their customers' experiences and boost sales. IT also enables firms co-create value with customers and partners (Kohli and Grover 2008; Prahalad and Krishnan 2008; Prahalad and Ramaswamy 2004). These developments in IT have been reflected in the Information Systems (IS) literature via empirical studies, theoretical models, and conceptual arguments on the role of IT in organizations. Research has also addressed how IT has evolved from merely enhancing efficiency to enabling business innovation and providing strategic value (Bardhan et al. 2008; Boynton et al. 1994; Chatterjee et al. 2002; Gordon and Tarafdar 2007; Joshi et al. 2010; Kearns and Lederer

2000; Kleis et al. 2012; Pavlou and El Sawy 2006; Sambamurthy et al. 2003; Wheeler 2002).

The evolving business capabilities enabled by IT reinforce emphasis on IS[15] leadership, the Chief Information Officer (CIO) (Chatterjee et al. 2001). Traditionally, CIOs were technology-focused, with responsibilities primarily limited to managing IT operations (Applegate and Elam 1992; Chun and Mooney 2009; Stephens et al. 1992). This was largely due to silo IT organizations (departments) and the mere efficiency-based supportive role of IT in large firms (Chen et al. 2010; Karimi et al. 1996). However, the modern CIO role is evolving. As IT emerges as an enabler of business innovation, CIOs are increasingly becoming business leaders who provide guidance in the strategic utilization of IT (Banker et al. 2011; Chen et al. 2010; Chun and Mooney 2009; Enns et al. 2001; Peppard et al. 2011). Firms and Chief Executive Officers (CEOs) now rely on IT and expect CIOs to leverage IT to help drive business innovation (Chen et al. 2010). It is important that CIOs become a partner and play an integral role in innovation since CIOs can be instrumental in shaping the conditions that facilitate innovation by leveraging IT. Thus, firms need to leverage "IS leadership" (the CIO) as a "core IS capability" (Feeny and Wilcocks 1998, p. 19).

Despite the importance of the CIO, practitioners still question the role of the CIO in terms of the contribution that CIOs make to innovation (Tansley et al. 2008). Furthermore, there is relatively limited academic research to enhance our collective understanding of the CIO role in organizational performance. This is also highlighted by prior research (Karahanna and Watson 2006; Preston et al. 2008). With IT increasingly enabling strategic capabilities, firms do not rely on IT to just lower costs, but also to drive

[15] We use the terms "Information Systems" (IS) and "Information Technology" (IT) interchangeably.

revenue through business innovation. It is hence important to better understand the role of CIOs in building innovative organizations (Watts and Hendersen 2006). Yet, even as IT continues to digitize business processes and as digital intelligence gets increasingly embedded in products and services, there is, to the best of my knowledge, no systematic empirical evidence of whether there is a role for the CIO in the firm's IT-enabled business innovation. To help bridge this knowledge gap in the extant literature, we examine the research question focusing on the role of the CIO and the firm's IT-enabled business innovation (defined in Chapter 1, Section 1.2): *What is the relationship between the role of the CIO and the firm's IT-enabled business innovation?*

As discussed earlier (Chapter 1), we draw on the definition of IT-enabled business innovation by prior research (Agarwal and Sambamurthy 2002; Joshi et al. 2010; Teo et al. 2007; Ye and Agarwal 2003) as 'new products, processes, or services developed by a firm through the application of IT'. We draw from organizational theory of boundary spanning leadership (Druskat and Wheeler 2003; Tushman 1977), and conceptual underpinnings in the IS and innovation literatures to propose a theory linking the CIO role to IT-enabled business innovation. We propose that the CIO's external linkages outside the IT organization (i.e., the role of the CIO as a boundary spanner between the IT organization and the rest of the firm and beyond [Watson 1990]) can have positive implications for IT to drive business innovation. We capture the CIO role to reflect activities of the CIO that pertain to his/her involvement and interactions with entities and functions outside the IT organization. Specifically, we examine four aspects of the CIO role: CIO's involvement in business strategy, CIO's involvement new product development, CIO's interactions with the firm's customers, and the CIO-CEO reporting structure.

We test our propositions on data from a large sample of U.S. firms. Our empirical study yields three principal findings. First, IT-enabled business innovation is more likely at firms with a direct CIO-CEO reporting structure. Our second and third findings are respectively that IT-enabled business innovation is more likely when the CIO has more interaction with the firm's customers, and when the CIO is more involved in new product development (R&D function). Taken together, these results suggest that the CIO role external to the IT organization can help enhance the firm's IT-enabled business innovation. The main contributions of this study to research are two-fold. First, it applies organizational theory of boundary-spanning leadership to the context of the CIO role in a strategic capability of IT-enabled business innovation. Second, it sheds new light on the relationship between the CIO role and IT-enabled business innovation, a dimension of IT value which has received limited attention in the extant IS literature. For practice, this study is important because debates still persist among practitioners regarding the role of the CIO in business innovation (e.g., Tansley et al. 2008). In this regard, this study contributes by illuminating the importance of the boundary-spanning nature of the CIO role.

The rest of this chapter is organized as follows. In Section 2.2, we briefly discuss the literature related to CIO, organizational performance, and innovation. We then develop our theoretical framework and discuss our hypotheses (Section 2.3), empirical setting, data and methodology (Section 2.4), and results (Section 2.5). In Section 2.6, we discuss the implications, limitations, and future research directions, before concluding in Section 2.7.

2.2. Literature Review

Prior literature pertinent to our study can be broadly categorized into three key areas. The first and second areas stem from IS research related to CIO and organizational performance. The third broad area draws from research on innovation from both strategy and IS. Next, we briefly review the three areas.

2.2.1. CIO and Organizational Performance Literature

Interest in the role of the CIO emanated from the differential extent of adoption of IS in organizations and the varied recognition of IS as a strategic asset (Applegate et al. 1992; Rockart et al. 1982). Early research pointed to the increasing role of CIOs in providing strategic vision through the exploitation of IT (Benjamin et al. 1985; Emery 1991). The main responsibilities of the CIO were initially recognized to include planning and overseeing technology operations (Gupta 1991).

The CIO research stream has advanced to increase our understanding of how CIOs can be more effective. Smaltz et al. (2006) found that CIO capabilities were significant predictors of CIO role effectiveness. Their analysis showed a mediating relationship between CIO-TMT (Top Management Team) engagements, CIO capability, and CIO effectiveness. Relatedly, Enns et al. (2003) found that the types of influence behaviors used by CIOs with their peers can affect the CIO's capacity to gain commitment for strategic information systems. Li et al. (2006) found that CIOs who are open, extroverted, and conscientious tend to use IT more effectively. Grover et al. (1993) found that the more centralized the IS resource, the more outward-looking is the role of the CIO, as captured by its interpersonal, informational, and decisional aspects. It is also suggested that the CIO role should be aligned with business strategy (Karimi et al. 1996). Such studies as the aforementioned emphasize the importance of IS leadership as a "core IS capability" (Feeny and Willcocks 1998, p. 19).

IS research has also examined how CIOs can impact IT's contribution to firm performance.[16] This research stream emphasizes the importance of CIO structural power, CIO characteristics, and CIO-CEO relationships. For example, Preston et al. (2008) found that strategic authority of the CIO influences the value that organizations get from IT. Johnson and Lederer (2005) found that the CIO-CEO agreement on IT's role predicts IT's contribution to financial performance. On a related note, Banker et al. (2011) found that a CIO-CEO reporting structure is beneficial for firm financial performance for differentiators, rather than cost leaders. The CIO human capital and structural power also impact IT's contribution to strategic growth and operational efficiency via CIO leadership capabilities (Chen et al. 2010). CIO role effectiveness has been found to affect the firm's ability to apply IT to support, shape, and enable value-chain activities (Wu et al. 2008). Sobol and Klein (2009) found that the technical background of CIOs was positively correlated with return on investment, net income, and market share. Announcements of CIO positions can also have a positive effect on market perception of firms (Chatterjee et al. 2001). Yet, while this stream has advanced, there remains, to my best knowledge, a gap linking the CIO role to business innovation.

[16] Refer Preston et al. (2008) for a list of studies linking aspects of the CIO to performance of the IT organization.

2.2.2. Business Innovation Literature

Reviews of the vast management literature on business innovation (Ahuja et al. 2008; Damanpour 1991; Gilbert 2006) broadly characterize innovation output as a production function with several input determinants including organizational structure, incentives, and other business, firm, industry and institutional factors. It is evident from these reviews that IS capability or the managerial capabilities of the IT function has been scantly studied as one of the drivers of business innovation. In the IS literature, the effect of IT on innovation has been captured more recently in some studies. For example, aggregate IT investments can complement a firm's R&D investments enabling greater innovation productivity (Cherian et al. 2009; Han and Ravichandran 2006; Kleis et al. 2012). IT can also facilitate innovation through improved knowledge management capabilities (Alavi and Leidner 2001; Chi et al. 2010; Freeze and Kulkarni 2007; Joshi et al. 2010), co-ordination and collaboration (Gordon and Tarafdar 2007; Malone et al. 1987; Teo et al. 2007), and a greater ability to manage the process of new product development (Pavlou and El Sawy 2006).

Despite the importance of innovation as a strategic asset and much research on the CIO, there has been, to my best knowledge, no empirical study of the relationship between the CIO role and IT-enabled business innovation. This chapter extends the CIO literature in this direction by taking an external perspective of the CIO role (outside the IT organization), consistent with the theory of organizational boundary spanning leadership. In doing so, we also build on prior research perspectives regarding the "role of IS managers in terms of the communication and information flows between the IS organization and outside environments" (Grover et al. 1993, p. 112).

2.3. Theory and Hypotheses Development

2.3.1. The CIO as a Boundary Spanner

In the organizational literature, 'boundary spanners' are defined as "persons who operate at the periphery or boundary of an organization, performing organizational relevant tasks, relating the organization with elements outside it"; the conceptual arguments of boundary spanning are also "applicable to inter-unit exchanges within an organization", such as the IT unit (organization) in our study (Leifer and Delbecq 1978, p. 41). Organizational theorists posit that leaders who are boundary spanners can be "strategic link[s] between the team and the organization, that can supply the team with resources and support" (Druskat and Wheeler 2003, p. 435; Tushman 1977). The boundary spanning activity of leaders has been found to be important for the performance of teams (Ancona and Caldwell 1988; Elkins and Keller 2003; Freeze et al. 2011).

Since IT is now pervasive in every aspect of business, the CIO can play a boundary spanning role serving as a link between IT and the rest of the firm and beyond (Watson 1990). CIOs can be "liaisons" between the IT organization and the external environment and can "act as an advocate for the IS function educating the organization on the strategic role of IT" (Carter et al. 2011, pp. 20-21). However, several CIOs remain locked in the traditional inward role and fail to effectively "boundary-span" outside the IT organization.[17] Indeed, as reported in practitioner press (Tansley et al. 2008, p. 3), "it appears that too few companies enjoy a clear, open and cooperative relationship between the CIO and his or her team, and the rest of the business". Consistent with organizational theory, it is reasonable to expect that the boundary spanning role of the CIO can be beneficial for the performance of the IT organization. Viewing the CIO role from a

[17] This observation came out of my discussion with CIOs of companies (anonymous for protecting identity) who mentioned that many CIOs continue to take an inward (within the IT organization) role in the firm.

boundary spanning perspective is especially relevant in light of the evolving role of IT in business.

Drawing from the aforementioned theoretical foundations and from prior literature, Figure 3 presents our theoretical framework for IT-enabled business innovation. It also draws on the fundamental notion that "outside sources of knowledge are critical to the innovation process, whatever the organizational level at which the innovating unit is defined" (Cohen and Levinthal 1990, p. 128). Consistent with the view that "the environment of the IS organization consists of the host organization's environment and everything within the organization that lies beyond the borders of the IS department" (Lederer and Mendelow 1990, p. 206; Peppard 2007), the framework consists of the IS organization and its external interfaces with the business, R&D function, and customers. The framework depicts IT-enabled business innovation as facilitated by interfaces of the IS organization with external entities (Cohen and Levinthal 1990; Teo et al. 2007).[18] First, the IS organization can transmit innovative business ideas to the business via the flow of information and development of IT systems. In a digital world, ideas originating from the business[19] are facilitated and implemented through IT. Second, IT-enabled business innovation can be facilitated through the interaction between IT and R&D functions. For instance, Avaya's IT organization works closely with R&D teams to facilitate innovation (Forrester 2005). Prior research has argued that IT investments complement R&D investments (Han and Ravichandran 2006; Kleis et al.

---

[18] This framework is by no means comprehensive. It captures the entities we focus on in this study. There are several other external entities (e.g., suppliers, competitors, universities) which are outside the scope of this study.

[19] 'IS organization' refers to "that body of individuals providing information technology (IT) resources and services to the business" (Peppard 2001, p. 249; Ward and Peppard 1996). Consistent with prior research, 'the business' refers to other non-IT "internal functions and end-users" (Teo et al. 2007, p. 220) or "business clients and partners" (Basselier and Benbasat 2004) external to the IS organization but within the firm (Chen et al. 2010; Peppard 2001; Peppard 2007; Reich and Benbasat 2000).

2012). Third, IT-enabled business innovation can be enhanced through involvement of customers. This ties in to the open innovation and co-creation paradigms (Chesbrough 2003; Prahalad and Ramaswamy 2004) wherein firms and customers create innovations in partnership. For example, YCH partners with select clients, leveraging their expertise to generate new IT-enabled services (Teo et al. 2007). Prior management literature recognizes that customers can be sources of innovation (von Hippel 1988).

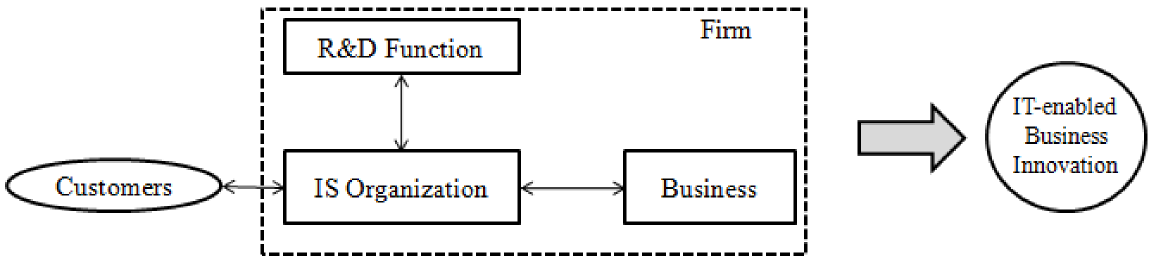

Figure 3: Theoretical Framework of IT-enabled Business Innovation

The framework (Figure 3) helps contextualize the phenomenon we examine (IT-enabled business innovation) with the lens of the IS organization and the CIO (boundary-spanning) role, focusing primarily on aspects of the CIO role directed outside the IS organization. In the backdrop of this theory, we discuss our hypotheses, focusing on the cross-functional role of the CIO in strategy, R&D, and customer interaction processes.

2.3.2. Hypotheses Development

Prior research has argued for synergy between IT and business to ensure strategic alignment of IT with the business (Armstrong and Sambamurthy 1999; Chan et al. 1997; Kearns and Sabherwal 2007; Powell and Dent-Micallef 1997; Sasidharan et al. 2006). In the context of alignment, Wade and Hulland (2004) characterize IS-business partnerships as 'spanning resources' (p. 114) that integrate the firm's 'inside-out and outside-in capabilities' (p. 111). The first boundary-spanning aspect of the CIO role we examine is the involvement of the CIO in business strategy.

The involvement of the CIO in business strategy can help IT-enabled business innovation in three ways. First, it can help business leaders understand how IT can be assimilated into the firm's innovation plans (Boynton et al. 1994; Tarafdar and Gordon 2007). Incorporating IT into the development of products, services, and processes potentially increases the speed and reduces the cost of innovation (Dewett and Jones 2001).

Second, through involvement in business strategy, CIOs can better understand the business, contribute ideas consistent with business strategies (Gordon and Tarafdar 2007; Smaltz et al. 1999), and "partner with the business to innovate" (Chen et al. 2010, p. 234). For example, Wal-Mart recognizes the importance of the CIO's business knowledge, and has rotated personnel between the CIO and business roles (Prahalad and Krishnan 2008). An understanding of business issues can help CIOs articulate to senior management, in business terms, how IT is changing the competitive landscape, and how the firm can take advantage of those changes for innovation. CIO involvement in business strategy can also help IS departments implement new information-based products and services and coordinate the development of IT and planned business changes in the firm to support the new IT-based products and services. Put differently, CIO involvement in business strategy can result in cross-knowledge exchanges between the business and IT (Kearns and Sabherwal 2007; Tanriverdi 2005). The role of the CIO as a strategic business partner can, in turn, foster IT-enabled innovation by bridging the disconnect between CIOs and business managers in the firm (McKenney et al. 1997; Willcocks and Sykes 2000).

Finally, CIO involvement in strategy can help CIOs make better decisions to support IT projects consistent with the firm's business innovation needs. Thus, in sum, we draw on organizational theory of boundary-spanning leadership to posit that CIO involvement in business strategy provides the CIO greater exposure to broader knowledge which can be usefully integrated and applied by the IT organization to drive business innovation. Hence we hypothesize,

H1: The extent of the CIO's involvement in business strategy is positively associated with the firm's propensity for IT-enabled business innovation.

The reporting structure between the CIO and CEO has received considerable research attention (Banker et al. 2011; Jones et al. 1995). The CIO can report to different CXO level entities in the firm, such as the CFO, CEO, and COO (Chief Operating Officer). Prior research suggests that each of these reporting structures could have varied benefits for performance; for example, reporting to the CFO or COO may have cost-related benefits (Banker et al. 2011). From the perspective of innovation, because innovation is inherently risky and strategic in nature (Ahuja et al. 2008), it is pertinent to examine the CIO's reporting to the CEO because such a reporting structure may provide the CIO greater access to resources to support risky innovation-oriented IT projects.

It has been argued that firms that have a direct CIO-CEO reporting structure make more effective (Armstrong and Sambamurthy 1999; Raghunathan and Raghunathan 1989; Rockart et al. 1982) and strategic use of IT (Applegate and Elam 1992), whereas a CIO-Chief Financial Officer (CFO) reporting structure reflects the use of IT as a cost center (Banker et al. 2011). Relatedly, prior research (Chen et al. 2010, p. 245) found that the CIO-CEO reporting relationship contributes to the CIO's "structural power", defined as the "CIO's level of legitimate power due to his or her formal position within the hierarchy of the organization", which enables the CIO to be a strategic partner and influence IT's contribution to strategic growth (in terms of market share, revenue, and return on investment [ROI]).

Building on prior research, we posit a positive relationship between a direct CIO-CEO reporting structure and the firm's propensity for IT-enabled business innovation, for the following reasons. First, a direct reporting structure between the CIO and the CEO promotes a shared understanding between the business and IT on how to use IT for competitive advantage and innovation (Cash et al. 2008; Smaltz et al. 2006). Second, a direct CIO-CEO reporting structure represents greater strategic authority of the CIO (Applegate and Elam 1992; Banker et al. 2011; Chen et al. 2010; Luftman and Kempaiah 2008). Shared understanding and greater strategic authority of the CIO can facilitate faster development, advancement and approval of innovative IT-supported business ideas (Feeny et al. 1992). Moreover, innovation is more about implementing new ideas than about reducing the cost of IT operations. In firms with a direct CIO-CEO reporting structure, there is, in general, a lesser tendency for IT to focus on minimizing the cost of IT operations as compared to firms with a CIO-CFO reporting structure (Banker et al. 2011). These reasons make it more likely that CIOs who report to the CEO may have more authority to influence the CEO and garner support for inherently risky innovation-oriented IT initiatives (Chen et al. 2010; Enns et al. 2001; Preston et al. 2008; Teo et al. 2007). Hence we posit,

H2: A direct CIO-CEO reporting structure is positively associated with the firm's propensity for IT-enabled business innovation.

Innovation in products and services can be enhanced through "insights, ideas, thoughts, and information the organization receives from its customers" (Desouza et al. 2008, p. 39). Customers can be a source of innovation for firms by participating as partners and co-producers (Chesbrough 2003). By "identifying, analyzing, interacting and communicating with customers", firms can increase their access to insights and ideas of customers about new products and services (Desouza et al. 2008, p. 35).

Digitization and the increasingly IT-enabled nature of innovation (Prahalad and Krishnan 2008) magnify the potential role of interaction between IT and customers to support innovation. We extend the interrogation of implications of customer communication for innovation to the IT context by examining whether the IS leadership's (CIO's) interaction with the firm's customers can explain IT-enabled business innovation. We posit such a relationship for three reasons. First, CIO interaction with customers promotes direct communication between IT and customers. This reduces the potential loss of information about customer needs that could occur when IT gets customer requirements from the business. Thus, CIO interaction with customers can improve his understanding of customers' unmet needs for products and services, and can help CIOs drive IT initiatives to build solutions around those needs (Evans 2009; Kohli and Melville 2009).

Second, CIO interaction with customers can facilitate dialog, feedback, and a shared understanding between customers and the IT organization about how IT can be used innovatively from the perspective of customers (Teo et al. 2007). For example, for a well-known U.S. bank, "listening to customer demand for faster, easier access to their accounts" resulted in a new IT-enabled process that minimized the need for customers to visit the bank for transactions which did not critically require their presence (Walsh 2007). As argued by Desouza et al. (2008), listening to customers transfers knowledge from customers to firms, thus helping firms implement innovations. As a banking CIO exclaims in a study of CIOs conducted by IBM (IBM 2009), "the challenge is to change from a 'push' model to a 'pull' model, where the customer expresses requirements and IT answers immediately". In the same study, more than 80% of CIOs expected "to seek customers' active input and interaction". Third, interaction with customers can help CIOs seek customer involvement to differentiate products and services from competitors. This can result in new products, services, and processes, and novel ways for IT to facilitate and deliver them. Thus, in line with organizational theory of boundary spanning leadership, the CIO's boundary-spanning role as a link between IT and the firm's customers can help tap into external sources (customers) of knowledge and ideas, which can aid the IT organization to drive business innovation (Ray et al. 2005). Hence we hypothesize,

H3: The extent of the CIO's interaction with the firm's customers is positively associated with the firm's propensity for IT-enabled business innovation.

New product development is a collaborative process where firms incorporate inputs from multiple entities such as scientists, designers, and marketers (Clark and Fujimoto 1991). New product development is also an information-intensive process (Madhavan and Grover 1998; Nambisan 2003) in which IT can play a crucial role by combining information and automating process and product design, thus increasing the value proposition of IT to the process of innovation (Pavlou and El Sawy 2006).

The CIO's involvement in new product development can help the CIO assess requirements for IT to support the innovation needs of the firm. Firms can reduce time-to-market of new products by developing "systems suggested by the CIO to streamline the product development process" (King 2008, p. 188). For example, for a video equipment manufacturer, the CIO's partnership with product development groups is recognized as a key facilitator of enablement and speed of new product introductions (Mitra et al. 2011). Thus, participation in product and service development provides an opportunity for the CIO to make a more direct commitment to innovation and to align IT with the innovation initiatives of the firm. Such involvement can lead to greater commitment of IT to facilitating the creation and delivery of new products and services. This involvement also facilitates interactions between the CIO and R&D personnel. Such interactions between "individuals with diverse knowledge structures" can "augment the organization's capacity for making novel linkages and associations- innovating beyond what any one individual can achieve" (Cohen and Levinthal 1990, p. 133). Further, the boundary-spanning role of the CIO in the R&D function provides the CIO greater exposure and helps IT get direct information about the firm's innovation needs, potentially reducing the chances of information loss (as discussed earlier). Hence,

H4: The extent of the CIO's involvement in new product development is positively associated with the firm's propensity for IT-enabled business innovation.

2.4. Research Design and Methodology

We obtain data for this study from *InformationWeek (IWeek)*, a leading, widely circulated IT publication in the United States. *IWeek* collected this data by surveying senior IT managers and CIOs at large U.S. firms across industries during the 2008 period.

Similar to prior research, collection of data from CIOs and senior IT managers is important because they are in a good position as key respondents to be knowledgeable and most informed about the IT practices and the CIO role in their company (Grover et al. 1998; Preston et al. 2006). *IWeek* data has also been argued to be "consistent with data from other secondary sources such as International Data Group and Bureau of Economic Analysis" (Rai et al. 1997, p. 92). *IWeek* surveys are thus considered as reliable sources of data and have been used in prior research (e.g., Bharadwaj et al. 1999; Mithas et al. 2005). We augment this data with firm-level variables from Standard and Poor's *Compustat* database and from SEC filings, and with industry-level data from the U.S. Census Bureau.

2.4.1. Variables Definition

2.4.1.1. Dependent and Key Independent Variables

Propensity for IT-enabled Business Innovation (*Innov*): This is a binary variable indicating "whether the firm sought to patent, trademark or copyright any IT-driven business processes, products or services in the 12 months prior" to the survey (Appendix 1). The notion of IT-enabled business innovation captured by this measure is consistent with the definition of firm-level IT-enabled business innovation in the IS literature (Agarwal and Sambamurthy 2002; Joshi et al. 2010; Kleis et al. 2012; Teo et al. 2007; Ye and Agarwal 2003) – 'new products, processes or services developed by a firm through the application of IT'. It is also consistent with the definition of innovation in the strategic management literature as the generation of "new ideas, processes, products or services" (Thompson 1965, p.2). Self-reported and binary measures of innovation have been used in prior research (e.g., Aragon-Correa et al. 2007; Georgellis et al. 2000;

Huergo 2006; Keeble 1997; Koellinger 2008; Leiponen and Helfat 2010; Li et al. 2006; Molina-Moralez and Martinez-Fernandez 2009; Tsai and Ghoshal 1998; Veugelers and Cassiman 1999).

CIO's involvement in Business Strategy (*CIOBusStratInvolv*): This indicates the extent to which the CIO is involved in business strategy decisions in the company ('Not at all involved', 'Somewhat involved', 'Very involved' and 'Highly involved'). A similar measurement approach has been used to capture the extent of involvement of senior IS executives in Top Management Teams (Armstrong and Sambamurthy 1999).

CIO-CEO Reporting Structure (*CIOCEOReport*): This is a binary indicator for whether the CIO reports to the CEO (Law and Ngai 2007).

CIO's interactions with Customers (*CIOCustomerInteract*): This indicates the extent to which the CIO interacts with the firm's most important customers ('does not meet customers', 'meets annually', 'bi-annually', 'quarterly', 'Monthly/more frequently'). A similar measurement approach has been used to capture the extent of contact between CIOs and members of Top Management Teams (Armstrong and Sambamurthy 1999).

CIO's involvement in new product development (*CIONewProdInvolv*): This is a summative index (count) indicating the extent to which the CIO is involved in the development of new products of the company. It includes 'Involved in the conception of new products', 'Involved in articulating the processes needed to develop new products', and 'Involved in the systems and support mechanisms for producing products'.

2.4.1.2. Control Variables

We control for several factors that can influence innovation, based on prior research.

IT Intensity (*ITIntensity*): This represents the firm's IT budget as a percentage of its annual sales revenue (Bardhan et al. 2006; Han and Ravichandran 2006; Mithas et al. 2005). Because our study examines propensity for IT-enabled business innovation, it is important to control for the overall quantum of IT investment in the firm.

R&D Intensity (*R&DIntensity*): R&D investment can be a determinant of innovation output (Ahuja et al. 2008). This variable is the ratio of R&D expenditure to sales of the firm, and it is obtained from Compustat database and SEC filings.

IT R&D Intensity (*ITR&DIntensity*): This represents the share (percentage) of the IT budget devoted to R&D. Since the dependent variable is IT-driven, we control for share of IT investment devoted to R&D. We use this as a proxy for innovation-related IT investments.

Proxy for Firm IT Innovativeness (*ITNewProjects*): Investments in new IT systems are more likely to extend a firm's IT capabilities for innovation, whereas investment in existing IT systems facilitates continued use of existing IT capabilities (Cherian et al. 2009). Therefore, to control for innovativeness in IT, we use the share of the IT budget devoted to new IT projects (as opposed to maintenance projects).

Organization Size (*Size*): This is the natural log of the annual revenue of the firm for its most recent fiscal year (Mithas et al. 2005). Larger firms tend to have more resources for innovation (Ahuja et al. 2008).

Firm age: Firm age can have dual consequences for innovation. While it improves experience and efficiency in organizational routines, it also reduces the fit between firm capabilities and environmental demands (Sorensen and Stuart 2000). Hence, following prior research (Chen et al. 2010; Huergo 2006), we control for firm age (measured as the logarithm of the number of years since the firm was founded).

Prior Profitability (*ROA*): Prior research suggests that profitable firms may be more innovative because they may have greater capacity to re-invest profits in innovation activities. (Ahuja et al. 2008). Consistent with prior studies, we use Return on Assets (ROA), calculated as the ratio of Net income to Total Assets (obtained from Compustat for the year 2006) to control for prior profitability (Bharadwaj 2000).

Industry Concentration Ratio: To account for potential positive and negative effects of competition on innovation (Ahuja et al. 2008), we control for industry concentration, a commonly used inverse measure of competition (Melville et al. 2007; Porter and Sakakibara 2004). As in prior research, we use the 'four-firm concentration ratio' defined as the sum of the market shares of the top four market share leaders of the firm's industry (Bharadwaj et al. 1999; Melville et al. 2007; Ray et al. 2009). Ratios at the 6-digit (or most detailed available) North America Industry Classification System levels are obtained from the 2007 U.S. Census.

High-tech and low-tech industry dummies: This is to control for the possibility that IT-enabled business innovation may be greater (lower) in industries which are high-tech (low-tech) in nature (Banker et al. 2011). The firm's industry is classified as high-tech, low-tech, or neither, based on the classification scheme identified and used in prior research (Banker et al. 2011; Francis and Schipper 1999).

IT orientation: Prior literature identifies three primary roles of IT in industries, namely, "automate, informate, transform", which respectively indicate whether IT's primary role is to automate manual tasks, to provide information to empower management, or to fundamentally alter ways of doing business (Chatterjee et al. 2001, p. 49; Mooney et al. 1996). IT-enabled business innovation may depend on IT's role in the industry (Armstrong and Sambamurthy 1999; Chatterjee et al. 2001). For example, where IT plays an 'automate' role, IT may be viewed as a cost center (Enns et al. 2001). As in prior research (Banker et al. 2011), we adopt Chatterjee et al.'s (2001) classification scheme and use two dummy variables that capture the 'informate' and 'transform' IT roles in the industry ('automate' dummy is dropped to prevent perfect collinearity).

Industry sector: The propensity for IT-enabled business innovation may likely vary by industry sector. Hence, following prior research, we include industry dummy variables which represent the primary industry sector to which the firm belongs (Scherer 1965; Veugellers and Cassiman 1999). These dummies account for potential industry-specific idiosyncrasies beyond those accounted for by the high-tech/low-tech variables and the IT orientation variables.

2.4.2. Estimation Approach

Since the dependent variable (*Innov*) is binary, a probit model is appropriate.[20] An important consideration in our estimation is the possibility that the CIO role may be endogenous.[21] More specifically, firms may not randomly assign a role to their CIO; rather, the CIO role may be defined based on several characteristics of the prevailing business environment. For instance, firms in industries where IT plays a more strategic role may likely assign their CIOs more strategic responsibilities, in terms of involvement in business strategy or direct reporting structure to the CEO, for example. If such

[20] Probit and logistic models are commonly used models for binary outcomes (Greene 2003). The logistic model gives similar results. We use the probit model because the bivariate form of the probit model (bivariate probit model) is a well-developed econometric model in the literature (Greene 2003).
[21] I thank Dr. Robert Franzese for providing insights and motivation for an extensive discussion of potential endogenity.

potential endogenity is not accounted for, the coefficients of our variables of interest may be biased because firms may have systematically elected to assign their CIOs with more strategic roles. We take two approaches to test our hypotheses accounting for potential endogenity.

The first approach is a two-step method recommended by Shaver (1998) and Bharadwaj et al. (2007), and first put forth by Heckman (1979). Following Bharadwaj et al. (2007) and consistent with Shaver (1998), we separate our sample firms into two groups: firms with scores above the mean on the sum of the four (standardized) CIO variables, coded as one; and firms below the mean on the sum of the four (standardized) CIO variables, coded as zero. Intuitively, this binary variable (which we label *StratCIOActivity*) captures the extent of strategic activity of the CIO of the firm. Then, we estimate the first-stage probit equation consisting of *StratCIOActivity* regressed on variables which, based on prior research, may predict a more strategic role of the CIO in the firm (Applegate and Elam 1992; Banker et al. 2011; Chatterjee et al. 2001; Chen et al. 2010; Emery 1991; Enns et al. 2001; Feeny et al. 1992; Karimi et al. 1996; Peppard et al. 2011; Smaltz et al. 1999). These include CIO-level variables, firm-level variables, and industry-level variables. At the CIO level, variables are included indicating whether the CIO is on the board of another firm, and whether the CIO is also responsible for security. The first of these suggest that the CIO plays a more strategic role outside the firm, while the second relates to the CIO role within the firm.[22] At the firm level, *ITIntensity*, *R&DIntensity*, *ITR&DIntensity*, *ITNewProjects*, *Size,* and *ROA* are included to account for the possibility that CIOs in firms with higher values on these variables may have a

[22] We do not make any prediction for the sign of the variable indicating CIO's responsibility for security. On one hand, it may suggest a wider role for the CIO in the firm while on the other hand, it may suggest a more technology-oriented role of the CIO.

more strategic role. We also include variables indicating outsourcing of IT operations domestically or offshore to another country; we expect these variables to be negatively associated with a more strategic role of the CIO (Chen et al. 2010). Finally, at the industry level, concentration ratio (Watson 1990), high-tech and low-tech industry dummies, 'informate' and 'transform' industry dummies, and industry sector dummies are included to control for industry factors that may shape the CIO role (Peppard et al. 2011). In the two-step approach, endogenity is addressed by calculating the Inverse Mills Ratio (IMR) using the estimates from the first stage and including the IMR in the second-stage innovation equation as an additional predictor (Bharadwaj et al. 2007; Heckman 1979; Shaver 1998). More specifically, the IMR variable is created using estimates from the first stage. The IMR is calculated as IMR = $\phi(\beta_r*\mathbf{W_r})/\Phi(\beta_r*\mathbf{W_r})$ if *StratCIOActivity* = 1; and IMR = $-\phi(\beta_r*\mathbf{W_r})/[1-\Phi(\beta_r*\mathbf{W_r})]$ if *StratCIOActivity* = 0; where $\mathbf{W_r}$ and β_r are respectively the vectors of independent variables and estimated (predicted) coefficients from the first stage probit model; ϕ denotes the standard normal distribution function; and Φ denotes the cumulative standard normal distribution function (Greene 2003; Shaver 1998; Bharadwaj et al. 2007). In the second stage, the propensity for IT-enabled business innovation is estimated as a function of its determinants, and the IMR is included as an additional control variable. This additional term appears in the equation because of the potential endogenity of the CIO role previously discussed; namely, unobserved factors may influence the CIO role and therefore there is potential for correlation between u and ε (Greene 2003; Shaver 1998; Bharadwaj et al. 2007).[23] As noted by Shaver (1998) and

[23] Due to the potential correlation between the error terms, the conditional expectation of the error term in equation (2) is not zero but is instead $\rho\phi(\beta_r*\mathbf{W_r})/\Phi(\beta_r*\mathbf{W_r})$ if *StratCIOActivity* = 1 and $\rho\{-\phi(\beta_r*\mathbf{W_r})/[1-\Phi(\beta_r*\mathbf{W_r})]\}$ if *StratCIOActivity* = 0; where ρ is the correlation between the error terms. Hence, if (2) is estimated without accounting for the IMR term, the estimates can be potentially misleading. Further

Van de Ven and Van Praag (1981), since the second-stage dependent variable is binary, the two-step approach, while addressing endogenity, provides an approximation to the probit. The equations are:

$$\underline{\text{CIORole Equation:}} \quad \text{Probability } (\textit{StratCIOActivity} = 1) = \Phi(\beta_a + \boldsymbol{\beta}_r{'}\ \mathbf{W}_r + u) \qquad (1)$$

$$\underline{\text{Innovation Equation:}} \quad \text{Probability } (\textit{Innov}=1) = \Phi\ (\beta_0 + \beta_1 \textit{CIOBusStratInvolv} + \beta_2 \textit{CIOCEOReport} + \beta_3 \textit{CIOCustomerInteract} + \beta_4 \textit{CIONewProdInvolv} + \beta_{imr} \textit{InverseMillsRatio} + \boldsymbol{\beta}_c{'}\mathbf{X}_c + \varepsilon) \qquad (2)$$

where the βs are the parameters for the respective variables; $\mathbf{X_c}$ is the vector of control variables; $\mathbf{W_r}$ is the vector of variables as described in the above paragraph; Φ denotes the normal cumulative distribution function; and u and ε are the error terms.

In a second approach to account for endogenity, we jointly estimate the above CIORole and Innovation equations (without Inverse Mills Ratio term) by full-information maximum likelihood using the bivariate probit model (Greene 2003).[24] This model enables testing whether there is significant correlation between unobserved (or unmeasured) factors that determine the CIO role and the propensity for IT-enabled business innovation, and consequently whether bivariate estimation is necessary (Greene 2003). If such factors exist, they must be accounted for by using the bivariate model. As an intuitive example, if longer-tenured CIOs are likely to have a more strategic role, and also possess unobserved characteristics (e.g., personality characteristics) that are more (or less) likely to drive IT-enabled business innovation, this would result in a positive (or

---

technical details and derivations of the expressions for the IMR can be found in Shaver (1998) and Greene (2003) and are not repeated here for brevity. I thank Dr. Nigel Melville, Dr. M.S. Krishnan, and Dr. Robert Franzese for motivating this extensive discussion.

[24] Technical details of the bivariate probit model are in Greene (2003) and not repeated here for brevity. Although an exclusion restriction is not formally required for identification of the bivariate probit model which is identified by the functional form, the additional variables in the CIORole equation (which are not present in the Innovation equation) aid in identification of the model (Greene 2003). The statistically significant coefficients of these variables in the CIORole equation suggest that there is unlikely to be a problem of weak identification (Bound et al. 1995). When the additional variables in the CIORole equation are also included in the Innovation equation, none of them are statistically significant and the hypotheses testing results remain unchanged.

negative) correlation between the error terms (u and ε), and hence inconsistent estimates. As another example of potential unobserved factors, consider a firm that has a CIO who is by nature risk-seeking and extroverted. Such a CIO may choose to play a more outward-looking strategic role in the organization. This firm would likely have a high error term (u) in equation (1). If risk-taking nature of the CIO can also be assumed to impact the probability that the CIO drives IT-enabled business innovation, this firm would be more likely to have a high propensity for IT-enabled business innovation and hence high error term (ε) in equation (2). If (2) is estimated independently without accounting for (1), the high propensity for IT-enabled business innovation would be erroneously attributed to the CIO role. Put differently, the high propensity for IT-enabled business innovation for this firm is not because of the role of the CIO per se, but because of the risk-taking and extroverted nature of the CIO's personality.

In sum, if not accounted for, the potential correlation between the unobserved error terms could potentially bias the coefficients. The bivariate model permits us to estimate the correlation between the unobserved error terms, and thus perform the regression accounting for such correlation. If the correlation between the error terms is statistically insignificant, separate estimation of the equations is preferable as the bivariate model is less efficient than standard probit models when the error terms are uncorrelated (Bollen et al. 1995; Cameron and Trivedi 2005; Greene 2003; Lawrence and Palmer 2002).

The econometric structures in the two-step probit model and the bivariate probit model capture the potential endogenous nature of the CIO role and are close representations of the theoretical possibility that firm and industry attributes may shape the CIO role. As we describe in the Results section, both approaches give substantively similar results, and do not suggest the presence of endogenity after accounting for our observed variables. We also report the univariate (standard) probit estimates of our main equation of interest (eq. 2).

2.5. Results

Table 4 shows the descriptive statistics.

	Variables	Mean	SD	Min	Max	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1	Innov	0.33	0.47	0	1	1																			
2	CIOCEOReport	0.44	0.49	0	1	0.24*	1																		
3	CIONewProductInvolv	1.91	1.02	0	3	0.26*	0.24*	1																	
4	CIOBusStratInvolv	2.25	0.82	0	3	0.09	0.24*	0.26*	1																
5	CIOCustomerInteract	2.52	1.41	0	4	0.27*	0.21*	0.28*	0.28*	1															
6	R&D Intensity	0.05	0.09	0.00	0.50	0.02	-0.10	0.02	-0.06	0.15*	1														
7	IT R&D Intensity	4.10	5.57	0	40.00	0.24*	0.06	0.17*	0.04	0.22*	0.26*	1													
8	IT Intensity	4.02	4.52	0.05	30.00	0.14*	0.05	0.13*	0.17*	0.20*	-0.01	0.13*	1												
9	ITNewProjects	39.02	15.96	10.00	91.00	0.13*	0.11	0.08	0.11	0.06	-0.10	0.03	0.03	1											
10	Organization Size	8.27	1.23	4.79	12.11	0.22*	0.01	0.00	0.06	0.07	-0.21*	-0.09	-0.08	0.01	1										
11	Firm Age	3.73	0.88	1.61	5.41	0.02	0.05	-0.07	0.15*	0.03	-0.03	-0.02	0.01	0.05	0.05	1									
12	ROA	0.07	0.06	-0.35	0.21	-0.03	0.07	0.00	-0.10	-0.01	0.14*	0.00	0.03	-0.01	-0.12	0.16*	1								
13	Industry Concentration	34.47	20.53	2.30	94.00	0.16*	-0.03	0.02	-0.06	-0.07	-0.01	0.05	0.02	-0.07	0.22*	-0.02	-0.11	1							
14	High-tech Industry	0.18	0.38	0	1	0.11	-0.10	-0.03	-0.04	0.02	0.27*	0.10	0.17*	-0.07	0.02	-0.21*	-0.09	0.26*	1						
15	Low-tech Industry	0.09	0.29	0	1	-0.05	0.11	0.19*	0.06	-0.04	-0.06	0.00	-0.15*	0.03	0.07	-0.04	-0.10	0.16*	-0.14*	1					
16	Informate IT-orientation Industry	0.44	0.50	0	1	0.02	-0.01	-0.08	-0.04	0.02	-0.05	0.00	-0.25*	-0.08	-0.04	0.12	0.14*	-0.11	-0.37*	-0.03	1				
17	Transform IT-orientation Industry	0.35	0.48	0	1	0.04	0.03	0.17*	0.11	0.12	0.03	0.07	0.37*	0.09	-0.04	-0.06	-0.08	0.10	0.18*	-0.08	-0.64*	1			
18	CIO responsible for security	0.23	0.42	0	1	0.04	0.18*	-0.01	0.12	0.14*	0.04	0.06	0.03	0.01	-0.06	0.05	-0.03	-0.02	0.13*	-0.01	0.01	0.04	1		
19	CIO on Board of another company	0.24	0.43	0	1	0.14*	0.13*	0.09	0.20*	0.13*	-0.09	0.00	0.16*	0.10	0.07	0.14*	0.06	-0.03	0.01	-0.01	-0.09	0.06	0.10	1	
20	Offshored IT to another country	0.57	0.50	0	1	0.02	-0.08	-0.09	-0.13*	-0.16*	0.03	-0.06	-0.04	-0.08	0.26*	0.02	-0.09	0.09	0.07	-0.03	0.01	-0.04	-0.09	-0.09	1
21	Outsourced IT domestically	0.21	0.41	0	1	0.01	-0.01	-0.08	-0.11	-0.04	0.00	-0.02	0.00	-0.21*	0.13*	-0.09	-0.03	-0.02	0.02	0.01	-0.06	-0.05	0.08	-0.08	0.23*

Notes: N = 294. * indicates significance at $\alpha = 0.05$

Table 4: Descriptive Statistics and Correlations

The results are provided in Table 5. The first two columns report the two-step estimates, the next two columns report the bivariate estimates, and the univariate (standard probit) estimates are provided in the last column.

--- This space is intentionally left blank ---

	Two-step Probit Estimates		Bivariate Probit Estimates		Univariate Probit
	CIO Role Equation	Innovation Equation	CIO Role Equation	Innovation Equation	Innovation Equation
	Dependent Variable = *StratCIOActivity*	Dependent Variable = *Innov*	Dependent Variable = *StratCIOActivity*	Dependent Variable = *Innov*	Dependent Variable = *Innov*
CIOBusStratInvolv	n/a	-0.136 (0.148)	n/a	-0.136 (0.149)	-0.150 (0.135)
CIOCEOReport	n/a	0.614*** (0.211)	n/a	0.614*** (0.213)	0.592*** (0.189)
CIOCustomerInteract	n/a	0.210** (0.082)	n/a	0.210** (0.082)	0.204** (0.080)
CIONewProductInvolv	n/a	0.334** (0.130)	n/a	0.336** (0.131)	0.319*** (0.112)
R&DIntensity	1.597 (1.117)	-0.171 (1.332)	1.612 (1.123)	-0.171 (1.333)	-0.176 (1.339)
ITR&DIntensity	0.033 (0.022)	0.046** (0.023)	0.032 (0.022)	0.046** (0.023)	0.047** (0.023)
ITIntensity	0.057* (0.033)	0.034 (0.026)	0.058* (0.033)	0.034 (0.026)	0.035 (0.026)
ITNewProjects	0.001 (0.006)	0.014** (0.006)	0.001 (0.006)	0.014** (0.006)	0.014** (0.006)
Organization Size	0.171** (0.080)	0.283*** (0.081)	0.171** (0.080)	0.282*** (0.082)	0.284*** (0.080)
Firm Age	0.104 (0.109)	0.053 (0.116)	0.104 (0.110)	0.050 (0.116)	0.054 (0.116)
ROA	-1.113 (1.350)	0.284 (1.827)	-1.117 (1.347)	0.284 (1.831)	0.281 (1.828)
Industry Concentration	0.002 (0.005)	0.005 (0.006)	0.002 (0.005)	0.005 (0.006)	0.005 (0.006)
High-tech Industry	0.125 (0.369)	0.198 (0.370)	0.126 (0.369)	0.198 (0.368)	0.196 (0.370)
Low-tech Industry	-0.164 (0.442)	-0.559 (0.491)	-0.165 (0.441)	-0.559 (0.490)	-0.551 (0.489)
Informate IT Orientation Industry	0.131 (0.320)	0.702* (0.364)	0.130 (0.320)	0.702* (0.363)	0.702* (0.364)
Transform IT Orientation Industry	-0.084 (0.332)	0.159 (0.405)	-0.085 (0.332)	0.159 (0.403)	0.156 (0.405)
CIO Responsible for Security	0.420* (0.225)	n/a	0.416* (0.227)	n/a	n/a
CIO on the Board of another company	0.563** (0.222)	n/a	0.570** (0.230)	n/a	n/a
Offshored IT to another country	-0.408** (0.190)	n/a	-0.407** (0.191)	n/a	n/a
Outsourced IT domestically	-0.478** (0.232)	n/a	-0.474** (0.233)	n/a	n/a
Inverse Mills Ratio	n/a	-0.043 (0.190)	n/a	n/a	n/a
Constant	-1.935** (1.044)	-5.677*** (1.158)	-2.433** (1.072)	-5.674*** (1.160)	-5.604*** (1.154)
Correlation between error terms of equations (for Bivariate Probit Model)	n/a	n/a	-0.044 (0.189)		n/a
Log Pseudo-likelihood	-145.935	-119.524	-265.459		-119.546
Wald Chi-square	55.86	81.79	145.03		80.08
Prob > Chi-Sqr	0.004	0.0000	0.0000		0.0000
Likelihood Ratio Test of null of Independent equations (for Bivariate Probit Model)	n/a	n/a	Chi-Square = 0.044, df = 1, Prob > Chi-square = 0.834		n/a
McKelvey and Zavoina Pseudo R-square	0.351	0.468	n/a		0.467
Akaike Information Criterion (AIC)	355.87	305.048	660.918		303.092
Bayesian Information Criterion (BIC)	469.441	422.168	891.608		416.662
Observations (N)	257	257	257		257

Notes: (1) Robust Standard Errors in parentheses. (2) Significant at *10%, **5% and ***1% level for Chi-Square tests. (3) In interest of space, estimates for industry sector dummies are not shown. (4) "n/a": Not applicable.

Table 5: Results for CIO Role and Innovation Model

We interpret the two-step probit model first (first two columns in Table 5). In the first step, the model is significant (Wald Chi-square = 55.86, $p < 0.01$) and several variables are statistically significant. Specifically, in line with our prior expectations, CIOs are likely to have a more strategic role at firms in which the CIO is on the board of another company, is responsible for security, and at firms which have greater IT intensity and size. Likewise, CIOs are likely to play a less strategic role in firms which have outsourced domestically or off-shored overseas their IT operations. The second stage of the model provides tests for our hypotheses and addresses endogenity by including in the regression the IMR term calculated from the first-stage (Bharadwaj et al. 2007; Shaver 1998). A Chi-square test of the null that all the four CIO-related variables are jointly zero is rejected ($p < 0.0001$). The McKelvey and Zavoina's pseudo-Rsquare, which most closely approximates the R-square obtained by fitting an Ordinary Least Squares (OLS) model on the underlying variable is 0.468 (Greene 2003; Hagle and Mitchell 1992; McKelvey and Zavoina 1975). The IMR coefficient is statistically insignificant ($p = 0.82$), suggesting a lack of bias due to potential endogenity (Heckman 1979; Shaver 1998). Also, a Hausman test (Hausman 1978) of the null of no systematic difference in coefficients of the univariate and second stage of the two-step model is not rejected ($p = 1.0$), further suggesting that endogenity is not problematic.

We find no support for hypothesis H1 (business strategy involvement) ($p > 0.10$). We later discuss potential reasons for this statistically insignificant finding. Consistent with our hypothesis H2, we find that a direct CIO-CEO reporting structure is positively associated with the propensity for IT-enabled business innovation ($\beta_2 = 0.61$, $p < 0.01$). Quantitatively, other variables constant at their mean, firms in which the CIO reports to the CEO experience an increase of 0.21 in the predicted probability of (*Innov* = 1). Similarly, H3 is supported ($\beta_3 = 0.21$, $p < 0.05$), with a unit increase in *CIOCustomerInteract* associated with an increase of 0.07 in the predicted probability of (*Innov* = 1). We also find support for H4 ($\beta_4 = 0.33$, $p < 0.05$), with a unit increase in *CIONewProdInvolv* associated with an increase of 0.11 in the predicted probability of (*Innov* = 1). These findings are consistent with anecdotal recognition of the increasingly strategic role of CIOs, and with the theoretical arguments of boundary-spanning leadership in the organizational literature (Druskat and Wheeler 2003; Leifer and Delbecq 1978; Tushman 1977) applied to the CIO role (Figure 3).

The control variables are generally in expected directions. The coefficients of *ITR&DIntensity* and firm size are positive and significant, consistent with prior research (Ahuja et al. 2008). *ITNewProjects* is positive and significant, corroborating the argument that IT for new projects helps IT-enabled business innovation (Cherian et al. 2009). Firms in industries where IT plays an 'informate' role have more propensity for IT-enabled business innovation compared to where IT plays an 'automate' role (Chatterjee et al. 2001). The directions of the control variables further validate our model.

Turning to the bivariate estimates (third and fourth columns, Table 5), we find similar results. H2, H3 and H4 are supported while H1 is not supported. The correlation between the error terms (of equations 1 and 2) is statistically insignificant ($p = 0.83$), suggesting that the model consists of independent equations that can be consistently estimated separately (Greene 2003). Also, Hausman tests (Hausman 1978) of the null of no systematic difference in coefficients of the bivariate and separately estimated models, and the bivariate model and the two-step model, are not rejected ($p = 1.0$), further suggesting that endogenity is not problematic. The univariate (standard) probit model (fifth column, Table 5) gives similar results.

2.5.1. Robustness Checks

We take several steps to assess the robustness of our findings. The Hosmer and Lemeshow Goodness-of-fit test ($p = 0.53$ for the two-step model) shows no evidence of poor model fit (Hosmer and Lemeshow 2000). A measure of the model's discriminatory power is the 'Area under the Receiver Operating Characteristic (ROC) Curve' which provides an assessment of the model's ability to discriminate between observations that experience the outcome of interest (in our case, innovation) and those that do not. In our estimation, the area under the ROC curve statistic was 0.84, which falls in the range described as "excellent discrimination" (Hosmer and Lemeshow 2000, p. 162).

Since the data related to the CIO variables and the dependent variable were obtained from the same respondent, there is a potential concern of common method bias. We assess this in two ways. First, we use Harman's one-factor test (Podsakoff and Organ 1986). Six factors with eigenvalues exceeding 1 are extracted, cumulatively explaining 57.17% of the variance, with the first factor accounting for only 14.47% of the variance. Thus, no single major factor emerges, suggesting that common method bias is not a large problem. Second, we run Lindell and Whitney's (2001) test, using a "marker variable" to partial out common method variance from correlations among variables. After correcting for common method variance, we find no substantial changes in correlations, further suggesting common method bias is not problematic (Malhotra et al. 2006).

The routine tests for reliability of survey measures are not applicable because we use summative (formative) scales (Jarvis et al. 2003). The mean (max) variance inflation factors of 1.35 (2.10) are below suggested limits (Greene 2003), indicating that multicollinearity, which reduces precision of estimates, is not an issue. The Lagrange Multiplier score test for heteroskedasticity (Davidson and Mckinnon 1984; Greene 2003) does not reject the null of homoskedasticity at conventional levels.[25] Further, a model specification test (linktest) suggested that there is no model specification error (Long and Freese 2003). This test is based on the logic that in a properly specified model, meaningful variables are included and one should not be able to find additional significant variables except by chance (UCLA 2010).

To assess the reliability of the self-reported measure of innovation, we examine the correlation in the sample between this measure and the number of patents applied for by the firm in the same year (patent counts were obtained from U.S. Patent & Trademark Office). The correlation coefficient (r) is positive and statistically significant ($r = 0.17$, $p < 0.01$), thus serving as a validity check of our measure of innovation.[26] This approach is consistent with prior research that validates subjective measures against external measures to ensure data integrity (Kulp et al. 2004; Pavlou and El Sawy 2006; Ravichandran and Lertwongsatien 2005). More specifically, it is in line with studies that validate subjective innovation measures by their correlation with quantitative innovation measures (Aragon-Correa et al. 2007).

2.6. Discussion

2.6.1. Findings

[25] Nevertheless, as suggested in the literature (Greene 2003), we use robust standard errors. Our results remain unchanged whether we use robust or non-robust standard errors.

[26] The correlation coefficients are statistically significant and not too high in magnitude. This is expected since the *Innov* variable refers to propensity for *IT-enabled* business innovation in particular, whereas the Patent counts measure all innovations.

	Hypothesis	Finding
H1	The extent of the CIO's involvement in business strategy is positively associated with the firm's propensity for IT-enabled business innovation.	Not supported
H2	A direct CIO-CEO reporting structure is positively associated with the firm's propensity for IT-enabled business innovation.	Supported
H3	The extent of the CIO's interaction with the firm's customers is positively associated with the firm's propensity for IT-enabled business innovation.	Supported
H4	The extent of the CIO's involvement in new product development is positively associated with the firm's propensity for IT-enabled business innovation.	Supported

Table 6: Summary of Findings (Chapter 2)

The role of IT in business innovation has been a subject of emerging interest in recent times (Gordon and Tarafdar 2007; Han and Ravichandran 2006; Joshi et al. 2010; Kleis et al. 2012). Our goal in this chapter was to examine the CIO role in the context of the firm's IT-enabled business innovation. Our findings (Table 6) add to the knowledge of the relationship between a key IS resource, the CIO, and the firm's IT-enabled business innovation. The study provides empirical evidence of how the IS leadership role external to IT explains the propensity of the firm for IT-enabled business innovation. Our results support three of our hypotheses. Specifically, the results suggest that when the CIO has more interaction with customers, is more involved in new product development, and has a direct reporting relationship to the CEO, IT is more likely to drive business innovation in the firm.

In contrast, our hypothesis regarding the involvement of the CIO in business strategy (H1) is not supported. Several explanations for this are plausible.[27] First, the clarity to innovation opportunities that CIOs get through involvement in strategy may be mixed across the firms. Second, from a strategy perspective, firms may vary in how IT drives business innovation (Tallon et al. 2000). To the extent that IT investment in new projects reflects innovative IT use, the *ITNewProjects* variable controls for the innovative nature of the firm's IT strategy. This apart, our data do not allow us to identify a firm's

[27] We thank three anonymous (for protecting identity) CIOs for suggesting some of these potential explanations during our discussions with them.

business strategy. Third, despite involvement of CIOs in business strategy, it is possible that business executives do not have as much faith in IT leaders who are often stereotyped as technical and less business-oriented. Therefore, despite having a 'seat at the table', CIOs may not have the support required from business executives to drive innovation. Fourth, there can be potential misalignment between the business strategy and the focus of the IT organization in that whereas the firm may have a strategy of innovation, the IT organization of the firm may be focused on cost reduction rather than revenue-generating innovation. Finally, if IT organizations are not able to meet the basic needs of the firm, it may be unlikely that IT would drive innovation, even though the CIO is involved in business strategy.

The coefficients on the CIO variables can be interpreted as the association of the CIO role with the propensity for IT-enabled business innovation controlling for other factors that may influence IT-enabled business innovation.[28] The inclusion of control variables (e.g., IT intensity, R&D intensity) help to partial out the effect of these variables on the IT-enabled innovation propensity of the firm. At the same time, the inclusion of these variables in the first stage of the two-step model help to account for the potential that they might influence the CIO role itself. Put differently, our empirical approach is an estimate of the association of aspects of the CIO role with the propensity for IT-enabled business innovation after partialling out the independent influence of the control variables on innovation, as well as accounting for the possibility these variables may systematically impact the CIO roles in the company.

---

[28] I thank Dr. Robert Franzese and Dr. M.S. Krishnan for motivating this discussion and providing insights for this discussion.

More specifically, the included control variables help account for many other factors which could drive the propensity for IT-enabled business innovation and be correlated with the CIO role, thus influencing the relationship under study. Some of these factors can be broadly related to the social or technical architecture of the firm. In the ensuing paragraphs, I discuss each control variable in light of these considerations.

First, the *ITIntensity* variable captures investments in the IT infrastructure. Inclusion of *ITIntensity* as a control is important because we examine IT-enabled business innovation. Firms that are IT-intensive may, by nature, be more prone to make IT investments that are oriented to business innovation. Greater IT investments may provide more financial leeway for the CIO to actually leverage the knowledge gained from boundary spanning (e.g., interaction with customers), in terms of implementing the necessary IT systems. Further, the inclusion of *ITIntensity* in the first stage of the estimation helps to control for the potential that CIOs in IT-intensive firms may play a more strategic role because of the higher share of IT investments and implicitly higher importance to IT in such IT-intensive companies. Consistent with this argument, we find a positive and significant coefficient of *ITIntensity* in the first stage of our estimation ($\beta = 0.057$, $p < 0.1$).

Second, the *ITR&DIntensity* and *ITNewProjects* variables broadly capture investments in innovation-related IT investments. For example, such investments might include IT investments in design systems for innovation. Investments in such systems are quite different from IT investments for other business operations (e.g., investments in IT systems for payroll). Greater investment in R&D related IT and new IT projects may also provide greater financial leeway for IT to implement ideas and benefit from boundary-spanning activities of the CIO. Similarly, inclusion of these variables in the first stage accounts for the potential that CIOs in firms that make greater investments in innovation-related IT may play a more strategic role. Consistent with our expectations, we find positive and significant coefficients for these variables in the innovation equation ($\beta = 0.046$, $p < 0.05$; and $\beta = 0.014$, $p < 0.05$ respectively).

Third, the firm *Size* can broadly be a proxy for the availability of organizational resources that may be part of the social architecture. Larger firms tend to have greater resources for innovation (Ahuja et al. 2008). Larger size of the firm may also provide the opportunity for the CIO to more extensively leverage other organizational capabilities (e.g., marketing, production, operations, human resources) in order to benefit from the boundary-spanning. Consistent with prior literature, we find a positive and significant coefficient for firm *Size* in the innovation equation ($\beta = 0.283$, $p < 0.01$). We also find a significant coefficient of *Size* in the first-stage equation ($\beta = 0.171$, $p < 0.05$), suggesting that CIOs in larger firms are more likely to play strategic roles.

Fourth, firm *Age* helps to account for potential cultural differences between old and young firms (Huergo 2006; Kashmiri and Mahajan 2010). Higher age of firms can be indicative of low technological content (Huergo 2006). Firm age may also be a proxy for organizational legacies and rigidities which may influence both the strategic nature of the CIO role and the extent to which the CIO can benefit from boundary spanning. At the same time, prior research suggests that the influence of age on innovation may be inconclusive: age may, on one hand, improve experience in organizational routines while reducing the fit between organizational capabilities and environmental demands on the other hand (Sorensen and Stuart 2000). Consistent with prior research which has tended to be inconclusive about the role of firm age on innovation, we do not find a statistically significant coefficient of firm *Age* in our estimations.

Fifth, other firm-level factors that may influence innovation (firm profitability and R&D investments) are included in our estimations. Prior research suggests that R&D investments can directly contribute to innovation and profitable firms may have more resources to invest in innovation (Ahuja et al. 2008). CIOs in firms that are more profitable or more R&D intensive may be better able to re-invest the profits or appropriately channel the R&D funds for the purpose of IT-enabled business innovation. Inclusion of these variables in the first stage accounts for the possibility that they may influence the CIO role. For example, greater R&D investments may entice the CIO to interact more with customers to better understand their needs for new products or services.

Sixth, the industry-level controls (high-tech/low-tech industry controls and the "Informate/Transform" industry controls, and industry dummies) account for potential industry idiosyncrasies that might in turn induce firms to make innovation-related IT investments. For example, in industries where the primary role of IT is to automate tasks, IT-enabled business innovation may be less likely compared to industries where the role of IT is more strategic. For example, firms in the banking or telecommunications industries (e.g., Avaya) may have greater opportunities for IT-enabled business innovation compared to firms in the wood furnishing industry. The high-tech nature of the industry may also provide more opportunities for the CIO to benefit from boundary-spanning. For example, CIOs in inherently high-tech industries like telecommunications may be better able to incorporate the ideas from customers. Consistent with these arguments, we find that the coefficient of the “Informate” IT industry control in the innovation equation is positive and statistically significant ($\beta = 0.702$, $p < 0.10$). The coefficients on the high-tech and low-tech industry controls are respectively positive and negative, though they are not statistically significant.

Last, the four-firm concentration ratio helps account for potential effects of competition; prior research suggests that monopolistic firms may be more innovative because they can more profitably reap the fruits of innovation (Ahuja et al. 2008). Such X-efficiency arguments may also factor into the extent to which firms may benefit from the boundary-spanning role of the CIO by potentially affecting the need for implementing innovations to keep up with the competition. Inclusion of the concentration ratio in the first-stage equation helps account for the possibility that industry competition may influence the strategic nature of the CIO.

Taken together, the control variables help to partial out many potential alternate factors that might influence the propensity for IT-enabled business innovation and the CIO role. Many of the control variables may be proxies for other factors of the social architecture and technical architecture of the firm. As a result, the estimated coefficients of the CIO role variables represent the residual relationship between the CIO role and the propensity for IT-enabled business innovation, i.e., after partialing out other potential factors (as permitted by our data).

Overall, the results are consistent with our theoretical framework (Figure 3) applied to the CIO role.

2.6.2. Contributions to Research

The contributions of this study for research are multifold. First, the results are consistent with the organizational theory of boundary spanning leadership applied to the CIO role (Druskat and Wheeler 2003; Tushman 1977). Our findings suggest that the CIO's interface with external entities and functions can have positive implications for IT to drive business innovation. Second, our results are consistent with the open innovation paradigm (Chesbrough 2003), in which customers are a potential source of ideas. Specifically, our results suggest that interaction of CIOs with customers can have positive implications for IT-enabled innovation. Third, the findings suggest that IT is more likely to drive innovation at firms in which CIO reports to CEO. This result builds on prior research findings that such firms make more strategic use of IT (Banker et al. 2011). Business innovation is often risky and experimental in nature (Graves and Langowitz 1993). Our finding suggests that a CIO-CEO reporting structure gives CIOs more influence or power to champion the cause of IT-enabled business innovation. Finally, our results suggest the potential of the CIO role in the R&D function, shedding light, from an IS leadership perspective, on the interplay between IT and R&D.

Our study reinforces the notion that IT-enabled business capabilities are increasingly dependent on how the IT organization interfaces with the rest of the firm and external entities (Chen et al. 2010; Peppard 2007; Teo et al. 2007). The resource-based view applied to IS posits that IS resources in combination with other firm resources create strategic synergies that are valuable, rare, inimitable, and non-substitutable (Barney 1991; Melville et al. 2004). Our study examined some interfaces between a key IS resource (the CIO) and other firm and external resources in the context of a strategic capability of business innovation. Our study is also a step towards addressing the call of

Karahanna and Watson (2006, p. 171) to examine "relationships, processes, structures and mechanisms" that help IS leadership drive new value streams for their firms.

More fundamentally, this study contributes by showing the importance of IS capability, as reflected in the CIO role (Feeny and Wilcocks 1998), for a strategic firm capability, IT-enabled business innovation. Our research can potentially add to the sparse but growing body of literature that is expanding the scope of IT value to include business innovation (Cherian et al. 2009; Gordon and Tarafdar 2007; Han and Ravichandran 2006; Joshi et al. 2010; Kleis et al. 2012; Pavlou and El Sawy 2003). This study also provides another example of how IS resources can create "indirect" (business innovation) value, as called for by prior research (Kohli and Grover 2008, p. 33). As discussed earlier, extant research has mainly focused on IT investments and other mechanisms by which IT drives business innovation. In this study, we advance this exploration in the direction of IS leadership, consistent with calls to "examine how CIO leadership influences other IT-enhanced organizational outcomes [besides efficiency and strategic growth]" (Chen et al. 2010, p. 261). In doing so, we also build on literature on IS leadership and strategic capabilities (Chen et al. 2010).

2.6.3. Contributions to Practice

It is well known that the CIO role is crucial within the IT organization. At the same time, practitioners "still question the relevance of the role, and the contribution that a CIO could make to strategy, innovation and growth" (Tansley et al. 2008, p. 2). This study sheds light on such issues. Our findings suggest when CIOs 'boundary span' with constituents outside IT such as the business, R&D function, and customers, IT is more likely to drive business innovation. Past research has suggested that CIOs need to advance business capabilities through IT-driven strategic and innovation initiatives (Karahanna and Watson 2006). Our results suggest a role for CIOs to engage with customers and be involved with the R&D function. In a digitized world, IT can draw on customers as a means to further business innovation. Although our hypothesis regarding business strategy involvement is unsupported, we find that a CIO-CEO reporting structure is associated with a greater propensity for IT-enabled business innovation. This suggests that the strategic orientation of the CIO (reflected by the reporting structure to the CEO) is more likely associated with IT-enabled innovation. This finding builds on research related to CIO-CEO reporting structure and strategic capabilities (Banker et al. 2011). Further, our results suggest that CIO-CEO reporting structure is more likely to give CIOs power to garner support for IT-driven innovation initiatives (Enns et al. 2001; Teo et al. 2007).

2.6.4. Limitations and Future Research Suggestions

This study should be viewed in light of its limitations, some of which can serve as starting points for future research. First, the sample firms (*IWeek*) may not be representative of the population of firms in their use of IT. Despite our use of control variables to account for related differences in firms and industries, the lack of a perfectly random sampling frame hinders the generalizability of our results. Second, the cross-sectional analysis design limits our inferences to association and does not allow us to empirically test causality. However, similar to prior literature, the bivariate and two-step model estimations that statistically account for endogenity and that gave us similar results as the univariate model mitigate endogenity concerns (Bharadwaj et al. 2007; Shaver 1998). Third, though the self-reported measure of innovation is positively correlated with external patents and though self-reported and binary innovation measures have been used in prior literature (e.g., Aragon-Correa et al. 2007; Georgellis et al. 2000; Huergo 2006; Keeble 1997; Koellinger 2008; Leiponen and Helfat 2010; Li et al. 2006; Molina and Martinez 2009; Tsai and Ghoshal 1998; Veugelers and Cassiman 1999), future studies can use more refined measures. Crucially however, we aim to examine firms' business innovation *driven by IT*. The self-reported measure specifically captures the IT-driven nature of business innovation. Finally, the data were collected from CIOs and senior IS managers who, despite being key respondents about IT practices and the CIO role in their company, could also overrate IT benefits (Grover et al. 1998). Still, the positive and significant correlation between our innovation measure and patents, along with common method tests that indicated no bias alleviate this concern.

This study can motivate much future research at the nexus of the CIO, IT, and business innovation. Future research can empirically validate the mechanisms by which we theorized the role of the CIO in IT-enabled business innovation. For example, how much does CIO interaction with customers help source customer ideas? Second, studies can examine other roles, such as role of CIO with regard to suppliers. Third, building on research on CEO leadership styles and innovation (Jung et al. 2003), future work can examine how CIO leadership styles foster innovation. Finally, our study primarily considers the *extent* of CIO interactions with external entities. Examining how the *quality* of interactions helps innovation is another potentially promising avenue for research.

2.7. Conclusion

In an age when firms increasingly use IT to provide strategic value, it is incumbent upon CIOs to contribute to their firms' capacity to innovate. This chapter first presented a theoretical framework in which IT-enabled business innovation is facilitated by interactions of the IT organization with external entities and functions, namely, the business, R&D function, and customers. Drawing on organizational theory of boundary spanning leadership and using data on U.S. firms, we empirically examined the CIO role in the context of the framework and found that the likelihood of IT-enabled business innovation is higher when the CIO reports directly to the CEO, has more interaction with firm's customers, and is more involved in product development. The findings contribute to collective scholarly and practitioner understanding of the CIO role in IT-enabled business innovation, and suggest that firms can enhance business innovation by leveraging IS leadership more extensively in external relationships outside the IT organization. More broadly, this chapter sheds light on the CIO role in a strategic capability, specifically IT-enabled business innovation. We hope that this research stimulates further exploration into the interplay between IS leadership, IT, and business innovation.

References

Agarwal, R., and V. Sambamurthy. "Principles and Models for Organizing the IT Function," *MIS Quarterly* (26:1), 2002, pp. 1.

Ahuja, G., C. Lampert, and V. Tandon. "Moving Beyond Schumpeter: Management Research on the Determinants of Technological Innovation," *Academy of Management Annals* (2:1), 2008, pp. 1-98.

Alavi, M., and D. Leidner. "Review: Knowledge Management and Knowledge Management Systems: Conceptual Foundations and Research Issues," *MIS Quarterly* (25:1), 2001.

Ancona, D., and D. Caldwell. "Beyond Task and Maintenance: Defining External Functions in Groups." *Group Organization Studies*1988, pp. 468.

Applegate, L., and J. Elam. "New Information Systems Leaders: A Changing Role in a Changing World," *MIS Quarterly* (16:4), 1992, pp. 469.

Aragon-Correa, J. A., V. Garcia-Morales, and E. Cordon-Pozo. "Leadership and Organizational Learning's Role on Innovation and Performance: Lessons from Spain," *Industrial Marketing Management* (36:3), 2007, pp. 349.

Armstrong, C., and V. Sambamurthy. "Information Technology Assimilation in Firms: The Influence of Senior Leadership and IT Infrastructures," *Information Systems Research* (10:4), 1999, pp. 304.

Bakos, J. Y., and M. E. Treacy. "Information Technology and Corporate Strategy: A Research Perspective," *MIS Quarterly* (10:2), 1986, pp. 107-119.

Banker, R., N. Hu, P. Pavlou, and J. Luftman. "CIO Reporting Structure, Strategic Positioning, and Firm Performance," *MIS Quarterly* (35:2), 2011, pp. 487-504.

Bardhan, I., J. Whitaker, and S. Mithas. "Information Technology, Production Process Outsourcing, and Manufacturing Plant Performance," *Journal of Management Information Systems* (23:2), 2006, pp. 13.

Bardhan, I., A. Gupta, and P. Tallon. "Research Perspectives on Innovation through Information Technology Management in a Networked World," *Information Technology & Management* (9:3), 2008, .

Barney, J. "Firm Resources and Sustained Competitive Advantage," *Journal of Management* (17:1), 1991, pp. 99.

Bassellier, G., and I. Benbasat. "Business Competence of Information Technology Professionals: Conceptual Development and Influence on IT-Business Partnerships," *MIS Quarterly* (28:4), 2004, pp. 673.

Benjamin, R., C. Dickinson, and J. Rockart. "Changing Role of the Corporate Information Systems Officer," *MIS Quarterly* (9:3), 1985, pp. 177.

Bharadwaj, A., S. Bharadwaj, and B. Konsynski. "Information Technology Effects on Firm Performance as Measured by Tobin's q," *Management Science* (45:7), 1999, pp. 1008.

Bharadwaj, S., A. Bharadwaj, and E. Bendoly. "The Performance Effects of Complementarities between Information Systems, Marketing, Manufacturing, and Supply Chain Processes," *Information Systems Research* (18:4), 2007, pp. 437.

Bharadwaj, A. S. "A Resource-Based Perspective on Information Technology Capability and Firm Performance: An Empirical Investigation," *MIS Quarterly* (24:1), 2000, pp. 169.

Bollen, K. A., D. K. Guilkey, and T. A. Mroz. "Binary Outcomes and Endogenous Explanatory Variables: Tests and Solutions with an Application to the Demand for Contraceptive use in Tunisia," *Demography* (32:1), 1995, pp. 111-131.

Bound,J., D. A. Jaeger, and R. M. Baker. "Problems with Instrumental Variables Estimation when the Correlation between the Instruments and the Endogeneous Explanatory Variable is Weak," *Journal of the American Statistical Association* (90:430), 1995, pp. 443.

Boynton, A., R. Zmud, and G. Jacobs. "The Influence of IT Management Practice on IT use in Large Organizations," *MIS Quarterly* (18:3), 1994, pp. 299.

Brynjolfsson, E., and L. Hitt. "Paradox Lost? Firm-Level Evidence on the Returns to Information Systems Spending," *Management Science* (42:4), 1996, pp. 541.

Cameron, A. C., and P. K. Trivedi. *Microeconometrics: Methods and Applications*, Cambridge University Press, New York, 2005.

Carter, M., V. Grover, and J. Bennett. "The Emerging CIO Role of Business Technology Strategist," *MIS Quarterly Executive* (10:1), 2011, pp. 19-29.

Cash, J., M. Earl, and R. Morison. "Teaming Up to Crack Innovation and Enterprise Integration," *Harvard Business Review* (86:11), 2008, pp. 90.

Chan, Y. E., S. L. Huff, D. W. Barclay, and D. G. Copeland. "Business Strategic Orientation, Information Systems Strategic Orientation, and Strategic Alignment," *Information Systems Research* (8:2), 1997, pp. 125-147.
Chatterjee, D., V. Richardson, and R. Zmud. "Examining the Shareholder Wealth Effects of Announcements of Newly Created CIO Positions," *MIS Quarterly* (25:1), 2001, pp. 43.
Chatterjee, D., R. Grewal, and V. Sambamurthy. "Shaping Up for e-Commerce: Institutional Enablers of the Organizational Assimilation of Web Technologies," *MIS Quarterly* (26:2), 2002, pp. 65.
Chen, D., D. Preston, and W. Xia. "Antecedents and Effects of CIO Supply-Side and Demand-Side Leadership: A Staged Maturity Model," *Journal of Management Information Systems* (27:1), 2010, pp. 231-272.
Cherian, S. P., J. W. Whitaker, and M. S. Krishnan. "Do IT Investments Enable Business Innovation in High-Tech Firms? an Empirical Analysis," *Ross School of Business Working Paper,*2009, .
Chesbrough, H. W. *Open Innovation: The New Imperative for Creating and Profiting from Technology*, Harvard Business School Press, Boston, MA, 2003.
Chi, L., Y. Liao, S. Han, and K. Joshi. "Alliance Network, Information Technology, and Firm Innovation: Findings from Pharmaceutical Industry," *Proceedings of the International Conference on Information Systems,* 2010, pp. 1-16.
Chun, M., and J. Mooney. "CIO Roles and Responsibilities: Twenty-Five Years of Evolution and Change," *Information & Management* (46:6), pp. 323-334.
Clark, K. B., and T. Fujimoto. *Product Development Performance*, Harvard Business School Press, Cambridge, MA, 1991.
Cohen, W., and D. Levinthal. "Absorptive Capacity: A New Perspective on Learning and Innovation," *Administrative Science Quarterly* (35:1), 1990, pp. 128.
Damanpour, F. "Organizational Innovation: A Meta-Analysis of Effects of Determinants and Moderators." *The Academy of Management Journal* (34:3), 1991, pp. 555.
Davidson, R., and J. MacKinnon. "Convenient Specification Tests for Logit and Probit Models," *Journal of Econometrics* (25:3), 1984, pp. 241-262.
Desouza, K., Y. Awazu, S. Jha, C. Dombrowski, S. Papagari, P. Baloh, and J. Kim. "Customer-Driven Innovation: To be a Marketplace Leader, Let Your Customers Drive." *Research Technology Management* (51:3), 2008, pp. 35.
Dewett, T., and G. Jones. "The Role of Information Technology in the Organization: A Review, Model, and Assessment," *Journal of Management* (27:3), 2001, pp. 313.
Druskat, V., and J. Wheeler. "Managing from the Boundary: The Effective Leadership of Self-Managing Work Teams," *The Academy of Management Journal* (46:4), 2003, pp. 435.
Elkins, T., and R. Keller. "Leadership in Research and Development Organizations: A Literature Review and Conceptual Framework," *The Leadership Quarterly* (14:4), 2003, pp. 587.
Emery, J. C. "What Role for the CIO?" *MIS Quarterly* (15:2), 1991, pp. R7-R9.
Enns, H., S. Huff, and B. Golden. "How CIOs Obtain Peer Commitment to Strategic IS Proposals: Barriers and Facilitators," *Journal of Strategic Information Systems* (10:1), 2001, pp. 3.

Evans, B. "Global CIO: The Top 10 CIO Issues for 2010," Http://www.Informationweek.com/news/global-cio/security/showArticle.Jhtml?articleID=222002799, 2009, .
Feeny, D. F., and L. P. Willcocks. "Core IS Capabilities for Exploiting Information Technology," *Sloan Management Review* (39:3), 1998, .
Feeny, D., B. Edwards, and K. Simpson. "Understanding the CEO/CIO Relationship." *MIS Quarterly,* 1992, pp. 435.
Fichman, R. G. "Going Beyond the Dominant Paradigm for Information Technology Innovation Research: Emerging Concepts and Methods," *Journal of the Association for Information Systems* (5:8), 2004, pp. 314.
Forrester Research. "Make IT Matter for Business Innovation," 2005, .
Francis, J., and K. Schipper. "Have Financial Statements Lost their Relevance?" *Journal of Accounting Research* (37:2), 1999, pp. 319.
Freeze, R., P. Lane, and S. Sasidharan. "Management Teams: The Case for Balancing Or Unbalancing," *Proceedings of the Hawaii International Conference on System Sciences,* 2011, pp. 1-9.
Freeze, R., and U. Kulkarni. "Knowledge Management Capability: Defining Knowledge Assets," *Journal of Knowledge Management* (11:6), 2007, pp. 94-109.
Georgellis, Y., P. Joyce, and A. Woods. "Entrepreneurial Action, Innovation and Business Performance: The Small Independent Business," *Journal of Small Business and Enterprise Development* (7:1), 2000, pp. 7-17.
Gilbert, R. "Looking for Mr. Schumpeter: Where are we in the Competition-Innovation Debate?," *Innovation Policy and the Economy*2006, pp. 159.
Gino, F., and A. P. McAfee. "Ducati Corse," *Harvard Business School Case 605-091,*2006, .
Gordon, S., and M. Tarafdar. "How do a company's Information Technology Competences influence its Ability to Innovate?" *Journal of Enterprise Information Management* (20:3), 2007, pp. 271-290.
Graves, S. B., and N. S. Langowitz. "Innovative Productivity and Returns to Scale in the Pharmaceutical Industry." *Strategic Management Journal* (14:8), 1993, pp. 593.
Greene, W. H. *Econometric Analysis*, Prentice Hall, Upper Saddle River, NJ, 2003.
Grover, V., S. Jeong, W. Kettinger, and C. Lee. "The Chief Information Officer: A Study of Managerial Roles," *Journal of Management Information Systems* (10:2), 1993, pp. 107.
Grover, V., J. Teng, A. Segars, and K. Fiedler. "The Influence of Information Technology Diffusion and Business Process Change on Perceived Productivity - the IS Executive' Perspective," *Information & Management* (34:3), 1998, pp. 141-159.
Gupta, Y. "The Chief Executive Officer and the Chief Information Officer: The Strategic Partnership," *Journal of Information Technology* (6:1991, pp. 128-139.
Hagle, T., and G. Mitchell. "Goodness-of-Fit Measures for Probit and Logit." *American Journal of Political Science* (36:3), 1992, pp. 762-784.
Han, S., and T. Ravichandran. "Does IT Impact Firm Innovativeness ? : An Empirical Examination of Complementary and Direct Effects," *Proceedings of the Twelfth Americas Conference on Information Systems,*2006, pp. 704-715.
Hausman, J. A. "Specification Tests in Econometrics," *Econometrica* (46:6), 1978, pp. 1251-1271.

Heckman, J. "Sample Selection Bias as a Specification Error," *Econometrica* (47:1979, pp. 153-161.
Hosmer, D., and S. Lemeshow. *Applied Logistic Regression*, John Wiley Sons, Inc., Hoboken, 2000.
Huergo, E. "The Role of Technological Management as a Source of Innovation: Evidence from Spanish Manufacturing Firms," *Research Policy* (35:9), 2006, pp. 1377.
IBM Corporation. "The New Voice of the CIO," 2009, .
Jarvis, C., S. MacKenzie, and P. Podsakoff. "A Critical Review of Construct Indicators and Measurement Model Misspecification in Marketing and Consumer Research," *Journal of Consumer Research* (30:2), 2003, pp. 199.
Johnson, A., and A. Lederer. "The Effect of Communication Frequency and Channel Richness on the Convergence between Chief Executive and Chief Information Officers," *Journal of Management Information Systems* (22:2), 2005, pp. 227.
Jones, M., C. S. Taylor, and B. Spencer. "The CEO/CIO Relationship Revisited: An Empirical Assessment of Satisfaction with IS," *Information & Management* (29:3), 1995, pp. 123.
Joshi, K. D., L. Chi, A. Datta, and S. Han. "Changing the Competitive Landscape: Continuous Innovation through IT-Enabled Knowledge Capabilities," *Information Systems Research* (21:3), 2010, pp. 472.
Jung, D., C. Chow, and A. Wu. "The Role of Transformational Leadership in Enhancing Organizational Innovation: Hypotheses and some Preliminary Findings," *The Leadership Quarterly* (14:4), 2003, pp. 525.
Karahanna, E., and R. Watson. "Information Systems Leadership," *IEEE Transactions on Engineering Management* (53:2), 2006, pp. 171-176.
Karimi, J., Y. Gupta, and T. Somers. "The Congruence between a Firm's Competitive Strategy and Information Technology Leader's Rank and Role," *Journal of Management Information Systems* (13:1), 1996, pp. 63.
Kashmiri, S., and V. Mahajan. "What's in a Name? an Analysis of the Strategic Behavior of Family Firms," *International Journal of Research in Marketing* (27), 2010, pp. 271-280.
Kearns, G. S., and A. L. Lederer. "The Effect of Strategic Alignment on the use of IS-Based Resources for Competitive Advantage," *The Journal of Strategic Information Systems* (9:4), 2000, pp. 265.
Kearns, G. S., and R. Sabherwal. "Antecedents and Consequences of Information Systems Planning Integration," *IEEE Transactions on Engineering Management* (54:4), 2007, pp. 628.
Keeble, D. "Small Firms, Innovation and Regional Development in Britain in the 1990s," *Regional Studies* (31:3), 1997, pp. 281-293.
Kennedy, P. *A Guide to Econometrics.*, Blackwell Publishing2008.
King, W. "It Strategy and Innovation - Including the CIO in Top Management," *Information Systems Management* (25:2), 2008, pp. 188-189.
Kleis, L., P. Chwelos, R. Ramirez, and I. Cockburn. "Information Technology and Intangible Output: The Impact of IT Investment on Innovation Productivity," *Information Systems Research,* (23:1), 2012, pp. 42-59.

Koellinger, P. "The Relationship between Technology, Innovation, and Firm Performance -- Empirical Evidence from e-Business in Europe." *Research Policy* (37:8), 2008, pp. 1317.

Kohli, R., and V. Grover. "Business Value of IT: An Essay on Expanding Research Directions to Keep Up with the Times," *Journal of the Association for Information Systems* (9:1), 2008, pp. 23-39.

Kohli, R., and N. Melville. "Learning to Build an IT Innovation Platform," *Communications of the ACM* (52:8), 2009, pp. 122-126.

Kulp, S., H. Lee, and E. Ofek. "Manufacturer Benefits from Information Integration with Retail Customers," *Management Science* (50:4), 2004, pp. 431.

Law, C., and E. Ngai. "ERP Systems Adoption: An Exploratory Study of the Organizational Factors and Impacts of ERP Success," *Information & Management* (44:4), 2007, pp. 418.

Lawrence, C., and H. Palmer. "Heuristics, Hilary Clinton, and Health Care Reform," *Annual National Meeting of the Midwest Political Science Association, Chicago,* 2002.

Lederer, A. L., and A. L. Mendelow. "The Impact of the Environment on the Management of Information Systems," *Information Systems Research* (1:2), 1990, pp. 205-222.

Leifer, R., and A. Delbecq. "Organizational/environmental Interchange: A Model of Boundary Spanning Activity," *The Academy of Management Review* (3:000001), 1978, pp. 40.

Leiponen, A., and C. Helfat. "Innovation Objectives, Knowledge Sources, and the Benefits of Breadth," *Strategic Management Journal* (31:2), 2010, pp. 224-236.

Li, Y., C. Tan, H. Teo, and B. Tan. "Innovative Usage of Information Technology in Singapore Organizations: Do CIO Characteristics make a Difference?" *IEEE Transactions on Engineering Management* (53:2), 2006, pp. 177.

Lindell, M., and D. Whitney. "Accounting for Common Method Variance in Cross-Sectional Research Designs," *Journal of Applied Psychology* (86:1), 2001, pp. 114.

Long, J., and J. Freese. *Regression Models for Categorical Dependent Variables using Stata*, College Station, Tex., Stata Press, 2003.

Luftman, J., and R. Kempaiah. "Key Issues for IT Executives 2007," *MIS Quarterly Executive* (7:2), 2008, pp. 99-112.

Madhavan, R., and R. Grover. "From Embedded Knowledge to Embodied Knowledge: New Product Development as Knowledge Management," *Journal of Marketing* (62:4), 1998, pp. 1.

Malhotra, N., S. Kim, and A. Patil. "Common Method Variance in IS Research: A Comparison of Alternative Approaches and a Reanalysis of Past Research," *Management Science* (52:12), 2006, pp. 1865.

Malone, T., J. Yates, and R. Benjamin. "Electronic Markets and Electronic Hierarchies," *Communications of the ACM,*1987, pp. 484.

McKelvey, R., and W. Zavoina. "A Statistical Model for the Analysis of Ordinal Level Dependent Variables," *The Journal of Mathematical Sociology* (4:1), 1975, pp. 103-120.

McKenney, J., R. Mason, and D. Copeland. "Bank of America: The Crest and Trough of Technological Leadership," *MIS Quarterly* (21:3), 1997, pp. 321.

Melville, N., V. Gurbaxani, and K. Kraemer. "The Productivity Impact of Information Technology Across Competitive Regimes: The Role of Industry Concentration and Dynamism," *Decision Support Systems* (43:1), 2007, pp. 229-242.

Melville, N., K. Kraemer, and V. Gurbaxani. "Review: Information Technology and Organizational Performance: An Integrative Model of IT Business Value," *MIS Quarterly* (28:2), 2004, pp. 283-322.

Mithas, S., M. S. Krishnan, and C. Fornell. "Why do Customer Relationship Management Applications Affect Customer Satisfaction?" *Journal of Marketing* (69:4), 2005, pp. 201.

Mitra, S., V. Sambamurthy, and G. Westerman. "Measuring IT Performance and Communicating Value," *MIS Quarterly Executive* (10:1), 2011, pp. 47-59.

Molina-Morales, F., and M. Martinez-Fernandez. "Too Much Love in the Neighborhood can Hurt: How an Excess of Intensity and Trust in Relationships may Produce Negative Effects on Firms," *Strategic Management Journal* (30:9), 2009, pp. 1013.

Mooney, J., V. Gurbaxani, and K. Kraemer. "A Process Oriented Framework for Assessing the Business Value of Information Technology," *The DATA BASE for Advances in Information Systems* (27:2), 1996, pp. 68-81.

Nambisan, S. "Information Systems as a Reference Discipline for New Product Development," *MIS Quarterly* (27:1), 2003, pp. 1-18.

Pavlou, P. A., and O. A. El Sawy. "From IT Leveraging Competence to Competitive Advantage in Turbulent Environments: The Case of New Product Development," *Information Systems Research* (17:3), 2006, pp. 198-227.

Peppard, J., C. Edwards, and R. Lambert. "Clarifying the Ambiguous Role of the CIO," *MIS Quarterly Executive* (10:1), 2011, pp. 31-44.

Peppard, J. "Bridging the Gap between the IS Organization and the Rest of the Business: Plotting a Route," *Information Systems Journal* (11:3), 2001, pp. 249-270.

Peppard, J. "The Conundrum of IT Management," *European Journal of Information Systems* (16:4), 2007, pp. 336-345.

Podsakoff, P., and D. Organ. "Self-Reports in Organizational Research - Problems and Prospects," *Journal of Management* (12:4), 1986, pp. 531.

Porter, M., and M. Sakakibara. "Competition in Japan." *The Journal of Economic Perspectives* (18:1), 2004, pp. 27.

Powell, T. C., and A. Dent-Micallef. "Information Technology as Competitive Advantage: The Role of Human, Business, and Technology Resources," *Strategic Management Journal* (18:5), pp. 375-405.

Prahalad, C. K., and M. S. Krishnan. *The New Age of Innovation- Driving Co-Created Value through Global Networks*, McGraw-Hill, New York, 2008.

Prahalad, C. K., and V. Ramaswamy. *The Future of Competition: Co-Creating Unique Value with Customers*, Harvard Business School Pub., Boston, Mass., 2004.

Preston, D., D. Chen, and D. Leidner. "Examining the Antecedents and Consequences of CIO Strategic Decision-Making Authority: An Empirical Study," *Decision Sciences* (39:4), 2008, pp. 605.

Preston, D. S., E. Karahanna, and F. Rowe. "Development of Shared Understanding between the Chief Information Officer and Top Management Team in U.S. and French Organizations: A Cross-Cultural Comparison," *IEEE Transactions on Engineering Management* (53:2), 2006, pp. 191-206.

Raghunathan, B., and T. Raghunathan. "Relationship of the Rank of Information Systems Executive to the Organizational Role and Planning Dimensions of Information Systems," *Journal of Management Information Systems* (6:1), 1989, pp. 111-126.
Rai, A., R. Patnayakuni, and N. Patnayakuni. "Technology Investment and Business Performance," *Communications of the ACM* (40:7), 1997, pp. 89.
Ravichandran, T., and C. Lertwongsatien. "Effect of Information System Resources and Capabilities on Firm Performance: A Resource-Based Perspective," *Journal of Management Information Systems* (21:4), 2005, pp. 237-276.
Ray, G., W. Muhanna, and J. Barney. "Information Technology and the Performance of the Customer Service Process: A Resource Based Analysis," *MIS Quarterly* (29:4), 2005, .
Ray, G., D. Wu, and P. Konana. "Competitive Environment and the Relationship between IT and Vertical Integration," *Information Systems Research* (93:4), 2009, pp. 585.
Reich, B., and I. Benbasat. "Factors that Influence the Social Dimension of Alignment between Business and Information Technology Objectives " *MIS Quarterly* (24:1), 2000, pp. 81-113.
Rockart, J. F., L. Ball, and C. Bullen. "Future Role of the Information Systems Executive," *MIS Quarterly* (6:1982, pp. 1-14.
Sambamurthy, V., V. Grover, and A. Bharadwaj. "Shaping Agility through Digital Options: Reconceptualizing the Role of Information Technology in Contemporary Firms," *MIS Quarterly* (27:2), 2003, pp. 237.
Sasidharan, S., J. Wu, D. Pearce, G. Kearns, and A. Lederer. "The Role of Convergence in Information Systems and Business Planning," *Journal of International Technology and Information Management* (15:3), 2006, pp. 1-18.
Scherer, F.M. " Firm Size, Market Structure, Opportunity, and the Output of Patented Inventions." *The American Economic Review* (55:5), 1965, pp. 1097-1125.
Shaver, J. M. "Accounting for Endogeneity when Assessing Strategy Performance: Does Entry Mode Choice Affect FDI Survival?" *Management Science* (44:4), 1998, pp. 571.
Smaltz, D., V. Sambamurthy, and R. Agarwal. "The Antecedents of CIO Role Effectiveness in Organizations: An Empirical Study in the Healthcare Sector," *IEEE Transactions on Engineering Management* (53:2), 2006, pp. 207.
Sobol, M., and G. Klein. "Relation of CIO Background, IT Infrastructure, and Economic Performance," *Information & Management* (46:5), 2009, pp. 271.
Sorensen, J., and T. Stuart. "Aging, Obsolescence, and Organizational Innovation." *Administrative Science Quarterly* (45:2), 2000, pp. 81.
Stephens, C., W. Ledbetter, A. Mitra, and F. N. Ford. "Executive Or Functional Manager? the Nature of the CIO's Job," *MIS Quarterly* (16:4), 1992, pp. 449.
Swanson, E. B., and N. Ramiller. "Innovating Mindfully with Information Technology," *MIS Quarterly* (28:4), 2004, pp. 553.
Swanson, E. B. "Information Systems Innovation among Organizations." *Management Science* (40:9), 1994, pp. 1069.
Tallon, P., K. Kraemer, and V. Gurbaxani. "Executives' Perceptions of the Business Value of Information Technology: A Process-Oriented Approach," *Journal of Management Information Systems* (16:4), 2000, pp. 145.

Tanriverdi, H. "Information Technology Relatedness, Knowledge Management Capability, and Performance of Multibusiness Firms," *MIS Quarterly* (29:2), 2005,.
Tansley, D., C. Loughran, C. Edwards, R. Lambert, and J. Peppard. "Realizing Value from a CIO: Navigating the Silicon Ceiling," *Deloitte LLP and Cranfield University Report,* 2008, pp. 1-16.
Tarafdar, M., and S. Gordon. "Understanding the influence of Information Systems Competencies on Process Innovation: A Resource-Based View," *Journal of Strategic Information Systems* (16:2007, pp. 353-392.
Teo, T., C. Ranganathan, S. Srivastava, and J. Loo. "Fostering IT-Enabled Business Innovation at YCH Group," *MIS Quarterly Executive* (6:4), 2007, pp. 211-223.
Thompson, V. "Bureaucracy and Innovation," *Administrative Science Quarterly* (10:1), 1965.
Tsai, W., and S. Ghoshal. "Social Capital and Value Creation: The Role of Intrafirm Networks." *Academy of Management Journal* (41:4), 1998, pp. 464-476.
Tushman, M. "Special Boundary Roles in Innovation Process," *Administrative Science Quarterly* (22:4), 1977, pp. 587-605.
UCLA: Academic Technology Services, Statistical Consulting Group. "Regression with Stata. (Http://www.Ats.Ucla.edu/stat/stata/webbooks/reg/chapter2/statareg2.Htm),".
Van de Ven, W., and B. Van Praag. "The Demand for Deductibles in Private Health Insurance. A Probit Model with Sample Selection," *Journal of Econometrics* (17:2), 1981, pp. 229-252.
Veugelers, R., and B. Cassiman. "Make and Buy in Innovation Strategies: Evidence from Belgian Manufacturing Firms," *Research Policy* (28:1), 1999, pp. 63.
von Hippel, E. *The Sources of Innovation*, Oxford University Press, New York, 1988.
Wade, M., and J. Hulland. "Review: The Resource-Based View and Information Systems Research: Review, Extension, and Suggestions for Future Research," *MIS Quarterly* (28:1), 2004, pp. 107.
Walsh, K. "IT Innovations that Generate Revenue and Get You More Customers," http://www.cio.com/article/print/127651 , (2010:5), 2007.
Ward, J., and J. Peppard. "Reconciling the IT/business Relationship: A Troubled Marriage in Need of Guidance," *Journal of Strategic Information Systems* (5:1), 1996, pp. 37-65.
Watson, R. T. ""Influences on the IS Manager's Perceptions of Key Issues: Information Scanning and the Relationship with the CEO"." *MIS Quarterly* (14:2), 1990, pp. 217.
Watts, S., and J. C. Henderson. "Innovative IT Climates: CIO Perspectives," *Journal of Strategic Information Systems* (15:2006, pp. 125-151.
Wheeler, B. C. "NEBIC: A Dynamic Capabilities Theory for Assessing Net-Enablement," *Information Systems Research* (13:2), 2002, pp. 125.
Willcocks, L., and R. Sykes. "The Role of the CIO and IT Function in ERP," *Communications of the ACM* (43:4), 2000, pp. 32-38.
Wu, J., Y. Chen, and V. Sambamurthy. "The Impacts of BTM Capability and CIO Role Effectiveness on Firms' Information Technology Assimilation: An Empirical Study," *Proceedings of the International Conference on Information Systems,*2008, .
Ye, F., and R. Agarwal. "Strategic Information Technology Partnerships in Outsourcing as a Distinctive Source of Information Technology Value: A Social Capital Perspective," *Proceedings of the ICIS,* 2003.

Appendix 1

Table A1: Variables				
Concept	**Variable**	**Description**	**Scale**	**Method of Measurement**
Propensity for IT-enabled Business Innovation	*Innov*	Has your organization sought to patent, trademark, or copyright any IT-driven business processes, products, or services in the past 12 months? Yes/No	Binary	Binary
CIO's involvement in Business Strategy	*CIOBusStratInvov*	How involved is your CIO in making decisions about business strategy for your company? Highly involved, Very involved, Somewhat involved, Not at all involved	Ordinal	4-level ordinal variable (Range: 0 to 3)
CIO-CEO Reporting Structure	*CIOCEOReport*	To whom does the CIO of your organization report? CEO, CTO, CFO (Chief Financial Officer),COO (Chief Operating Officer),Other Senior Corporate Executive, Line-of-Business Executive, Other.	Binary	Binary
CIO's interaction with customers	*CIOCustomerInteract*	How often does your CIO meet with your company's most important customers? Monthly/more frequently, Quarterly, Bi-annually, Annually, Our CIO does not meet with customers	Ordinal	5-level ordinal variable (Range: 0 to 4)
CIO's involvement in New Product Development	*CIONewProdInvov*	In what ways is your CIO involved in developing new products for your company? (Choose ALL that apply.) (1) Involved in the conception of new products (2) Involved in articulating the processes needed to develop new products (3) Involved in the systems and support mechanisms for producing products (4) All of the above (5) Not involved with new product development at all	Composite	Count of the number of items chosen among (1), (2), and (3). (4) and (5) were also considered for calculation. (Range: 0 to 3)
Proxy for IT innovativeness	*ITNewProjects*	What percentage of your organization's projected worldwide IT budget, including capital and operating expenses, is devoted to new projects (as opposed to ongoing maintenance)?	Continuous (Percentage)	Unidimensional
IT R&D Intensity	*ITR&DIntensity*	What percentage of your organization's projected 2008 worldwide IT budget, including capital and operating expenses, is devoted to Research and Development (not including salaries)?	Continuous (Percentage)	Unidimensional
IT Intensity	*ITIntensity*	What percentage of your company's worldwide annual sales revenue (for last fiscal year) did its total worldwide IT budget represent?	Continuous (Percentage)	Unidimensional

Chapter 3

IT-enabled Business Innovation and Customer-centricity: The Role of Web 2.0 Technologies and Service-Oriented Architecture

3.1. Introduction

As discussed in Chapter 2, IT has evolved from merely providing efficiency benefits to enabling strategic and innovation value (Bardhan et al. 2008; Joshi et al. 2010; Kearns and Lederer 2000; Kleis et al. 2012; Kohli and Melville 2009; Pavlou and Sawy 2006; Sambamurthy et al. 2003). An emerging set of information technologies – Web 2.0 technologies- potentially present new opportunities for firms to leverage the innovative and strategic capabilities of IT. Broadly, Web 2.0 technologies comprise blogs, wikis, social networks, and other such technologies which facilitate online social interactions and user-generated content (O'Reilly 2005). These technologies have emerged to enable the transformation of the Internet towards greater participation by users. The approach to development of content is transitioning from being owned and protected, to being developed through participation in a fluid, contextual manner through collaboration (Sawhney et al. 2005). The interactive, dynamic, and unstructured nature of Web 2.0 technologies makes them different from traditional enterprise technologies (McAfee 2006; Parameswaran and Whinston 2007a).

There is considerable anecdotal evidence about the fruitful use of Web 2.0 technologies in business (Cook 2008; McAfee 2006). For example, deployment of Web

2.0 technologies at Wachovia (McDougall 2008) and Philips (Burnham 2010) enabled employees to better connect and collaborate with each other. IBM uses blogs to boost productivity and profits (Orr 2004), and harnesses social networking technologies to facilitate collaboration for innovation (Majchrzak et al. 2009). These and other real-world examples suggest the strong potential of Web 2.0 technologies to change the way how work is done (Cook 2008). Nevertheless, despite anecdotal appreciation of the role of Web 2.0 technologies in business, skepticism about their business value has also been widespread. Many Chief Information Officers (CIOs) fear that Web 2.0 technologies may create information overload (Parameswaran and Whinston 2007a) and increase the time spent by employees on non-work related tasks, thus hampering productivity. There is a school of thought that Web 2.0 technologies are disorganized, anarchic, and threatening to the controlled deployment of IT in support of established, structured business processes. There is also uncertainty about accuracy of information in Web 2.0, concerns over security and privacy (Murugesan 2007), and a lack of clear business benefits (Lai and Turban 2008).

This chapter examines the relationship between the business use of Web 2.0 technologies and IT-enabled business capabilities of firms: firm propensity for IT-enabled business innovation and IT-enabled customer-centricity. We seek to address the following two research questions in the context of the use of Web 2.0 technologies in business: *1) Is there an association between the use of Web 2.0 technologies and a firm's propensity for IT-enabled business innovation and IT-enabled customer-centricity? If so, how?;* and *2) How can firms better leverage the capabilities of Web 2.0 technologies?*

As discussed earlier (Chapter 1), drawing upon prior IS research (e.g., Agarwal and Sambamurthy 2002; Ye and Agarwal 2003), we refer to IT-enabled business innovation as ‘new products, processes, or services developed by a firm through the application of IT’.[29] Next, we refer to *customer-centricity* as that characteristic of the business that makes the needs of “customers as the starting point for planning new products and services or improving existing ones” (Sheth et al. 2000; Wagner and Majchrzak 2006). Customer-centricity is a key source of competitive advantage (Shah et al. 2006) and is an important performance metric for marketing research. The marketing literature identifies “ensuring customer-relevant innovation” as an important research priority (Kristensen et al. 2008, p. 475). We refer to ‘*IT-enabled customer-centricity*’ as the use of IT to support customer-oriented business capabilities. For example, a retail bank can use IT to introduce new services for its customers and to integrate data, systems, and processes across different product lines so that relevant, up-to-date customer information can be shared with customer-facing employees. We hypothesize a positive association between the use of Web 2.0 technologies by firms and firms’ propensity for IT-enabled business innovation and IT-enabled customer-centricity. We then argue for an important role of a services-oriented architecture (SOA) in moderating these relationships. Finally, we propose that improved information integration in the firm will mediate these relationships. We test our propositions on a large sample of public U.S. firms across industries.

[29] This notion of IT-enabled business innovation in terms of new products, processes, and services (our dependent variable) is, by definition, quite different from the adoption of Web 2.0 technologies (our independent variable). Furthermore, this distinction was also evident in my discussion with ten CIOs. When I discussed with the ten CIOs their understanding of IT-enabled business innovation, none of them mentioned Web 2.0 technologies under the definition of IT-enabled business innovation. I thank Dr. Nigel Melville for motivating this discussion and providing related insightful explanation.

We find that firms that use Web 2.0 technologies are more likely to derive business innovation value from IT and are more likely to be customer-centric in their use of IT. Furthermore, a flexible IT architecture (SOA) positively moderates the relationship between Web 2.0 technology use and IT-enabled customer-centricity. We also find that improved integration partially mediates the Web 2.0-innovation relationship and fully mediates the Web 2.0-customer centricity relationship.

The contributions of this study are four-fold. First, it provides empirical evidence of a positive association between IT and the propensity for business capabilities of innovation and customer-centricity. Despite widespread recognition of business innovation as a source of competitive advantage and the need for IT to provide firms with innovation capabilities, IS research has paid only limited attention to business innovation as a potential performance outcome of IT (Han and Ravichandran 2006; Joshi et al. 2010; Kleis et al. 2012; Sambamurthy et al. 2003). Second, to the best of my knowledge, this is the first large-sample empirical assessment of the often-questioned and heretofore anecdotal role of Web 2.0 technologies in business. Prior research has suggested the need to examine whether and how Web 2.0 technologies may directly or indirectly impact innovation outcomes (Joshi et al. 2010, p. 492). Third, we empirically demonstrate a mechanism linking Web 2.0 technologies to the propensity for IT-enabled business innovation and customer-centricity via improved integration. Finally, we provide empirical evidence of complementary synergies between IT applications (Web 2.0) and IT infrastructure (SOA) towards enabling business capabilities, a result consistent with related findings from prior research (Tanriverdi 2006; Zhu 2004).

The remainder of this chapter proceeds as follows. Section 3.2 reviews the related literature. Theory and hypotheses are presented in Section 3.3. Section 3.4 describes our research design and methodology, and Section 3.5 presents the study results. In Section 3.6, we discuss contributions and limitations of the study, and suggestions for future research. We conclude in Section 3.7.

3.2. Literature Review

Three streams of literature are relevant to our study. The first research stream pertains to business innovation and draws from the strategic management and IS literatures. The second research stream relates to the relatively nascent academic literature and largely anecdotal discourse on Web 2.0 technologies in business. The third literature stream is the marketing and IS literature related to technology-enabled customer capabilities. Each research stream is briefly reviewed below.

3.2.1. Literature on Business Innovation

As earlier noted (Chapter 2), it is evident from reviews of the innovation literature (Ahuja et al. 2008; Gilbert 2006) that IS capabilities have not been extensively studied as drivers of business innovation. However, IS capabilities have significant potential and capacity to shape the business processes, products, and services of firms (Fichman 2004; Swanson 1994). In the IS literature, the effect of IT on business innovation has been captured more recently in some studies. It has been found that IT investments complement a firm's investments in R&D and can contribute to business innovation (Cherian et al. 2009; Han and Ravichandran 2006; Kleis et al. 2012). IT-enabled absorptive capacity has been found to have a positive effect on firm innovation (Joshi et al. 2010). Prior IS research has also suggested mechanisms by which IT can facilitate business innovation such as through improved knowledge management capabilities (Alavi and Leidner 2001), co-ordination and collaboration (Nambisan 2003), greater IS-business linkages (Gordon and Tarafdar 2007), and a greater ability to manage product development (Nambisan 2003; Pavlou and El Sawy 2006). IT can also lessen the cost of product development by reducing product cycle time and improving product quality (Banker et al. 2006). Several aspects of the management literature on innovation can be considered closely related to some distinguishing characteristics of Web 2.0 technologies. For example, prior research alludes to the key role of openness (Pierce and Delbecq 1977), informal communications (Brown and Eisenhardt 1997), and social interactions (Tsai 2002; Tsai and Ghoshal 1998) in enabling firm innovation.

3.2.2. Literature on Web 2.0 in Organizations

The term 'Web 2.0' was coined to refer to Internet-based technologies - such as wikis, blogs and social networking sites - that facilitate user-generated content and online interactions among users (O'Reilly 2005). Web 2.0 technologies are widely argued to have changed the way in which content is created on the Web and the way in which people communicate online. Web 2.0 technologies have been espoused to have potential in the field of education, in the research process (Kane and Fichman 2009), and in politics (Wattal et al. 2010).

In the business context, McAfee (2006) emphasized the potential of Web 2.0 technologies and identified six critical characteristics of Web 2.0 technologies that provide business capabilities. These characteristics are the ability of Web 2.0 technologies to provide capabilities of search, linking, authoring, tagging, extension, and signals (McAfee 2006). Using a case-study approach, Corso et al. (2008) suggested that business models based on Web 2.0 are driven by the need for firms to be more social, open, and adaptive. It has been argued that Web 2.0 fosters communication and collaboration which extend beyond geographical and organizational barriers (Lai and Turban 2008). Parameswaran and Whinston (2007a; 2007b) provide a good overview of social computing[30] and portray new opportunities for academic research to study forms of collaboration enabled by Web 2.0 platforms. These collaboration platforms help to harness the power of crowds through the "co-generation" of content across the enterprise (Majchrzak et al. 2009, p. 1; Raman and McAfee 2009). In a study based on interviews of bloggers, Fun and Wagner (2008) examine the behavior patterns of four types of bloggers and suggest that Web 2.0 technologies could have a significant impact on organizations. Paroutis and Saleh (2009) also examine the use of Web 2.0 technologies in the organizational context, focusing on the antecedents and motivations of user participation in Web 2.0 platforms. They find that history, outcome expectations, management support, and trust are key determinants of knowledge sharing in organizational Web 2.0 platforms. In the context of online communities, Bateman et al. (2010) find that the types of commitment of individuals to their online communities predict their behavior on these communities. Demographic characteristics such as age and managerial influences have also been linked to contributions of individuals to blogs in corporate environments (Wattal et al. 2009). In the context of social bookmarking use by individuals in a services firm, Gray et al. (2011) find that individuals whose networks bridge more structural holes are likely to be more innovative.

---

[30] 'Social computing' is another commonly used term to describe 'Web 2.0' (Parameswaran and Whinston 2007a). We use the terms 'social computing' and 'Web 2.0' interchangeably.

Other scholars have suggested that Web 2.0 technologies can have business value. For example, social networks have been posited to potentially play a significant role in helping firms manage knowledge (McKeen and Smith 2007). Social networks can enhance the value of business networks by increasing social interactions and stimulating collaboration among users (Lea et al. 2006). More recently, there is growing academic interest in how social networking and the Web 2.0 phenomena can provide business value by improving business processes and knowledge-sharing (Ali-Hassan and Nevo 2009; Boateng et al. 2009; Kane and Fichman 2009; Kettles and David 2008; Nath et al. 2010).

3.2.3. Literature on Technology-enabled Customer-related Capabilities

The second business capability that we examine in this study is IT-enabled customer-centricity, which fundamentally relates to the marketing literature on customer-related capabilities. The marketing literature places significant emphasis on the need for firms to improve their customer-related capabilities such as customer satisfaction (Oliver 1999), customer loyalty (Kumar and Shah 2004), and customer service (Parasuraman and Grewal 2000). The basic philosophy of customer-centricity is to have a focus on serving customers and making customers the starting point for decisions (Shah et al. 2006). Researchers have argued that even though customer-centricity can significantly improve firm performance (Singh and Ranchhod 2004), customer-centricity is difficult to build and maintain (Hart 1999). Some organizational mechanisms and characteristics which have been posited to improve customer-centricity are a horizontal organizational structure, open culture, cross-functional processes, and customer-oriented financial metrics and incentives (Shah et al. 2006).

Studies at the intersection of IS and marketing have addressed how IT can improve a firm's customer-related capabilities. For example, Mithas et al. (2005) found a positive link between the use of Customer Relationship Management (CRM) applications and satisfaction of the firm's customers; this link was mediated by improved customer knowledge. CRM technology has also been found to moderate the role of information processes in enhancing a firm's customer-relationship performance (Jayachandran et al. 2005). The level of IT integration in a firm can positively influence the extent of the firm's IT-enabled customer focus (Karimi et al. 2001). IT-enabled services have also been found to improve customer satisfaction (Krishnan et al. 1999). Researchers have recognized that information management and IT capabilities are key enablers of effective customer-related capabilities (Day 2003; Payne and Frow 2005; Ray et al. 2005).

3.2.4. Synthesis of Related Literature Streams

Our preceding reviews of the three related literature streams reveal gaps in our collective knowledge. First, while several authors have touted the perceived benefits of Web 2.0 technologies in business (e.g., Cook 2008; McAfee 2006), these claims are based largely on anecdotal evidence and are not supported by empirical research. As noted by prior researchers (Ali-Hassan and Nevo 2009; Parameswaran and Whinston 2007a), the relationship between Web 2.0 technologies and organizational performance remains, in general, understudied. Moreover, as mentioned earlier, doubts persist among CIOs about the value of Web 2.0 technologies for business. Second, as discussed earlier and also indicated by prior researchers (Joshi et al. 2010), there is limited theoretical and empirical research relating IT capabilities to business innovation. Our study helps to bridge these gaps by focusing on the relationship between the use of Web 2.0

technologies by firms and firms' propensity for two business capabilities (IT-enabled business innovation and IT-enabled customer centricity) which have heretofore received limited attention in the IS literature. We recognize that the path from Web 2.0 to business innovation and customer-centricity is a long leap, and we begin to bridge this connection by specifically focusing on the IT-enabled nature of these capabilities. That is, we focus on IT-enabled business innovation as opposed to business innovation in general. Similarly, we examine whether Web 2.0 technologies may enable a firm to be more customer-centric in its use of IT. Henceforth, in this chapter, we use the shorter terms 'innovation' and 'customer-centricity' to refer to 'IT-enabled business innovation' and 'IT-enabled customer-centricity' respectively.

3.3. Theory and Hypotheses Development

Prior research has drawn from theories related to the empowerment of people, the access to ideas, and the ability to collaborate. One such theory is the theory of dynamic organizational knowledge creation (Nonaka 1994) which describes organizational knowledge creation as a dynamic process requiring continuous interaction between tacit and explicit knowledge. The theory is relevant and applicable to innovation because, as argued by prior researchers (Fichman and Kemerer 1997; King et al. 1994; Massey et al. 2002), the management and creation of organizational knowledge are important for innovation and organizational performance (Sabherwal and Sabherwal 2005; Schultze and Leidner 2002). According to the theory of dynamic organizational knowledge creation, social interaction among people enables knowledge of an individual to be transformed into new knowledge through the four modes of inter-conversion between tacit and explicit knowledge. These four modes are socialization (tacit to tacit), combination (explicit to explicit), externalization (tacit to explicit), and internalization (explicit to tacit). Moreover, Nonaka (1994, p. 15) goes on to argue that "although ideas are formed in the minds of individuals, interaction between individuals typically plays a critical role in developing these ideas. That is, communities of interaction contribute to the amplification and development of new knowledge". In line with this theory, researchers have proposed that the exposure of ideas to others is a powerful mechanism by which ideas can be co-developed into new innovations (Markova and Foppa 1990; Prahalad and Ramaswamy 2004).

Based on the foregoing arguments, we posit that information technologies that can facilitate information dissemination among people and interaction among forms of knowledge can, in principle, enhance innovation through the creation of new knowledge. Drawing on conceptual arguments in prior research (Boateng et al. 2009; Hu et al. 2007), we ground our study in the theory that Web 2.0 technologies have the ability to facilitate innovation through dynamic organizational knowledge creation.

First, Web 2.0 technologies can facilitate socialization. The easy-to-use and interactive nature of Web 2.0 technologies encourages online social interactions (Tredinnick 2006) because they make it easy to create informal communities and connections. Social interactions can be channels of information and resource flows, and are important in the process of innovation (Tsai and Ghoshal 1998). Blogs, wikis, and social networks provide platforms that stimulate informal collaborative interactions and provide a mechanism to reveal patterns among the aggregation of contributions by individual users. Knowledge from collaborative conversations can be effectively captured and shared using Web 2.0 technologies. In the context of innovation, the individual skills, know-how, experiences, and resourcefulness of individuals to solve issues and deliver innovative solutions are often tacit. Using Web 2.0 technologies, firms can leverage the tacit knowledge of their employees. This argument is consistent with those in prior research that Web documents can act as a "facilitator in the knowledge management process by leveraging tacit knowledge in an intra-organizational web" (Stenmark 2001, p. 23).

Second, Web 2.0 technologies provide ways in which multiple sources of explicit knowledge can be combined to form new knowledge (combination). Web 2.0 technologies provide the ability to accumulate information from multiple sources and expand the scope of innovation resources from an internal perspective to a more open environment. Access to greater number of knowledge sources improves the likelihood of obtaining knowledge that leads to valuable innovations (Leiponen and Helfat 2010). Web 2.0 technologies help to harness unstructured information (Cash et al. 2008) and combine it with formal knowledge sources to generate new knowledge. Blogs can enable the generation of new ideas and immediate feedback from peer groups in the firm, facilitating the aggregation of content and the reuse of information in a participatory manner. Mashups can be used to collect information from multiple sources and combine them in intelligent ways (Murugesan 2007). Web 2.0 technologies also help in expertise matching. For instance, using social networks, employees can locate the right talent within the firm for specific projects. Firms can use social networks to match employee expertise and create teams. This ability to find, to connect, and to engage with subject matter experts can help generate ideas through the appropriate combination of skill sets.

Third, Web 2.0 technologies can facilitate the process of knowledge creation through externalization (conversion of tacit to explicit knowledge) and internalization (conversion of explicit to tacit knowledge). Blogs and wikis allow for flexibility and richness in their presentation and display and, when properly managed, are suitable for presenting complex ideas effectively. They allow users to link to other blogs and sources of information, and to communicate ideas from a personal perspective. The capability to link to other sources of knowledge makes it easier to draw relationships among information, creating what Nonaka (1994, p. 32) terms the "hypertext organization". The conscious and voluntary nature of knowledge sharing on Web 2.0 technology platforms increases the efficiency and quality of transformation of tacit knowledge to explicit knowledge (Hu et al. 2007). Social networking capabilities greatly enhance knowledge workers' ability to access relevant content and expertise in a business setting (Kettles and David 2008). Using blogs, employees can get quick feedback on new ideas and transform the explicit knowledge of others into their own tacit knowledge (internalization). Organizational knowledge stored in wikis can be shared by employees and applied in their personal work context; by continuous learning, experience and practice, it can be made part of their own tacit skills and know-how (Hu et al. 2007). Thus, Web 2.0 technologies facilitate the inter-conversion between tacit and explicit knowledge.

In addition to facilitating dynamic organizational knowledge creation, there are other mechanisms by which Web 2.0 technologies can foster innovative capabilities of the firm. Web 2.0 technologies enhance collaboration and promote greater engagement among employees. The democratization of access to information in Web 2.0 technologies allows users to freely express their creativity, increasing their (users') innovative capabilities. They provide open and direct communication channels which are critical to the success of innovation (Rizova 2006). Thus, Web 2.0 can enhance creativity, information sharing, and collaboration among users.

We note that while Web 2.0 technology use can potentially facilitate business innovation in general, it is more likely to facilitate *IT-enabled* business innovation in particular, for two main reasons. First, IT-enabled innovations are knowledge-intensive and are more likely to benefit from the dynamic knowledge creation capabilities of Web 2.0. Second, IT-savvy users and executives are more likely to use Web 2.0 technologies than users not savvy with IT. We therefore focus our attention on the relationship between Web 2.0 technologies and the firm's propensity for IT-enabled business innovation specifically.

In sum, we theorize that Web 2.0 technologies can facilitate the "re-configuration, re-categorization and re-contextualization" of knowledge, espoused by the theory of dynamic knowledge creation by making information more accessible (Boateng et al. 2009) to a wider group of people to work openly. Scholars have suggested that Web 2.0 technologies can increase collective wisdom useful in generating and propagating new ideas (McAfee and Brynjolfsson 2008), and reduce the time-to-market of new products and services through improved access to expertise. Consistent with these arguments, we hypothesize,

Hypothesis 1 (H1): The use of Web 2.0 technologies is positively associated with the firm's propensity for IT-enabled business innovation.

We next examine the relationship between the use of Web 2.0 technologies and the firm's propensity for IT-enabled customer-centricity. We argue for a positive relationship for the following three reasons.

First, Web 2.0 technologies can enable direct and new forms of communication between the firm and its customers (Fun and Wagner 2008; Wagner and Majchrzak 2006). For example, using blogs, managers of the firm can engage customers directly. Blogs and wikis can serve as a platform providing interactive environments where firms can co-create personalized experiences with customers (Prahalad and Krishnan 2008). For instance, Texas Instruments used a Web 2.0 based collaborative platform to allow customers to interact with other customers and staff to solve problems (Lynch 2009). Wikis can enable firms to be more customer-centric through new forms of engagement (Wagner and Majchrzak 2006), providing a broader platform for customer-related ideas to emerge. Recognizing the capabilities of Web 2.0 technologies to transform the way companies interact with customers, vendors such as SAP Inc. have begun to incorporate Web 2.0 capabilities into their CRM offerings (Kothari and Ostroff 2009).

Second, the use of Web 2.0 technologies helps firms overcome impediments and facilitate enablers of customer-centricity identified in the marketing literature. Organizational silos have been identified in the marketing literature as a major impediment to customer-centricity in firms (Jaworski and Kohli 1993; Shah et al. 2006). Web 2.0 technologies help reduce silos across the organization by opening up direct and informal communication channels. Another impediment to a customer-centric organization is the lack of collaboration and lack of cooperation within marketing and between marketing and other functions (Band and Guaspari 2003). Web 2.0 technologies can enable easier cross-functional cooperation and engagement across the organization. For example, using a wiki, sales and marketing associates at Eastern Mountain Sports were able to share insights, tips, and best sales practices throughout the organization (Neville 2007). Furthermore, organizational openness is a key enabler to sharing information about customers (Day 2003). Web 2.0 technologies such as blogs, wikis, and social networks allow for more open communications among employees in the organization. These communication channels are less prone to formal hierarchical structures and procedural bureaucracies.

Third, Web 2.0 technologies provide new sources of unstructured data which can be monitored and leveraged by the firm contextually. Analysis of unstructured data from Web 2.0 technologies can provide new insights about customers (Prahalad and Krishnan 2008). For example, by capturing customer input from blogs, service designers can reduce complaints and collectively develop solutions with their customers. Tacit knowledge from wikis and blogs can be combined to provide customer-related insights (Prahalad and Krishnan 2008).

In sum, Web 2.0 technologies provide capabilities that enable firms to understand customers better through greater access to information and new sources of unstructured data, increased organizational collaboration, and reduction of organizational silos. These capabilities enable the firm to be more customer-centric in their use of IT. Hence we hypothesize,

Hypothesis 2 (H2): The use of Web 2.0 technologies is positively associated with the firm's propensity for IT-enabled customer-centricity.

Prior management and organizations research has argued that synergistic combinations of organizational resources can significantly contribute to value creation and innovation in firms (Kogut and Zander 1992; Tsai and Ghoshal 1998). The complementary view of IS resources with other organizational resources is prevalent and well-recognized in the IS literature (Melville et al. 2004). In our study, we focus on the complementarity between Web 2.0 technologies and Services Oriented Architecture (SOA). SOA is a flexible, modular, standardized software architecture that supports the connection of various applications (Liang and Tanniru 2007; Tiwana and Konsynski 2010). In SOA, the basic element of design, development, and use of software solutions is a service (Papazoglou and Georgakopoulos 2003). SOA provides the ability to seamlessly integrate business processes across business units, customers, and partners by structuring large applications as a collection of smaller modules (Lim and Wen 2003; Mueller et al. 2010).

We posit complementarities between Web 2.0 technologies and the flexibility and interoperability of IT infrastructure, as represented by the use of SOA. First, as discussed earlier, Web 2.0 places emphasis on making use of information from a variety of data sources. The value of Web 2.0 applications is enhanced when they can be connected and integrated with other systems in the organization. For example, if a firm desires to enhance the capabilities of its sales force through mashup applications, it needs to have the ability to connect mashups to backend sales systems. When Web 2.0 technologies are connected to existing systems, knowledge workers can collaborate on information that is used as input to or output from business processes. Hence, the synergy that Web 2.0 technologies form with the firm’s technology architecture is likely to influence the extent of value creation. SOA can make Web 2.0 technologies more interoperable with other IT applications in the company, allowing firms to weave Web 2.0 technologies easily into existing business processes. Thus, the agility and flexibility provided by SOA (Choi et al. 2010) help reduce organizational silos, minimizing the barriers to effective Web 2.0 collaboration. The ability of a firm to leverage Web 2.0 technologies for innovation can therefore be enhanced when their capabilities are coupled with the flexibility and ease of connectivity provided by SOA.

Second, we argue that the ability of the firm to exploit information gained through Web 2.0 technologies and be more customer-centric in its use of IT is reinforced when the firm can adapt to the needs of its customers. This adaptability requires flexibility in business processes, which in turn requires IT systems to be flexible, responsive, and configurable to meet changing customer preferences (Liang and Tanniru 2007). Compared to traditional legacy systems, systems based on SOA are more flexible, making it easier to implement changes in a cost-effective manner (Choi et al. 2010; Prahalad and Krishnan 2008). An SOA, where customer data can be consolidated and integrated across organizational silos, can provide a single, comprehensive real-time view of a company's relationship with a customer. SOA helps to link Web 2.0 technologies with business processes and create systems and workflows that put the firm in touch with customer needs. Moreover, SOA simplifies the process of enabling applications to offer core functionalities as services that can be combined into new services (Liang and Tanniru 2007). Firms using Web 2.0 technologies are likely to be more customer-centric when their IT infrastructure is flexible and allows re-configuration of IT systems and resources to meet changing customer needs.

In sum, Web 2.0 technologies are a set of IT resources leveraging the social side of the firm. SOA represents the flexibility and interoperability of the firm's IT architecture. SOA helps to seamlessly incorporate Web 2.0 capabilities into the business environment. When the openness and transparency of Web 2.0 technologies are combined with flexibility and interoperability of an SOA-based IT infrastructure, it provides a powerful combination where Web 2.0 and SOA complement each other and support greater IT-enabled business innovation and customer-centricity. Hence, we hypothesize,

Hypothesis 3a (H3a): SOA positively moderates the relationship between the use of Web 2.0 technologies and the firm's propensity for IT-enabled business innovation.

Hypothesis 3b (H3b): SOA positively moderates the relationship between the use of Web 2.0 technologies and the firm's propensity for IT-enabled customer-centricity.

Finally, we examine the role of information integration across systems and departments in mediating the relationship between Web 2.0 technology use and IT-enabled business innovation and customer-centricity.

As argued earlier, Web 2.0 technologies provide the ability to accumulate information from multiple sources and expand the scope of innovation resources. Web 2.0 technologies help to harness unstructured information and combine it with formal knowledge sources to generate new knowledge. For example, blogs facilitate the aggregation and re-use of content. Mashups can be used to collect and combine information from multiple sources (Murugesan 2007). Moreover, SOA would complement Web 2.0 technologies in achieving integration because, as previously argued, SOA facilitates the interconnection of systems in a flexible manner.

In turn, improved integration is likely to enable greater IT-enabled innovation capability through the use of multiple sources and types of knowledge. Organizational research argues that interdepartmental separation and lack of co-ordination result in a lack of understanding and synchronization for developing new products (Dougherty 1992; Dougherty and Heller 1994). Improved integration overcomes barriers to inter-departmental co-ordination facilitating interactive learning and continuous expansion of knowledge. Knowledge accumulated from multiple diverse sources facilitates implementation of novel ideas and combination of various types of knowledge (Hurley et al. 1998). Access to greater number of knowledge sources improves the likelihood of obtaining knowledge that leads to valuable innovations (Leiponen and Helfat 2010). Information integration can also increase "firms' ability to analyze, interpret, and synthesize large volumes of data from a variety of sources to derive new insights about changing product, customer, and market preferences and conditions" (Joshi et al. 2010, p. 478). Novel linkages among customer needs, technology, and the firm's resources are facilitated by the integration of systems and information in the firm (Sethi et al. 2003). Integration across departments helps overcome problems and increases joint learning and collective action, both of which are critical for innovation (Dougherty 1992; Frishammar and Horte 2005). Cross-functional integration has been found to be beneficial for new product development (Pavlou and Sawy 2006).

Last, the marketing literature acknowledges that greater co-ordination across departments improves the market orientation of firms (Kohli and Jaworski 1990). Improved integration across departments facilitates well-coordinated decision-making and execution, thus engendering higher market orientation (Schlegelmilch and Ram

2000). Improved integration also facilitates the reduction of organizational silos and thus, greater customer-centricity (Band and Guaspari 2003; Sheth et al. 2006). For example, integration of information across departments can be greatly beneficial for sales teams in terms of delivering individual customer needs and wants.

The preceding arguments lead us to make the following hypotheses:

H4a: The relationship between use of Web 2.0 technologies and the firm's propensity for IT-enabled business innovation is mediated by improved information integration.

H4b: The interactive relationship between use of Web 2.0 technologies and SOA on the firm's propensity for IT-enabled business innovation is mediated by improved information integration.

H4c: The relationship between use of Web 2.0 technologies and the firm's propensity for IT-enabled customer-centricity is mediated by improved information integration.

H4d: The interactive relationship between use of Web 2.0 technologies and SOA on the firm's propensity for IT-enabled customer-centricity is mediated by improved information integration.

Figure 4 and Figure 5 summarize the proposed hypotheses under study.

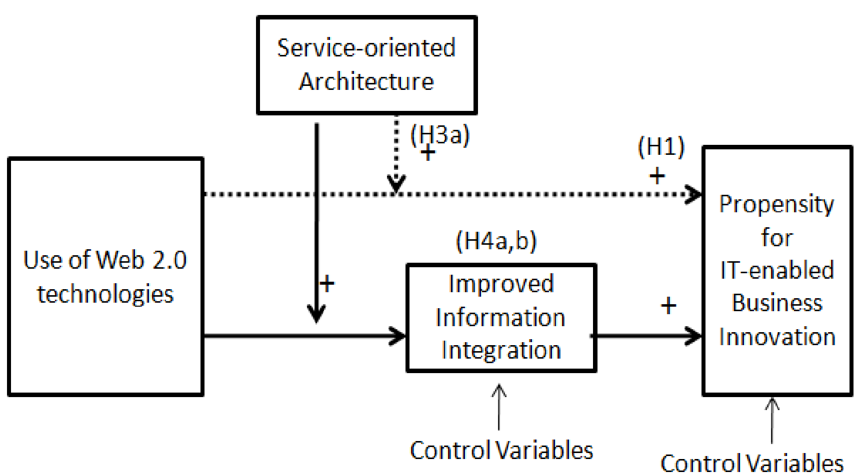

Figure 4: Web 2.0 and IT-enabled Business Innovation Model

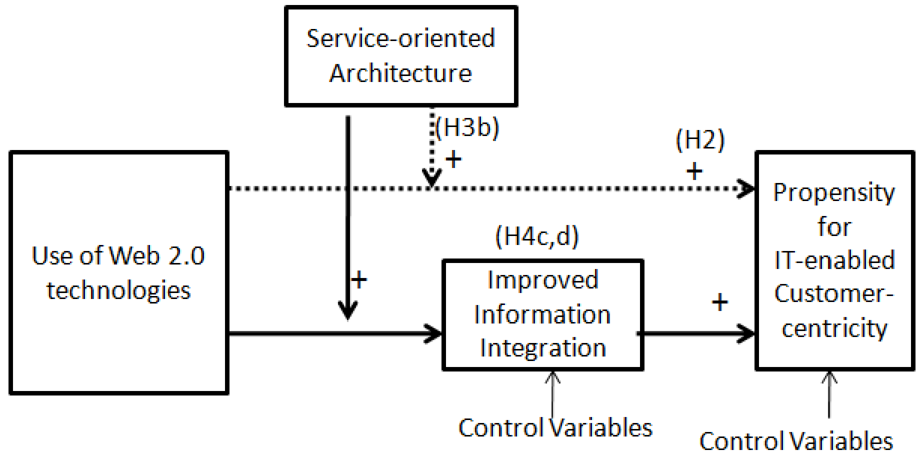

Figure 5: Web 2.0 and Customer-centricity Model

3.4. Research Design and Methodology

We obtain data for this study from *InformationWeek*, a leading, widely circulated IT publication in the United States. *InformationWeek* collected this data by surveying senior IT managers and CIOs at large U.S. firms across industries in 2008 timeframe.[31] Similar to prior research, execution of the survey to CIOs and senior IT managers is important because they are in the best position as key respondents to be knowledgeable and most informed about the IT practices of their company (Grover et al. 1998). *InformationWeek* data has also been argued to be "consistent with data from other secondary sources such as International Data Group and Bureau of Economic Analysis" (Rai et al. 1997, p. 92). *InformationWeek* data are thus considered as reliable sources of data and have been used in prior research (e.g., Bharadwaj et al. 1999; Mithas et al. 2005). We augment this data with firm-level variables from Standard and Poor's

[31] While *InformationWeek* conducts similar surveys annually, the survey questions vary from year to year. To my knowledge, the variation in surveys occurs for reasons that include technology trends, optimization of survey length for better response rate, etc. As a result, the number of questions and the actual questions vary from year to year, and several questions get dropped or started in particular years. I chose the year 2008 because that year is, to my best knowledge, the only year in which the data for all the variables of interest in my models (Figure 4 and Figure 5) are included in the survey and available to me.

Compustat database and SEC filings, and industry-level data from the U.S. Census Bureau.

3.4.1. Variables Definition

Propensity for IT-enabled business innovation (*Innov*): This is a binary variable indicating "whether the firm sought to patent, trademark or copyright any IT-driven business processes, products or services within the 12 months prior" to the survey (Appendix 2). This measure is consistent with the definition of IT-enabled firm-level innovation in the IS literature (e.g., Agarwal and Sambamurthy 2002; Ye and Agarwal 2003): 'new products, processes or services developed by a firm through the application of IT'. It is also consistent with the definition of innovation in the strategic management literature as the generation of "new ideas, processes, products or services" (Thompson 1965, p.2). Self-reported (and binary) measures of innovation have been used in prior research (Aragon-Correa et al. 2007; Georgellis et al. 2000; Huergo 2006; Keeble 1997; Koellinger 2008; Leiponen and Helfat 2010; Li et al. 2006; Molina-Moralez and Martinez-Fernandez 2009; Tsai and Ghoshal 1998; Veugellers and Cassiman 1999).

Propensity for IT-enabled customer-centricity (*CustInit*): This is the number of customer-oriented ways in which the firm planned to innovate with IT in the same year. Of eleven options, four options related to customers. These customer-related measures included 'Introduce new IT-led products for customers', 'Improve customer service', 'Improve customer experience', and 'Engage customers in new ways'. These represent the IT-supported customer-centric initiatives by the firm. We use this as a measure of the propensity of the firm for IT-enabled customer-centricity. The resultant measure used in the model is a count-based summative measure ranging from 0 to 3.

Use of Web 2.0 technologies (*Web20Appl*): This variable is a 4-item summative measure indicating the extent of the firm's deployment of Web 2.0 technologies. It includes use of Web 2.0 technologies such as 'Wikis, blogs, other social networking for internal communications', 'Wikis, blogs, other social networking for external dialog with customers, others', and 'mashups that combine Web and enterprise content in new ways'. The assessment by a single respondent of organizational use of IT has been used in prior research (Igbaria et al. 1996).

Service-Oriented Architecture (*SOA*): This is a 2-item summative measure indicating the level of SOA adoption in the firm. The items that form the index include Service-oriented architecture and Web Services applications using SOA, UDDI, and XML[32] (Kumar et al. 2007).

Improved Information (Data) Integration (*ImprovedIntegration*): This is a binary variable which indicates whether the organization has achieved improved data integration between systems or departments.

IT Intensity (*ITIntensity*): This represents the firm's IT budget as a share (percentage) of its annual sales revenue (Bardhan et al. 2006).

IT R&D Intensity (*ITR&DIntensity*): This represents the share (percentage) of the IT budget devoted to R&D. Since the dependent variables in both the estimation models are IT-driven, we control for the fraction of IT investment devoted to R&D.

Firm Size (*Size*): This is the natural log of the annual revenues of the firm. Prior research indicates that larger firms tend to have more resources with which to enhance innovation (Ahuja et al. 2008) and to pursue a customer-centric strategy (Liu 1995).

[32] UDDI and XML are technical acronyms for 'Universal Description, Discovery, and Integration' and 'Extensible Markup Language' respectively.

R&D Intensity (*R&DIntensity*): This is the ratio of R&D expenditure to sales of the firm and is obtained from Compustat.

Proxy for Prior Customer-related investments *(EncrCustRecords)*: In the customer-centricity model, to control for potential effects of prior customer-related investments in the firm (Mithas et al. 2005), we use as a proxy, an indicator of whether there is a wide deployment of encrypted customer-related records in the firm.

Proxy for Firm IT Innovativeness (*ITNewProjects*): Prior research has argued that firms which use IT for new projects are likely to be more innovative because investments in new IT systems are more likely to extend a firm's IT capabilities for innovation whereas investment in existing IT systems facilitates continued use of existing IT capabilities (Cherian et al. 2009). Therefore, to control for the extent of the firm's innovativeness in IT, we use the share of the IT budget devoted to new IT projects (as opposed to maintenance projects).

Firm age (*FirmAge*): We control for firm age (measured as the natural logarithm of the number of years since the firm was founded) to account for possible cultural differences between old and young firms that relate to the extent of innovation and customer-centricity (Huergo 2006; Kashmiri and Mahajan 2010). Prior research argues that firm age can have dual consequences for innovation: on one hand, it improves experience and efficiency in execution of organizational routines; on the other hand, it reduces the fit between organizational capabilities and environmental demands (Sorensen and Stuart 2000).

Prior Firm Performance (*ROA*): Prior research indicates that high-performing and profitable firms may be more innovative (Ahuja et al. 2008). Consistent with prior studies, we use Return on Assets (ROA), calculated as the ratio of Net income to Total Assets (obtained from Compustat for the year 2006) of the firm to control for the firm's prior profitability (Bharadwaj 2000).

Industry Dummies (*Indxx*): The propensity for innovation may vary by industry (Ahuja et al. 2008). To control for this, following prior research, industry dummies [at the 2-digit North American Industry Classification System (NAICS) level] are included, which represent the industry sector to which the firm belongs (Veugellers and Cassiman 1999).

Industry sector (*Mfg*): This indicator variable represents whether the firm's offering is primarily a good or a service, based on the NAICS classification (1 = Manufacturing; 0 = Services) (Bharadwaj et al. 2009; Mithas et al. 2005). We use this to control for the possibility that customer-centricity may be more likely if the firm's customers are more responsive to intangible factors, rather than tangible product offerings (Kashmiri and Mahajan 2010).

3.4.2. Estimation Approach

We use two empirical models. The first model (Model 1) uses *Innov* as the dependent variable to test H1 and H3a. The second model (Model 2) uses *CustInit* as the dependent variable to test H2 and H3b. We account for the potential that Web 2.0 technology use may be endogenous. More specifically, it may be argued that Web 2.0 technologies may be more likely to be adopted by particular types of firms. For example, firms that have more open cultures or flat organizational structures may be more prone to use Web 2.0 technologies. Likewise, firms with a younger workforce may be more likely to use Web 2.0 technologies than a firm with an older workforce. If the average age of the workforce and organizational culture and structures also positively impact the IT-enabled innovativeness of the firm, then the coefficient of Web 2.0 technologies in the regression of innovation on Web 2.0 technologies could be biased upwards.[33] Put differently, as organizational scholars have argued (Davis 2010, p. 705), the nature of empirical studies of organizations means that "researchers typically lack experimental control" because organizations "cannot generally be assigned to treatment and control conditions". Thus, the failure to account for potential endogenity can bias the estimates (Greene 2003).

3.4.2.1. Model 1: Propensity for IT-enabled Business Innovation

Since the dependent variable (*Innov*) is binary and the potentially endogenous variable (*Web20Appl*) is ordered, the traditional approach using the Heckman's two-step estimator to account for endogenity in cross-sectional data is not directly applicable; instead, bivariate models (bivariate ordered probit models) are preferred (Greene 2003). The bivariate model accounts for potential endogenity of Web 2.0 technology use (Greene 2003). This model enables testing whether there is correlation between unobserved (or unmeasured) factors that determine Web 2.0 use and the propensity for IT-enabled business innovation, and consequently whether bivariate estimation is necessary (Greene 2003). If such factors exist, they must be accounted for by using the bivariate model. If the correlation between error terms is statistically insignificant, separate estimation of the equations is preferable, as the bivariate model is less efficient

[33] To intuitively understand this potential bias, consider a firm with a younger workforce. Such a firm may be more likely to use Web 2.0 technologies and have a high error term u_1 in equation (i). However, because workforce age may also impact innovation, such a firm may have higher propensity for IT-enabled innovation. Thus, because of the potential correlation between the error terms, the coefficient of Web 2.0 technologies in the estimation of (ii) may be biased.

than standard probit models when the errors are uncorrelated (Bollen et al. 1995; Cameron and Trivedi 2005; Greene 2003; Lawrence and Palmer 2002).

We specify the bivariate model comprising two equations: the Web 2.0 technology use equation and the Innovation equation. Given our objective to control for endogenity of use of Web 2.0 technologies, the first equation (eqn. i) consists of *Web20Appl* regressed on predictors of innovation. The second equation (eqn. ii) consists of *Innov* as dependent variable regressed on the independent and control variables. In line with prior research, we control for IT intensity, R&D Intensity, firm size, firm age, IT R&D intensity, share of IT investment in new projects, and industry dummies.

The equations are:

$$\text{Ordered Probit } (\textit{Web20Appl}) = \alpha_{10} + \alpha_{11}\textit{ITIntensity} + \alpha_{12}\textit{R\&DIntensity} + \alpha_{13}\textit{ITR\&DIntensity} + \alpha_{14}\textit{Size} + \alpha_{15}\textit{ITNewProjects} + \alpha_{16}\textit{FirmAge} + \alpha_{17}\textit{ROA} + \alpha_{18}\textit{SearchToolsOnWeb} + \alpha_{1I}\textit{Industry} + u_1 \quad \text{(i)}$$

$$\text{Probability } (\textit{Innov}=1)=\Phi(\beta_{10}+\beta_{11}\textit{Web20Appl}+ \beta_{12}\textit{SOA} + \beta_{13}(\text{Web20Appl X SOA}) + \beta_{14}\textit{R\&DIntensity} + \beta_{15}\textit{ITIntensity} + \beta_{16}\textit{ITR\&DIntensity} + \beta_{17}\textit{Size} + \beta_{18}\text{ITNewProjects} + \beta_{19}\textit{FirmAge} + \beta_{110}\textit{ROA} + \beta_{I}\textit{Industry} + \varepsilon_1) \quad \text{(ii)}$$

where Ordered Probit (.) is the cumulative standard normal function linking the latent variable as expressed on the right-hand side to the observed ordered outcome; the βs and αs are the coefficient parameters for the respective variables; β_I is the vector of coefficients for the industry dummies; Φ denotes the standard normal cumulative distribution function; and u_1 and ε_1 are the error terms.

If the dependent variables in (i) and (ii) were both binary, the estimation approach would be the standard bivariate probit model. One of our two equations (eqn. i), however, is an ordered probit, where the dependent variable (*Web20Appl*) can take four possible values. Our model is therefore a bivariate semi-ordered probit model (Armstrong and

McVicar 2000) which is an extension of the standard bivariate probit, and a special case of the bivariate ordered probit model outlined by Weiss (1993), where both equations are ordered probits. The model is estimated by maximum likelihood.[34]

3.4.2.2. Model 2: Propensity for IT-enabled Customer-centricity

Our second empirical model consists of an ordered probit regression[35] with *CustInit* as the dependent variable. In this model, in line with prior research, we control for firm size, firm age, whether the firm's offering is primarily a good or service, IT intensity and a proxy for prior customer-related IT investments in the firm. Since our dependent variable measures the extent the firm is customer-centric in innovating with IT, we include both *ITR&DIntensity* and *ITNewProjects* as controls to control for the aggregate level of innovative IT investment. Similar to Model 1, to control for potential endogenity in the customer-centricity model, we utilize the bivariate specification. The equations are:

$$\text{Ordered Probit }(\textit{Web20Appl}) = \alpha_{10} + \alpha_{21}\textit{ITIntensity} + \alpha_{22}\textit{ITR\&DIntensity} + \alpha_{23}\textit{Size} + \alpha_{24}\textit{ITNewProjects} + \alpha_{25}\textit{FirmAge} + \alpha_{26}\textit{EncrCustRecords} + \alpha_{27}\,\textit{SearchToolsOnWeb} + \alpha_{28}\textit{Mfg} + u_2 \qquad \text{(iii)}$$

$$\text{Ordered Probit }(\textit{CustInit}) = \beta_{20} + \beta_{21}\textit{Web20Appl} + \beta_{22}\textit{SOA} + \beta_{23}(\textit{Web20Appl}\ \text{X}\ \textit{SOA}) + \beta_{24}\,\textit{ITIntensity} + \beta_{25}\textit{ITR\&DIntensity} + \beta_{26}\textit{ITNewProjects} + \beta_{27}\textit{Size} + \beta_{28}\textit{EncrCustRecords} + \beta_{29}\textit{FirmAge} + \beta_{210}\textit{Mfg} + \varepsilon_2 \qquad \text{(iv)}$$

---

[34] Technical details of the bivariate probit model are in Greene (2003), and are not repeated here for brevity. Although an exclusion restriction is not formally required for identification of the bivariate model, which is identified by the functional form, the variable *SearchToolsOnWeb* (which indicates whether the firm integrates search tools from Google or other search engines with the firm's website) aids in identification of the model (Greene 2003). Because of the ubiquitous availability of the Internet and search tools in this day and age, implementing search tools on a company website may not be a significantly relevant capability, in that it is unlikely to promote IT-enabled business innovation or customer-centricity simply on its own accord. Also, having search tools on the company website may be reflective of the company's strategy towards adopting modern Web-enabled applications like Web 2.0 technologies. The statistically significant coefficient of this variable in the Web 2.0 equation (shown in the Results section) suggests that there is unlikely to be a problem of weak identification (Bound et al. 1995).

[35] Ordered probit and ordered logit models can be used for regressions with ordinal dependent variables (Greene 2003). Using the ordered logit model gave us qualitatively similar results. We use the probit model because the bivariate form of the probit models (i.e., bivariate probit model and bivariate ordered probit model) are well-developed econometric models in the literature (Greene 2003).

where Ordered Probit (.) is the cumulative standard normal function linking the latent variable as expressed on the RHS to the observed ordered outcome; the βs and αs are the coefficient parameters for the respective variables; and u_2 and ε_2 are the error terms.

3.4.2.3. Mediation Analysis

We used the Sobel Test to assess the mediation hypotheses (Baron and Kenny 1986; Sobel 1982).This approach has been used in the IS literature to examine mediation (e.g., Bharadwaj et al. 2007; Mithas et al. 2005; Mithas et al. 2010; Ramasubbu et al. 2008). The Sobel Test of the mediating role of a variable M in the relationship between X and Y essentially consists of estimating three equations: Y= f(X, controls), M = f(X, controls), and Y = f(X, M, controls). For concluding mediation, three conditions are required to be satisfied. In the first two estimations, the coefficient of X should be statistically significant. In third estimation, the coefficient of M should be statistically significant, and the coefficient of X should either be reduced (partial mediation) or insignificant (full mediation). In our research model, *ImprovedIntegration* is the mediating variable.

Consistent with the Sobel Test procedure, to test hypotheses H4a and H4b, we estimate the following three equations:

$$\text{Probability } (\mathit{Innov}=1)=\Phi(\beta_{10}+\beta_{11}\mathit{Web20Appl}+\beta_{12}\mathit{SOA}+\beta_{13}(\mathit{Web20Appl} \text{ x } \mathit{SOA})+\beta_{c2}'X_{c2}+\varepsilon_1) \quad \text{(ii)}$$

$$\text{Probability } (\mathit{ImprovedIntegration}=1)=\Phi(\beta_0+\beta_1\mathit{Web20Appl}+\beta_2\mathit{SOA}+\beta_3(\mathit{Web20Appl} \text{ x } \mathit{SOA})+\beta_c'X_c+\varepsilon_3) \quad \text{(v)}$$

$$\text{Probability } (\mathit{Innov}=1)=\Phi(\beta_{30}+\beta_{31}\mathit{Web20Appl}+\beta_{32}\mathit{SOA}+\beta_{33}(\mathit{Web20Appl}\ X\ \mathit{SOA})+\beta_{34}\mathit{ImprovedIntegration}+\beta_{3c2}'X_{c2}+\varepsilon_4) \quad \text{(vi)}$$

where X_{c2} *is* the set of control variables described earlier in eqn. (ii) and X_c is a vector of control variables that may influence *ImprovedIntegration.* Among variables in X_c, we include variables indicating whether the firm has reengineered applications, implemented business process frameworks, consolidated data center operations, and implemented life cycle management systems. These infrastructure implementations are likely to favorably impact the likelihood of improved integration.

To test hypotheses H4c and H4d, we estimate the following three equations:

$$\text{Ordered Probit } (\textit{CustInit}) = \beta_{20} + \beta_{21}\textit{Web20Appl} + \beta_{22}\textit{SOA} + \beta_{23}(\textit{Web20Appl} \text{ x } \textit{SOA}) + \beta_{c4}' X_{c4} + \varepsilon_2 \quad \text{(iv)}$$

$$\text{Probability}(\textit{ImprovedIntegration}=1)=\Phi(\beta_0 + \beta_1\textit{Web20Appl} + \beta_2\textit{SOA} + \beta_3(\textit{Web20Appl} \text{ x } \textit{SOA}) + \beta_c' X_c + \varepsilon_3) \quad \text{(v)}$$

$$\text{Ordered Probit } (\textit{CustInit}) = \beta_{40} + \beta_{41}\textit{Web20Appl} + \beta_{42}\textit{SOA} + \beta_{43}(\textit{Web20Appl} \text{ x } \textit{SOA}) + \beta_{44}\textit{ImprovedIntegration} + \beta_{4c4}' X_{c4} + \varepsilon_5 \quad \text{(vii)}$$

where X_{c4} is the set of control variables described earlier in eqn. (iv); and X_c is a vector of control variables that may influence *ImprovedIntegration,* as discussed earlier.

3.5. Results

Table 7 and Table 8 show the descriptive statistics.

	Variables	Mean	SD	Min	Max	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	Innov	0.28	0.45	0	1	1													
2	Web20Appl	1.71	1.14	0	4	0.34*	1												
3	SOA	0.72	0.76	0	2	-0.13*	-0.14*	1											
4	R&D Intensity	0.05	0.10	0.00	0.5	0.05	0.06	-0.03	1										
5	IT R&D Intensity	3.44	4.52	0	40	0.15*	0.06	-0.09	0.25*	1									
6	IT Intensity	3.72	4.07	0	30	0.19*	0.23*	-0.07	-0.04	0.07	1								
7	Firm Size	8.35	1.25	4.79	12.11	0.25*	0.05	-0.05	-0.22*	-0.12*	-0.12	1							
8	ITNewProjects	38.78	15.73	10	91	0.15*	-0.04	-0.08	-0.09	-0.01	0.08	0.02	1						
9	Firm Age	3.74	0.89	1.61	5.41	0.01	-0.04	0.06	-0.00	-0.03	-0.03	0.06	0.04	1					
10	ROA	0.07	0.06	-0.35	0.21	-0.04	-0.00	0.09	0.16*	0.01	0.03	-0.10	-0.03	0.19*	1				
11	IntegratedSearch	0.51	0.50	0	1	0.09	0.37*	-0.03	-0.01	-0.02	0.01	0.03	-0.03	-0.02	-0.04	1			
12	ReenginExistAppl	0.64	0.48	0	1	0.07	0.22*	-0.03	-0.02	-0.02	0.04	-0.02	0.03	-0.01	0.09	0.16*	1		
13	EstabBusProcFrks	0.60	0.49	0	1	0.16*	0.26*	-0.07	-0.03	0.03	0.05	0.00	0.00	-0.06	-0.02	0.18*	0.44*	1	
14	ConsolDCOps	0.43	0.49	0	1	0.15*	0.13*	-0.12	0.02	0.15*	0.12*	0.10	-0.11	-0.11	-0.19*	0.01	-0.11	0.04	1
15	ImprovedIntegration	0.50	0.50	0	1	0.32*	0.54*	-0.09	0.09	0.01	0.15*	-0.02	0.07	-0.04	0.01	0.28*	0.37*	0.39*	-0.09
Notes: N = 258. * indicates significance at $\alpha = 0.05$																			

Table 7: Descriptive Statistics and Correlations for Innovation Model

	Variables	Mean	SD	Min	Max	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	CustInit	1.1	0.77	0	3	1													
2	Web20Appl	1.7	1.15	0	4	0.13*	1												
3	SOA	0.7	0.75	0	2	0.01	-0.09	1											
4	ITR&DIntensity	3.6	5.04	0	40	-0.06	0.07	-0.10	1										
5	ITNewProjects	39	16.04	10	91	0.10	-0.02	-0.08	0.06	1									
6	ITIntensity	4	6.00	0	80	0.04	0.07	-0.09	0.10	0.13*	1								
7	EncrCustRecords	0.3	0.46	0	1	0.00	-0.05	0.26*	0.04	-0.06	-0.13*	1							
8	Firm Size	8.3	1.24	4.79	12.11	0.00	0.07	-0.04	-0.11	-0.01	-0.13*	0.03	1						
9	Manufacturing	0.5	0.50	0	1	-0.2*	-0.06	0.18*	-0.05	-0.08	-0.29*	0.19*	0.16*	1					
10	Firm Age	3.7	0.87	1.61	5.41	-0.04	-0.04	0.04	-0.01	0.03	-0.03	0.12*	0.03	0.11	1				
11	IntegratedSearch	0.50	0.50	0	1	0.09	0.36*	-0.04	0.01	0.00	-0.04	0.02	-0.03	0.02	0.00	1			
12	ReenginExistAppl	0.65	0.48	0	1	0.13*	0.22*	-0.03	0.00	0.07	-0.04	-0.03	-0.06	-0.07	0.00	0.17*	1		
13	EstabBusProcFrks	0.58	0.49	0	1	0.11	0.23*	-0.07	0.00	-0.01	-0.04	-0.05	0.01	-0.07	-0.05	0.19*	0.41*	1	
14	ConsolDCOps	0.41	0.49	0	1	-0.11*	0.16*	-0.09	0.09	-0.12*	0.04	-0.05	0.09	-0.07	-0.09	0.03	-0.11	0.04	1
15	ImprovedIntegration	0.52	0.50	0	1	0.32*	0.48*	-0.08	0.03	0.08	0.04	-0.04	-0.04	-0.05	-0.02	0.25*	0.36*	0.37*	-0.11

Notes: N = 294. * indicates significance at $\alpha = 0.05$

Table 8: Descriptive Statistics and Correlations for Customer-centricity Model

3.5.1. Results of Model 1: IT-enabled Business Innovation Model

The results for the Innovation model are shown in Table 9. The bivariate estimates are in columns 9.1 and 9.2. The Likelihood Ratio (LR) test does not reject the null that the two equations are independent (p = 0.697), suggesting that the model consists of independent equations that can be consistently estimated separately (Cameron and Trivedi 2005; Greene 2003). Also, Hausman tests (Hausman 1978) of the null of no systematic difference in coefficients of the bivariate and separately estimated models are not rejected (p = 1.0), further suggesting that endogenity is not problematic. In view of these considerations, we interpret and discuss the (more efficient) univariate estimation results in this chapter (Cameron and Trivedi 2005; Greene 2003). The bivariate model gives us qualitatively similar results. The results of the univariate probit regression for the innovation model are depicted in Table 9 (column 9.3).

The Wald Chi-square value of the full model is 93.85 (p < 0.0001) which suggests that we can reject the null hypothesis that the coefficients of the model are jointly zero. The Hosmer and Lemeshow goodness-of-fit test (p-value = 0.15) shows no evidence of lack of model fit. This implies that our model adequately fits the data (Hosmer and Lemeshow 2000). A measure of the discriminatory power of the model is the ‘Area under the Receiver Operating Characteristic (ROC) curve', which provides an assessment of the model's ability to discriminate between observations that experience the outcome of interest (in our case, innovation) and those that do not. In our model, the area under the ROC curve statistic was 0.872, which falls in the range described as "excellent discrimination" (Hosmer and Lemeshow 2000, p. 162).

--- This space is intentionally left blank ---

Model Specifications→	Bivariate (semi) ordered probit model		Mediation Analysis (Sobel Test) (Probit models)		
			Unmediated Model	First step of Mediation	Mediated Model
Columns →	9.1	9.2	9.3	9.4	9.5
Dependent Variables →	Web 2.0 Technologies	Innov	Innov	Improved Integration	Innov
Web 2.0 Technologies	n/a	0.541** (0.254)	0.634*** (0.106)	0.848*** (0.113)	0.456*** (0.131)
SOA	n/a	-0.178 (0.145)	-0.182 (0.144)	-0.035 (0.131)	-0.190 (0.145)
Web 2.0 Technologies X SOA	n/a	0.110 (0.120)	0.107 (0.122)	-0.095 (0.121)	0.129 (0.120)
R&D Intensity	1.182 (0.842)	1.039 (1.282)	0.952 (1.233)	n/a	0.612 (1.267)
IT R&D Intensity	0.006 (0.013)	0.067** (0.026)	0.068*** (0.026)	n/a	0.074*** (0.027)
IT Intensity	0.063*** (0.022)	0.043 (0.029)	0.036 (0.026)	0.034 (0.022)	0.038 (0.027)
Firm Size	0.122** (0.056)	0.493*** (0.087)	0.487*** (0.087)	-0.012 (0.091)	0.492*** (0.085)
ITNewProjects	-0.001 (0.004)	0.022*** (0.007)	0.022*** (0.007)	n/a	0.020*** (0.007)
Firm Age	-0.018 (0.083)	0.008 (0.120)	0.014 (0.121)	-0.030 (0.109)	0.049 (0.122)
ROA	0.608 (1.135)	-1.145 (1.761)	-1.219 (1.766)	n/a	-1.146 (1.778)
SearchToolsOnWeb	0.856*** (0.154)	n/a	n/a	n/a	n/a
Improved Information Integration	n/a	n/a	n/a	n/a	0.652** (0.271)
Reengineered Applications	n/a	n/a	n/a	0.883*** (0.229)	n/a
Business Process Frameworks	n/a	n/a	n/a	0.433** (0.209)	n/a
Consolidated Data Center Operations	n/a	n/a	n/a	-0.139 (0.204)	n/a
Information Lifecycle Management	n/a	n/a	n/a	0.491** (0.212)	n/a
Log Pseudolikelihood	-446.386		-101.184	-105.546	-98.166
Wald Chi-square	78.28		93.85	86.92	102.59
Prob > Chi-Sqr	0.0000		0.0000	0.0000	0.0000
Correlation between error terms of equations	0.122 (0.282)		n/a	n/a	n/a
LR Test of null of Independent equations	Chi-Square = 0.15 Prob > Chi-square = 0.697		n/a	n/a	n/a
McKelvey and Zavoina Pseudo R-square	n/a		0.592	0.629	0.605
Observations (N)	258		258	258	258
Notes: (1) Robust standard errors in parentheses. (2) Significant at *10%, **5% and ***1% level for Chi-Square tests. (3) Estimates for industry dummies not shown. (4) "n/a": Not applicable.					

Table 9: Results for Web 2.0 and Innovation Model

Consistent with H1, we find a positive and significant coefficient ($\beta_{11} = 0.634$, $p < 0.01$) of *Web20Appl* in Model 1. Hypothesis H3a posited that SOA and Web 2.0 technologies would be complementary in the firms' propensity for IT-enabled business innovation. However, we do not find support for this hypothesis in our results. Later, we discuss a possible reason for non-support of this hypothesis.

3.5.1.1. Mediation Analysis of IT-enabled Innovation Model

Table 9 (columns 9.3, 9.4, 9.5) show the results for the mediation analysis for the Innovation Model. In the estimation for the *ImprovedIntegration* model, we find that the coefficient of *Web20Appl* is positive and significant ($\beta_1 = 0.848$, $p < 0.01$). However, the coefficient of the interaction of *SOA* and *Web20Appl* (β_3) is insignificant. Hence, H4b is not supported. Controlling for *ImprovedIntegration* in the Innovation equation shows that the coefficient of *ImprovedIntegration* is positive and significant ($\beta_{34} = 0.652$, $p < 0.05$) while the coefficient of *Web20Appl* remains positive and significant ($\beta_{31} = 0.456$, $p < 0.01$). The coefficient of *Web20Appl* is considerably lower in magnitude as compared to the coefficient of *Web20Appl* when *ImprovedIntegration* is not included in the regression ($\beta_{11} = 0.634$). Taken together, these results suggest that the relationship between Web2.0 technologies and IT-enabled business innovation is partially mediated by *ImprovedIntegration*. This is consistent with hypothesis H4a. To formally test mediation, we use the Sobel test adapted for a dichotomous dependent and mediating variable (Mackinnon and Dwyer 1993).[36] The Sobel test for the mediating role of *ImprovedIntegration* in the Web2.0-Innovation relationship indicated that the partial mediation is significant ($p < 0.05$).

---

[36] In the case of dichotomous mediating and outcome variables, the coefficients on the mediation analysis are in different scales across the three equations; hence, to make the scale equivalent across the equations, appropriate scaling of the regression coefficients and variances are required in order to perform the Sobel Test (MacKinnon and Dwyer 1993). We followed the procedure specified in MacKinnon and Dwyer (1993) to appropriately scale the coefficients and variances prior to performing the Sobel Test.

3.5.2. Results of Model 2: IT-enabled Customer–Centricity Model

The results for the customer-centricity model are shown in Table 10. The bivariate estimates are shown in the columns 10.1 and 10.2. The Likelihood Ratio (LR) test does not reject the null that the two equations are independent ($p = 0.33$), suggesting that the model consists of independent equations that can be consistently estimated separately (Cameron and Trivedi 2005; Greene 2003). Also, Hausman tests (Hausman 1978) of the null of no systematic difference in the coefficients of the bivariate model and the separately estimated models are not rejected, further suggesting that endogenity is not problematic. In view of these considerations, we interpret and discuss the (more efficient) univariate estimation results in this chapter (Cameron and Trivedi 2005; Greene 2003). The bivariate model gives us qualitatively similar results.

The results of the univariate probit regression for the innovation model are depicted in Table 10 (column 10.3). The Likelihood Ratio (LR) Chi-square indicates that we can reject the null hypothesis that the coefficients of the model are jointly zero. In an ordered probit regression model, it is important that the 'parallel regression' assumption holds, so that the slopes (βs) can be considered to be equal across all outcomes of the dependent variable (Long and Freeze 2003). [37] An LR test of the parallel regression assumption[38] (Wolfe and Gould 1998) suggested that this assumption holds ($p = 0.707$) in our data. Since ordered probit models "are not used for predictive purposes and we are primarily interested in parameter estimates for the coefficients of interest, the models show reasonable levels of pseudo R-squared values consistent with those observed in

[37] An ordered probit model consisting of a dependent variable of J levels is equivalent to J-1 binary probit regressions, with the critical assumption that the slope coefficients are identical across each regression (Long and Freese 2003).
[38] This test compares the log likelihood from the ordered probit estimation (with J levels of the dependent variable) with that obtained from pooling J-1 binary probit models, making the adjustment for correlation between binary outcomes (Long and Freese 2003).

social sciences research" (Bardhan et al. 2006, p. 27), IS research (Bardhan et al. 2006; Mithas et al. 2010; Whitaker et al. 2007) and management research (Jeppesen and Laursen 2009).

Model Specifications→	Bivariate ordered probit model		Mediation Analysis (Sobel Test)		
			Ord. Probit (Unmediated model)	Probit (First step of mediation)	Ord. Probit (Mediated Model)
Columns →	10.1	10.2	10.3	10.4	10.5
Dependent Variables →	Web 2.0 Technologies	*CustInit*	*CustInit*	Improved Integration	*CustInit*
Web 2.0 Technologies	n/a	0.287** (0.145)	0.157*** (0.059)	0.731*** (0.099)	-0.017 (0.075)
SOA	n/a	0.078 (0.087)	0.075 (0.087)	-0.114 (0.126)	0.087 (0.087)
Web 2.0 Technologies X SOA	n/a	0.200** (0.080)	0.206** (0.080)	0.214 (0.131)	0.171** (0.081)
IT Intensity	0.013 (0.019)	-0.008 (0.013)	-0.007 (0.015)	0.007 (0.011)	-0.006 (0.015)
IT R&D Intensity	0.017 (0.012)	-0.017 (0.013)	-0.015 (0.013)	n/a	-0.016 (0.013)
ITNewProjects	-0.002 (0.004)	0.008* (0.004)	0.008* (0.004)	n/a	0.006 (0.004)
Encrypted Customer Records	-0.101 (0.131)	0.097 (0.144)	0.087 (0.145)	n/a	0.092 (0.149)
Firm Size	0.109** (0.051)	0.004 (0.053)	0.016 (0.053)	-0.053 (0.080)	0.030 (0.054)
Firm Age	-0.037 (0.076)	-0.025 (0.067)	-0.031 (0.067)	0.004 (0.102)	-0.031 (0.067)
Manufacturing	-0.122 (1.136)	-0.433*** (0.142)	-0.45*** (0.144)	n/a	-0.48*** (0.067)
SearchToolsOnWeb	0.792*** (0.133)	n/a	n/a	n/a	n/a
Improved Information Integration	n/a	n/a	n/a	n/a	0.731*** (0.173)
Reengineered Applications	n/a	n/a	n/a	0.751*** (0.200)	n/a
Business Process Frameworks	n/a	n/a	n/a	0.408** (0.188)	n/a
Consolidated Data Center Operations	n/a	n/a	n/a	-0.178 (0.179)	n/a
Information Lifecycle Management	n/a	n/a	n/a	0.422** (0.181)	n/a
Log Pseudolikelihood	-735.432		-319.093	-135.589	-308.348
Wald Chi-square	45.53		24.8	91.71	48.61
Prob > Chi-Sqr	0.0000		0.005	0.000	0.000
Correlation between error terms of equations	-0.170 (0.175)		n/a	n/a	n/a
LR Test of null of Independent equations	Chi-Square = 0.95 Prob > Chi-square = 0.330		n/a	n/a	n/a
Test of null of parallel regression assumption	n/a		p-value =0.707	n/a	p-value =0.155
McKelvey and Zavoina Pseudo R-square	n/a		0.113	0.545	0.188
Observations (N)	294		294	294	294

Notes: (1) Robust standard errors in parentheses. (2) Significant at *10%, **5% and ***1% level for Chi-Square tests. (3) "n/a": Not applicable.

Table 10: Results for Web 2.0 and Customer-centricity Model

The positive and significant coefficient ($\beta_{21} = 0.157$, $p < 0.01$) of *Web20Appl* provides support for the hypothesis (H2) that Web 2.0 technologies are associated with greater propensity for IT-enabled customer-centricity. Table 10 also shows that the interaction term of *Web20Appl* and *SOA* is positive and significant ($\beta_{23} = 0.206$, $p <0.05$), rendering support for hypothesis (H3b) that SOA moderates the relationship between Web 2.0 and IT-enabled customer-centricity.

3.5.2.1. Mediation Analysis of IT-enabled Customer-centricity Model

Table 10 (columns 10.3, 10.4, 10.5) shows the results for the mediation analysis for the Customer-centricity Model. Like before, in the estimation for the *ImprovedIntegration* model, we find that the coefficient of *Web20Appl* is positive and significant ($\beta_1 = 0.731$, $p < 0.01$). However, the coefficient of the interaction of SOA and *Web20Appl* (β_3) is insignificant. Hence H4d is not supported. Controlling for *ImprovedIntegration* in the Customer-centricity equation shows that the coefficient of *ImprovedIntegration* is positive and significant ($\beta_{44} = 0.731$, $p < 0.01$) while the coefficient of *Web20Appl* (β_{41}) is statistically insignificant (H4c supported). Taken together, these results suggest that the relationship between Web2.0 technologies and the propensity for IT-enabled customer-centricity is fully mediated by *ImprovedIntegration*. This is consistent with hypothesis H4c, whereas H4d is not supported.

3.5.3. Robustness Checks

We performed a number of checks to assess the robustness of our results. In our study, several variables were obtained from the same respondent. Therefore, there is a potential concern of common method bias which can arise when measurements of variables are obtained from a single respondent. We assessed this potential concern by using Harman's one-factor test (Podsakoff and Organ 1986). In Model 1 (Model 2), five (five) factors with eigenvalues exceeding 1 were retained, explaining a cumulative proportion of 64.85% (62.04%) of the variation, with the first principal factor accounting for only 16.95% (17.67%) of the variation. Thus, no single major factor emerged in the tests, suggesting that common method bias is unlikely to be a serious problem in the data. We also ran the Lindell and Whitney's (2001) test, using a "marker variable" to partial out common method variance from the correlations among the variables. After correcting for common method variance, we found no substantial changes in the correlations, further suggesting that common method variance is not a significant concern (Malhotra et al. 2006). The routine tests for reliability of survey measures are not applicable in our study because we use summative (formative) measures (Jarvis et al. 2003). We also checked for multicollinearity between the variables because in a regression, high multicollinearity between variables increases the standard errors of the estimates, reducing their precision (Kennedy 2008). The mean Variance Inflation Factor (VIF) for Model 1 (Model 2) was 1.06 (1.09) and the maximum VIF was 1.10 (1.18) which are well below the suggested limits (Greene 2003), suggesting that multicollinearity is not an issue in our data. The data was also tested for heteroskedasticity. The Lagrange Multiplier score test for heteroskedasticity (Davidson and Mckinnon 1984; Greene 2003) did not reject the null of homoskedasticity at conventional levels. In both models (Model 1 and Model 2), a specification test (linktest) suggested that meaningful predictors have been chosen and there is no specification error (Long and Freese 2003). The linktest performs a model specification test and is based on the logic that if a regression is properly specified, one should not be able to find any additional independent variables that are significant, except by chance (UCLA 2010).

Further, it may be argued that the customer-centricity model can also be estimated as a count model. To test the sensitivity of the result to alternate models, we estimated the customer-centricity model using the negative binomial and Poisson count regression models. In results not reported here, the findings remain qualitatively unchanged and are similar to those shown for the ordered probit model. We believe that the ordered probit model is more appropriate for our context, since the underlying concept we really intend to get at is the propensity of the firm to be more customer-centric in IT.

Finally, we took four steps to further assess the validity of our self-reported measure of the propensity for IT-enabled business innovation. First, we examined the correlation in our sample between this measure (*Innov*) and the number of successful patents (patent count data obtained from the U.S. Patent & Trademark Office) applied for by the firm in the same year. The correlation coefficient was positive and statistically significant ($r = 0.182$, $p < 0.01$), [39] thus serving as one form of validity check of our binary self-reported firm innovation dependent variable. This approach is consistent with prior literature that recommends validating subjective measures against external quantitative measures to ensure data integrity (Kulp et al 2004; Miller and Roth 1994; Pavlou and El Sawy 2006; Ravichandran and Lertwongsatien 2005). More specifically, it is also in line with prior studies that validate subjective measures of innovation by examining their correlation with quantitative measures of innovation (Aragon-Correa et al. 2007). Second, we further explored the robustness of our results by creating a composite measure of IT-enabled business innovation. We combined the binary dependent variable (*Innov*) from our dataset with the number of successful patents applied for by the firm in the same year (patent count data obtained from the U.S. Patent & Trademark Office). We created a new composite dependent variable (*ITPatents*) as follows:

[39] The correlation coefficient is statistically significant and not too high in magnitude. This is to be expected since the *Innov* variable refers to propensity for IT-enabled innovation in particular whereas the Patent counts measure all innovations.

$$ITPatents = 0 \qquad ; \text{if } Innov = 0$$

$$ITPatents = ITIntensity \times TotalPatents \; ; \text{if } Innov = 1$$

where *TotalPatents* is the total number of successful patents applied for by the firm; *ITIntensity* and *Innov* are defined earlier. Estimating a negative binomial regression model, we found that the coefficient of *Web20Appl* is positive and significant. Interestingly, we find that the coefficient remains positive and significant even when we take *TotalPatents* (rather than *ITPatents*) as the dependent variable.[40]

Third, to further assess the validity of the measure of the propensity for IT-enabled business innovation, we categorized patents as 'IT-enabled' and 'not IT-enabled' in order to calculate the correlation between our measure with the count of IT-enabled patents obtained through this categorization (data of patents and their counts were obtained from the USPTO database).[41] For this categorization, we examined the patent abstracts and searched for words such as 'computer', 'digital', 'database', 'online', etc. A patent was classified as 'IT-enabled' if such words were present in the abstract; and it was categorized as 'non IT-enabled' if such words were not found in the abstract. We then checked the correlation of the binary measure with the 'IT-enabled' patents using this categorization. We found a correlation of ($r = 0.470$, $p < 0.001$), which is significantly higher than the correlation between the measure and all patents in our previous validity check discussed earlier ($r = 0.182$, $p < 0.01$), thus adding further confidence to the validity of our measure. Fourth, we had qualitative telephonic discussions with ten CIOs. Our measure of propensity for IT-enabled business innovation used was consistent with

[40] When we repeated the robustness check by taking TotalPatents to be the 3-year (2006-2008) aggregation of patent application counts (following Joshi et al. 2010), the coefficient of Web 2.0 remained positive and significant.

[41] I thank Dr. Gerald Davis for providing this insightful suggestion for robustness check.

the notion of IT-enabled business innovation that these CIOs elaborated on in these discussions.

3.6. Discussion

3.6.1. Findings

Our objectives in this study were to examine the role of Web 2.0 technologies in firms' propensity for IT-enabled business innovation and IT-enabled customer-centricity.

Hypothesis		Finding
H1	The use of Web 2.0 technologies is positively associated with the firm's propensity for IT-enabled business innovation.	Supported
H2	The use of Web 2.0 technologies is positively associated with the firm's propensity for IT-enabled customer-centricity.	Supported
H3a	SOA positively moderates the relationship between the use of Web 2.0 technologies and the firm's propensity for IT-enabled business innovation.	Not supported
H3b	SOA positively moderates the relationship between the use of Web 2.0 technologies and the firm's propensity for IT-enabled customer-centricity.	Supported
H4a	The relationship between use of Web 2.0 technologies and the firm's propensity for IT-enabled business innovation is mediated by improved information integration.	Partial Mediation supported
H4b	The interactive relationship between use of Web 2.0 technologies and SOA on the firm's propensity for IT-enabled business innovation is mediated by improved information integration.	Not supported
H4c	The relationship between use of Web 2.0 technologies and the firm's propensity for IT-enabled customer-centricity is mediated by improved information integration.	Full Mediation supported
H4d	The interactive relationship between use of Web 2.0 technologies and SOA on the firm's propensity for IT-enabled customer-centricity is mediated by improved information integration.	Not supported

Table 11: Summary of Findings (Chapter 3)

Our findings (Table 11) suggest that use of Web 2.0 technologies is associated with greater likelihood of IT-enabled business innovation and IT-enabled customer-centricity in firms. The coefficients of our regressions represent the association between Web 2.0 technology use and propensity for IT-enabled innovation and IT-enabled customer-centricity controlling for the variables that may potentially influence both the use of Web 2.0 technologies and the propensity for IT-enabled business innovation and customer-centricity.[42]

[42] I thank Dr. Robert Franzese and Dr. M.S. Krishnan for motivating and providing insights for this discussion.

Many of these control variables can be proxies for components of the social and technical architecture of the firm and may influence the propensity for IT-enabled business innovation and be correlated with the use of Web 2.0. For example, *ITR&DIntensity*, *R&DIntensity*, and *ITNewProjects* control for innovation-oriented investments (e.g., investments in CAD systems) that might influence innovation as well as influence the extent to which employees that use Web 2.0 technologies may have complementary resources to be able to translate their knowledge capabilities for innovation. Consistent with this reasoning, we find positive and significant coefficients of *ITR&DIntensity* ($\beta = 0.067$, $p < 0.05$) and *ITNewProjects* ($\beta = 0.022$, $p < 0.01$) in the innovation equation. Inclusion of these variables in the first stage accounts for the potential that firms that invest more in innovation may be more likely to use Web 2.0 technologies.

Firm *Size* accounts for the potential that larger firms may have greater resources for innovation (Ahuja et al. 2008) as well as have the complementary organizational resources (e.g., access to physical facilities and other human resources) to benefit more from Web 2.0 collaboration capabilities. Inclusion of *Size* in the first stage accounts for the potential that larger firms may have a greater need to implement Web 2.0 technologies to facilitate knowledge sharing across a large workforce. We find significant and positive coefficients of *Size* in the innovation equation ($\beta = 0.493$, $p < 0.01$) and in the first-stage equation ($\beta = 0.122$, $p < 0.05$).

Firm *Age* helps to control for its potential negative and positive influences in innovation. Younger firms may also be more prone to use Web 2.0 technologies and benefit from Web 2.0 technology use, due to lesser organizational and social legacies. For example, older firms may have ingrained mindsets that may be difficult to change and adapt to a Web 2.0 environment.

ITIntensity controls for the potential that firms that invest heavily in IT in general may be also more likely to invest more in Web 2.0 technologies. It also controls for the potential that investments in other IT technologies may enable employees to leverage Web 2.0 technologies to a greater extent. For example, investments in business intelligence systems may help employees give a context to knowledge shared through Web 2.0. Broadly in line with these arguments, we find a positive and significant coefficient of *ITIntensity* in the first-stage Web 2.0 equation ($\beta = 0.063$, $p < 0.01$).

Prior firm profitability (*ROA*) accounts for the potential that greater profits might enable firms to re-invest some of the profits into innovation related activities, as well as provide organizational resources to better leverage Web 2.0 capabilities.

Thus, taken together, the control variables help to partial out many potential alternate factors that might influence the propensity for IT-enabled business innovation and the use of Web 2.0 technologies. Many of the control variables may be proxies for other factors of the social and technical architecture of the firm. As a result, the estimated coefficients represent the residual relationship after partialing out other potential factors (as permitted by our data).

We theorized that the higher IT-enabled innovation propensity is, among other mechanisms, enabled by the ability of Web 2.0 technologies to increase the scope of knowledge from multiple sources available for re-combination and to facilitate social interactions for dynamic knowledge creation. Furthermore, we argue that the increased propensity for IT-enabled customer-centricity is facilitated by the ability of Web 2.0 to reduce organizational silos, increase cross-functional collaboration, and enable new capabilities to help focus on the customer. Consistent with the argument that Web 2.0 technologies facilitate accumulation of information from multiple sources and reduction of silos, we found that improved integration mediates the link between Web 2.0 and innovation (partial mediation), and mediates the link between Web 2.0 and customer-centricity (full mediation). Our finding regarding the complementarity between Web 2.0 and SOA in IT-enabled customer-centricity suggests that a flexible and interoperable IT infrastructure helps firms to leverage unstructured Web 2.0 information platforms and be more customer-centric in their IT use. The statistical insignificance of complementarity between Web 2.0 and SOA in the innovation regression is not in line with our hypothesis. We conjecture that one reason for this insignificance is that the flexibility in business processes (provided by SOA) is not as critical to business innovation as it is to providing the adaptability to meet varying customer needs. Another potential reason is that firms are obtaining the necessary flexibility through other means rather than through SOA-based IT systems. Such factors can include organizational flexibility capabilities, such as flexible human resource allocations and organizational strategies (Prahalad and Krishnan 2008). Thus, it is possible that there could be potentially other sources of flexibility that firms are drawing on that may substitute the need for SOA-based flexibility. However, further research is warranted to examine this relationship more deeply.

3.6.2. Contributions to Research

First, this study fundamentally sheds light on IT and strategic business capabilities. The role of IT in business innovation (e.g., Han and Ravichandran 2006; Joshi et al. 2010; Kleis et al. 2012; Sambamurthy et al. 2003) and enabling customer-related capabilities (e.g., Mithas et al. 2005; Ray et al. 2005) has been a subject of renewed interest in recent times. Our study provides empirical evidence of the relationship between Web 2.0 technologies, IT flexibility (SOA), and the propensity for IT-enabled business capabilities of innovation and customer-centricity. This study provides another example of how IT can create "indirect" (business innovation) and "intangible" (customer-centricity) value, as called for by prior research (Kohli and Grover 2008, p. 33). This study can motivate further research into how best to leverage IT in the pursuit of these strategic organizational capabilities. Second, another research contribution pertains to the role of complementarities between IT applications deployed in a firm and the firm's IT architecture. While complementarities between IT and organizational resources have been a subject of much research (e.g., Bharadwaj et al. 2007), our findings provides further evidence of complementarities between IT applications and IT infrastructure in relation to business capabilities, a result consistent with related prior IS research (Tanriverdi 2006; Zhu 2004). Our research is also a step towards responding to the call of Parameswaran and Whinston (2007b, p. 777) towards "interpreting and guiding" the trend of social computing "into fully realizing its potential".

Third, this study investigated how the role of Web 2.0 in IT-enabled innovation and customer-centricity is mediated through improved integration in the firm. The results suggest that part of the association between Web 2.0 technologies and IT-enabled business innovation is mediated by improved information integration. Future research can study other mechanisms for how Web 2.0 might improve a firm's capacity to innovate and be more customer-centric. Some of the likely candidates include improved knowledge management capability and an open organizational culture.

3.6.3. Contributions to Practice

With the use of Web 2.0 technologies becoming increasingly more widespread, there is a need for managers and decision makers to understand the performance implications of such technologies for their organization. The findings of this study serve to allay apprehensions that Web 2.0 technologies could hamper performance. Rather, the findings suggest that firms can use Web 2.0 technologies strategically for IT-enabled business innovation and customer-centricity. Our results suggest that Web 2.0 technologies can help managers tap into the collective knowledge and ideas of employees. Web 2.0 technologies can also be used as a medium to increase cross-unit collaboration and improve information integration, thus helping to make the firm more innovative and customer-centric. Moreover, firms can extract greater value from their Web 2.0 implementations by combining their capabilities with flexible and interoperable IT architectures like SOA. A flexible IT architecture is more likely to allow firms to embed the collaborative Web 2.0 technology capabilities within business processes. Using Web 2.0 technologies, firms can move toward building innovative and customer-focused capabilities. Business success, competitiveness, and future growth are dependent on creating a sustained cycle of innovation, and a unique and distinctive customer value proposition. The ability of firms to succeed and thrive is dependent on co-creation (Prahalad and Ramaswamy 2004) and collaboration to drive business innovation (Prahalad and Krishnan 2008). Our study results suggest that Web 2.0 technologies are enabling an infrastructure for IT to drive business innovation and customer-focus, which can potentially be sources of competitive advantage in a changing world of business.

3.6.4. Limitations and Future Research Suggestions

Our results must be viewed in light of the study's limitations, which can be addressed by future research. First, the sample may not be representative of the population of firms as a whole. This can limit the generalizability of the conclusions.

Second, the cross-sectional nature of our analysis inhibits direct inference of and does not permit empirical tests of causality. However, given our consistent findings using bivariate estimation models that address potential endogenity of use of Web 2.0 technologies, we believe that reverse-causality is unlikely. Also, our findings regarding a mediating mechanism in the link between Web 2.0 and innovation and customer-centricity further mitigate such concerns, consistent with prior IS business value research which examine mediating mechanisms using cross-sectional data (e.g., Banker et al. 2006; Bharadwaj et al. 2007; Mishra et al. 2007; Mithas et al. 2005). Nevertheless, using longitudinal research designs, future research can adopt additional empirical strategies that can explicitly model firm-level heterogeneity and temporal ordering.

Third, we use a self-reported measure of IT-enabled business innovation (*Innov*). Though self-reported and/or binary measures of innovation have been used in prior research (Aragon-Correa et al. 2007; Georgellis et al. 2000; Huergo 2006; Keeble 1997; Koellinger 2008; Leiponen and Helfat 2010; Li et al. 2006; Molina-Moralez and Martinez-Fernandez 2009; Tsai and Ghoshal 1998; Veugelers and Cassiman 1999), future research can use more refined measures. Nevertheless, (as described earlier) the positive and significant correlation between our measure and the number of successful patents applied for by the firm mitigates such concerns. More importantly, our goal in this study was to examine the extent to which the firm's business innovation is driven by IT. This is more appropriately incorporated by our self-reported measure, which specifically and better captures the IT-enabled nature of innovation as compared to the measure of patent counts.

Fourth, we acknowledge that our measure of IT-enabled customer-centricity may not capture all facets of customer-centricity possible. Though we believe that this is one of the first measures for IT-enabled customer-centricity and that it reasonably and adequately captures the propensity of the firm for IT-enabled customer-centricity, future research can identify more refined measures of IT-enabled customer-centricity. Moreover, our research context is limited to firms in the United States. More research is needed to examine whether the findings hold in other geographical contexts and cultures. Web 2.0 technologies could have different implications depending on the social and cultural norms in the organization and in different geographies.

Finally, though we consider deployment of Web 2.0 technologies as a proxy for usage, deployment of IT may not necessarily imply usage (Devaraj and Kohli 2003). Although many prior studies have employed binary measures of deployment of IT as proxies for usage (e.g., Banker et al. 2006; Heim and Peng 2010; Hitt et al. 2002), future research can use more refined measures of usage of Web 2.0 technologies.

Given the nascent nature of research on Web 2.0 in organizational and business contexts, there are several opportunities for future related research. The issue of how to effectively deploy Web 2.0 projects is one among many potential research questions. Other research questions that could guide future research in this area pertain to how companies can use Web 2.0 technologies to attract new customers and partners, and what are the incentives and human resource policies that firms need to implement in order to promote user contributions to leverage Web 2.0 technologies for innovation. Furthermore, as pointed out by Majchrzak (2009), the nature of user-generated content may call for a re-examination of several traditionally accepted IS theories and management practices in the context of Web 2.0 technologies in business. More research is also warranted to compare traditional information systems with Web 2.0 technologies, to shed light on the question of when best to deploy Web 2.0 technologies, and what organizational success factors and environments could enhance the value of Web 2.0 technologies (Kettles and David 2008). Also, while we focused on one mediator between the use of Web 2.0 technologies and IT-enabled business innovation and customer-centricity, a logical extension is to empirically explore other potential mediating mechanisms through which Web 2.0 technologies (in conjunction with SOA) facilitate IT-enabled business innovation and customer-centricity. Finally, in this study, we examined the relationship between Web 2.0 technologies and the propensity for IT-enabled business innovation and IT-enabled customer-centricity. It is plausible that Web 2.0 technologies may also facilitate general business innovation and customer-centricity (that is not driven by IT). Future research can expand the scope of our exploration to envelop overall innovation and customer-centricity.

3.7. Conclusion

Web 2.0 technologies can potentially provide business capabilities to firms by leveraging its social and technology dimensions to improve performance. Despite considerable anecdotal evidence and case studies related to the use of Web 2.0 in the business context, there is still hesitancy among CIOs and uncertainty about whether and how Web 2.0 technologies provide business value. This study is, to the best of our knowledge, the first empirical examination of Web 2.0 technologies and business capabilities using a large sample of firms. It takes a step in the direction of showing the role of IT (Web 2.0 technologies specifically) in business innovation and customer-centricity as well as showing how firms can leverage synergies between IT applications (Web 2.0 technologies) and an IT architecture (SOA) that is flexible and highly connectible in supporting these strategic business capabilities.

References

Agarwal, R., and V. Sambamurthy. "Principles and Models for Organizing the IT Function," *MIS Quarterly* (26:1), 2002, pp. 1.

Ahuja, G., C. Lampert, and V. Tandon. "Moving Beyond Schumpeter: Management Research on the Determinants of Technological Innovation," *Academy of Management Annals* (2:1), 2008, pp. 1-98.

Alavi, M., and D. Leidner. "Review: Knowledge Management and Knowledge Management Systems: Conceptual Foundations and Research Issues," *MIS Quarterly* (25:1), 2001, .

Ali-Hassan, H., and D. Nevo. "Identifying Social Computing Dimensions: A Multidimensional Scaling Study," *Proceedings of the International Conference on Information Systems,* 2009, .

Aragon-Correa, J. A., V. Garcia-Morales, and E. Cordon-Pozo. "Leadership and Organizational Learning's Role on Innovation and Performance: Lessons from Spain," *Industrial Marketing Management* (36:3), 2007, pp. 349.

Armstrong, D., and D. McVicar. "Value Added in further Education and Vocational Training in Northern Ireland," *Applied Economics* (32:13), 2000, pp. 1727-1736.

Band, W., and J. Guaspari. "Creating the Customer-Engaged Organization," *Marketing Management* (12:4), pp. 34-39.

Banker, R., I. Bardhan, and O. Asdemir. "Understanding the Impact of Collaboration Software on Product Design and Development," *Information Systems Research* (17:4), 2006, pp. 352.

Banker, R., I. Bardhan, H. Chang, and S. Lin. "Plant Information Systems, Manufacturing Capabilities, and Plant Performance," *MIS Quarterly* (30:2), 2006, pp. 315.

Bardhan, I., J. Whitaker, and S. Mithas. "Information Technology, Production Process Outsourcing, and Manufacturing Plant Performance," *Journal of Management Information Systems* (23:2), 2006, pp. 13.

Bardhan, I., A. Gupta, and P. Tallon. "Research Perspectives on Innovation through Information Technology Management in a Networked World," *Information Technology Management* (9:3), 2008, .

Baron, R., and D. Kenny. "The Moderator-Mediator Variable Distinction in Social Psychology Research - Conceptual, Strategic and Statistical Considerations," *Journal of Personality and Social Psychology* (51:6), 1986, pp. 1173-1182.

Bateman, P., P. Gray, and B. Butler. "The Impact of Community Commitment on Participation in Online Communities," *Information Systems Research (Articles in Advance),* 2010.

Bharadwaj, A., S. Bharadwaj, and B. Konsynski. "Information Technology Effects on Firm Performance as Measured by Tobin's q," *Management Science* (45:7), 1999, pp. 1008.

Bharadwaj, S., A. Bharadwaj, and E. Bendoly. "The Performance Effects of Complementarities between Information Systems, Marketing, Manufacturing, and Supply Chain Processes," *Information Systems Research* (18:4), 2007, pp. 437.

Bharadwaj, A., M. Keil, and M. Mahring. "Effects of Information Technology Failures on the Market Value of Firms," *The Journal of Strategic Information Systems* (18:2), 2009, pp. 66.

Bharadwaj, A. S. "A Resource-Based Perspective on Information Technology Capability and Firm Performance: An Empirical Investigation," *MIS Quarterly* (24:1), 2000, pp. 169.

Boateng, R., A. Maliky, and V. Mbarika. "Web 2.0 and Organizational Learning: Conceptualizing the Link," *Proceedings of Americas Conference on Information Systems,* 2009, .

Bollen, K. A., D. K. Guilkey, and T. A. Mroz. "Binary Outcomes and Endogenous Explanatory Variables: Tests and Solutions with an Application to the Demand for Contraceptive use in Tunisia," *Demography* (32:1), 1995, pp. 111-131.

Bound,J., D. A. Jaeger, and R. M. Baker. "Problems with Instrumental Variables Estimation when the Correlation between the Instruments and the Endogeneous Explanatory Variable is Weak," *Journal of the American Statistical Association* (90:430), 1995, pp. 443.

Brew, F., B. Hesketh, and A. Taylor. "Individualist-Collectivist Differences in Adolescent Decision Making and Decision Styles with Chinese and Anglos," *International Journal of Intercultural Relations* (25:1), 2001, pp. 1.

Brown, S., and K. Eisenhardt. "The Art of Continuous Change: Linking Complexity Theory and Time-Paced Evolution in Relentlessly Shifting Organizations," *Administrative Science Quarterly* (42:1), 1997, pp. 1.

Burnham, K. "My Enterprise 2.0 Rollout: 4 Keys to Success," *Http://www.Cio.com/article/print/598921* (2010:7/9), 2010, .

Cameron, A. C., and P. K. Trivedi. *Microeconometrics: Methods and Applications*, Cambridge University Press, New York, 2005.

Cash, J., M. Earl, and R. Morison. "Teaming Up to Crack Innovation and Enterprise Integration," *Harvard Business Review* (86:11), 2008, pp. 90.

Cherian, S. P., J. W. Whitaker, and M. S. Krishnan. "Do IT Investments Enable Business Innovation in High-Tech Firms? an Empirical Analysis," *Ross School of Business Working Paper,* 2009.

Choi, J., D. Nazareth, and H. Jain. "Implementing Service-Oriented Architecture in Organizations," *Journal of Management Information Systems* (26:4), 2010.

Cook, N. *Enterprise 2.0: How Social Software Will Change the Future of Work*, Gower Publishing, 2008.

Corso, M., A. Martini, L. Pellegrini, and A. Pesoli. "Emerging Approach to E2.0: The Case of Social Enterprise - First Results from a 1-Year Field Research," *Communications in Computer and Information Science* (19:2008), pp. 92.

Cronin, J. J. "Upgrading to Web 2.0: An Experiential Project to Build a Marketing Wiki," *Journal of Marketing Education* (31:1), 2009, pp. 66-75.

Davidson, R., and J. MacKinnon. "Convenient Specification Tests for Logit and Probit Models," *Journal of Econometrics* (25:3), 1984, pp. 241-262.

Davis, G. F. "Do Theories of Organizations Progress?" *Organizational Research Methods* (13:4), 2010, pp. 690-709.

Day, G. "Creating a Superior Customer-Relating Capability," *MIT Sloan Management Review* (44:3), 2003, pp. 77-82.

Devaraj, S., and R. Kohli. "Performance Impacts of Information Technology: Is Actual Usage the Missing Link?" *Management Science* (49:3), 2003, pp. 273.

Dougherty, D. "Interpretive Barriers to Successful Product Innovation in Large Firms," *Organization Science* (3:2), 1992, pp. 179-202.

Dougherty, D., and T. Heller. "The Illegitimacy of Successful Product Innovation in Established Firms," *Organization Science* (5:2), 1994, pp. 200.

Fichman, R. G. "Going Beyond the Dominant Paradigm for Information Technology Innovation Research: Emerging Concepts and Methods," *Journal of the Association for Information Systems* (5:8), 2004, pp. 314.

Fichman, R., and C. Kemerer. "The Assimilation of Software Process Innovations: An Organizational Learning Perspective." *Management Science,* 1997, pp. 1345.

Frishammar, J., and S. Hörte. "Managing External Information in Manufacturing Firms: The Impact on Innovation Performance," *The Journal of Product Innovation Management* (22:3), 2005, pp. 251-266.

Fun, R., and C. Wagner. "Weblogging: A Study of Social Computing and its Impact on Organizations," *Decision Support Systems* (45:2), 2008, pp. 242.

Georgellis, Y., P. Joyce, and A. Woods. "Entrepreneurial Action, Innovation and Business Performance: The Small Independent Business," *Journal of Small Business and Enterprise Development* (7:1), 2000, pp. 7-17.

Gilbert, R. "Looking for Mr. Schumpeter: Where are we in the Competition-Innovation Debate?," *Innovation Policy and the Economy,* 2006, pp. 159.

Gordon, S., and M. Tarafdar. "How do a Company's Information Technology Competences Influence its Ability to Innovate?" *Journal of Enterprise Information Management* (20:3), 2007, pp. 271-290.

Gray, P. H., S. Parise, and B. Iyer. "Innovation Impacts of using Social Bookmarking Systems," *MIS Quarterly* (35:3), 2011, pp. 629-643.

Greene, W. H. *Econometric Analysis*, Prentice Hall, Upper Saddle River, NJ, 2003.

Grover, V., J. Teng, A. Segars, and K. Fiedler. "The Influence of Information Technology Diffusion and Business Process Change on Perceived Productivity - the IS Executive' Perspective," *Information & Management* (34:3), 1998, pp. 141-159.

Han, S., and T. Ravichandran. "Does IT Impact Firm Innovativeness ? : An Empirical Examination of Complementary and Direct Effects," *Proceedings of the Twelfth Americas Conference on Information Systems,*2006, pp. 704-715.

Hart, C. "Customers are Your Business," *Marketing Management* (8:4), 1999, pp. 6.

Hausman, J. A. "Specification Tests in Econometrics," *Econometrica* (46:6), 1978, pp. 1251-1271.

Heim, G., and D. Peng. "The Impact of Information Technology use on Plant Structure, Practices, and Performance: An Exploratory Study," *Journal of Operations Management* (28:2), 2010, pp. 144.

Hitt, L., D. J. Wu, and X. Zhou. "Investment in Enterprise Resource Planning: Business Impact and Productivity Measures," *Journal of Management Information Systems* (19:1), 2002, pp. 71-98.

Hosmer, D., and S. Lemeshow. *Applied Logistic Regression*, John Wiley Sons, Inc., Hoboken, 2000.

Hu, C., Y. Zhao, and X. Zhao. *"Wiki-Based Knowledge Sharing in a Knowledge-Intensive Organization," Integration and Innovation Orient to E-Society,* W. (Boston Wang Springer) (ed.), 2007, pp. 18-25.

Huergo, E. "The Role of Technological Management as a Source of Innovation: Evidence from Spanish Manufacturing Firms," *Research Policy* (35:9), 2006, pp. 1377.

Hurley, R., and G. T. M. Hult. "Innovation, Market Orientation, and Organizational Learning: An Integration and Empirical Examination," *Journal of Marketing* (62:3), 1998, pp. 42.

Igbaria, M., S. Parasuraman, and J. Baroudi. "A Motivational Model of Microcomputer Usage," *Journal of Management Information Systems* (13:1), 1996, pp. 127.

Jarvis, C., S. MacKenzie, and P. Podsakoff. "A Critical Review of Construct Indicators and Measurement Model Misspecification in Marketing and Consumer Research," *Journal of Consumer Research* (30:2), 2003, pp. 199.

Jaworski, B. J., and A. K. Kohli. "Market Orientation - Antecedents and Consequences," *Journal of Marketing* (57:3), 1993, pp. 53-70.

Jayachandran, S., S. Sharma, P. Kaufman, and P. Raman. "The Role of Relational Information Processes and Technology use in Customer Relationship Management," *Journal of Marketing* (69:4), 2005, pp. 177.

Jeppesen, L., and K. Laursen. "The Role of Lead Users in Knowledge Sharing," *Research Policy* (38:10), 2009, pp. 1582.

Joshi, K. D., L. Chi, A. Datta, and S. Han. "Changing the Competitive Landscape: Continuous Innovation through IT-Enabled Knowledge Capabilities," *Information Systems Research* (21:3), 2010, pp. 472.

Kane, G., and R. Fichman. "The Shoemaker's Children: Using Wikis for Information Systems Teaching, Research, and Publication," *MIS Quarterly* (33:1), 2009, pp. 1.

Karimi, J., T. Somers, and Y. Gupta. "Impact of Information Technology Management Practices on Customer Service," *Journal of Management Information Systems* (17:4), 2001, pp. 125-158.

Kashmiri, S., and V. Mahajan. "What's in a Name? an Analysis of the Strategic Behavior of Family Firms," *International Journal of Research in Marketing* (27), 2010, pp. 271-280.

Kearns, G. S., and A. L. Lederer. "The Effect of Strategic Alignment on the use of IS-Based Resources for Competitive Advantage," *The Journal of Strategic Information Systems* (9:4), 2000, pp. 265.

Keeble, D. "Small Firms, Innovation and Regional Development in Britain in the 1990s," *Regional Studies* (31:3), 1997, pp. 281-293.

Kennedy, P. *A Guide to Econometrics.*, Blackwell Publishing, 2008.

Kettles, D., and J. David. "The Business Value of Social Network Technologies: A Framework for Identifying Opportunities for Business Value and an Emerging Research Program," *Proceedings of the Americas Conference on Information Systems*, 2008.

King, J., V. Gurbaxani, K. Kraemer, F. McFarlan, K. Raman, and C. Yap. "Institutional Factors in Information Technology Innovation," *Information Systems Research* (5:2), 1994, pp. 139-169.

Kleis, L., P. Chwelos, R. Ramirez, and I. Cockburn. "Information Technology and Intangible Output: The Impact of IT Investment on Innovation Productivity," *Information Systems Research,* (23:1), 2012, pp. 42-59.

Koellinger, P. "The Relationship between Technology, Innovation, and Firm Performance -- Empirical Evidence from e-Business in Europe." *Research Policy* (37:8), 2008, pp. 1317.

Kogut, B., and U. Zander. "Knowledge of the Firm, Combinative Capabilities and the Replication of Technology," *Organization Science* (3:3), 1992, pp. 383.

Kohli, A., and B. Jaworski. "Market Orientation: The Construct, Research Propositions, and Managerial Implications." *Journal of Marketing* (54:2), 1990, pp. 1.

Kohli, R., and V. Grover. "Business Value of IT: An Essay on Expanding Research Directions to Keep Up with the Times," *Journal of the Association for Information Systems* (9:1), 2008, pp. 23-39.

Kohli, R., and N. Melville. "Learning to Build an IT Innovation Platform," *Communications of the ACM* (52:8), 2009, pp. 122-126.

Kothari, A., and L. Ostroff. "How Web 2.0 is Transforming CRM: Leveraging Social Media to Improve the Customer Experience," *SAP Insider,* 2009, .

Krishnan, M.S., V. Ramaswamy, M. Meyer, and P. Damien. "Customer Satisfaction for Financial Services: The Role of Products, Services, and Information Technology," *Management Science* (45:9), 1999, pp. 1194.

Kristensson, P., J. Matthing, and N. Johansson. "Key Strategies for the Successful Involvement of Customers in the Co-Creation of New Technology-Based Services," *International Journal of Service Industry Management* (19:4), 2008, pp. 474.

Kulp, S., H. Lee, and E. Ofek. "Manufacturer Benefits from Information Integration with Retail Customers," *Management Science* (50:4), 2004, pp. 431.

Kumar, S., V. Dakshinamoorthy, and M. S. Krishnan. "SOA and Information Sharing in Supply Chain: 'how' Information is Shared Matters!" *Proceedings of the International Conference on Information Systems (ICIS),* 2007.

Kumar, V., and D. Shah. "Building and Sustaining Profitable Customer Loyalty for the 21st Century." *Journal of Retailing* (80:4), 2004, pp. 317.

Lai, L., and E. Turban. "Groups Formation and Operations in the Web 2.0 Environment and Social Networks," *Group Decision and Negotiation* (17:5), 2008, pp. 387.

Lawrence, C., and H. Palmer. "Heuristics, Hilary Clinton, and Health Care Reform," *Annual National Meeting of the Midwest Political Science Association, Chicago,* 2002.

Lea, B., W. Yu, N. Maguluru, and M. Nichols. "Enhancing Business Networks using Social Network Based Virtual Communities," *Industrial Management Data Systems* (106:1), 2006.

Leiponen, A., and C. Helfat. "Innovation Objectives, Knowledge Sources, and the Benefits of Breadth," *Strategic Management Journal* (31:2), 2010, pp. 224-236.

Li, Y., C. Tan, H. Teo, and B. Tan. "Innovative Usage of Information Technology in Singapore Organizations: Do CIO Characteristics make a Difference?" *IEEE Transactions on Engineering Management* (53:2), 2006, pp. 177.

Liang, T., and M. Tanniru. "Special Section: Customer-Centric Information Systems," *Journal of Management Information Systems* (23:3), 2007, pp. 9-15.

Lim, B., and J. Wen. "Web Services: An Analysis of the Technology, its Benefits, and Implementation Difficulties," *Information Systems Management* (20:2), 2003, pp. 49.

Lindell, M., and D. Whitney. "Accounting for Common Method Variance in Cross-Sectional Research Designs," *Journal of Applied Psychology* (86:1), 2001, pp. 114.

Liu, H. "Market Orientation and Firm Size: An Empirical Examinationin UK Firms," *European Journal of Marketing* (29:1), 1995, pp. 57-71.

Long, J., and J. Freese. *Regression Models for Categorical Dependent Variables using Stata*, College Station, Tex., Stata Press, 2003.

Lynch, C. G. "TI's Web 2.0 Success Story: Better Customer Service," (2009:7/28), 2009.

Mackinnon, D., and J. Dwyer. "Estimating Mediated Effects in Prevention Studies." *Evaluation Review* (17:2), 1993, pp. 144.

Majchrzak, A. "Comment: Where is the Theory in Wikis?" *MIS Quarterly* (33:1), 2009, pp. 18.

Majchrzak, A., L. Cherbakov, and B. Ives. "Harnessing the Power of the Crowds with Corporate Social Networking Tools: How IBM does it," *MIS Quarterly Executive* (8:2), 2009.

Malhotra, N., S. Kim, and A. Patil. "Common Method Variance in IS Research: A Comparison of Alternative Approaches and a Reanalysis of Past Research," *Management Science* (52:12), 2006, pp. 1865.

Markova, I., and K. Foppa . *"The Dynamics of Dialogue,"* Anonymous Harvester Wheatsheaf, New York, 1990.

Massey, A., M. Montoya-Weiss, and T. O'Driscoll. "Knowledge Management in Pursuit of Performance: Insights from Nortel Networks," *MIS Quarterly* (26:3), 2002, pp. 269.

McAfee, A. "Enterprise 2.0: The Dawn of Emergent Collaboration," *MIT Sloan Management Review* (47:3), 2006.

McAfee, A., and E. Brynjolfsson. "Investing in the IT that Makes a Competitive Difference," *Harvard Business Review* (86:7-8), 2008, pp. 98.

McDougall, P. "Enterprise 2.0: Wachovia Turns to Wikis, Blogs to Support Growth," http://www.informationweek.com/news/internet/web2.0/showArticle.jhtml?articleID=208403368, (2011:9/18), 2008.

McKeen, J., and H. Smith. "Developments in Practice XXVI: Social Networks: Knowledge Management's "Killer App"?" *Communications of the Association for Information Systems,* 2007.
Melville, N., K. Kraemer, and V. Gurbaxani. "Review: Information Technology and Organizational Performance: An Integrative Model of IT Business Value," *MIS Quarterly* (28:2), 2004, pp. 283-322.
Miller, J., and A. Roth. "A Taxonomy of Manufacturing Strategies." *Management Science* (40:3), 1994, pp. 285.
Mishra, A., P. Konana, and A. Barua. "Antecedents and Consequences of Internet use in Procurement: An Empirical Investigation of U.S. Manufacturing Firms," *Information Systems Research* (18:1), 2007, pp. 103.
Mithas, S., J. Khuntia, and P. Roy. "Green Information Technology, Energy Efficiency, and Profits: Evidence from an Emerging Economy," *Proceedings of International Conference on Information Systems,* 2010 .
Mithas, S., M. S. Krishnan, and C. Fornell. "Why do Customer Relationship Management Applications Affect Customer Satisfaction?" *Journal of Marketing* (69:4), 2005, pp. 201.
Molina-Morales, F., and M. Martinez-Fernandez. "Too Much Love in the Neighborhood can Hurt: How an Excess of Intensity and Trust in Relationships may Produce Negative Effects on Firms," *Strategic Management Journal* (30:9), 2009, pp. 1013.
Mueller, B., G. Viering, C. Legner, and G. Riempp. "Understanding the Economic Potential of Service-Oriented Architecture," *Journal of Management Information Systems* (26:4), 2010, pp. 145-180.
Murugesan, S. "Understanding Web 2.0," *IT Professional Magazine* (9:4), 2007, pp. 34-41.
Nambisan, S. "Information Systems as a Reference Discipline for New Product Development," *MIS Quarterly* (27:1), 2003, pp. 1-18.
Nath, A., R. Singh, and L. Iyer. "Web 2.0: Capabilities, Business Value and Strategic Practice," *Journal of Information Science and Technology* (7:1), 2010, .
Neville, J. "X-Treme Web 2.0 -- Specialty Retailer EMS Uses Blogs, Wikis, and BI Tools to Expand Collaboration Internally and with Business Partners," *Optimize* (6:1), 2007.
Nonaka, I. "A Dynamic Theory of Organizational Knowledge Creation," *Organization Science* (5:1), 1994, pp. 14-37.
O'Brien, J. P. "The Capital Structure Implications of Pursuing a Strategy of Innovation," *Strategic Management Journal* (24:5), 2003, pp. 415-431.
Oliver, R. "Whence Consumer Loyalty?" *Journal of Marketing* (63:SUPPL.), 1999, pp. 33-44.
Opler, T., L. Pinkowitz, R. Stulz, and R. Williamson. "The Determinants and Implications of Corporate Cash Holdings," *Journal of Financial Economics* (52:1), 1999, pp. 3.
O'Reilly, T. "What is Web 2.0: Design Patterns and Business Models for the Next Generation of Software," (2009:3/12), 2005.
Orr, B. "Blogging for Profits," *ABA Banking Journal* (96:10), 2004, .
Papazoglou, M., and D. Georgakopoulos. "Service-Oriented Computing," *Communications of the ACM* (46:10), 2003, pp. 24.

Parameswaran, M., and A. Whinston. "Research Issues in Social Computing," *Journal of Association for Information Systems* (8:6), 2007a, pp. 336.
Parameswaran, M., and A. Whinston. "Social Computing: An Overview," *Communications of the Association for Information Systems* (19),2007b, pp. 762-780.
Parasuraman, A., and D. Grewal. "The Impact of Technology on the Quality-Value-Loyalty Chain: A Research Agenda," *Journal of the Academy of Marketing Science* (28:1), 2000.
Paroutis, S., and A. Saleh. "Determinants of Knowledge Sharing using Web 2.0 Technologies," *Journal of Knowledge Management* (13:4), 2009, pp. 52.
Pavlou, P. A., and O. A. El Sawy. "From IT Leveraging Competence to Competitive Advantage in Turbulent Environments: The Case of New Product Development," *Information Systems Research* (17:3), 2006, pp. 198-227.
Payne, A., and P. Frow. "A Strategic Framework for Customer Relationship Management," *Journal of Marketing* (69:4), 2005, pp. 167-176.
Pierce, J., and A. Delbecq. "Organization Structure, Individual Attitudes and Innovation," *The Academy of Management Review* (2:1), 1977, pp. 27.
Podsakoff, P., and D. Organ. "Self-Reports in Organizational Research - Problems and Prospects," *Journal of Management* (12:4), 1986, pp. 531.
Prahalad, C. K., and M. S. Krishnan. *The New Age of Innovation- Driving Co-Created Value through Global Networks*, McGraw-Hill, New York, 2008.
Prahalad, C. K., and V. Ramaswamy. *The Future of Competition: Co-Creating Unique Value with Customers*, Harvard Business School Pub., Boston, Mass., 2004.
Rai, A., R. Patnayakuni, and N. Patnayakuni. "Technology Investment and Business Performance," *Communications of the ACM* (40:7), 1997, pp. 89.
Raman, A., and A. McAfee. "Enterprise 2.0: How a Connected Workforce Innovates," *Harvard Business Review* (87:12), 2009, pp. 80.
Ramasubbu, N., S. Mithas, M. S. Krishnan, and C. Kemerer. "Work Dispersion, Process-Based Learning, and Offshore Software Development Performance," *MIS Quarterly* (32:2), 2008, pp. 437.
Ravichandran, T., and C. Lertwongsatien. "Effect of Information System Resources and Capabilities on Firm Performance: A Resource-Based Perspective," *Journal of Management Information Systems* (21:4), 2005, pp. 237-276.
Ray, G., W. Muhanna, and J. Barney. "Information Technology and the Performance of the Customer Service Process: A Resource Based Analysis," *MIS Quarterly* (29:4), 2005, .
Riegner, C. "Word of Mouth on the Web: The Impact of Web 2.0 on Consumer Purchase Decisions," *Journal of Advertising Research* (47:4), 2007, pp. 436-447.
Rizova, P. "Are You Networked for Successful Innovation?" *MIT Sloan Management Review* (47:3), 2006, pp. 49.
Sabherwal, R., and S. Sabherwal. "Knowledge Management using Information Technology: Determinants of Short-Term Impact on Firm Value," *Decision Sciences* (36:4), 2005, pp. 531-567.
Sambamurthy, V., V. Grover, and A. Bharadwaj. "Shaping Agility through Digital Options: Reconceptualizing the Role of Information Technology in Contemporary Firms," *MIS Quarterly* (27:2), 2003, pp. 237.

Sawhney, M., G. Verona, and E. Prandelli. "Collaborating to Create: The Internet as a Platform for Customer Engagement in Product Innovation," *Journal of Interactive Marketing* (19:4), 2005, pp. 4.
Schlegelmilch, B., and S. Ram. "The Impact of Organizational and Environmental Variables on Strategic Market Orientation: An Empirical Investigation," *Journal of Global Marketing* (13:3), 2000, pp. 11.
Schultze, U., and D. Leidner. "Studying Knowledge Management in Information Systems Research: Discourses and Theoretical Assumptions," *MIS Quarterly* (26:3), 2002, pp. 213.
Seo, D., and A. Rietsema. "A Way to Become Enterprise 2.0: Beyond Web 2.0 Tools," *Proceedings of the International Conference on Information Systems (ICIS),* 2010.
Sethi, R., S. Pant, and A. Sethi. "Web-Based Product Development Systems Integration and New Product Outcomes: A Conceptual Framework," *The Journal of Product Innovation Management* (20:1), 2003, pp. 37.
Shah, D., R. Rust, A. Parasuraman, R. Staelin, and G. Day. "The Path to Customer Centricity," *Journal of Service Research* (9:2), 2006, pp. 113-124.
Sheth, J., R. Sisodia, and A. Sharma. "The Antecedents and Consequences of Customer-Centric Marketing," *Academy of Marketing Science Journal* (28:1), 2000, pp. 55.
Singh, S., and A. Ranchhod. "Market Orientation and Customer Satisfaction: Evidence from British Machine Tool Industry," *Industrial Marketing Management* (33:2), 2004.
Sobel, M. E. *"Asymptotic Confidence Intervals for Indirect Effects in Structural Equation Models," Sociological Methodology,* S. Leinhardt (ed.), Washington DC, 1982, .
Sorensen, J., and T. Stuart. "Aging, Obsolescence, and Organizational Innovation." *Administrative Science Quarterly* (45:2), 2000, pp. 81.
Stenmark, D. "Leveraging Tacit Organizational Knowledge," *Journal of Management Information Systems* (17:3), 2001, pp. 9-24.
Swanson, E. B., and N. Ramiller. "Innovating Mindfully with Information Technology," *MIS Quarterly* (28:4), 2004, pp. 553.
Swanson, E. B. "Information Systems Innovation among Organizations." *Management Science* (40:9), 1994, pp. 1069.
Tanriverdi, H. "Performance Effects of Information Technology Synergies in Multibusiness Firms," *MIS Quarterly* (30:1), 2006, pp. 57-77.
Teo, T., C. Ranganathan, S. Srivastava, and J. Loo. "Fostering IT-Enabled Business Innovation at YCH Group," *MIS Quarterly Executive* (6:4), 2007, pp. 211-223.
Thompson, V. "Bureaucracy and Innovation," *Administrative Science Quarterly* (10:1), 1965.
Tiwana, A., and B. Konsynski. "Complementarities between Organizational IT Architecture and Governance Structure," *Information Systems Research* (21:2), 2010, pp. 288-304.
Tredinnick, L. "Web 2.0 and Business: A Pointer to the Intranets of the Future?" *Business Information Review* (23:4), 2006, pp. 228-234.
Tsai, W. "Social Structure of "Coopetition" within a Multiunit Organization: Coordination, Competition, and Intraorganizational Knowledge Sharing," *Organization Science* (13:2), 2002, pp. 179.

Tsai, W., and S. Ghoshal. "Social Capital and Value Creation: The Role of Intrafirm Networks." *Academy of Management Journal* (41:4), 1998, pp. 464-476.
UCLA: Academic Technology Services, Statistical Consulting Group. "Regression with Stata. (Http://www.Ats.Ucla.edu/stat/stata/webbooks/reg/chapter2/statareg2.Htm),".
Veugelers, R., and B. Cassiman. "Make and Buy in Innovation Strategies: Evidence from Belgian Manufacturing Firms," *Research Policy* (28:1), 1999, pp. 63.
Wagner, C., and A. Majchrzak. "Enabling Customer-Centricity using Wikis and the Wiki Way," *Journal of Management Information Systems* (23:3), 2006, pp. 17.
Wattal, S., P. Racherla, and M. Mandvivalla. "Employee Adoption of Corporate Blogs: A Quantitative Analysis," *Proceedings of the 42nd Hawaii International Conference on System Sciences,* 2009, .
Wattal, S., D. Schuff, M. Mandviwalla, and C. Williams. "Web 2.0 and Politics: The 2008 U.S. Presidential Election and an E-Politics Research Agenda," *MIS Quarterly* (34:4), 2010, pp. 669.
Weiss, A. A. "A Bivariate Ordered Probit Model with Truncation: Helmet use and Motorcycle Injuries." *Journal of the Royal Statistical Society.Series C, Applied Statistics* (42:3), 1993, pp. 487-500.
Whitaker, J., S. Mithas, and M. S. Krishnan. "A Field Study of RFID Deployment and Return Expectations," *Production and Operations Management* (16:5), 2007.
Wolfe, R., and W. Gould. "An Approximate Likelihood-Ratio Test for Ordinal Response Models," *Stata Technical Bulletin* (42), 1998, pp. 24-27.
Ye, F., and R. Agarwal. "Strategic Information Technology Partnerships in Outsourcing as a Distinctive Source of Information Technology Value: A Social Capital Perspective," *Proceedings of International Conference on Information Systems* 2003.
Zhu, K. "The Complementarity of Information Technology Infrastructure and E-Commerce Capability: A Resource-Based Assessment of their Business Value," *Journal of Management Information Systems* (21:1), 2004, pp. 167-202.

Appendix 2

Table B1: Variables				
Concept	**Variable**	**Description**	**Scale**	**Method of Measurement**
Propensity for IT-enabled Business Innovation	*Innov*	Has your organization sought to patent, trademark, or copyright any IT-driven business processes, products, or services in the past 12 months?	Binary	Binary
		Yes/No		
Web 2.0 Technology Use	*Web20Appl*	Are the following technologies widely deployed in your company's IT organization? - Web 2.0 development tools?	Binary	Summative index
		Which new technologies are adopted by your company?		
		Wikis, blogs, other social networking for internal communications	Binary	
		Wikis, blogs, other social networking for external dialog with customers, others	Binary	
		Mash ups that combine Web and enterprise content in new ways	Binary	
SOA Use	*SOA*	Are the following technologies widely deployed in your company?		Summative index
		Services-oriented architecture	Binary	
		Web services (applications using Soap, UDDI, XML)	Binary	
Propensity for IT-enabled customer-centricity	*CustInit*	From the list below, please select up to three ways in which your company plan to innovate with technology in 2008.	Composite	Summative index of number of items chosen among (1), (3), (4), and (9)
		(1) Introduce new IT-led products/services for our customers		
		(2) Lower IT costs/business costs		
		(3) Improve customer service		
		(4) Improve customer experience		
		(5) Make business processes more efficient		
		(6) Improve interaction with partners & suppliers		
		(7) Pursue new global opportunities		
		(8) Get better business intelligence to more employees, more quickly		
		(9) Engage customers in new ways		
		(10) Move organization toward an eco-friendly IT environment		
		(11) Create a new business model/revenue stream for the company		
Proxy for prior customer-related IT investments	*EncrCustRecords*	Are encrypted customer records widely deployed in the firm? ('Widely deployed' means that more than half of the IT organization has access to it)	Binary	Binary
IT Intensity	*ITIntensity*	What percentage of your company's worldwide annual sales revenue did its total worldwide IT budget represent?	Continuous (Percentage)	Unidimensional
Inherent innovativeness in IT	*ITNewProjects*	What percentage of your organization's worldwide IT budget, including capital and operating expenses, is devoted to new projects (as opposed to ongoing maintenance)?	Continuous (Percentage)	Unidimensional
IT R&D Intensity	*ITR&Dintensity*	What percentage of your organization's worldwide IT budget, including capital and operating expenses, is devoted to Research and Development (not including salaries)?	Continuous (Percentage)	Unidimensional

Chapter 4

Conclusion

In this Chapter, I connect the empirical results to the theory discussed in Chapter 1. Chapter 1 proposed the IT-enabled business innovation is driven by the technical and social dimensions of the firm's architecture. Leadership and Web 2.0 technologies comprise part of the social and technical architecture respectively of the firm. Despite developments in practice about the role of the CIO and Web 2.0 technologies, academic research has, to my best knowledge, not kept pace with empirically examining whether or how the role of the CIO and Web 2.0 technologies may drive IT-enabled business innovation.

The study on the CIO role (Chapter 2) theorized that the boundary-spanning role of the CIO external to the IT organization is a key factor driving IT-enabled business innovation. About three decades ago, when the CIO role was first established in companies, CIOs would typically be focused on technology operations of the IT organization. However, even though the role of the CIO is now evolving to encompass large parts of the business, it is unclear whether and how the CIO role plays a part in IT-enabled business innovation. Debates persist around the role of the CIO. The results of this study (Chapter 2) suggest that the CIO's boundary-spanning role is an important factor in IT-enabled business innovation. By studying the role of the CIO external to IT, this chapter builds on the theoretical argument in Chapter 1 that IT-business linkages and decision-making are important mechanisms linking the social architecture to IT-enabled business innovation. The CIOs boundary spanning role can be a catalyst for improved understanding between IT and the business (IT-business linkages) which can result in improved decision-making in the organization. In sum, specific underlying mechanisms facilitating IT-enabled business innovation can be enhanced by the role of the CIO as a boundary-spanner between IT and external entities.

The study on Web 2.0 technologies (Chapter 3) examined how Web 2.0 technology use by firms may improve their propensity for IT-enabled business innovation and propensity for IT-enabled customer-centricity. The findings from this chapter suggest that Web 2.0 technologies can drive IT-enabled business innovation by several of the underlying mechanisms identified in Chapter 1: integration across organizational silos, access to knowledge, and agility in the organization. For example, Web 2.0 technologies can improve knowledge sharing and creation by increasing the access to weak ties among employees in the organization and by converting some potential ties to weak or strong ties. The findings of Chapter 3 suggest empirical credence to the theoretical model in Chapter 1.

Taken together, the empirical studies (Chapter 2 and Chapter 3) suggest support to some parts of the theoretical framework (in Chapter 1) for the link between IS resources and IT-enabled business innovation. The studies contribute to enhanced collective understanding of how firms can leverage IS resources for IT-enabled business innovation.

Nevertheless, there is still much to be learnt about how IS resources drive business innovation. Future research can examine a broad range of questions related to IT and business innovation. First, the phenomena can be examined at the level of analysis of group, team, and individual. Such studies can, for example, include the use of particular technologies at the team level.

Second, future research can empirically examine other mediating mechanisms linking the role of the CIO and use of Web 2.0 technologies to IT-enabled business innovation. For example, while the work in this dissertation empirically examines the relationship between the IT and business innovation, the underlying links can be further empirically investigated by future research. For example, such work can include empirical examination of how interaction of CIOs with customers may help IT gain quicker access to customer-related ideas. Future research can also probe deeper into our finding of insignificant effect of involvement of CIO in the business strategy. Perhaps there are organizational and IT-related contingencies that moderate the relationship. Similarly, another potential area for further research is empirically examining how Web 2.0 technology use provides opportunities for knowledge-sharing, specific learning capabilities, and agility which can drive innovation.

Third, future research can explore how IT influences business innovation by complementing other organizational capabilities, for example organizational structure and culture. Fourth, future studies can also address how IT facilities the involvement of partners, customers and suppliers in the innovation process. Finally, future research can extend the analysis conducted in this dissertation and explore alternate metrics of IT-enabled business innovation. One potential metric can be created by classifying patents into categories or classes.

In sum, as demonstrated in the theory and empirical analyses described herein, the area of IT-enabled business innovation is fertile ground for further research. The theoretical framework and empirical studies in this dissertation can serve as a motivation for future research to further explore questions at the nexus of IT and business innovation.