

Outsourcing of IT Services: Studies on Diffusion
and New Theoretical Perspectives

by

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ABSTRACT

Information technology (IT) outsourcing, including foreign or offshore outsourcing, has been steadily growing over the last two decades. This growth in IT outsourcing has led to the development of different hubs of services across nations, and has resulted in increased competition among service providers. Firms have been using IT outsourcing to not only leverage advanced technologies and services at lower costs, but also to maintain their competitive edge and grow. Furthermore, as prior studies have shown, there are systematic differences among industries in terms of the degree and impact of IT outsourcing. This dissertation uses a three-study approach to investigate issues related to IT outsourcing at the macro and micro levels, and provides different perspectives for understanding the issues associated with IT outsourcing at a firm and industry level. The first study evaluates the diffusion patterns of IT outsourcing across industries at aggregate level and within industries at a firm level. In addition, it analyzes the factors that influence the diffusion of IT outsourcing and tests models that help us understand the rate and patterns of diffusion at the industry level. This study establishes the presence of hierarchical contagion effects in the diffusion of IT outsourcing. The second study explores the role of location and proximity of industries to understand the diffusion patterns of IT outsourcing within clusters using the spatial analysis technique of *space-time clustering*. It establishes the presence of simultaneous space and time interactions at the global level in the diffusion of IT outsourcing. The third study examines the development of specialized hubs for IT outsourcing services in four developing economies: Brazil, Russia, India, and

China (BRIC). In this study, I adopt a theory-building approach involving the identification of explanatory anomalies, and propose a new hybrid theory called- *knowledge network theory*. The proposed theory suggests that the growth and development of the IT and related services sector is a result of close interactions among adaptive institutions. It is also based on new knowledge that is created, and which flows through a country's national diaspora of expatriate entrepreneurs, technologists and business leaders. In addition, relevant economic history and regional geography factors are important. This view diverges from the traditional view, wherein effective institutions are considered to be the key determinants of long-term economic growth.

This work is dedicated

to my husband and dearest friend

Suhas Kulraj Bhardwaj

I give my deepest expression of love and appreciation for the encouragement and support you gave

&

to my parents

Ranbir Singh Mann and Rashmi Mann

who passed on a love of reading and respect for education

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TABLE OF CONTENTS

	Page
LIST OF TABLES	viii
LIST OF FIGURES	ix
CHAPTER	
1 INTRODUCTION	1
2 ARE THERE CONTAGION EFFECTS IN THE DIFFUSION OF INFORMATION TECHNOLOGY AND BUSINESS PROCESS OUTSOURCING?	7
Introduction.....	7
Theory	12
Diffusion of Innovation.....	12
Contagion Effects.....	13
Sources of Influence	16
Data, Analysis Procedure and Empirical Model.....	19
Data.....	19
Analysis Procedure	22
Empirical Model development for Firm-Level Analysis.....	24
Empirical Model Extension for Firm-Level Analysis	26
Industry-Level Analysis.....	27
Results and Discussion	29
Results of Analysis of Outsourcing Patterns at the Firm and Industry Levels.....	30

CHAPTER	Page
Results of Firm-Level Analysis	32
Results of Industry-Level Analysis.....	35
Key Findings and Limitations of Chapter 2.....	39
3 SPATIAL AND TEMPORAL TRENDS IN IT OUTSOURCING.....	44
Introduction.....	44
Theory	48
Data, Analysis Procedure and Method.....	51
Data.....	51
Analysis Procedure	52
Space-Time Clustering Methods.....	53
Results ad Discussion	57
Spatial and Temporal Patterns	57
Space-Time Cluster Analysis.....	60
Key Findings and Limitations of Chapter 3.....	75
4 IT SERVICES SECTOR GROWTH IN THE BRIC ECONOMIES	81
Introduction.....	81
Theory Development	84
Method: Theory Building with Anomalies.....	87
Long-Run Performance and Effective Institutions	89
New Knowledge, Global Interdependence, and Networks.....	92
Country Characteristics, Economic History, and Geography	95

CHAPTER	Page
Evidence from the BRIC Countries	98
Brazil.....	100
Russia.....	105
India	107
China.....	115
Evidence from Cross-Case Analysis.....	122
Key Findings and Limitations of Chapter 4.....	130
6 SUMMARY, IMPLICATIONS AND CONTRIBUTIONS.....	133
Summary of Findings.....	133
Implications.....	135
Contributions.....	137
REFERENCES	139
APPENDIX A.....	152

LIST OF TABLES

Table	Page
1. IT Outsourcing Predicted Distributions for Deals in US\$, 1999-2008.....	32
2. Announcement Frequency by Firm Size for Outsourcing Deal Sizes	34
3. Influence Model Estimation Results by Industry.....	37
4. IT Outsourcing Space-Time Cluster	68
5. Theoretical Perspectives	86
6. Early Policies in Brazilian IT and Related Services Industry.....	100
7. Globalization in Brazil.....	104
8. Globalization in Russia.....	107
9. Early Policies in Indian IT and Related Services Industry	110
10. Globalization in India	114
11. Early Policies in Chinese IT and Related Services Industry.....	115
12. Globalization in China	118
13. Summary of Theoretical Constructs	120
14. ICT Services Exports (% of total services exports).....	127
15. Summary of Propositions.....	130
A1. Education and Demographic Trends.....	153
A2. Information and Communication Technologies (ICT) in BRIC Countries ..	153

LIST OF FIGURES

Figure	Page
1. Empirical Analysis Procedure.....	22
2. Total IT Outsourcing in US\$ in Four IT-Intensive NAICS Industries by Year 1999-2007	30
3. IT Outsourcing Deals in U.S. in Four IT-Intensive NAICS Industries, 1999- 2007.....	31
4. IT Outsourcing in Four IT-Intensive Industries in US\$ by NAICS Industry, 1999-2007	31
5. Analysis Procedure	53
6. IT outsourcing Announcements, 2000-2010.....	58
7. Space-Time Views of IT Outsourcing Announcements	59
8. p -values of the Jacquez Test for Selected Values of k	62
9. Distances Associated with the Jacquez Test for Selected Values of k	63
10. Times Associated with the Jacquez Test for Selected Values of k	63
11. IT Outsourcing Space-Time Clusters.....	67
12. Industry and IT Outsourcing Function Interaction	70
13. Evaluation Procedure	88
14. The Key Constructs of Knowledge Network Theory	122

Chapter 1. Introduction

Over the last two decades, as corporations have searched for ways to grow and maintain their competitive edge, outsourcing has emerged as a strategic choice for achieving those goals through cost control. Gartner, one of the leading information technology (IT) research firms, predicted that the market for business process outsourcing (BPO) services would expand from US\$160.7 billion in 2007 to US\$235.2 billion by 2011, a compound annual growth rate of 10.3% (Musico 2008). As IT outsourcing and offshoring have grown, so has the presence of service providers in the domestic and international markets. Many hubs of IT outsourcing service providers have developed based on the types of specialized services they provide; this is especially true of the hubs in India, China, Central and South America, Russia, and the Philippines. According to the United Nations Conference on Trade and Development's (UNCTAD 2009) *Information Economy Report*, the value of the global market for IT and information and communications technology (ICT) enabled services was about US\$90 billion in 2008, of which IT services accounted for 60%. Also, in 2004, five countries—Canada, China, India, Ireland, and the Philippines—accounted for 95% of the total market for BPO services. But, by 2008, their combined share shrank to 80% as attractive new locations emerged in places such as Malaysia, Singapore, Brazil, Mexico, Argentina, Poland, and Romania.

Despite the economic downturn, the global outsourcing market continued to grow steadily in 2010; transaction volumes in North America and Europe were

higher than 2009 volumes by 20% and 17%, respectively, which indicated a revival of activities in these geographies (Everest Research Group 2010). For many developing countries, the IT and related services industry is a driver of economic growth. This dissertation deals with macro and micro-level issues associated with IT outsourcing. In particular, it evaluates the diffusion patterns of IT and related services outsourcing across industries and within industry clusters in the United States. It also examines the factors behind the development of specialized services hubs across developing countries.

Onshore and offshore IT outsourcing has made a dramatic difference across various industries, such as banking and finance, healthcare, telecommunications, etc. It has developed from being an inexpensive way to support non-crucial services to being strategically important for businesses. With the growing importance of services outsourcing in today's economy, researchers have begun to examine its economic impact (Olsen 2006). Some studies have found evidence of positive productivity impacts of services outsourcing. For instance, Raa and Wolff (2001) found that productivity growth in U.S. manufacturing industries was positively related to an increased use of services outsourcing. Similarly, Amiti and Wei (2006) found that foreign services outsourcing contributed to higher labor productivity growth in U.S. manufacturing industries. Han et al. (2011) have shown that IT outsourcing makes a positive contribution to the output and productivity in U.S. industries, and IT services outsourcing in particular, adds substantially greater value to the U.S. economy compared with outsourcing in

other areas. Han et al. (2011) also revealed systematic differences across industries with respect to the degree and impact of IT outsourcing.

These studies raise several questions. How has IT outsourcing spread within different industries and across firms? What are the different factors influencing the diffusion of IT outsourcing? This dissertation deals with these issues, and attempts to answer the questions posed above.

The first study of this three-study dissertation answers the following questions. How do IT and business process outsourcing spread at the firm level? Can IT outsourcing be explained by a pure diffusion process alone, or is there a contagion process involved? Do mega-deals of more than US\$1 billion affect the observed patterns of diffusion? What are the different sources of influence?

The second study adopts a different perspective. It uses the spatial analysis technique of *space-time clustering*, which is widely used in the epidemiology literature to evaluate whether events are close geographically and temporally. It is used to provide evidence that common factors are responsible for observed events (Selvin 1991; Mantel 1967; Lilienfeld and Lilienfeld 1980). The study evaluates the diffusion patterns of IT outsourcing within space-time clusters in the United States. In this study, I ask the following questions. How does IT outsourcing diffuse across a space-time cluster? What role does industry similarity play in the diffusion of IT outsourcing within a cluster?

IT outsourcing is unique in many respects, which makes it an interesting area of research from the client and vendor perspectives. The spatial distribution of IT outsourcing providers is marked by the development of different hubs, which

specialize in different services across nations. For instance, Israel is well known for security software; India is a popular producer of business process outsourcing services; and Russia is associated with application development.

This raises the following additional questions. What are the factors that are responsible for the development of IT and related services hubs? Is it economic and political institutions? Or, is it history-driven path dependence, resulting in the development of specific resources? Or, is it geography resulting in knowledge spillovers? A well-rounded understanding of these factors and issues is imperative for policymakers in the client and the service-providing countries.

The third study, using the approach of theory development through anomalies (Carlile and Christensen 2005), develops a new *knowledge network theory* to integrated theory to explain the growth and development of IT services outsourcing in different emerging economies and the factors that are most influential in the various places.

This dissertation draws upon theories in the fields of information systems (IS), economics, regional economics, epidemiology, political science, sociology, and marketing. Specifically, the three studies rely on theories of political and economic institutions and new growth from economics literature, the theory of diffusion from sociology and marketing literature, and network effects from the IS literature. I also leverage ideas related to scale and scope externalities, the concepts of urbanization and localization, and brain circulation theory from regional economics literature. Finally, I consider contagion effects theory from epidemiology and political science. I discuss the theoretical perspectives used for

the three studies in detail within the individual studies in the remainder of this work.

This dissertation uses both quantitative and qualitative techniques of analysis. The quantitative techniques used include the lognormal distribution model and non-linear least squares estimation of different diffusion models to empirically validate the hypotheses. Additionally, I will use spatial econometric methods for space-time clustering to evaluate IT outsourcing diffusion patterns within space-time clusters. For one of the studies, I will use a multiple case study analysis approach. I will perform within-country, as well as cross-country case analyses.

A key contribution of this dissertation is establishing the presence of hierarchical contagion effects in the diffusion of IT outsourcing by analyzing data at the industry and firm levels. Understanding the diffusion patterns of IT and business process outsourcing has practical implications for both vendors and clients. Vendors stand to gain by making information public about their contracts and deals, especially if they have high-profile clients or high-value contract deals. To take advantage of the contagion effects, vendors should optimize their pricing strategy and better equip themselves to meet the increased demand by scaling their operations. Since understanding the diffusion process is crucial for the timing of outsourcing decisions, clients can take advantage of this knowledge. They can leverage economies of scale, especially if they decide to outsource when the IT and outsourcing contagion is spreading.

The second contribution is a theoretical explanation of the specialized services growth that is observed in the IT and related services sector in a number

of emerging economies. The proposed theory suggests that the growth and development of the IT and related services sector is a result of close interactions among adaptive institutions. It is also based on new knowledge that is created by information spillovers, especially how information flows through a country's diaspora of expatriate entrepreneurs, technologists and business leaders. In addition, relevant economic history and regional geography factors are important. This view diverges from the traditional view, wherein effective institutions are considered to be the key determinants of long-term economic growth.

Finally, this dissertation brings the perspective of regional and urban economics into IS research and draws upon spatial econometric methods to understand the diffusion patterns of IT outsourcing within industry clusters.

The remainder of this work is organized as follows. Chapters 2 and 3 discuss the micro-level issues associated with IT outsourcing and are focused on understanding the diffusion patterns of IT outsourcing across firms and industries. Chapter 4 discusses the macro-level issues associated with IT outsourcing and focuses on developing theory to explain the growth and development observed in the IT and related services sector of several emerging economies. This hybrid theory is called *knowledge network theory*. Chapter 5 brings together the findings of the three studies and also discusses interpretations and implications.

Chapter 2. Are There Contagion Effects in the Diffusion of Information

Technology and Business Process Outsourcing?

2.1. Introduction

IT outsourcing involves “contributions by external vendors [to] the physical and/or human resources associated with ... components of the IT infrastructure in the user organization” (Loh and Venkatraman 1992b, p. 336). Over the last two decades, IT spending and outsourcing have grown quickly and spread widely. In 2007, Gartner predicted global IT services spending to grow by 7.3% annually to US\$958 billion in 2011 (De Souza et al. 2007). Forrester Research predicted that IT spending in the United States would reach US\$568 billion in 2010, nearly one-third of global IT spending of US\$1.6 trillion (*Supply Demand Chain Executive* 2010). This included a 3.8% gain in business process outsourcing, somewhat less than the cumulative annual growth of 10.9% from 2005 onwards that the consultancy, IDC, had been predicting (ZDNet Research 2005). Another 2010 study by Accenture (McCartney 2010) indicated that business process outsourcing spending grew more rapidly than IT outsourcing, with estimates that IT outsourcing spending will be between US\$230 and US\$250 billion, while business process outsourcing spending is likely to grow to US\$300 billion by 2012. *Business process outsourcing* is the contracting of a specific business process or service to a third party, and often involves IT outsourcing (Frauenheim 2003). It includes software, process management, and people to operate the service that are outsourced.

The main objective of this study is to understand the underlying factors of IT outsourcing growth and establish the extent to which the spread of IT and IT-supported business process outsourcing is subject to contagion effects in their observed patterns of growth. In addition to this, the study also analyzes the factors that influence the diffusion of IT and business process outsourcing, and tests models that help understand the rate and patterns of diffusion at the industry level. In particular, the goal is to provide evidence for the presence of *contagion effects*. They are “the spread of a particular type of behavior through time and space as a result of a prototype or model performing the behavior and either facilitating that behavior in the observer or reducing the observer’s inhibitions against performing that same behavior” (Midlarsky 1978, p. 1006). Contagion effects are present in the spread of diseases, and have *precipitating events* – like initial infection – that prompt diffusion across a population (Midlarsky et al. 1980; Rogers 1995).

Such precipitating events often occur at random, independent of each other and across locations (Dornbusch et al. 2000). The intention is to look for evidence that runs counter to the observation that IT outsourcing will exhibit linear growth. This is similar to what one might observe with the diffusion of diseases also, where predisposing factors and population characteristics lead to the non-linear, non-random spread of epidemics. This analogy provides support for understanding how diffusion of IT outsourcing has occurred at the industry level.

For nearly two decades now, academicians have been conducting research on outsourcing. Most studies have focused on a particular aspect of outsourcing. Aubert et al. (1998) studied the risks that are involved, while Lacity and

Willcocks (1998) examined best practices in outsourcing. Loh and Venkatraman (1992b) are known for exploring the reasons that firms engage in outsourcing. Other research by Kern and Willcocks (2002) has shown that firms tend to form focal outsourcing relationships with their IT services suppliers. Walden (2005) studied how firms deal with intellectual property rights and their division in IT outsourcing relationships, which is also likely to affect the diffusion of outsourcing practices. More recently, Goo et al. (2009) evaluated the role of service-level agreements in relational management of IT outsourcing, and Benaroch et al. (2010) modeled and analyzed how to price back-sourcing options in IT services outsourcing contracts. Also, Han et al. (2011) empirically evaluated the contribution of IT services outsourcing as intermediate inputs to production in an analysis of industry-level output and productivity. They suggested its increasing importance in the American and global economies across many different industries.

Two notable studies have explored the sources of influence in the adoption of IT outsourcing. Loh and Venkatraman (1992b) treated IT outsourcing as an administrative innovation and focused on the factors in its adoption using diffusion modeling at the firm level. They found that in the adoption of IT outsourcing, internal influences and imitative behavior play a more important role compared to external influences and the mass media. The authors analyzed Eastman Kodak's widely-publicized outsourcing decision in 1989 as a critical event. They found that internal influences were more pronounced in the post-Kodak regime. In this research, they coined the term *Kodak effect*, as a means to indicate

the influence of one firm's outsourcing announcement on the decision-making at other firms. Another study by Hu et al. (1997) used a sample of 175 firms to test for different sources of influence on the adoption of IT outsourcing. They found that the mixed influence model was more effective in characterizing the diffusion of IT outsourcing. They tested for the Kodak effect in diffusion, but found no evidence of any differences between the results of different influence models in the pre-Kodak and post-Kodak regimes, contradicting Loh and Venkatraman's (1992b) findings.

The focus of this study is on trying to understand the extent to which contagion effects drive the spread of IT outsourcing, and what factors influence these contagion effects. First, I assess whether IT outsourcing follows a pure diffusion process at the firm level, by estimating a lognormal distribution. This permits evaluation of whether there are contagion effects present in data. Random, independently-occurring, large dollar mega-deals may act as precipitating events for outsourcing contagion, and large firms may act as exemplars for smaller ones, reducing smaller firms' inhibition to outsource. I will use firm size as a stratifier. It is representative of other possible stratifiers in the illustration of the methodology in this research.

Second, the study tests two flexible S-curve diffusion models and the factors that influence the adoption of IT outsourcing at the industry level. These additional tests at the industry level offer four distinct benefits. (1) Evaluating the factors that drive the contagion effects at an industry-level is a way of providing additional evidence on the phenomenon that is being studied – through

“triangulation” with data at a more aggregated level of analysis. (2) Analyzing industry-level data gives an opportunity to evaluate models that posit different structures for the communication channels to the marketplace. In this work, I evaluate the extent to which the internal and external communication channels were active. (3) This also provides an opportunity to showcase corroborating results with respect to other research. In particular, it provides an option to explore the explanatory capacity of the mixed influence model as the primary evaluator of the relationships in the data, and from this, to draw conclusions about the importance of the internal communication channel relative to the external communication channel in explaining the contagion outcomes. (4) Further, it provides a basis for evaluating other empirical models to obtain insights into the different diffusion patterns for IT outsourcing in several different industries.

To understand the underlying factors and test for contagion effects, I address the following research questions. How do IT and business process outsourcing spread at the firm level? Can IT outsourcing be explained by pure diffusion with no contagion effects? Or is there a contagion process involved? What role do different communication channels play? Do mega-deals of more than US\$1 billion affect the observed patterns of diffusion?

To understand the diffusion patterns and to examine whether IT outsourcing follows a pure diffusion process or there are contagion effects involved, I estimate a *lognormal diffusion curve* (Aitchison and Brown 1957). This permits gauging the consequences of outsourcing events, and the effects of different orders of magnitude in IT contract amounts. The study also evaluates the sources of

influence in IT outsourcing diffusion at the industry level (Mahajan 1985; Mahajan et al. 1990). Using firm size as a stratifier, I assess how firms may act as market exemplars, reducing a market observer firm's inhibitions against adopting IT outsourcing (Midlarsky 1978).

The next section presents the theory and hypotheses for this research. I then test these hypotheses with firm-level and industry-level data. Finally, I present a broader discussion and interpretation of what I learned, and offer a summation of the main results and limitations.

2.2. Theory

IT outsourcing and IT-related business process outsourcing account for a large share of the overall outsourcing activities related to IT, and so they are appropriate for this research. I consider the *diffusion of innovation theory* and other precursors to *contagion effects theory* to develop insights on IT outsourcing diffusion at an industry and a firm level.

2.2.1. Diffusion of Innovations

The *diffusion of innovation* is the process by which information about an innovation is communicated over time among members of a social system, leading to adoption (Rogers 1995). Diffusion has been shown to follow an S-shaped curve with five phases. Each represents a proportion of the total number of adopters up to some time: innovators, early adopters, early majority, late majority, and laggards. Diffusion also involves *network externalities*, representing the boost in value a participant derives from the network as others join it (Rohlf's 1974).

With interdependent demand, multiple equilibria can exist at any price. Another

related concept in diffusion studies is *critical mass*, which indicates the time in the diffusion process when the number of adopters is sufficiently large to naturally sustain further growth of adoption (Markus 1987). Sometimes, critical mass is referred to as a *tipping point* because the rate of adoption increases rapidly after critical mass is reached. Mahler and Rogers (1999) suggest that adoption and critical mass involve decision-making by individuals who have insights about other potential adopters, thus influencing their own decisions.

Midlarsky (1978, p. 1006) defines *diffusion* as “the spread of a particular type of behavior through time and space as the result of the cumulative impact of a set of statistically independent events.” Thus, a way to understand the process of IT outsourcing diffusion is to model the connectedness of the events that precede outsourcing deals. I view *randomly-occurring, independent precipitating events*, such as mega-deals, as potentially influencing the later diffusion of IT and business process outsourcing. This occurs on a *proportional basis*: the number of new outsourcing deal announcements is proportional to the number of deals that have been concluded. Hence, I assert:

- **Hypothesis 1 (The Randomly Proportional Outsourcing Diffusion Hypothesis):** *The set of responses reflecting IT outsourcing diffusion is randomly proportional to independently occurring, random precipitating events.*

2.2.2. Contagion Effects

Contagion effects theory posits the connectedness of adoption events over time, and offers a refined expression of the diffusion of innovation theory (Kauffman

and Techatassanasoontorn 2009). Contagion effects arise in two ways. The first is *spillovers* that are due to interdependencies among market activities: aligned management interests, or business activities in an industry, in a region, or across firms with similar interests or operating characteristics, etc. Another way contagion effects arise is based on macroeconomic drivers that are external to business, industry, and geography.

Another perspective for why we might observe contagion effects with IT outsourcing is *social contagion*. It occurs when organizations feel social pressure to adopt an innovation that increases in proportion to the extent of prior adoption (Greve 1995; Teo et al. 2003). This perspective is based on social learning theory (Bandura 1977) and neo-institutional theory (DiMaggio and Powell 1983; Rowan 1982). *Social learning theory* posits that people engage in social learning by examining the actions of similar peers. People communicate with each other, or observe the actions of others, as well as the consequences of those actions. They also rely on rational processing of information gained from observing their peers, which may lead to making adoption decisions similar to their peers (Bikhchandani et al. 1992).

Neo-institutional theory deals with the forces that lead to institutional isomorphism, which represents institutional constraints that are imposed on the firms in an organization that lead to homogeneity of structure (DiMaggio and Powell 1983). Researchers recognize three forces that cause this: *coercive forces* arising from societal expectations; *normative forces* arising from professionalization; and *mimetic forces* arising from the tendency to imitate peers

perceived to be successful under conditions of uncertainty (DiMaggio and Powell 1983; Fichman 2004).

In the context of IT outsourcing within industries such as banking and finance, the IT outsourcing adoption decision is often influenced by institutional forces (Ang and Cummings 1997), while for small and medium firms it may be influenced by coercive, normative, or mimetic forces. In the presence of social contagion, the adoption decision is contingent on a firm's own assessment of the innovation's merits, and on who the prior adopters are (Fichman 2004). Thus, in an industry, large prominent firms may serve as exemplars for smaller firms, influencing their outsourcing adoption decisions. This is what was observed when IBM and Eastman Kodak entered into their IT services outsourcing contract in 1989 (Halvey 2003), and when Nortel Networks and PricewaterhouseCoopers signed a US\$625 million business process outsourcing deal in 2000 (Foran 2000). There was a surge in IT outsourcing announcements then, and for small and medium-sized firms, IT outsourcing all of a sudden became a desirable strategic choice. Similar waves of outsourcing have occurred when large, prominent firms have entered into large-scale IT services contracts.

Another stream of research in which contagion effects theory is relevant is political science. It is used to explain the adoption of innovations (Gray 1973) and social security policy by states (Collier and Messick 1975), the growth of terrorism (Midlarsky et al. 1980) and other phenomena. Midlarsky's (1978) study of urban disorders in 1960s tests whether the spread of civil disorders in small cities in the United States can be attributed to *baseline diffusion effects* as well as

to *stratifying effects*. The proposed relevant contagion effect is the association between civil unrest in smaller cities and what has occurred in the larger cities – a large city to small city effect. This may occur even though there are differences in the critical mass of the minority populations in the smaller cities.

Contagion effects theory has been used to explain the adoption patterns of successive generations of technology in analog and digital wireless phones (Kauffman and Techatassanasoontorn 2006). In the present context, evidence for contagion effects might include a significant increase in the number of IT outsourcing contract announcements in a period immediately following earlier periods with IT outsourcing announcements from large leading firms. *Leading firms* may act as models for other firms to emulate. Variables that influence the observed outcomes can be assessed. Such stratifiers may occur with industries, geography, firms, strategic business units, senior managers, and so on. Hence, I assert:

- **Hypothesis 2 (The Stratified Outsourcing Adoption Hypothesis):** *With contagion effects, the diffusion of outsourcing depends on the influence of variables that act as stratifiers for the settings under which specific diffusion patterns are observed.*

2.2.3. Sources of Influence

To compete successfully, it is necessary for a firm to update and adjust its strategy based on what it learns from its environment. Managerial decision-making is often influenced by such informational updates (Dixit and Pindyck 1994). Prior research shows that a firm's decision to outsource is influenced by internal

factors, such as its financial constraints, its strategy and size, and its business sector. In addition, there may be factors that create external influences. These include institutional pressures, interpersonal and media channels, and risks, such as hidden costs, the inability to control the vendor, and loss of innovative capacity. There are also benefits from cost advantages, the improved focus on the strategic use of IT, and new access to management skills that become available. Depending on which of the factors are prominent, and whether the benefits associated with outsourcing outweigh the associated risks, the firm will decide whether outsourcing offers an appropriate value proposition. Thus, to get a better understanding of how the diffusion process for outsourcing is occurring across an industry, it is important to understand the roles of the different factors that influence a firm's decision-making.

Based on diffusion of innovation theory, different *communication channels* often act as the conduits for the major *sources of influence* in the adoption of innovations. Three models have been extensively used to study the diffusion of innovation in marketing, telecommunication and IT: the internal influence model, the external influence model and the mixed influence model.¹ This study focuses on the *mixed influence model*. It states that potential adopters are influenced by internal sources, especially information from current adopters, and external

¹ The *external influence model* suggests that the potential adopters of an innovation are influenced by information from sources external to the adopters' social system, such as the industry, economy or country (Dos Santos and Peffers 1998; Mahajan 1985). In the external influence model, the mass media channels are considered as the main communication channels. In contrast, the *internal influence model* suggests that an increase in the number of new adoptions is driven by influence from current adopters through their communication and interaction with potential adopters, like word of mouth.

sources outside the adopters' social system (Bass 1969; Dos Santos and Peffers 1998). For IT outsourcing diffusion, potential adopters may be influenced by both external sources (e.g., vendors or service providers) and internal sources (e.g., competing firms), so a mixed influence model may be the best representation of the process.

Using the concepts of *critical mass* and the *tipping point*, Meade and Islam (1998) characterize the different diffusion models and include the location of the *inflection point for growth* and the *symmetry of the diffusion curve*. The inflection point characterizes the penetration rate of a diffusion process in terms of when peak adoption occurs. Curve symmetry captures the inter-temporal acceleration and deceleration of the diffusion rate. It is important to understand the rates and curve symmetry within an industry because these patterns give us an insight into how IT and business process outsourcing are diffusing within an industry over time. Diffusion patterns can be symmetric or asymmetric because the maximum rate of adoption can occur at any time during the diffusion process. Diffusion is symmetric when the adoption process rate is the same before and after peak adoption. Asymmetric diffusion can occur under different conditions, for instance, when rapid diffusion occurs in the initial period followed by slowing adoption during the following periods or vice versa.

Different models of diffusion vary based on their curve symmetry and inflection points for growth. The external influence model has a constant rate of growth but no inflection point. The internal and mixed influence models are symmetric; the internal influence model has a fixed inflection point whereas the

mixed influence model has a flexible inflection point. The Gompertz model is asymmetric but has a fixed inflection point. The Weibull model can be symmetric or asymmetric, and has a flexible inflection point for diffusion growth. *Flexible diffusion models* with fixed or flexible inflection points and asymmetric shapes potentially provide a better fit for the observed patterns (Geroski 2000; Mahajan 1985; Mahajan et al. 1990). For IT outsourcing across different industries, I believe that the Weibull model, which is the most flexible model out of the models considered, may be able to best capture the IT outsourcing diffusion pattern.

The Randomly Proportional Outsourcing Diffusion Hypothesis (H1) characterizes the patterns of IT outsourcing. The Stratified Outsourcing Adoption Hypothesis (H2) does this at a more fine-grained level. The observed effect could be from larger to smaller firms, or between firms in close proximity. This study considers only the influence of firm size. The flexible diffusion models with flexible curve symmetry and the inflection point allow for fitting a flexible diffusion model for the patterns across different industries. This supports our general understanding of the different rates and patterns of IT and business process outsourcing diffusion across these industries.

2.3. Data, Analysis Procedure and Empirical Model

2.3.1. Data

I used two data sets for the empirical research in this study. One data set captures IT outsourcing information at the industry level, and includes annual data for 60 non-farm industries in the U.S. private sector from 1998 to 2007. I obtained it

from the Bureau of Labor Statistics (BLS) and the Bureau of Economic Analysis (BEA). The industries are defined by three-digit 1997 North American Industry Classification System (NAICS) codes. These data show the value of output produced by one industry that is purchased and used by another industry for all possible pairs of the industries whose inputs and outputs are tracked in a given year. An industry's *IT outsourcing* is measured as services purchased from two IT services industries: Data Processing Services (NAICS 5142) and Computer Systems Design and Related Services (NAICS 5415). The most common areas for IT outsourcing are systems development and integration, software and hardware maintenance and support, and data processing and management (Toolbox.com 2004). This IT outsourcing measure, based on intermediate purchases from the two IT services industries, closely matches the definition of IT outsourcing.

Chain-type quantity indices are used as deflators, a relatively standard choice, which shows the growth of output or other variables over time, holding prices constant (Rossiter 2000).² I use the industry-level data set to analyze the empirical regularities, as well as to test the influence models and other critical

² The BEA introduced these indices in 1996 to improve the accuracy of its estimates of the growth in real GDP by eliminating the bias present in fixed-weight indices that had been used. The chain-type Fisher index addresses the problem of choosing the base period for measures of real output and prices to which all other periods are compared. This index is the geometric mean of the conventional fixed-weighted Laspeyres index, which uses the weights of the first period in a two-period setting, and the Paasche index, which relies on the weights of the second period. Changes in the Fisher index are calculated using the weights of adjacent years. These annual changes are chained or multiplied together to form a time-series that allows for the effects of changes in relative prices and in the composition of output over time. See Landefeld and Parker (1997) for additional details.

mass and diffusion growth inflection point models for the overall diffusion process.

The other data set consists of announcements of IT and business process outsourcing deals. It was collected from a full-text search of firm announcements related to IT and business process outsourcing between April 1, 1999 and December 31, 2008. Two leading news sources: *PR Newswire* and *Business Wire* were used. The online *Lexis/Nexis* database was used to search the news wires for announcements containing the words “deal” or “contract” or “launch” or “announcement” in the same sentence as the words “BPO” and “IT,” and “outsourcing” or “offshoring.” The search yielded 643 announcements in total, of which 295 announcements had information about IT or business process outsourcing.

Not all of the relevant details – for example, dollar amounts for the contracts required for analysis – were found in the company announcements, however. To collect these data, I searched other secondary sources, including trade journals, company websites, magazine articles, and newspaper articles. I took extra care to differentiate between independent announcements and announcements that were a part of ongoing deals, and to only include independent announcements. I collected only firm-level announcement data that involved either clients or vendors or both that were located in the U.S., to maintain consistency across the industry- and firm-level data.

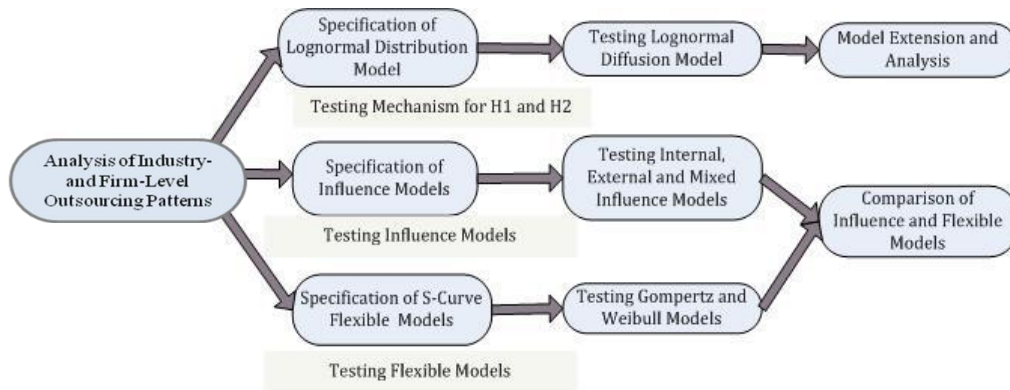
To test for contagion effects a subset of the data that had complete information required for the analysis, especially the dollar amount of the

outsourcing deals that firms announced and the firm size, was used. For this analysis, the final data set was somewhat smaller, with 80 announcements.

2.3.2. Analysis Procedure

Figure 1 shows the analysis procedure.

Figure 1 Empirical Analysis Procedure



First, I compared the trend patterns at the firm and industry levels for four IT-intensive industries: Broadcasting and Telecommunications (NAICS 513), Banking and Finance (NAICS 521, 522, 523), Computer Systems Design and Related Services (NAICS 5415), and Healthcare Services (NAICS 621, 622). I used industry-level IT outsourcing data and firm-level IT and business process outsourcing announcement data for comparison. Then, I applied the lognormal diffusion model to explore IT outsourcing diffusion patterns at the firm level. When the lognormal diffusion model failed to adequately capture the diffusion patterns of IT outsourcing at the firm level, I extended the model to test for underlying contagion effects.

To understand the effects of different sources of influence on IT outsourcing diffusion patterns at the industry level, I specified a mixed influence model, and

tested it using non-linear least squares. I also checked the internal and external influence models during the analysis process. In addition to the influence models, I also evaluated the Gompertz and Weibull S-curve models. I further used the industry-level data to analyze the influence models because “a key aspect of the Bass model is that it addresses the market in the aggregate ... The emphasis is on total market response rather than an individual customer” (Mahajan et al. 1990, p. 6). The aggregate data that I obtained for the four industries were more suitable for the analysis of diffusion models than the announcement data obtained across the industries. The announcement data provide incomplete information about the adoption of IT outsourcing across different industries. This is because not all outsourcing contracts are announced to the extent that they are picked up in the business press. Thus, with the announcement data, it is difficult to obtain reliable estimates for market potential and the coefficients of innovation and imitation, which are known to be highly sensitive to small variations (Bass 1969).

The observed patterns in the industry-level IT outsourcing data set were compared with those in the announcement data. The focus was on data from 1999 to 2007 for a few industries that have high *IT outsourcing intensity*. To measure an industry’s IT outsourcing intensity, I used industry-level data, and divided the amount of IT outsourcing by the amount of output created. I picked industries that ranked high on the list. These industries also have the largest share of the worldwide IT and business process outsourcing market, according to *Business Wire* (2004) and Plunkett Research (2009). They include Broadcasting and Telecommunications (NAICS 5130), Banking and Finance (NAICS 5210, 5220

and 5230), Computer Systems Design and Related Services (NAICS 5415), and Healthcare Services (NAICS 621, 622).

2.3.3. Empirical Model Development for Firm-Level Analysis

Thereafter, I examined the overall patterns of outsourcing at the firm level over time with a methodology based on the estimation of a *lognormal diffusion model* (Aitchison and Brown 1957; Midlarsky 1978). The reason for its use is its emphasis on the *proportionate effect* of the diffusion process. The lognormal distribution model has been used to describe different growth processes (e.g., personal income, gross national income, etc.). It incorporates an assumption of *independence* regarding the observations that exhibit diffusion, and a high degree of *skewness* (lack of distributional symmetry) and *leptokurtosis* (more observations near the mean of the distribution) compared to other distributions (Aitchison and Brown 1957). This allows me to test whether IT outsourcing deals follow a pure diffusion process, or if a contagion effects-influenced process is more appropriate. The conjecture is that outsourcing diffusion develops over time via a mechanism in which each additional increment of outsourcing-related events is proportional to the existing size of the process, based on the current installed base of outsourcing contracts (Midlarsky 1978).

The lognormal diffusion model is:

$$x_i - x_{i-1} = \mu_i x_{i-1} \tag{1}$$

μ_i represents a set of mutually-independent random drivers for IT outsourcing growth, and x_i represents the dollar amounts associated with $i = 1$ to n outsourcing announcements. The dollar amount is used because all the variation among the

announcements and the responses to mega-deals is expressed by the different dollar amounts of the contracts.³ Responses to the mega-deals are not the same across all of the industries though; some deals are small with a low-dollar value, and some deals are large with a high-dollar value. This model can be interpreted as the *change in the dollar amount of IT outsourcing as a result of an additional announcement*, and is proportional to the size of the dollar amount of the IT outsourcing contract. It can be stated as the fundamental equation for a lognormal distribution (Aitchison and Brown 1957):

$$\log x_n = \log x_0 + \mu_1 + \mu_2 + \dots + \mu_n. \quad (2)$$

The value of $\log x_n$ is normally-distributed in the limit by the additive form of the central limit theorem. So x_n also is lognormally-distributed as

$$f(x) = \frac{1}{x\sigma\sqrt{2\pi}} \exp\left[-\frac{1}{2}\left(\frac{\log x - m}{\sigma}\right)^2\right], x > 0, \text{ with } m \text{ as the mean of } \log x \text{ and}$$

standard deviation σ . The parameters m and σ can be estimated by two additional equations:

$$m = \frac{\sum_{i=1}^n \log_2 x_i}{n} \quad (3)$$

$$\sigma^2 = \frac{\sum_{i=1}^n (\log_2 x_i - m)^2}{n-1} \quad (4)$$

This model gives an opportunity to test whether the data exhibit proportional behavior. If the model does not fit the lognormal distribution, it means that IT

³ The dollar amounts of the outsourcing deals were converted to their real dollar values in 2005 U.S. dollars, using the price deflators for industry output for the years 1998 to 2008 from the BEA, with 2005 as the base year.

outsourcing does not follow a pure diffusion process. Then a natural choice is to extend it to include other variables, a different functional form, or different underlying assumptions to capture the true behavior.

2.3.4. Empirical Model Extension for Firm-Level Analysis

To capture the patterns of diffusion beyond the lognormal model, the equation is transformed to represent the data in longitudinal form (Midlarsky 1978). I evaluated the data longitudinally as the sum of the dollar amounts of outsourcing deal announcements. These should approximate a straight line if the announcements occur randomly. I also tested the data for the presence of a stratifying effect in diffusion for IT outsourcing. This effect is represented in terms of firm size, in particular, large and small firms. Diffusion patterns in prior studies suggest that such a contagion effect may come into play when we see a rapid increase in the outcome variable of interest (DeLone 1981; Kauffman and Techatassanasoontorn 2006). In this case, it is the number of outsourcing announcements following the news of a mega-deal. To test for this kind of contagion, I analyzed outsourcing announcement frequency by firm size for different time periods. I also used the number of employees as a proxy for firm size.⁴ I also checked for over-representation or under-representation of mid-size to small firms.

⁴ The firms were classified into the following firm size categories, based on the proxy, number of employees: extra small with less than 1,000 employees; small with greater than 1,000 but less than 10,000 employees; medium with more than 10,000 but less than 50,000 employees; large with greater than 50,000 but less than 100,000 employees; and extra large with greater than 100,000 employees.

The dollar amount associated with announcements is specified as x_i , with μ_i representing the random, precipitating event, the *mega-deals*, $x_1 = k_1 e^{\mu_1}, x_2 = k_2 e^{\mu_2}, \dots, x_n = k_n e^{\mu_n}$, where k_i is a *proportionality constant* between the dollar amount and the exponential function. Multiplying terms by one another gives:

$$\prod_{i=1}^n x_i = \prod_{i=1}^n [k_i e^{\mu_i}] = \left[\prod_{i=1}^n k_i \right] e^{\mu_i} = (k_1 k_2, \dots, k_n) e^{\mu_1 + \mu_2 + \dots + \mu_n} \quad (5)$$

$$\log(x_1 x_2 \dots x_n) = \sum_{i=1}^n \log x_i = k'(\mu_1 + \mu_2 + \dots + \mu_n), \quad (6)$$

Taking the log of Equation 5 gives Equation 6 where k' is the value of proportionality constant after taking the log. Precipitating incidents occur in time order, so that μ_n occurs after μ_{n-1} . Thus, $\sum_{i=1}^n \log x_i = k''t$, the logs of the dollar amounts of the outsourcing deals are proportional to time, where k'' is the value of the proportionality constant after taking the sum of the log values.

2.3.5. Industry-Level Analysis

I next analyzed the effects of different sources of influence on IT outsourcing diffusion patterns at the industry level. It is important to understand the role of different communication channels in the diffusion process because this gives us insight into firm-to-firm interactions within an industry and how the diffusion process works in different industries over time. Learning about the influence of different communication channels helps in recognizing how the contagion is spreading within an industry as well, which may come about as a result of

external stimuli or internal interactions or a combination of both. Furthermore, testing for the two flexible S-curve models will shed light on the diffusion patterns of IT outsourcing for different industries, and it will reveal whether the diffusion patterns are symmetric or asymmetric. Thus, they will be left-skewed or right-skewed, which may indicate the propensity toward early adoption or late adoption. Finally, testing for the influential factors and diffusion patterns at the industry level provides additional evidence about the contagion effects at the more aggregate level of analysis, and this can help to build a “weight of evidence” beyond the firm-level analysis.

The study focuses on the four groups of IT-intensive industries discussed earlier. Under the *mixed influence model* the rate of diffusion is driven by internal and external influences (Mahajan et al. 1990).⁵ The mixed influence model is:

$$N(t) = dN(t) / dt = [p + qN(t)] [m - N(t)] \quad (7)$$

Solving Equation 7 gives the functional form for the model (Srinivasan and Mason 1986):

$$N(t) = [1 - \exp(-(p + q)t)] / [1 + (p/q) \exp(-(p + q)t)] \quad (8)$$

⁵ Under the internal influence model, the rate of adoption depends on the extent of previous adoption in the social system (Dos Santos and Peffers 1998; Mahajan 1985; Mahajan et al. 1990). The diffusion rate is $dN(t) / dt = qN(t)[m - N(t)]$, where $dN(t) / dt$ is the number of adopters at time t , $N(t)$ is the cumulative number of adoptions at time t , q is the coefficient of internal influence, and m is the market potential. Solving the diffusion rate equation gives us the following functional form, $N(t) = m / [1 + ((m - m_0) / m_0) \exp(-qmt)]$, where m_0 is the number of adopters in the initial period. Under the external influence model, the rate of diffusion at time t is dependent only on the number of potential adopters (Loh and Venkatraman 1992a, 1992b; Mahajan et al. 1990). The diffusion rate is $dN(t) / dt = p[m - N(t)]$, where p is the coefficient of external influence. When we rearrange the terms of this equation, we obtain $N(t) = m[1 - \exp(-pt)]$.

Continuing to analyze the different diffusion patterns at the industry level, I estimated two additional models for the four IT-intensive industries discussed earlier. The diffusion rate equation for the Gompertz model is given by:

$$dN(t) / dt = qN(t) [\log m - \log N(t)] \quad (9)$$

where $dN(t) / dt$ is the number of adopters at time t , $N(t)$ is the cumulative number of adoptions at time t , q is the coefficient of internal influence, and m is the market potential. The solution of the rate equation for the Gompertz model is given by:

$$N(t) = m \exp [-(\log(m/N_0) \exp (-q (t - t_0)))] \quad (10)$$

The functional form of the Weibull model, in contrast, is:

$$dN(t) / dt = m(\beta / \alpha)(t / \alpha)^{\beta-1} e^{-(t/\alpha)^\beta} \quad (11)$$

where $dN(t) / dt$ is the number of adopters at time t , m is the market potential, α is the parameter for scale and β for shape (Sharif and Islam 1980). The solution of the rate equation for the Weibull model is:

$$N(t) = m(1 - e^{-(t/\alpha)^\beta}) \quad (12)$$

2.4. Results and Discussion

I will present the results of the analysis of outsourcing patterns using firm-level and industry-level data first. Then, I will show the results of evaluating the Randomly Proportional Outsourcing Diffusion Hypothesis (H1) based on the firm-level announcement data. I will analyze these data using the lognormal diffusion model, which evaluates the overall diffusion pattern of IT outsourcing at the firm level. To capture the underlying contagion effects, I tested the Stratified Outsourcing Adoption Hypothesis (H2) using firm-level data and follow this with

discussion. Then, using the industry-level IT outsourcing data, I fit the mixed influence model at the industry level, and further evaluated the Gompertz and Weibull models to test curve symmetry and the inflection point for growth. Finally, I will discuss the results and their implications.

2.4.1. Results of Analysis of Outsourcing Patterns at the Firm and Industry Levels

I compared the patterns in the industry-level IT outsourcing data to those associated with the firm-level announcement data in the four IT-intensive industries we defined above. I focused on 1999 to 2007. (See Figures 2, 3 and 4.)

Figure 2 Total IT Outsourcing in US\$ in Four IT-Intensive NAICS Industries by Year, 1999-2007

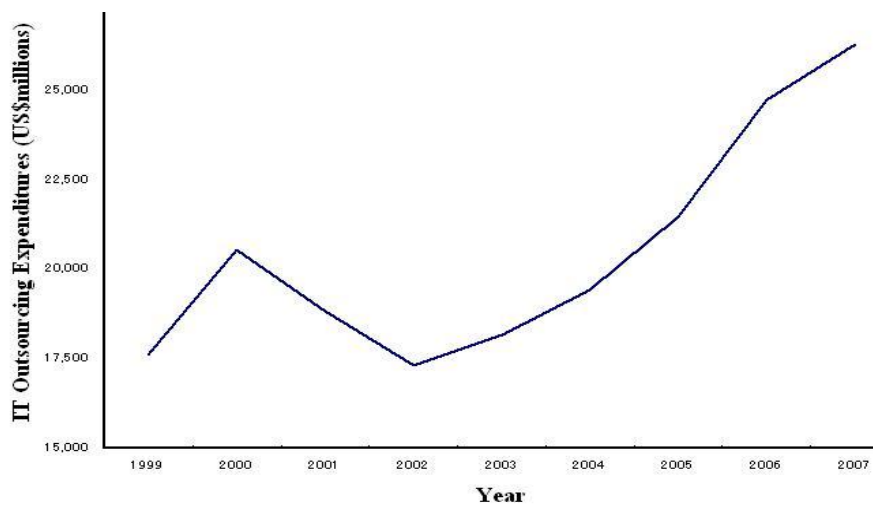


Figure 3 IT Outsourcing Deals in the U.S. in Four IT-Intensive NAICS Industries, 1999-2007

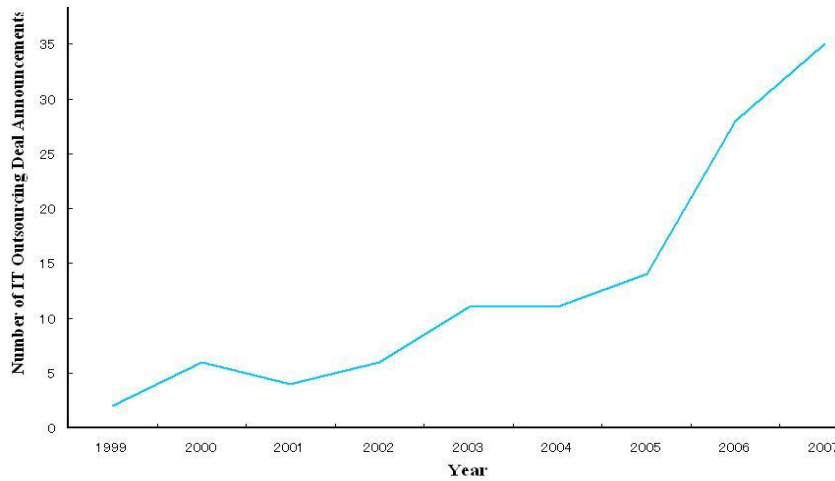
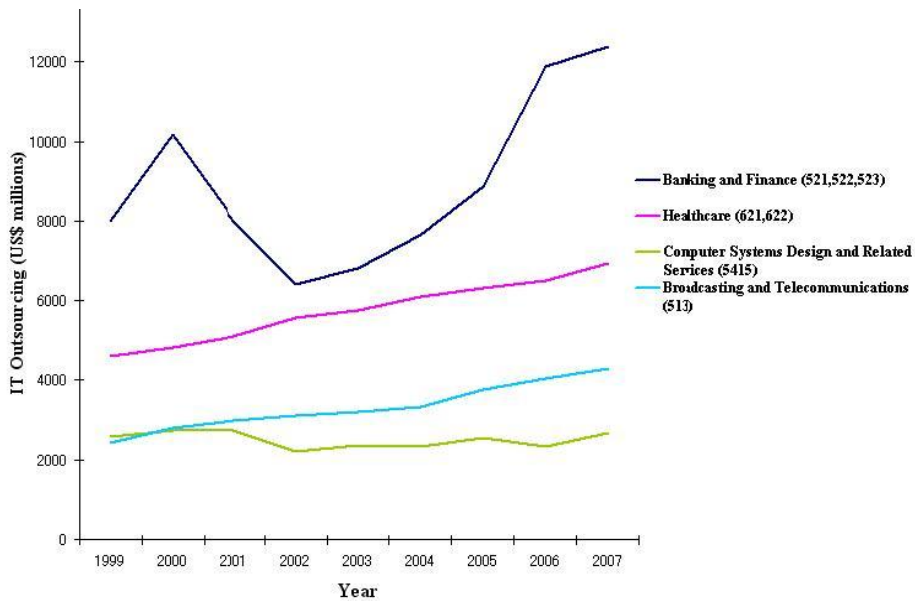


Figure 4 IT Outsourcing in Four IT-Intensive Industries in US\$, by NAICS Industry, 1999-2007



The industry-level data show that there was growth in total outsourcing from 1999 to 2000, and then a decline from 2000 to 2002, after which steady growth is again observed. At the firm-level, there were similar patterns, except for 2001 to 2002, where growth was observed in the number of announcements. These observations suggest that IT outsourcing has been growing in the IT-intensive

industries from 2003 onwards, and the outsourcing announcement data generally reflect the industry trends, except in 2001 and 2002.

Somewhat different patterns emerged when the four IT-intensive industries are compared. IT outsourcing spending in Healthcare Services, and Broadcasting and Telecommunications grew linearly over the period. In contrast, IT outsourcing spending in the Computer Systems Design and Related Services industry hardly grew, while the Banking and Finance industry's spending grew through the Year 2000 (Y2K) systems expenditures, but then fell sharply for two years as the financial markets absorbed the shocks of the September 11, 2001, terrorist attacks and economic growth stalled.

2.4.2. Results of Firm-Level Analysis

The Randomly Proportional Outsourcing Diffusion Hypothesis (H1) Results. To test this hypothesis, I used firm-level deal announcement data collected from 1999 to 2008. The approach involves log base 10 arithmetic values for the U.S. dollar amounts to define the announcement categories: 10^5 for \$100,000 to \$1,000,000, 10^6 for \$1,000,000 to \$10,000,000, etc. (See Table 1.)

Table 1 IT Outsourcing Predicted Distributions for Deals in US\$, 1999-2008

Outsourcing Deal Range	LOG ₁₀ US\$	Frequency	Expected Frequency
10^5 : US\$100,000 - 1 million	5	11	2.74
10^6 : US\$1 - 10 million	6	16	12.54
10^7 : US\$10 - 100 million	7	24	26.18
10^8 : US\$100 million – 1 billion	8	21	24.98
10^9 : US\$1- 10 billion	9	8	10.89

Notes. Lognormal distribution of dollar amounts for outsourcing deals; 80 announcements total; mean by deal range of 7.44 in log base 10 format. Std. dev. = 1.13. $\chi^2 = 27.37$ with 2 d.f. ($p < .05$).

All outsourcing contract announcements had a value of more than US\$100,000 or 10^5 dollars. The beginning points of each range represent the log values. This choice doesn't affect the conclusions that were drawn, since it applies to all IT outsourcing deal dollar ranges. The values of $\log x_i$ are normally-distributed, which is necessary to implement the χ^2 test. The values obtained with $k - 3$ degrees of freedom, with k representing the number of categories are reported. The χ^2 test was significant at $p < 0.05$. Thus, the null hypothesis that the data follow a lognormal distribution was rejected. For the US\$ categories 10^5 (\$100,000 - \$1,000,000) and 10^6 (\$1,000,000 – \$10,000,000), the observed values were higher than the expected values.

In contrast, the observed values in the middle range of US\$1 million to US\$1 billion were under-represented. The under-representation of US\$1 billion-plus deals can be explained by industry trends. Not many mega-deals have been signed in the IT outsourcing industry. Those that have been signed include services contracts for multiple locations across multiple nations and sometimes even multiple business functions. The number of vendors that can provide such large-scale services based in the U.S. is small, as suggested by the data. The results indicate that the lognormal distribution is not capable of characterizing the diffusion patterns of IT outsourcing for the data and time period that was used, even though the lognormal model is generally appropriate for representing over-dispersed data. The data may be over-dispersed beyond the range of a lognormal distribution, making it unsuitable. Another possibility is that some other process is

at work, so the combination of multiple processes makes a single pattern-based representation of the lognormal model ineffective.

Stratified Outsourcing Adoption Hypothesis (H2) Results. To test for contagion effects due to firm size, I analyzed outsourcing announcement frequency by firm size for different time periods. I used the number of employees for firm size and checked for over-representation or under-representation of mid-size to small firms based on a cutoff of 76,000 employees. I tested whether the proportion of smaller firms was greater in the contagion periods compared to the non-contagion periods, as suggested by the theory. Contagion periods are the time periods where rapid increases in the number of announcements was observed following either mega-deal announcements or multiple announcements above US\$100 million. I observed a greater proportion of smaller firms in the contagion periods. (See Table 2.)

Table 2 Announcement Frequency by Firm Size for Outsourcing Deal Sizes

Periods	Firms with < 76,000 Employees	Firms with > than 76,000 Employees
10 ⁵ : US\$100,000 - 1 million	5	11
10 ⁶ : US\$1 - 10 million	6	16
10 ⁷ : US\$10 – 100 million	7	24
10 ⁸ : US\$100 million – 1 billion	8	21
10 ⁹ : US\$1 - 10 billion	9	8

Notes. $\chi^2 = 5.36$, 1 d.f., $p < .05$. There are 21 announcements in the data set for which no client information were available, and so we did not include them. 59 observations were used for the χ^2 test of independence.

Out of the 295 announcements in this study, 80 had complete information related to the dollar amount of the deal. This permitted the identification of their log range for outsourcing deal size, and simultaneously enabled their inclusion in

this part of the study. The χ^2 test of independence (Lehmann and Romano 2005) was used to establish the contagion period for the firm size effect, as indicated by the higher frequency of smaller firms. The null hypothesis that the number of small firms (31) and the number of large firms (9) were not statistically different can be rejected ($\chi^2 = 5.36, p < 0.02$). Other values for the firm size stratifier associated with a different number of employees as the criterion level for large and small firms were also evaluated. For example, I found that splitting the data based on the number of employees less than or greater 76,000 in the firm was the appropriate level for this stratifier.

2.4.3. Results of Industry-Level Analysis

Sources of the Influence Results. To test for the fit of the mixed influence models, I used data for the four IT-intensive industries from 1999-2007 and non-linear least squares estimation (Srinivasan and Mason 1986).⁶ Full results are reported for the mixed-influence model using ordinary least squares (OLS) estimation, our base case results. I used the estimation results for the m , p , and q parameters as starting values for the non-linear estimations of the model, as a means to assure convergence for the parameter estimates. I further assessed model performance based on *model fit* via the proportion of variance explained by adjusted- R^2 and the overall model quality using the F test values. Only the results of the mixed-

⁶ The Levenberg-Marquardt method was used instead of the more standard Gauss or Newton-Raphson methods. This is appropriate for estimation when model the parameters may be highly correlated (Marquardt 1963), so it was a safe choice for the data set and others that involve the influence models.

influence model are reported; the internal and external-influence models did not always converge.

Table 3 shows the results. The first part of the table presents the OLS results for the mixed influence model, and the partial results using non-linear estimation.⁷ The second part of the table presents the estimation results for the Gompertz and Weibull models using non-linear estimation.

⁷ Estimation results for internal and external models could not be established due to the lack of convergence of the non-linear estimation algorithm. Because the sample size was small, we used the estimation technique of bootstrapping with replacement to see if we could obtain results, but our capability to do so was mixed.

Table 3 Influence Model Estimation Results by Industry

Industries by NAICS Codes	Influence Model Variables				
	M	p	q	Adj.- R^2	F
Mixed Influence Model (Estimated using ordinary least squares)					
Broadcasting and Telecom	29,921	0.08**	0.14**	0.96	106.40***
Banking and Finance	80,191	0.11**	0.03**	0.63	7.91**
Comp. Sys. Design and Related Services	22,536	0.12	0.06	0.13	1.64
Healthcare Services	51,708	0.08***	0.15***	0.98	355.46***
Mixed Influence Model (Estimated Using Non-Linear Least Squares)					
Broadcasting and Telecom	33,475**	0.099**	0.267**		294***
Banking and Finance	94,640**	0.026**	0.118**		136.2***
Comp. Sys. Design and Related Services	26,005**	0.007**	0.257**	N.A.	649.9***
Healthcare Services	62,152**	0.092**	0.178**		455.2***
Gompertz Model	M	p	q	Adj. R^2	RMSE
Broadcasting and Telecom	69,639***	N.A.	0.150***	0.99	654.4
Banking and Finance	216,881***		0.131***	0.99	2293.5
Comp. Sys. Design and Related Services	41,604***		0.167***	0.99	570.5
Healthcare Services	130,085***		0.143***	0.99	1,108.8
Weibull Model	M	α	β	Adj. R^2	RMSE
Broadcasting and Telecom	15,900,000***	6,572,090***	1.15***	0.99	142.3
Banking and Finance	611,000,000***	41,839***	1.06***	0.99	2188.1
Comp. Sys. Design and Related Services	29,200,000***	15,749***	0.96***	0.99	155.3
Healthcare Services	638,000,000***	13,100,000***	1.15***	0.99	305.0

Notes. m is the market potential, p is the coefficient of external influence, and q is the coefficient of internal influence. We report the significance via the F -values for all models for which estimation was possible. The F -values of the mixed influence model were significant at 0.01 level and the parameter values were significant at 0.05 level, except for Healthcare Services (NAICS 621, 622) using OLS estimation, where the parameter values were significant at 0.01 level. Unable to obtain coefficient estimates due to lack of convergence of the non-linear least squares estimation using both the Newton-Raphson method and the Levenberg-Marquardt methods in some cases (Marquardt 1963). For the Weibull model, α is the scale parameter and β is the shape parameter. For the Gompertz and Weibull models, I report the root mean squared error (RMSE) values and the adjusted- R^2 values. The estimated values of the Gompertz and Weibull model were all significant at the 0.01 level.

Critical Mass and Flexible Inflection Point for Growth Results. To test for the fit at the industry level of the critical mass and flexible growth inflection point

models with the Gompertz and Weibull models, I used non-linear estimation again. The empirical evidence based on the R^2 values and the significance of the estimated parameters suggests that the Gompertz model and the Weibull model offer equally good fit for all four industries. The adjusted- R^2 values of 0.99 were high for both the models and the estimated parameters were significant at a 0.01 significance level. Conclusive results from the comparative analysis of the R^2 values and the significance of the estimated coefficients could not be drawn. The *root mean square error* (RMSE) evaluates goodness of fit. The model that has the lowest RMSE value is the best model to explain the diffusion pattern for IT outsourcing. Based on the comparison of the RMSE values, the Weibull model provides the best fit for the diffusion pattern of IT outsourcing across different industries.

The Weibull model has two parameters, α for scale and β for shape. Based on the estimated value of β that was obtained, the diffusion curves for all four industries appear to be left-skewed. This means that their inflection points for growth occur before the 50% level of possible IT outsourcing contracts are observed. It further suggests that the growth curves are relatively flat, based on the high values of α and β . The Weibull model provides a better fit because it allows for the diffusion curve to be asymmetric and the location of the inflection point for growth to be flexible. The Gompertz curve, in contrast, allows for an asymmetrically-shaped curve but has a fixed inflection point.

Based on the OLS estimates, the mixed influence model provides a good fit for diffusion of outsourcing in Broadcasting and Telecommunications (adj.- $R^2 =$

0.96), the Healthcare Services industry (adj.- $R^2 = 0.98$) and Banking and Finance (adj.- $R^2 = 0.63$). These results indicate that the mixed influence model captures the effects of the sources of influence on the overall diffusion patterns of IT outsourcing. The non-linear estimation results for the mixed influence model for Computer Design and Related Services showed the values of the external influence parameter ($p = 0.007$, 0.05 significance level) and the internal influence parameter ($q = 0.257$, 0.05 significance level). For the Healthcare Services industry, the values of the external influence parameter ($p = 0.092$, 0.05 significance level) and the internal influence parameter ($q = 0.178$, 0.05 significance level) also were significant.

Since the estimated values of p are smaller than the estimated values of q in all three industries, it appears that the internal influence channel via word of mouth plays a bigger role in the diffusion of IT outsourcing than the external influence channel does via the mass media. The values of the internal influence q parameter estimates (ranging from $q = 0.14$ to 0.17) obtained from OLS and the Gompertz model estimation were significant. The values of the potential market parameter m varied for all of the industries across all of the models. Since not every model has all the same parameters, it is hard to draw strong conclusions from this observation though.

2.5. Key Findings and Limitations of Chapter 2

Explaining diffusion patterns of IT and business process outsourcing in their many observed forms has been of long-standing interest to business leaders,

policy-makers and researchers. The focus has been on understanding this from the perspective of contagion effects theory.

In the first part of my study, I asserted that the diffusion patterns for IT and business process outsourcing will be randomly proportionate to the set of announcements that occurred in the market, and that these are responses to prior precipitating events. This makes observed diffusion non-linear. It was also asserted that, in the presence of contagion effects, the diffusion of IT outsourcing from large firms to small firms will depend on the extent of outsourcing penetration in large firms.

I obtained evidence to show that the diffusion of IT outsourcing is not distributed lognormally, contrary to what would be indicated in the absence of any contagion effects. Instead, the analysis showed the presence of other underlying drivers that do not allow the diffusion pattern to be lognormal. So an analysis of the frequency of outsourcing announcements based on firm size was done. I observed that there was an increase in the frequency of smaller firms announcing outsourcing deals during periods of contagion for outsourcing deals, suggesting that outsourcing deals cannot be explained by a pure diffusion process that does not include any consideration of contagion effects. I also obtained evidence for the presence of a contagion effect with a stratifying variable that captured relative firm size in the data set.

In the second part of the study, I evaluated the roles of different sources of influence on the overall diffusion patterns of IT outsourcing at the industry level. The evaluation of the mixed influence model associated with the Bass model,

along with the Gompertz and Weibull models, yielded insights on the underlying influences on the diffusion process that shaped the visible patterns. The symmetric and asymmetric growth curve models offer somewhat richer representations of the underlying dynamics of the diffusion process in the context of IT outsourcing. I analyzed models with fixed and flexible inflection points too. The model with the flexible inflection point allowed growth to vary for different levels of diffusion penetration across different industries.

I also obtained evidence that the mixed influence model was able to capture quite well the effects of the different communication channels on the diffusion patterns of IT outsourcing for three out of the four industries: Broadcasting and Telecommunication, Healthcare Services, and Banking and Finance. Thus, prior knowledge that existing users and the mass media influence adoption behavior in these industries was confirmed. The Gompertz and Weibull models fit all the industries' diffusion patterns fairly well. The significant value of the internal influence parameter obtained using the Gompertz model estimation indicated that IT outsourcing adoption behavior across all four industries was influenced by word-of-mouth. Based on the estimated parameters of the best-fitting Weibull model, it was found that the adoption process was asymmetric, left-skewed and flat. There was more rapid adoption in the initial stages of diffusion than later. This suggests that firms across all four industries were predisposed to adopt IT outsourcing during the earlier stages of the diffusion process, a sign of contagion effects.

Prior studies have suggested that diffusion processes are more likely to follow an asymmetric S-curve rather than a symmetric curve (Geroski 2000; Mahajan 1985; Mahajan et al. 1990). It may take longer to get a diffusion process started than it does for diffusion to tail off and the market to get saturated, which induces S-curve asymmetry. The industry-level analysis suggested evidence of an asymmetric diffusion process for some industries. Thus, it was appropriate to test for the fit capabilities of the flexible growth inflection point diffusion models, such as the Gompertz and Weibull models.

In the context of IT and business process outsourcing, the results of the Gompertz and Weibull models indicated spillovers associated with contagion effects theory. With spillovers, contagion effects arise due to interdependencies among market activities, such as aligned management interests, or business activities in an industry, in a region, or across firms with similar interests; furthermore, the results showed that internal communication channels appear to play a more prominent role. The results of the Weibull model indicated that diffusion is faster early on. This might mean that across all four industries some of the firms were predisposed toward IT outsourcing (as also indicated in the IT outsourcing announcement data), and other firms after a short period of time tended to imitate the behavior of the early adopters. This is consistent with the inflection point for growth occurring before the 50% penetration point.

There are a number of limitations to this study. First, the results are based on outsourcing contract announcements and contract details from two well-accepted news sources. It is likely that not all outsourcing contract announcements and

details are covered by these sources though, so there may be relevant omitted data that may be important for the development of more fully representative results.

Second, I focused on firm size as the main stratifier for observing contagion effects. Firm size is measurable and valid based on my field study observations, and consistent with control variables used in other research on firm strategy.

There are other possible factors that can be used to analyze the contagion effect, such as geographic location, industry, international linkages, IT-intensity, and managerial structure. I will leave these other aspects for future research.

Chapter 3. Spatial and Temporal Trends in IT Outsourcing

3.1. Introduction

The main objective of my study is to understand the underlying factors for IT outsourcing growth and to discern how the diffusion of IT outsourcing occurs, especially whether it is across industries or within industries. In addition, I also aim to understand the geographic and temporal extent of IT outsourcing diffusion. To analyze the diffusion patterns of IT outsourcing I use the concepts of proximity and spillover, from contagion effects theory and the industry agglomeration literature.

Contagion effects are defined as “ the spread of a particular type of behavior through time and space as a result of a prototype or model performing that behavior and either facilitating that behavior in the observer or reducing the observer’s inhibition in performing that same behavior” (Midlarsky 1978, p. 1006). Prior literature, including Dornbusch et al. (2000), Midlarsky (1978), Midlarsky et al. (1980), Kauffman and Techatassanasoontorn (2006), and Mann et al. (2011), has shown that contagion effects can spread in different ways based on a population’s predisposing factors and characteristics. They include, strong or weak ties, physical proximity, and the presence of hierarchical effects.

In this study, I use the concept of *proximity*, based on industry similarity (a kind of conceptual distance between the industries that matches my spatial approach) to analyze the diffusion of IT outsourcing. *Industry similarity* is the distance between the firms in different industries, indicating the differences in the contents of their activities. To implement the idea of industry similarity, I will use

the NAICS codes mentioned earlier. For instance, banking (NAICS 522) is more similar to insurance (NAICS 524) than it is to advertising services (NAICS 541) or educational services (NAICS 611). We can see this from the first two digits of the code also, for example, “52,” in comparison to “54” and “61” in the three-digit NAICS codes.

The spatial clustering or agglomeration of economic activity is generally viewed as a sign of increasing returns and competitive advantage. Underlying the phenomenon of clustering are mechanisms that facilitate the interchange and flow of information between firms (Porter 1990). These information flows or *knowledge spillovers* are sources of innovative output and productivity growth (Griliches 1992), and also are one of the main reasons why firms collocate. Positive externalities associated with collocation may occur within or across industries, often leading to endogenous growth (Aghion et al. 1998). Pavitt (1987) suggests that, due to its informal and uncodified nature, new knowledge flows more easily within a region than over great distances. As a result, there will be more knowledge spillovers in industrial centers, and this will lead to more innovative output.

In seeking to understand how location affects economic activity, empirical researchers have classified agglomeration economies into either localization economies or urbanization economies (Loesch 1954). *Localization economies* are what Glaeser et al. (1992) define as *Marshall-Arrow-Romer (MAR)* externalities; they are external to the firm but internal to an industry within a geographic region and represent *economies of scale* (Arrow 1962; Marshall 1890; Romer 1987). In

contrast, *urbanization economies* are external to industries but internal to geographic units such as cities, and represent the *economies of scope* (Glaeser et al. 1992; Jacobs 1970).

My goal is to discern the patterns of IT outsourcing diffusion within space-time clusters, and to establish whether IT outsourcing diffuses across industries (scope externalities) or within industries (scale externalities). A *space-time cluster* is defined as a statistically significant set of events, such as IT outsourcing announcements, that occur within a limited space and time (Lilienfeld and Lilienfeld 1980; Selvin 1991). I asked the following research questions. How does IT outsourcing spread? What are the underlying patterns? What is the role of *proximity*, in terms of geographic nearness and industry similarity, in the diffusion of IT outsourcing?

Suppose that several IT outsourcing announcements are observed from firms in a particular industry within a space-time cluster, say banking (NAICS 522). Then, following this, there is an IT outsourcing announcement from another firm in the banking and insurance industry (NAICS 524). It may be possible to conclude that scale externalities are at play in the diffusion of IT outsourcing in this particular case. The only pre-condition is that the IT outsourcing announcements from firms in both of the industries should occur relatively close in time. The reader should recognize that the word “close” requires a more precise operational definition. The main consideration that I recognize is that if the times are too close together – for example, two days or two weeks – then it will be difficult to claim that one firm is actually responding to another’s actions. I

considered the years 2000-2010, during this time IT outsourcing was already embedded in the business landscape. Thus, it may take a firm anywhere between 30-120 days and in many cases even more (if the firm is engaging in outsourcing for the first time) to go from recognizing the need to outsource to the actual announcement of outsourcing deal. It takes time for managers to observe a competitor that has announced an IT outsourcing deal, and then to find a vendor, do the negotiation and due-diligence legal work, and so on to consummate a control. In addition, the variation in time may be influenced by the complexity of service being outsourced, whether or not the services of vendors, with whom the client has a prior relationship, are being engaged, and client company's response capabilities etc. Thus, to analyze the spillover effects within or across industries, I used varying levels of response time- 30, 60, 90 and 120 days- as the minimum lag-time between the outsourcing announcement of one firm that acted first, and a second that responded to it. For an alternative treatment of these issues involving the characterization of *clustered adoption* of technology, and some related specification tests, the interested reader should see Au (2004).

To analyze the diffusion patterns, I first identify space-time clusters using IT outsourcing announcement data and firm headquarters locations. Identifying a space-time cluster establishes the timing of the diffusion pattern, and it may also be possible to consider the geolocation and industry similarities as alternate bases for proximity or similarity. I use firm headquarters locations for analysis in this study because it provides me with an interesting vantage point to understand the diffusion process of IT outsourcing decision. In the business world we see that

firms spatially distribute their business processes to maximize efficiency. The headquarters are generally located in larger cities – and for some industries even collocated in industry clusters – with other business functions distributed spatially depending on different business needs. For example, Apple has its headquarters in Silicon Valley, a server farm to support its cloud services in the North Carolina country side, a call center in Texas, and manufacturing and assembly operations in China.

Strategic decisions are generally made at the corporate level though. The strategic management literature identifies three levels of strategic decision-making; corporate, business unit and operational (Kelly and Gennard 2007). Strategic business decisions are generally formulated and made at the Chief Executive Officer Group (CEOG) level, and sometimes at the board level or the business unit level. IT outsourcing decisions are strategic business decisions and it is common that the CEOG is usually housed at the corporate headquarters. Thus, I use the corporate headquarters location to identify the space-time clusters, and analyze the geographic and temporal aspects of the diffusion patterns of IT outsourcing.⁸

In next section, I discuss the theories that explain the diffusion process of outsourcing. In the following sections, I introduce the data set, present the details

⁸ My work in this study is exploratory in nature. So I was not able to disentangle other more complex issues, such as the centralization or decentralization of decision-making, the size and complexity of the outsourced services, or ideal contract lengths, etc. associated with the IT outsourcing decision-making. A richer dataset is required to address these issues associated with IT outsourcing diffusion. My inferences were established by looking at a handful of space-time slices and a less-than-complete dataset. Thus, the results of my work should be interpreted accordingly.

of my methods, and discuss the main findings. In the final section I conclude and discuss the limitations of this research.

3.2. Theory

For over two decades now, academicians have been conducting research on different aspects and issues associated with IT outsourcing. However, there have been only a handful of studies that have looked at the issues associated with diffusion of IT outsourcing. Loh and Venkatraman (1992b) and Hu et al. (1997) have explored the sources of influence in the adoption of IT outsourcing. Mann et al. (2011) have evaluated the presence of contagion effects in the diffusion of IT and business process outsourcing. In addition to prior research in the area of IT outsourcing, this study is also related to work in IS literature that seeks to understand the geographic dispersion in the location of high-tech industries and issues associated with collocation of clients and vendors (Arora and Forman 2007).

Next, I will discuss contagion effects theory and concepts of localization and urbanization economies in more detail. I will leverage these theoretical perspectives to develop additional insights on IT outsourcing diffusion from the spatial and temporal, and industry similarity perspectives.

Contagion effects theory posits the connectedness of adoption events over time, and offers a more refined expression of the diffusion of innovation theory (Kauffman and Techatassanasoontorn 2009). Contagion effects are time-bounded, and may also be affected by geolocational proximity and proximity in other ways that are not physical, such as industry similarity. Contagion effects arise in two

ways. The first is spillovers due to interdependencies among market activities: aligned management interests, or business activities in an industry, in a region, or across firms with similar interests. Another is external to business, industry, and geography, and is based on macroeconomic drivers (Mann et al. 2011). The spillovers usually involve tacit knowledge, and their transmission depends on distance. *Tacit knowledge* is ill-documented, uncodified, and can only be acquired through the process of social interaction. Consequently, knowledge spillovers may be related to the region in which the new knowledge is created (Anselin et al. 1997; Feldman and Audretsch 1999). This introduces the need for geographical proximity and encourages firms to concentrate in specific regions (Feldman 1994).

The two main types of knowledge spillovers are MAR externalities or scale externalities arising due to specialization and Jacobs externalities or scope externalities arising due to diversity are recognized. *Specialization or scale externalities* operate mainly within a specific industry, whereas *diversity or scope externalities* work across industries (Bathelt et al. 2004; Glaeser et al. 1992). The concept of localization economies based on MAR or scale externalities is that the concentration of an industry in a region promotes knowledge spillovers between firms and facilitates innovation in that particular industry (Arrow 1962; Glaeser et al. 1992; Marshall 1890). This *specialization* and the related *specialized knowledge* encourages the transmission and exchange of ideas and information, whether tacit or codified, of product and processes through imitation, business interactions, and inter-firm circulation of skilled workers.

On the other hand, urbanization economies imply that the most important sources involving knowledge spillovers are external to the industry within which a firm operates. A more diverse industrial fabric in close proximity fosters opportunities to imitate, share and recombine ideas and practices across industries. Also, the exchange of *complementary knowledge* across firms and economic agents facilitates experimentation in innovation.

IT outsourcing announcements are conduits for information about firms' activities and also are mechanisms of disseminating the information about firm activities through the environment in which they operate. Prior research has shown that managerial decision-making is often influenced by such information updates (Dixit and Pindyck 1994).

Another perspective for why contagion effects might be observed with IT outsourcing is *social contagion*. This perspective is based on *social learning theory*, which posits that people engage in social learning by examining the actions of similar peers. People communicate with each other, or observe the actions of others, and the consequences of those actions. They also rely on rational processing of information gained from observing their peers, which may lead them to making similar adoption decisions (Bikhchandani et al. 1992). In the presence of social contagion, the adoption decision is contingent on a firm's assessment of the innovation's merits, and the prior adopters (Fichman 2004).

3.3. Data, Analysis Procedure and Method

3.3.1. Data

The data set consist of announcements of IT and business process outsourcing deals between January 1, 2000 and December 31, 2010. I collected it using a full-text search of firm announcements related to IT and business process outsourcing. I used two leading news sources: *PR Newswire* and *Business Wire*. I used the online *Lexis/Nexis* database to search the newswires for announcements containing the words “deal” or “contract” or “launch” or “announcement” in the same sentence as the words “BPO” and “IT,” and “outsourcing” or “offshoring.” The search yielded 643 announcements in total, of which 257 announcements had information about IT or business process outsourcing.

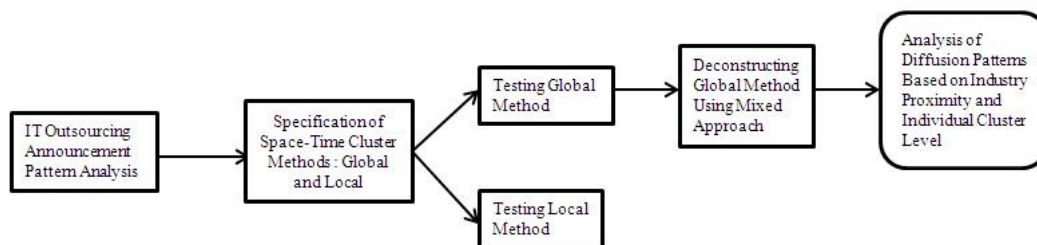
Not all of the relevant details – for example, physical addresses required for analysis – were found in the company announcements, however. To collect these data, I searched other secondary sources, including company websites, magazine articles, and newspaper articles. I took extra care to differentiate between independent announcements and announcements that were a part of ongoing deals, and only to include the independent announcements. The announcements data are at the firm level. Only announcements for clients located in the U.S. are included. I did this to maintain consistency across the industry- and firm-level data. Once I screened the data for complete information about the dates of announcement, clients, client industries, physical addresses of a firm headquarters and type of services being outsourced, and reoccurrence 179 observations remained.

I used three-digit 2007 NAICS codes to classify firms based on their primary business activities. In the case of diversified conglomerates such as Unilever, which has multiple NAICS codes, I either used the primary NAICS code or used the NAICS code of the relevant business unit, if that information was specified in the outsourcing announcement. This represents the best available proxy, in my view.

3.3.2. Analysis Procedure

First, I will present the individual temporal and spatial patterns for the firm-level IT and business process outsourcing announcement data. Next, I will present the space-time clustering methods I have selected for this research, and will test them to produce results that allow me to characterize the space-time interactions at the global and local levels. Following that, I use proximity and similarity information on the firms to evaluate the diffusion patterns for IT outsourcing announcements if the identified space-time clusters are significant. See Figure 5.

Figure 5 Analysis Procedure



3.3.3. Space-Time Clustering Methods

I will employ a broad view of the role of industry relationships in the diffusion of IT outsourcing decisions – diffusion can happen within an industry and across industries. Instead of imposing within industry scale or between industry scope

hypotheses *a priori*, I will leverage information on the spatial and temporal footprints of IT outsourcing announcements across the U.S. for the eleven-year period from 2000 to 2010. This will permit me to derive an understanding of intra- and inter-industry relationships from the observed patterns.

Space-time clustering is an exploratory approach to data analysis that is rooted in the epidemiology literature. See Mantel (1967) for an early example. It allows me to explore the properties of any pattern where there are both spatial and temporal stamps on each observation. This way I can pursue the goal of uncovering diffusion-type processes. A process that only exhibits temporal clustering may be indicative of a cyclical pattern that follows say, the national business cycle or fluctuations in the stock market. Similarly, spatial clustering alone could point to heterogeneity in the spatial distribution of firms, for example, imagine that the process for the diffusion of IT outsourcing is concentrated in coastal cities or cities with more firms overall. In contrast, my interest, like that of epidemiologists, is focused on the diffusion or the spread of something, and the subsequent characterization of any meaningful patterns that can be observed.

The space-time analysis is split into two levels: global and local. The *global analysis* investigates the entire data set as a whole, while the *local analysis* looks at its different components. The global analysis explores questions of clustering and tries to evaluate the tendency of IT outsourcing events to be near one another in both space and time. The local analysis is intended to pick up clusters, or identify particular sets of observations that exhibit abnormally high levels of space-time interaction.

The statistical methods employed are inference-based, in the sense that they can identify significant levels of space-time interaction, but these are best characterized as tools that help highlight patterns for further investigation. Once some clusters are identified, I will incorporate detailed information on firm's type and the activity outsourced. Greater similarity is indicative of scale-type interaction and dissimilarity points to scope based interactions. I follow this general research approach to understanding the potential interactions between spatial effects and IT outsourcing decisions.

Global analysis: The analysis begins with exploring the system as whole using the *Jacquez (1996) test of space-time interaction*. The test iterates over each observation in the system, that is, each IT outsourcing announcements, and counts the number of other observations that are proximate in both space and time. Proximity is determined based on nearest neighbors. The Jacquez test statistic is:

$$J_k = \sum_{i=1}^n \sum_{j=1}^n a_{ijk}^s a_{ijk}^t \quad (1)$$

where:

$a_{ijk}^s = \{1, \text{ if observations } j \text{ is a } k \text{ nearest neighbor of observation } i \text{ in space. } 0, \text{ otherwise}\}$

$a_{ijk}^t = \{1, \text{ if observations } j \text{ is a } k \text{ nearest neighbor of observation } i \text{ in time. } 0, \text{ otherwise}\}$

$n = \text{total number of observations}$

$k = \text{an integer defining proximity in terms of nearest neighbors.}$

If $k = 5$, then $a_{ijk}^s = 1$ for the five observations closest to i in terms of two-dimensional spatial distance. Similarly, $a_{ijk}^t = 1$ for the five nearest neighbors in

the linear time dimension; a coincidence of ones, that is, the number of events that are neighbors in both dimensions, adds one to the statistic.

One advantage of the Jacquez test over alternative space-time measures is that it is flexible in the face of spatial and temporal heterogeneity. The U.S. urban system is quite diverse with dense metropolitan areas such as New York and Chicago, and more spread out places such as Phoenix and Atlanta. A k nearest neighbor approach does not require an *a priori* definition of the spatial and temporal extent of possible interactions in terms of kilometers or days, and is to some extent adaptive to the context in which the observations are located. So the value of k remains an open question to explore for a particular dataset.

Local analysis: While the study's sample is representative of U.S. based firms whose outsourcing announcements reached the newswires, it may not be representative of the IT outsourcing activity of all firms within the U.S. From an epidemiological perspective, we have a set of known cases, but little information on how these cases relate to the *population at risk*, in other words, the possible firms that have been able to make IT outsourcing deals. The challenge is one of *utilization*—some people choose to utilize a hospital when they feel ill and others do not. Similarly, certain firms choose to engage the media when they make decisions and others do not. Not knowing these underlying motivations, and, by extension, the population from which they are drawn, should not preclude an effort to understand the patterns of firms that choose to utilize media outlets though. The *space-time permutation approach* (Kulldorff et al. 2005) for cluster

detection was developed for this particular situation since it does not require information on the underlying population.

The goal of the local approach is to identify specific announcements that, as a group, are located close together in both space and time as a cluster, subject to my forty-day minimum lag-time requirement for the announcement. The method might be best visualized as operating on the data in a space-time cube, where the base is the spatial dimension and the height of the cube represents time. The algorithm then defines a relatively small space-time cylinder, again with the base representing the spatial dimension and height time, and places the cylinder within the space-time cube. The typical approach is to first iterate over a finite number of geographical grid points, and then increase the circle radius from zero to some maximum value (Kulldorff et al. 2005). In this way, both small and large circles are considered, all of which overlap with many circles. Additionally, for each center and radius of the circular cylinder base, the algorithm iterates over all possible temporal cylinder lengths. This essentially means that cylinders that are geographically large and temporally short (forming a flat disc), those that are geographically small and temporally long (forming a pole), and every combination in between is considered. Thus, if the number of announcements within this cylinder is higher than what would be expected based on the underlying probability model, then those observations form a potential cluster. See Kulldorff et al. (2005) for fuller discussion of the details.

3.4. Results and Discussion

First, I present the individual temporal and spatial patterns that my modeling approach reveals in the data. Next, I discuss the results of the space-time interactions that are observed at the global, local and mixed levels based on the IT outsourcing announcement data. Following that, I use the proximity information for the firms to evaluate the diffusion patterns for IT outsourcing announcements within the identified space-time clusters.

3.4.1. Spatial and Temporal Patterns

Figure 6 presents a map of the U.S. with each announcement represented by a circle. As might be expected, announcements generally follow the urban hierarchy; more announcements originated in and around larger cities. This straightforward two-dimensional presentation of the data masks the temporal dimension.

Figure 6 IT Outsourcing Announcements, 2000-2010

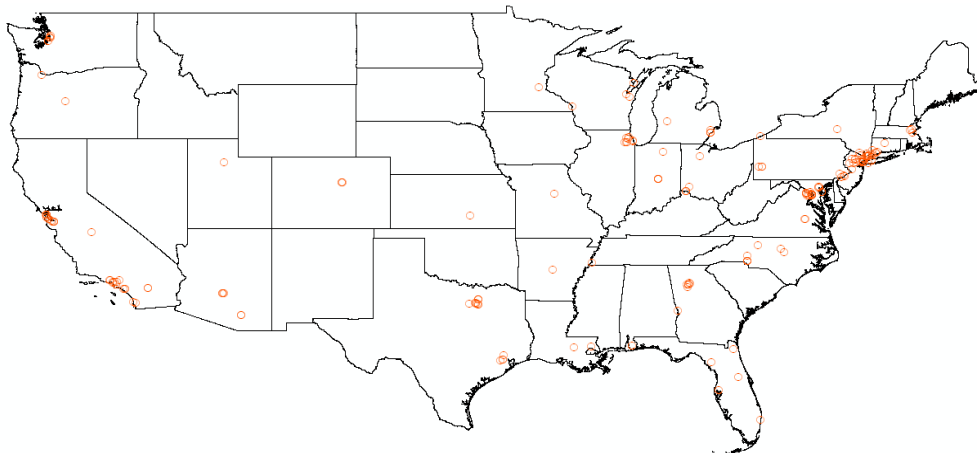
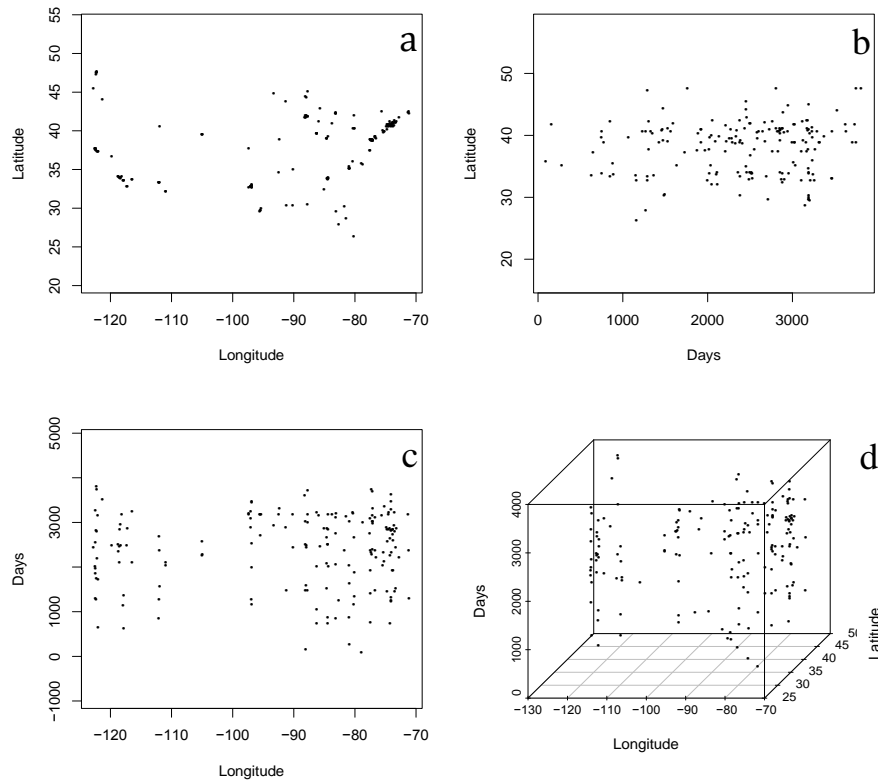


Figure 6 brings this geospatial dimension into view, allowing for a greater understanding of the space-time pattern in the data. Figure 7a repeats the

presentation in Figure 6 to form a point of reference. Figure 7d is a *space-time cube*, where the base represents the longitude and latitude, and the height represents time (days in this case). Figure 7a presents a view of the cube from the top, and Figures 7b and 7c are presenting views from the side. These representations can help inform our understanding of the interaction of space and time.

Figure 7b presents latitude on the vertical axis and time on the horizontal axis. I observed no north-south trends in the data relative to time. Figure 7c presents time on the vertical axis and longitude on the horizontal axis. Again, there are no pronounced east-west trends in the data with respect to time. The earliest three announcements happened in the east, but this may not be indicative of a trend. Based on these maps, a general increase in activity over time, excluding the latter recessionary period is clear, but there is little indication of national-scale diffusion patterns. For example, I don't see the northeast leading in IT outsourcing actions and the south or west following later. This might simply be an artifact of the time frame chosen for the analysis. IT outsourcing started in earnest nearly fifteen to twenty years ago and is embedded in the business landscape of the entire country. It may have had a spatial trend over the decade 1985-1995, but that is gone now and cannot be captured through the data and time frame that I am using in this study.

Figure 7. Space-Time Views of IT Outsourcing Announcements



3.4.2. Space-Time Cluster Analysis

Global analysis: As I mentioned above, the k -nearest neighbor approach does not require an *a priori* definition of the spatial and temporal extent of possible interactions in terms of kilometers or days. It is adaptive to the context in which the observations are located. Figure 8 presents the pseudo p -values for the Jacquez test at varying levels of k after the data has been aggregated to a monthly level. Lacking an analytic distribution for the Jacquez statistic, my study follows Jacquez's (1996) recommendation to use a permutation-based inference approach that randomizes the input data, and re-computes the statistic for that

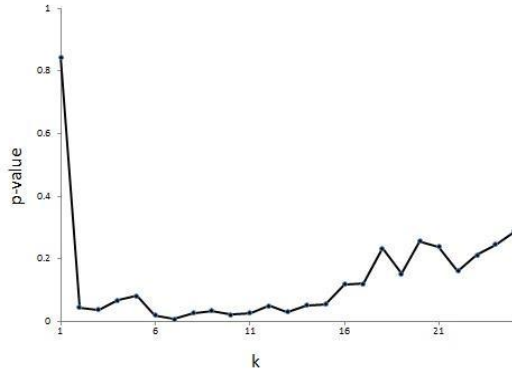
randomization. This randomization step is repeated 999 times in order to construct an empirical distribution.

The null hypothesis is that the actual data came from a random process; this hypothesis is rejected if the actual Jacquez test statistic is extreme relative to this distribution. If the critical value is set at $\alpha = 0.05$, the Jacquez test identifies significant space-time interaction for values of k ranging from 2 to 13, with $k = 4$ and 5 falling above the 0.05 threshold for significance.

There is a multiple testing problem related to testing a range of k values though. The standard methods did not permit them to be tested together. Jacquez (1996) proposed a combined test in response. It permits the analyst to perform a test that spans a range of k values, and assesses their joint significance. This test returned a p -value of 0.001 for values of k from 2 to 13, corroborating my earlier finding that this range of k values point to significant space-time interactions in IT outsourcing announcements when the data has been aggregated to a monthly level.⁹

⁹ The computations were conducted using the open-source Python Spatial Analysis Library (PySAL) (Rey and Anselin 2007), supplemented by the authors' implementation of Jacquez's combined test in Python.

Figure 8 *p*-values of the Jacquez Test Statistic for Selected Values of *k*



Figures 9 and 10 translate these values of *k* into kilometers and months in order to contextualize the results for my IT outsourcing announcement data. These magnitudes are computed as the average distance or time between space-time pairs, for those observations *i* and *j*, where $a_{ijk}^s = 1$ and $a_{ijk}^t = 1$ (Malizia and Mack 2011). The smallest significant distance is 37.1 km ($k = 3$) and largest is 251.5 ($k = 13$). This is a broad range of distances. At the low end, it reflects an intra-metropolitan area scale, and at the high end, it points to inter-metropolitan area interactions. While an average interaction distance of 251 km is quite large and certainly extends beyond the range that could be explained through regular face-to-face interactions, it does point toward other underlying factors. Some of the underlying factors influencing the diffusion behavior could be hierarchical effects, strong or weak ties between firms across industries and geography, and different channels of communication.

Figure 9 Distances Associated with the Jacquez Test Statistic for Selected Values of k

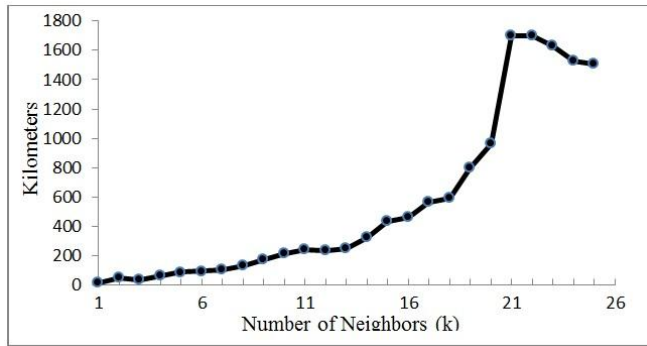
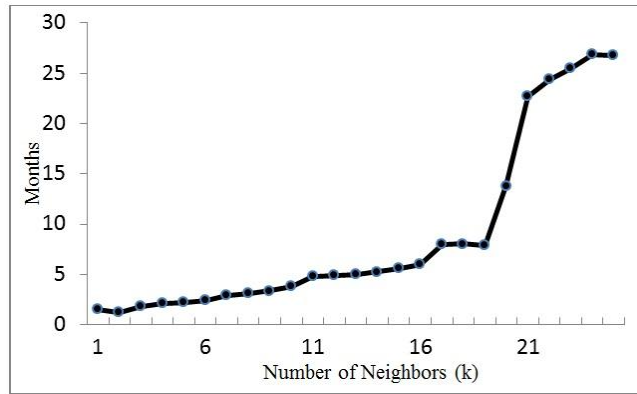


Figure 10 Times Associated with the Jacquez Test Statistic for Selected Values of k



From a temporal standpoint, interactions ranging from 1.2 months ($k = 2$) to 4.98 months ($k = 13$) are observed. Relatively short time frames could point to simultaneity of IT outsourcing actions, rather than any direct interactions between firms outside of the media that are substantive. Some lead time is needed to get an IT outsourcing decision to the point of a public announcement, and, by the same token, some more time will be needed for firms to respond to the announcement as a stimulus, and then do something on their own.

To give the reader an idea for how this might work, consider the following. It probably takes at least a month or more to do a vendor search, another month to figure out the legal contracting and compliance issues, and then additional follow-on negotiation. So differences in time of a few days or weeks, or even a month or two, won't be easy to justify on the basis of the usual logic of business operations.

One scenario could be that physical proximity is linking the firms in ways that cannot be directly observed. An example might be informal exchanges of information between CIOs or CEO of firms at a conference or during a golf game. This might result in an exchange of information that economists call "cheap talk."

On the other hand, another scenario could be "unobservable vendor action". A vendor or a group of vendors may have focused on developing services market share in a region at some point in time. What I observe in terms of IT outsourcing announcements in the market around that region are the various responses of companies that were stimulated to think about IT outsourcing some time ago (may be 2, 3, or even 6 months ago). The variation in timing of announcements by client firms can be a result of vendor stimulus as well as client companies' response capabilities. As I don't have information about analogous activities in the outsourcing market in a region, it is highly likely that the temporal clustering that I observe in my data is not because of stimulus-response from one IT outsourcing deal being picked up over a short period of time and then stimulating another. Rather it is because of some other "unobservable" stimulus.

Apart from the very close-in-time observations, some of these temporal results, when combined with the spatial results, point to some sort of space-time

pattern. In the following section, I explore the local scale in an effort to uncover specific clusters within the overall system.

Local analysis: Where the global Jacquez test statistic has a moderate level of multiple testing problems as we explore different values of k , the challenge for the space-time permutation approach is orders of magnitude greater. The solution is to use a randomization approach where the observations' time labels are randomly shuffled, then for this new dataset the most likely cluster is identified. This process is repeated many times, 999 times for this study, and an empirical distribution is constructed based on these most likely clusters. Any clusters from the actual dataset that are extreme relative to this distribution are identified as statistically significant at the .05 level. This method is implemented in the free SatScan software (Kulldorff 2009). Seven clusters were identified but none was statistically significant at the 0.05 level, so drawing any conclusions on the basis of this evidence is difficult.

Mixed analysis: With a small sample, spanning a large area and eleven years, it is unclear if the lack of local clusters is a substantive result or an artifact of sample size. I cannot rule out the findings of lack of significant local clusters based on the space-time permutation method. Additionally, I also cannot say with certainty that there are no truly local clusters because the data I have is very sparse.

To explore this case further, I employed a mixed approach offered by Malizia and Mack (2011) that blends the global and local perspectives on space-time clustering. Given that significant global clustering is observed, my intention is to

better understand the process driving this result. Malizia and Mack's (2011) approach deconstructs the global Jacquez test into the clusters of observations that are located within k nearest neighbors of each other in both space and time. In this sense, it pulls apart the global measure and presents the local pieces for closer investigation.

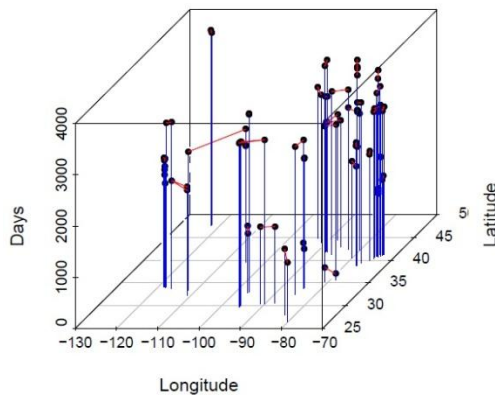
The broad objective of the work is to understand the relationship of scale and scope externalities on IT outsourcing decisions, and based on this goal a low value of k is selected to reflect the importance of proximity. This analysis is conducted at the $k = 7$ scale (avg. distance = 106 km and avg. time = 2.8 months). Clusters are then defined as those announcements that are seventh nearest neighbors to one another, and have positive relationship in both space and time dimension. At this scale, 36 clusters were identified.

I present these clusters below in Figure 11 and provide the details of the same in Table 4. As mentioned earlier, I consider thirty days or more of time-lag between the outsourcing announcements to analyze the scale or scope externalities effect.

The majority of the clusters contain two announcements, with the largest containing five (Cluster 20). The majority of clusters are located within a single metropolitan statistical area (MSA), with thirteen spanning two MSAs and three clusters that include announcements from non-metro areas (Clusters 7, 28, and 30). Most clusters span less than 5 months; those that do exceed 5 months are generally located at the beginning and end of our study period, corresponding to the limited number of announcements at the temporal extremes.

While I am working with a small dataset, I believe that the proximate observations driving the significant global result are worth exploring to shed some light on the spillover effects that the proximity has based on the contagion effects as well as scale and scope externalities perspectives.

Figure 11 IT Outsourcing Space-Time Clusters



3.4.3. Analysis of Diffusion Patterns within Space-Time Clusters

Industry and Outsourcing Function Interactions. In order to understand how IT outsourcing is diffusing across the observed clusters, I grouped the different observations together based on the industries they belong to, using the 2007 NAICS codes and looked at the patterns of diffusion within clusters. In six clusters (2, 9, 15, 26, 31, and 35) out of thirty six, the observations belonged to the same industry based on three-digit NAICS codes. To further analyze if there were any commonalities in the services that were being outsourced, I considered the types of functions being outsourced. Three clusters (2, 9, and 31) had the observations that belonged to the same industry and for which similar services were outsourced.

Table 4 IT Outsourcing Space-Time Clusters

Cluster ID	Count	NAICS	MSA	Months	Dist. (km)
1	2	334,511,522	Durham NC, Charlotte-Gastonia-Concord NC-SC	7	193
2	2	515,517,334	Atlanta-Sandy Springs-Marietta GA	6	16
3	2	445,447,481	Dallas-Fort Worth-Arlington TX	5	8
4	2	518,524	Miami-Fort Lauderdale-Miami Beach FL, Tampa-St. Petersburg-Clearwater FL	5	301
5	3	923,524	New York-Northern New Jersey-Long Island NY-NJ-PA	3	1
6	2	454, 334, 335, 336	Bridgeport-Stamford-Norwalk CT	3	19
7	2	926, 517	Baton Rouge LA, Non-Metro	1	326
8	4	452, 541, 334, 524, 488	San Francisco-Oakland-Fremont CA, San Jose-Sunnyvale-Santa Clara CA	6	32
9	2	524	Pittsburgh PA, Washington-Arlington-Alexandria DC-VA-MD-WV	2	276
10	2	312, 311, 541	New York-Northern New Jersey-Long Island NY-NJ-PA	1	6
11	3	522, 454, 512	Riverside-San Bernardino-Ontario CA, Tucson AZ	2.33	360
12	2	325, 621	Philadelphia-Camden-Wilmington PA-NJ-DE-MD	4	23
13	2	523, 621, 622	Denver-Aurora CO	2	4
14	3	334, 336, 721	Washington-Arlington-Alexandria DC-VA-MD-WV	3	20
15	4	522	Chicago-Naperville-Joliet IL-IN-WI, Grand Rapids-Wyoming MI, Green Bay WI	2.17	199
16	3	517, 923, 522	Los Angeles-Long Beach-Santa Ana CA	1.67	26
17	2	722, 721	Atlanta-Sandy Springs-Marietta GA	2	2
18	2	522, 524	Denver-Aurora CO, Phoenix-Mesa-Scottsdale AZ	4	931
19	2	336, 524	Detroit-Warren-Livonia MI, Erie PA	3	245
20	5	522, 541, 524, 511, 454	Bridgeport-Stamford-Norwalk CT, New York-Northern New Jersey-Long Island NY-NJ-PA	2.8	39

21	2	541, 522	New York-Northern New Jersey-Long Island NY-NJ-PA	1	3
22	4	541, 325, 524	New York-Northern New Jersey-Long Island NY-NJ-PA, Trenton-Ewing NJ, Poughkeepsie-Newburgh-Middletown NY	1.5	62
23	2	541, 511	Columbus GA-AL, Atlanta-Sandy Springs-Marietta GA	1	164
24	2	524, 522, 541	La Crosse WI-MN, Minneapolis-St. Paul-Bloomington MN-WI	3	195
25	3	922, 921, 524	Washington-Arlington-Alexandria DC-VA-MD-WV	1.67	1
26	2	522	Charlotte-Gastonia-Concord NC-SC, Raleigh-Cary NC	1	206
27	2	519, 311, 312	Chicago-Naperville-Joliet IL-IN-WI	1	35
28	2	541, 339	Detroit-Warren-Livonia MI, Non- Metro	3	260
29	2	519, 524	Baltimore-Towson MD, Washington-Arlington-Alexandria DC-VA-MD-WV	3	58
30	2	54, 531	New York-Northern New Jersey-Long Island NY-NJ-PA, Non-Metro	1	207
31	4	522	Houston-Baytown-Sugar Land TX, New Orleans-Metairie-Kenner LA	1	269
32	2	522, 512, 454	Los Angeles-Long Beach-Santa Ana CA, Riverside-San Bernardino-Ontario CA	2	165
33	2	312, 311, 518	Dallas-Fort Worth-Arlington TX	1	2
34	2	522, 523	New York-Northern New Jersey-Long Island NY-NJ-PA	6	6
35	2	336	Chicago-Naperville-Joliet IL-IN-WI	4	39
36	4	211, 213, 928, 927, 921	Washington-Arlington-Alexandria DC-VA-MD-WV	5.67	2

In one case (Cluster 31), the same vendor provided the services for all four firms and these firms outsourced similar services. In another case (Cluster 9) same type of service was outsourced but to different vendors. See Figure 12.

Also, for four clusters (1, 3, 4, and 5), although the observations belonged to different industries, similar functions were outsourced. The rest had neither the industry nor the outsourced functionality in common.

Figure 12 Industry and IT Outsourcing Function Interactions

		Similar Outsourced Function	
		Yes	No
Same Industry	Yes	3	3
	No	4	26

Next, to provide more information about what is observed in the clusters, I analyze Cluster 2 in a bit more detail. The cluster is comprised of IT outsourcing announcements from two telecommunications competitors headquartered in the Atlanta-Sandy Springs-Marietta MSA. Cox Communications, a provider of cable television, broadband and phone services and BellSouth, a provider of fixed-line and wireless phone services and broadband services, had announcements within six months of one another (January 28, 2002 and June 14, 2002), are located less than 20km from each other, and outsourced the same function, third party verification services, to the same vendor firm. This type of pair could be indicative of localization economies in the telecommunications industry in the region.

Similarly, in Cluster 4 the IT outsourcing announcements were from two firms that belong to different industries: the data processing and insurance industry. Both had announcements within four months of one another (March 13, 2003 and July 1, 2003) and both outsourced the same function to the same vendor firm:

document management service. This type of pair could be indicative of urbanization economies in the industry in the region.

Diffusion patterns within MSAs: I further explored the diffusion patterns within the space-time clusters, based on the metropolitan statistical area (MSA) they fell in. I recognized four MSAs based on the highest frequency of IT outsourcing announcements and space-time clusters observed. These MSAs are: Atlanta-Sandy Springs-Marietta (GA), New York-Northern New Jersey-Long Island (NY-NJ-PA), Chicago-Naperville-Joliet (IL-IN-WI) and, Washington-Arlington-Alexandria (DC-VA-MD-WV). To provide more information about how IT outsourcing is diffusing within these MSAs, I took a closer look at the individual MSAs.

New York-Northern New Jersey-Long Island (NY-NJ-PA): This MSA is also known as Greater New York or Tri-State area and consists of New York City and the surrounding region. It is the most populous metropolitan area in United States and is the center for international banking and commerce. The other leading industries are manufacturing, real estate, finance, biotechnology, education, entertainment and news media. Seven space-time clusters (5, 10, 20, 21, 22, 30, and 34) were identified within this MSA. Next, I look at some of the clusters in a little more detail to provide insight into how IT outsourcing is diffusing. Cluster 21 comprised of IT outsourcing announcements from Nielsen and Deutsche Bank (NAICS 541 and 522), cluster 20 comprised of announcements from MasterCard, Butler International, Wilton Re, SLM holdings, and the Reader's Digest Association (NAICS 522, 541, 524, 454, and 511), and cluster 22 comprised of

announcements from York Insurance Services group, LiveTechnology Holdings, Merck & co., and RadPharm (NAICS 524, 325, and 541). It is interesting to note that none of the firms within the clusters belonged to the same industry (except cluster 22) but at least one firm in each cluster belonged to either banking or the insurance industry. The banking and insurance industries are more similar to each other, and additionally, the announcements are temporally close to each other. In this case, I cannot say with surety that the announcement from Deutsche Bank influenced the outsourcing decision of MasterCard or York Insurance group since the time lag between the announcements is about a month, but keeping this time window in mind and also looking at the physical proximity of the firms, this pattern could be indicative of localization economies in the banking and insurance industries in the region.

Atlanta-Sandy Springs-Marietta (GA): Also known as metro Atlanta, this is the most populous metro area in the state of Georgia and the ninth largest MSA in the United States. The main industries in this MSA are hospitality, health services, manufacturing, business services and education. Three space-time clusters (2, 17 and 23) were identified within this MSA. Cluster 2 is comprised of announcement from Cox Communications and BellSouth (NAICS 517). Cluster 17 includes announcements from Church's Chicken and Inter-Continental Hotels (NAICS 722 and 721). Cluster 23 comprised of announcements from Business Software, Inc. and Magnum Communications, Ltd. (NAICS 541 and 511). For two of the clusters (2 and 17), the announcements belonged to not only the same industry or closely related industries, but also the firms were located less than

20km from each other. Additionally, the types of services outsourced were also very similar. They include third party verification services in case of Cluster 2, and internal corporate functions for accounting and human resources in the case of Cluster 17. This is indicative of localization economies in the telecommunications industry.

Chicago-Naperville-Joliet (IL-IN-WI): This MSA is home to corporate headquarters of 57 Fortune 1000 companies, including Boeing, Discover Financial Services, United Airlines and McDonald's, representing a diverse group of industries. Three space-time clusters (15, 27, and 35) were identified within this MSA. Cluster 15 comprised of announcements from American Financial Services and Allstate Bank, Denmark State Bank, and Allstate Insurance Company (NAICS 522). Cluster 27 included announcements from Tribune Publishing, subsidiary of the Tribune Company and Sara Lee Corporation (NAICS 519 and 311). Cluster 35 is comprised of announcements from Boeing and Navistar (NAICS 336). Two out of the three clusters had announcements from firms that belonged to the same industry (Clusters 15 and 35) and two firms belonging to Cluster 27, although they outsourced different services (Tribune Publishing for the - accounting function and Sara Lee for- IT infrastructure), but used the same vendor to provide the services. In case of Cluster 35, the patterns could be indicative of localization economies because the firms are located less than 40km from each other and the announcements had a lag-time of about 4 months.

Washington-Arlington-Alexandria (DC-VA-MD-WV): The federal government provides the underlying basis for economy in this region. It is also home to many major research universities, think tanks and non-profit organizations. Major industries include biotechnology and defense contracting. Five space-time clusters (9, 14, 25, 29, and 36) were identified in this MSA. Cluster 9 had announcements from Gateway Health Plan and TIAA-CREF (NAICS 524). Both firms in this cluster not only belonged to the same industry, but also outsourced the same type of services. This was administrative services, but the services were provided by different vendors. Cluster 14 had announcements from Lockheed Martin Corporation and Crestline Hotels & Resorts (NAICS 334 and 721). Cluster 25 included announcements from the U.S. Department of Justice, a federal agency, and the Council for Affordable Quality Healthcare (CAQH) (NAICS 922, 921, and 524). Cluster 29 had announcements from Project MUSE (a joint collaboration of Johns Hopkins University Press and the Milton S. Eisenhower Library at Johns Hopkins University), and the Nolan Financial Group (NAICS 519 and 524).

The final Cluster 36 comprised of announcements from Federal Govt., Statoil, Federal Bureau of Investigation (FBI), and National Aeronautics and Space Administration (NASA) (NAICS 522, 211, 928, and 927). Announcements in Clusters 25 and 29 fell within four months of each other (March-July 2008), and also were from firms that belonged to the same industry. Within Cluster 14, although the firms belonged to three different industries, the announcements were within 3 months of each other and the firms were located within 20km of each

other. Additionally, types of services outsourced were very similar. All three firms outsourced internal corporate functions, including customer support, back office support and accounting. This pattern could be indicative of urbanization economies.

I tried to assess clustering in a small sample spanning a large geographical area and eleven years, but I didn't find the results to be very insightful. It is unclear if the lack of local clusters was a substantive result, such that geography and physical distance truly don't matter, or an artifact of sample size. I cannot rule out the findings, which suggest there may be no significant local clusters based on the space-time permutation method. Additionally, I also cannot say with certainty that there are no truly local clusters because the data I have are very sparse. So this portion of my results lacks finality based on the methods I applied. Nevertheless, I have tried to report on what I learned with as much scientific honesty as possible.

3.5. Key Findings and Limitations of Chapter 3

In the first part of the study, I employed an exploratory approach that initially focused on geographic proximity, and then shifted to assess industry similarity in an effort to gain insights into the various diffusion processes that might be occurring. I used space-time clustering methods at the global and local levels. I obtained some evidence for significant space-time interaction at the global level, for my IT outsourcing announcement data. At the local level, I found no significant clusters using the local space-time clustering methods. To further

understand the interactions, I employed a mixed approach that blended the global and local perspectives on space-time clustering.

Based on the mixed analysis results I obtained, I cannot draw any conclusions as the data are very sparse with at most two announcements in majority of clusters. In addition, I had problems with limiting the amount of time between possible stimulus IT outsourcing announcements and subsequent response IT outsourcing announcements. I found that data limitations precluded my implementation of space-time cluster analysis establishing meaningful clusters when the time between stimulus and response announcements was constrained to be greater than forty days.

Several possible explanations are worthwhile to point out based on my experience with analyzing the data and reviewing the results I was able to obtain. It also makes sense to consider other ways to obtain meaningful results.

- (1) Perhaps the space-time clustering method performed poorly because of the time frame chosen for the analysis. I considered the years 2000-2010, but by this time IT outsourcing was already embedded in the business landscape. Thus I was unable to easily observe distinct space-time trends.
- (2) Another possible way to analyze the data might have been to slice it based on the different types of services that are involved, and then to look at the interactions based on those service types. The extent to which the different services are able to be outsourced varies considerably. Outsourcing of traditional services such as programming and applications development has already achieved a high level of maturity, so the growth in adoption

has already tapered off. Firms considering outsourcing these services have multiple options for suppliers and locations to choose from. I might be able to evaluate the diffusion patterns and tease out more information about spillover effects by analyzing interactions while handling stimulus-response time-lags between the announcements more carefully. To constrain the interactions based on a proposed minimum time-lag between announcements (say two or three months), I will have to consider some other methods. The space-time clustering methods that I used are exploratory, and I found that I could not do stimulus-response time constraint-based analysis with them.

- (3) Another different approach might be to consider industry similarity and time as the two dimensions for analysis. Instead of first looking at the space-time interactions and then industry similarity, as I did, it might be more effective to just consider time and industry similarity. This approach might be better suited to understanding the diffusion process.

We know there are systematic differences between the degree and impact of IT outsourcing across different industries. Also we know that the diffusion of IT outsourcing is influenced by mixed communication channels. So the behavior of potential adopters is influenced by those who have already adopted IT outsourcing, as well as by the mass media and other external factors such as vendors. Additionally, many firms have compartmentalized and distributed their business processes. Thus, even if their strategic decisions are taken at the headquarters level, it still is possible that the impetus and research on the actions,

as well as the implementation happen at other geographical locations. So the real contagion effects may be occurring elsewhere than via the firms' headquarters. As a result, the diffusion behavior is probably influenced more by the firms that are located closer to where the implementation occurred. Because IT outsourcing announcements do not contain information about where the actual implementation happens, it is worthwhile to reconsider whether the headquarters location is a workable proxy variable for studying the geographic source of the contagion effect. It also might be more beneficial to just consider the time aspect and industry similarity in trying to understand the diffusion behavior across firms.

Next, I will discuss some other limitations of this study. While my data sample is representative of U.S.-based firms whose outsourcing announcements reached the newswires, it may not be representative of the IT outsourcing activity of all firms within the U.S. The number of observations is small relative to the national spatial patterns of economic activity. As a result although I have information about IT outsourcing events, but I don't have any information about how these IT outsourcing events relate to the underlying population. Thus I cannot draw any inferences about the entire population based on the observed results. Additionally, as I do not have information about the analogous activities (such as vendor activities, competitor's activities, and other influencing factors). I cannot conclusively assert that the temporal clustering that I observe is a result of "stimulus-response" from one deal over another within a short period of time and not because of some external unobservable stimulus.

The U.S. urban system is quite heterogeneous, with areas of high and low density spread across a large land area. A k nearest neighbor approach (Jacquez Test) does not require an *a priori* definition of the spatial and temporal extent of possible interactions in terms of kilometers or days, and is to some extent adaptive to the context in which the observations are located. I do recognize that the method is not truly random in space, although the method doesn't require a priori definition of spatial extent but distances between firms in dense metropolitan areas will invariably be shorter than those between firms that are located in more spread out metropolitan areas such as Phoenix. One way to address this concern could be to make use of inverse distance and thus do a weighted test when calculating the test statistic. I did look for a weighted test in the existing space-time clustering literature to address this issue but couldn't find one that has been implemented. As a result at this point I am hesitant to go forward with implementing the test without rigorous testing. This is one of the issues to be addressed in the future iterations of the paper.

I used an exploratory approach and found some positive interactions in space-time clusters at the global level that suggest the presence of some underlying effects. Although my results indicated a lack of local clusters, I cannot say with certainty that there are none. For this reason, I investigated those observations that were close in space and time, and might be indicators of the types of clusters that would be observed if more data were available. Going forward, I am interested identify and establish the presence of contagion effects within the space-time

clusters by separating the stimulus events from the response events by using some other analysis methods.

Chapter 4. IT Services Sector Growth in the BRIC Economies

4.1. Introduction

Most of the IT outsourcing-related studies in the information systems (IS) literature have applied individual, economic, strategic and social perspectives (Dibbern et al. 2004). A variety of theoretical perspectives have been used. These include transaction cost theory (Ang and Straub 1998), social exchange theory (Kern and Willcocks 2000), and resource dependence theory (Goo et al. 2007). In addition, others have used move-to-the-middle theory (Clemons et al. 1993), agency theory (Hancox and Hackney 1999), innovation diffusion theory (Loh and Venkatraman 1992b), and economic and political institutions theory (Ang and Cummings 1997; Vitharana and Dharwadkar 2007). This has enabled our understanding of the IT outsourcing decision-making processes, the relationships between clients and providers, the economic benefits accruing from IT outsourcing, and institutional influences.

These theories also have helped in identifying the roles of different criteria used by organizations to decide on external acquisition of outsourced services, but not much effort has been expended to seek an explanation for the development of global clusters or hubs of specialized services for IT outsourcing in emerging economies. Firms make strategic decisions about outsourcing particular services to different service cluster locations. For example, India is a popular business process outsourcing services producer, just as Russia supports offshore application development, and China supports R&D activities.

There is a knowledge gap in IS literature when it comes to our understanding of why and how different countries have been successful in developing certain portfolios for providing IT outsourcing services though. I try to fill this knowledge gap, and provide a theoretical explanation for the sectoral and portfolio growth of IT-related services across Brazil, Russia, India, and China (BRIC) economies. My proposed theory is called *knowledge network theory*.

Towards that end, I will address the following research questions. What are the factors that are responsible for the development of IT and related services hubs? What roles do economic and political institutions play? How do networks of knowledgeable and entrepreneurial expatriates influence the development of this sector? What are the main drivers of growth in the IT and related services sector?

A well-rounded understanding of these factors and issues is not only important for the IS research community at large but also imperative for policy-makers in the client and service-providing countries. This is especially true for policy-makers in emerging economies that are trying to establish a foothold in the IT and related services sector, and would like to emulate the success of already established leaders such as India and China.

The main objective is to develop a hybrid theory to explain the growth and development of IT services outsourcing in different emerging economies, and the factors that are most influential in various places. My focus is on the BRIC countries because these countries have demonstrated high potential for economic growth and are among the biggest and fastest developing emerging economies.

They also are major players in the IT outsourcing and IT-related services markets (Wilson and Purushothaman 2003). Over the next forty years, the combined GDP of the BRIC economies is predicted to collectively exceed that of the G6 nations (U.S., Japan, France, Germany, Italy and U.K.) in U.S. dollar terms. China already is the second largest economy in nominal gross domestic product (GDP) terms, with an estimated value US\$5.878 trillion in 2011, followed by Brazil and India in the eighth and ninth positions. These countries hold a combined GDP in purchasing power parity terms of about US\$18.45 trillion dollars. They encompass over 25% of the world's land coverage and nearly 40% of the world's population, and are recognized as countries with high potential for knowledge-based economic growth (Central Intelligence Agency 2011; Cooper 2006). I will focus on this dimension of knowledge-based economic growth for comparison among the BRIC countries, and evaluate the IT and related services sector, excluding computer hardware.

To explain the sectoral and portfolio growth of IT-related services in these economies, I will leverage different theoretical perspectives, including economic and political institutions theory, new growth theory and brain circulation theory among others with a belief that none of the theoretical perspectives alone can effectively explain the growth and development that has been observed. Thus, the focus is on developing a hybrid theory, and the empirical work on these issues utilizes the case study approach. I develop several theoretical propositions to address the research questions with an emphasis on the role of adaptive institutions and new knowledge spillovers, which are created by the integration of

a country into the global market, and by interactions with technologists, business investors and entrepreneurs in the countries' diasporas of past émigrés. I also consider the role of country characteristics, economic history and geography and their influence on growth of the IT and related services sector in the BRIC economies.

Next, I will discuss the relevant theories in the theory-building process that enabled me to distill my proposed knowledge network theory. Following that, I will describe the data and case settings, and individual within-case analyses of Brazil, Russia, India, and China. Thereafter, I will perform cross-case analysis to develop a more integrated theoretical understanding. This process permits assessment of similarities and differences among the cases, and distillation of the key findings about how well the proposed theory works across different kinds of observations. Finally, I will offer some interpretations and insights for policy-makers. I will conclude with contributions and limitations.

4.2. Theory Development

Mason and Mitroff (1973) proposed the *inquiring systems* perspective, which involves bringing together multiple theoretical perspectives to form a new synthesis in a *hybrid theory development process*. They suggest applying *induction* when existing theory seems inadequate to explain new observations to reach a new synthesis. With their perspective in mind, I focus on analyzing the capabilities of different theories that have been proposed to see if they are sufficient to explain the growth in the IT and related services area in the BRIC countries. This process also encourages *deduction* to determine the limits of

applicability of different theories, and offers a means to reconcile opposing explanation. In this study, I will use Carlile and Christensen's (2005) *theory building with anomalies* approach to reach the new synthesis. The authors assert that process of building a new theory is iterative and ongoing. This permits researchers to change, update and improve their ability to explain the past, interpret the present, and predict the future.

A researcher can improve a theory by identifying an *anomaly*, which is an outcome that the theory cannot explain. Once an anomaly is identified, an effort should be made to define and assess the phenomena, and work through a disciplined process of reconstituting the contents of the theory so that the relevant independent variables can explain the dependent variables (Carlile and Christensen 2005). I adapt this process to try to find a better explanation for IT and related services growth across the BRIC economies. Once I identify an anomaly using the base theory, I then add on the elements of other theoretical perspectives that provide relevant explanations for the observed anomalies to the base theory, instead of reconstituting the elements of the base theory. I use this approach because simply reconstituting the elements of the base theory does not provide a comprehensive explanation of the observed phenomena.

Next, I offer a brief summary of literature from which the theoretical perspectives are drawn. (See Table 5.)

Table 5 Theoretical and Related Perspectives

Theory	Literature	Main Findings
Political and Economic Institutions Theory	North (1990) Acemoglu et al. (2005)	Institutions support interactions between trading partners in an environment of interdependent specializations and complex exchange across time and space. Economic institutions determine aggregate economic growth potential of an economy; shape incentives of key economic actors in society; and influence investments in physical and human capital and technology, and the organization of production.
New Growth Theory	Romer (1986)	Accumulation of knowledge is a driver of growth. Technology is treated endogenously; externalities, increasing returns in the production of output, and decreasing returns in the production of new knowledge combine to produce growth in the presence of competition.
Brain Circulation Theory	Saxenian (2006)	A country's national diaspora of émigrés builds tech and entrepreneurial capabilities outside a country. They are role models, mentors, and investors in their home countries,
Country Characteristics	Dahlman and Aubert (2001)	The four pillars of knowledge based economy are: first, an educated and skilled population; second, an effective innovation system; third, a dynamic information infrastructure; fourth, an economic and institutional regime.
Economic History (Path-Dependent Development)	David (1985)	Path-dependent economic changes influence the eventual outcomes that relate to economic growth and development. These events can occur early in a country's timeline of development, and be a product of serendipitous influences, rather than systematic forces that reflect more general pathways to beneficial growth.
Geography	Porter (1998)	Industry clusters are common. The paradox is that enduring competitive advantage in the global economy is based on the creation of local capabilities: knowledge, relationships, and motivation. External rivals may not be able to match these capabilities, which leads to unique geographical effects on development and growth.

Note: Country characteristics are a synthesis of characteristics deemed important by scholars from various disciplines, for sustaining economic growth and development especially in the context of knowledge based economies. See, for example: Dahlman and Aubert (2001), Feenstra and Hanson (1997), Goldberg and Pavcnik (2007), Markusen (2006) in economics; Krueger (1968), Krugman and Lawrence (1994), Dornbusch et. al. (1977) in international trade; Arora et al. (2001), Arora and Athreye (2002), Heek (1999), and Li and Gao (2003) in IS.

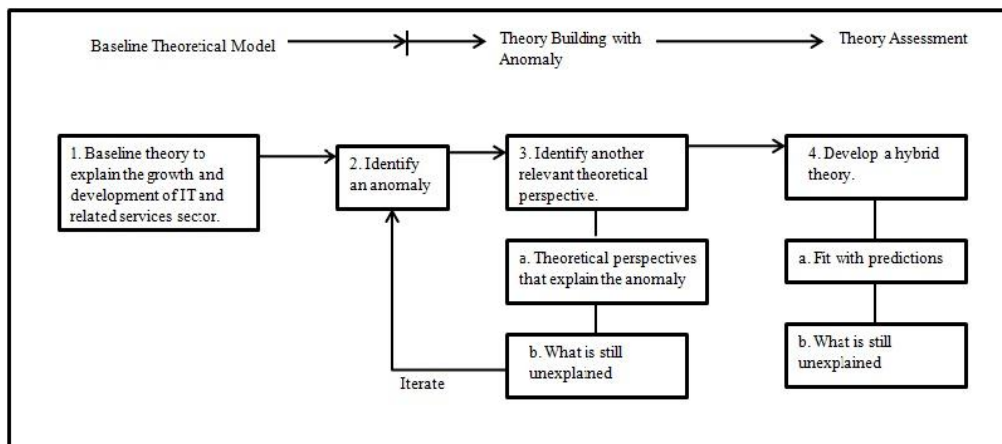
4.2.1. Method: Theory Building from Anomalies

Carlile and Christensen (2005) propose two major stages for theory building¹⁰ – the descriptive stage and the normative stage. Each of these stages is broken down into three steps: observation, categorization, and association. I adapt Carlile and Christensen's (2005) theory building with anomalies approach for this study's context and focus on observation and association steps. The categorization scheme that I follow is – developing countries and as mentioned before I focus on BRIC countries. Based on the observation and description of the phenomena, I identify the relevant high level constructs. Following that, I provide a description for the relationships between the different constructs and discuss their effect on the outcome. I do this for each theoretical perspective. Finally, I describe the interactions between these constructs and propose the hybrid theory.

To implement the above method, I applied the following evaluation procedure. (See Figure 13.) First, I used the base theory to explain the phenomena and describe the general facts that suggest its uses. Second, I identified an anomaly in the theoretical explanation for the setting. Third, I considered another relevant theoretical perspective to explain the anomaly. Following that, I evaluated the efficacy of the new theoretical perspective and identified the high-level constructs. I did this for each theoretical perspective. Then, in the fourth step, I focused on developing the hybrid theory by describing the interactions between the different constructs that had been identified in the previous steps.

¹⁰ This model of theory development proposed by Carlile and Christensen is a synthesis of models that have been developed by scholars in a range of fields: Kuhn (1962) and Popper (1959) in the natural sciences; Kaplan (1964), Stinchcombe (1968), Roethlisberger (1977), Simon (1976), Weick (1989), Eisenhardt (1989) and Van de Ven (2000) in the social sciences.

Figure 13 Evaluation Procedure



I use *economic and political institutions theory* as the base theory. This theory has traditionally been used to explain the disparities between economic growths across different countries (Acemoglu et al. 2002; 2005). Differences exist because institutions are required for effective management, and they shape aggregate economic growth potential and control resource distribution. They also affect the incentives of economic actors in society, and influence investments in physical and human capital, technology and production. Essentially, institutions act as engines for growth and development and provide the critical support needed to sustain growth. But when I evaluated economies exhibiting high rates of growth where the knowledge component is predominant, I found that economic and political institutions theory alone was insufficient to provide a satisfactory explanation. It failed to account for the creation, assimilation and adaption of domain knowledge and social context required to sustain growth in the global arena.

Having identified these anomalies, I use the perspectives of new growth theory and the concepts of globalization and brain circulation theory to decipher how domain knowledge is created. Further, to understand the factors that determine the trajectories of development and resources and capabilities, which influence the social context, I use the perspectives of country characteristics, path dependent economic development and geography. Building on these theoretical perspectives I provide a more robust explanation for the exponential growth that is observed in the IT and related services sector in BRIC economies. Next, based on Step 1 of my evaluation procedure, I evaluate the base theory, institutions theory, and discuss the facts that prompt the consideration and inclusion of this theory.

4.2.2. Long-Run Performance and Effective Institutions

Institutions involve rules, their enforcement characteristics, and the norms of behavior that structure repeated human interaction (North 1989). They provide a stable and reliable means of interactions between the trading partners in an environment of interdependent specializations and complex exchange ties that extend in time and space. They also play a role in determining the long-run performance of economies. Institutions matter because they support the effective functioning of the economy, and produce incentives and guidelines for continuous economic growth, provided they have the ability to adapt to changing economic situations.

Economic institutions are of interest because they determine the distribution of economic resources in an economy too. The choice of economic institutions is

endogenously dependent on the political power of key political groups. Political forces often either fully or partly determine the allocation of resources based on the segments of a society that have political clout, and they may also have more say in shaping political and economic institutions that they prefer. The dominant political power, as a result, is often able to use (or misuse) the existing political institutions and economic institutions. In this interaction lies the main reason behind the radically different performance of economies over long periods of time. As North (1990) explains, there are differences between the rules and institutions across countries and the players in the dominant political group. Further, the interactions between them shape and change the institutions that are present in their environment. The players make choices based on imperfect information or self-interest, and the resulting institutional changes often have unintended consequences that are not always optimal choices to support the improvement of economic welfare. Hence I propose:

- **Proposition 1 (The Adaptive Institutions Proposition):** *A developing country will achieve IT services growth when the participating political and economic institutions create the ability to adapt to changing economic situations, and manage and allocate resources more effectively.*

For the BRIC economies, effective management and allocation of resources, economic and political institutions are important. Institutional efforts towards market liberalization, reducing trade barriers and bureaucratic intervention have played an important role in the economic transformation of the BRIC countries. As we observe in case of India. In India the policy initiatives to support IT and

related services sector started in early 1970's and continued through early 1990's. But it was the IT services boom in the form of technology pressures of Year 2000 (Y2K) that provided the thrust to establish India in the global market. One of the main contributing factors towards this exponential growth was the entrepreneurial efforts of private firms and the interactions between the Indian business community and members of Indian international diaspora in the developed countries. This interaction was crucial in creating the domain knowledge and social context that was required to compete in the global market (Arora et al. 2001; Arora and Athreye 2002). As we observed in case of India (details discussed further in the individual case analysis section), institutions play a crucial role but alone cannot create the domain knowledge and social context that are required for a country to compete and be successful in the global market for IT services. Additionally, this has also been shown by numerous failed attempts to "grow the next Silicon Valley," by mobilizing researchers, capital, and modern infrastructure. These failed attempts have provided evidence that a shared language and trust of technical communities are of utmost importance for creation and transfer of domain knowledge. Open information exchange, collaboration, and learning, cannot be replicated or created by institutional fiat (Bresnahan and Gambardella 2004; Saxenian 2005).

On the other extreme, within the context of BRIC countries, we have the example of Russia where there is negligible support from the institutions but still growth is being observed in the IT and related services sector although at a much reduced scale. In case of Russia the institutional support has been weak and policy

implementation has been unreliable (details provided in individual case discussion section). The growth and development that has been observed in the IT and related services sector is mainly because of the initiatives of the entrepreneurial private firms and increased interaction in the recent past between the Russian business community and members of Russian diaspora in developed countries (Hawk and McHenry 2005). This increased interaction has helped in creating domain knowledge and the social context required to sustain growth and compete in the global market. Having recognized this anomaly, my intention is to blend this proposition with other theoretical perspectives as a basis for restating the theory to provide a fuller explanation. Next, based on Step 3 of the evaluation procedure, I use the perspectives of new growth theory, brain circulation theory and concepts of globalization to explain the observed anomaly.

4.2.3. New Knowledge, Global Interdependence, and Networks

Romer (1986; 1992) put forth the idea that creating *new knowledge*, and not labor or capital, drives economic growth. Different theorists have asserted that economic growth develops in the presence of the creation and accumulation of knowledge, which is characterized by increasing returns (Grossman and Helpman 1994; Nelson and Winter 2002). In economics, new growth theory has played an important role in explaining the ongoing shifts that have been observed from *resource-based economies to knowledge-based economies*. This is an essential shift in today's economic environment: new knowledge is the driving force behind economic growth. The neo-classical approach emphasizes capital accumulation and labor force improvement as sources of growth, but these have

diminishing returns, so there are implied limits to economic growth. New growth theory emphasizes creation of new ideas and new knowledge, which have increasing returns. New innovations such as software, for example, have high initial fixed costs and low marginal costs for serving an additional customer or user. As new knowledge accumulates, it is possible to create the basis for dramatic economic growth.

One way that new knowledge is created and transferred within a country is through an effective innovation system. Another way is through the *integration* of a regional economy with the world market as it grows. Residents of countries that are integrated into the global market enjoy access to a much larger technical and practical knowledge base. *Trade* is one means by which knowhow is disseminated across countries. Another way is a country's *diaspora* (Saxenian 2007). The diaspora represents a group of highly-educated professionals who contribute to the economic development of their home countries by facilitating the transfer of specialized knowledge and financial capital. They typically received their education or worked in specialized industries of countries that create new technical knowledge.

Saxenian (2007) refers to these ideas about human capital networks as *brain circulation theory*. It is valuable to explain how knowledge spillovers contribute to the growth and development of economies, in particular that of IT and related services sector. The focus of this theory is on the participants in the diaspora. They set up cross-regional networks, and transfer technological and institutional knowhow to their home countries. They do this by enabling open information

exchanges and maintaining close interactions related to the fast-changing technologies and markets of developed countries. This permits them to support and build technological and entrepreneurial capabilities. Thus, I also propose:

- **Proposition 2 (The Entrepreneurship Diaspora Network Proposition):**

A developing country that has more extensive diaspora-based entrepreneurship networks, and is integrated into the global market will see higher levels of IT services growth due to easier knowledge transfer.

Interactions with the diaspora and integration into the global market can support the creation of domain knowledge, but to compete successfully in the global market, besides domain knowledge, other capabilities and resources are required. These resources and capabilities are determined by the country characteristics, economic history and certain geographic locations within a country. As has been shown by the extensive work done by Saxenian (2002; 2003; 2005; 2007) in the context of setting up cross-regional entrepreneurial networks. The new technology centers, such as China and India, differ significantly from one another, and from Silicon Valley, in terms of the, sophistication and specializations of local producers, which in turn are determined by the skills, and technical and economic resources of the home country. Having recognized this anomaly, I iterate through Step 3 of the evaluation procedure and build on the Adaptive Institutions Proposition (P1) and the Entrepreneurship Diaspora Network Proposition (P2). This enables me to provide a fuller basis for explaining growth in the BRIC countries' IT services industries.

4.2.4. Country Characteristics, Economic History and Geography

The endogenous treatment of technology under new growth theory influences how institutions, history and geography affect economic development. To get a fuller understanding of what is occurring, it is important to consider institutions, economic history, and geography together. Why? This is because institutions provide a framework for growth. Economic history plays an important role in shaping the trajectories of development. Finally, geography can be a limiting factor in knowledge development. In addition to institutions, economic history and geography, it is important to consider country characteristics that influence the rates of growth and development. The role of institutions has already been discussed, so next the focus is on the roles of country characteristics, economic history and geography.

In a knowledge-based economy, innovation is far more important than land or physical capital as the primary factor affecting a nation's economic growth and development. Further, the ability to innovate is directly affected by country characteristics such as: (1) an educated and skilled population able to productively employ and advance knowledge; (2) effective innovation systems, forming a network of higher educational establishments and R&D institutions; and (3) a dynamic information infrastructure that can facilitate communication, and processing of information (Dahlman and Aubert 2001).

Economic history matters because increasing returns associated with new knowledge create *path dependence*: future options are constrained by the exercise of past options (David 1997). Chance events occurring at the “right” time can

have persistent long-term effects also. Increasing returns also generate positive feedback that results in economies confining themselves to particular technologies and locations for their development and application. Economic history is further influenced by the effectiveness of resource allocation by the institutions.

Idea creation, new business development and economic changes happen in specific places. Globally-competitive firms in an industry are not only found in a particular nation, but also may be concentrated in particular regions within them, often in the same city, for example (Porter 1990). *Geography* matters because knowledge spillovers that form the basis of new growth theory are limited by distance, and the defining factor for their geographical scope is the type of knowledge that is involved (Polanyi 1967). Codifiable and explicit knowledge, which can be written down, is easier to transfer and not limited by geographic distance. Tacit knowledge develops from experience, and cannot be easily transferred. It is limited by geographic distance, as close and frequent interactions may be required for its transfer. Another factor besides geography that influences knowledge spillovers is the diversity and specialization that occurs in a location. The close interactions between different economic actors within a location helps promote the development and generation of new innovative ideas and products, which generate new work, leading to economic growth and development (Jacobs 1969).

Geography, country characteristics and economic history influence resources and capabilities development. In the presence of interactions with the diaspora and integration into the global market, they determine development of specialized

IT services clusters across different countries too. The diaspora not only provides a mechanism for the international diffusion of knowledge, but it also helps in creating and upgrading local capabilities. These are distinct but essential complements to the global IT production networks that have been observed for the BRIC countries.

The discussion above indicates that the growth and development of the IT and related services sector is a result of interrelationships among a number of constructs that are associated with different theoretical perspectives. They include adaptive institutions, and the new knowledge that is created and flows through a country's diaspora of technology entrepreneurs and financiers, which supports its integration into the world market for trade in services. This perspective suggests that resources and capabilities developed as a result of the diaspora's activities, relevant economic history, country characteristics and regional geography will play a role. For the growth and development of any industry sector or an economy as a whole, the availability of resources and capabilities to compete are a prerequisites, and this true in case BRIC countries also. Of special interest is how these resources and capabilities are influenced by, and in turn, develop in the presence of interactions with diaspora-based human networks.

None of the theoretical perspectives that have been discussed above, taken individually, yield a full explanation of the process that results in the growth of the IT and related services sector of a given country. It is the combination of them that helps us understand the reasons behind what has been observed in the BRIC countries. Hence I propose:

- **Proposition 3 (The Knowledge Network Proposition):** *A developing country, which has adaptive institutions, with close interactions with its diaspora and diaspora-based entrepreneurial networks, and industry capabilities to participate in global markets and provide complementary services will exhibit a higher level of IT services growth.*

Next, I describe the data and case setting and analyze what happened in the BRIC countries. The discussion of individual cases is based on the constructs that I have identified above. I focus on the role of adaptive institutions, the knowledge transfer mechanisms (globalization and diaspora based networks), and also on the concepts of resources and capabilities. The latter includes industry structure, portfolio of services provided, and geographic location of technology cluster. These give us insight into the trajectories of development of the IT and related services sectors. (I provide a detailed cross-country comparison of country characteristics important for the growth of IT and related services sector. See Appendix A.). Next, in the cross-case analysis section I focus on the interactions among the constructs of the different theoretical perspectives, which form the basis of the hybrid theory.

4.3. Evidence from the BRIC Countries

In this section, I first explain the methodology, including the research setting, and case selection and data collection. Thereafter, I present a set of single-case analyses for Brazil, Russia, India, and China, as a basis for touching on issues discussed in the theory development section.

Next, I use a multiple case study approach to explore the validity of theoretical propositions, following Eisenhardt (1989) and Benbasat et al. (1987). Multiple cases not only provide empirical evidence for the theoretical perspectives but also enable broader exploration of the research questions under study. Theory building from multiple cases typically yields more robust, generalizable, and testable theory than do single-case study research designs. I selected the BRIC countries as the empirical setting for the study for a number of reasons. First, three of the four BRIC countries are developing countries, except for Russia, with a large population, and have shown exceptional potential for economic growth (Wilson and Purushothaman 2003). Second, the BRIC countries are major players in the IT and related services market. Third, market liberalization and other economic policy changes pertaining to the IT and related services sector were initiated in the BRIC countries in the same time period during the late 1980s and early 1990s. This gives more credibility to the comparison of growth and development of IT and related services sectors over time across the BRIC countries. Another reason for selecting the BRIC countries was to choose cases in which the process of interest is “transparently observable” (Eisenhardt 1989). This allows the cases to create a basis for validating or extending the emergent theory.

I collected data for this study from secondary sources, including policy reports, government websites, and firm and trade associations’ Web sites. I also used other authoritative news sources, such as *Forbes* and *CIO Magazine*, and books and published reports. Other sources include articles from academic

journals and publications from the World Bank, the Organization of Economic Cooperation and Development (OECD), and the United Nations.

4.3.1. Brazil

Based on Step 1 of my evaluation procedure, first, I will explore the role of institutions in the growth and development of IT and related services sector. The roots of the Brazilian IT industry can be traced back to the 1970s, when the Brazilian government introduced new policies for the computer hardware market. (See Table 6.) Brazil’s software market was valued at US\$1.1 billion in 1991 (Dedrick et al. 2001). The rapid growth in the IT sector happened in the mid to late 1990s. The Brazilian software industry generated revenues of US\$29.3 billion by 2008 and accounted for 1.99% of the world market and 48% of the Latin American market (Associação Brasileira das Empresas de Software (ABES)).

Table 6 Early Policies in Brazilian IT and Related Services Industry

Year	Policy	Detail
1970s	Computer hardware market reserve policy	The goal was to help domestic firms grow and develop self-sufficient technology in critical market segments, so as to limit the incorporation of foreign technology.
1992	Program for strategic development of IT	The main policy initiative was SOFTEX 2000, a national program for software exports aimed at creating an export-oriented software industry.
1996	The SOFTEX Society was established to coordinate the SOFTEX 2000 Program’s activities.	Its goal was to stimulate creation of start-up firms through creation of business incubators in various parts of the country.

Source: Adapted from Veloso et al.(2003).

The government of Brazil promulgated reforms from 1991 onwards, which benefited the IT industry, based on a more market-oriented policy. An associated result was the investment of resources in R&D for corporate and sponsored

research in universities and research institutes. Close collaboration among the state, private firms and universities led to the creation of technology parks and software development centers, which helped to build and support the innovation infrastructure of Brazil. According to an organization called the Brazilian National Association of Science Parks and Business Incubators, in 2008 there were 74 technology parks catering to different sectors comprised of 520 enterprises (Avritchir 2010). But because of the institutional strategies and policy changes in the IT industry, the software sector has been more isolated from global influences and has been mainly dependent on domestic demand. This is reflected in the industry's low export rates and limited service portfolios and indicates towards the non-adaptive nature of institutions and also points towards the lack of domain knowledge as recognized in the Step 2 of the evaluation procedure.

After the initial thrust of policy support from the government, the major impetus for the development of software services has come from non-government organizations (NGOs). They include the SOFTEX Society, and the National Association of Promotion Entities for Innovative Enterprises (ANPROTEC). Other players are trade associations, such as the Brazilian Association of Software Enterprises (Associação Brasileira das Empresas de Software, ABES), the Brazilian Association for Information and Communication Technology (BRASSCOM), and ApexBrasil. Senior managers and consultants associated with the NGOs and trade associations have strong ties to developed nations, such as the U.S., Japan, and Europe. Within the BRIC countries group, Brazil stands out

because there is not much information available about the role of diaspora in the development of IT and related services sector.

Brazil has long been integrated into the global market. (See Table 7.) Brazil implemented unilateral trade reforms in 1988 through 1994 (Goldberg and Pavcnik 2007). An important feature of these reforms was the drastic reduction in tariffs, from a whopping 58.8% to 14.4%, which led to increased trade. A related development was the growth in presence of multinationals companies, reflected in the FDI inflows. In 1980, the FDI inflow was a mere 0.81 % of GDP, but by 2000 it had increased to 5.08% of GDP (Goldberg and Pavcnik 2007). It currently stands at 2.3% of GDP, and is approximately US\$25.9 billion in value.

The discussion above touches on two important mechanisms of knowledge transfer: integration into the global market, and the influence of knowledge networks. Both of these mechanisms play an important role in the creation and dissemination of knowledge, and are indicative of Step 3 of the evaluation procedure.

Next, I will discuss the geographic location of technology clusters and the service portfolios influencing the growth of IT and related services sector.¹¹ The IT firms in Brazil are concentrated in the south of the country. A main reason for this is the policy initiatives that were undertaken in the 1970s and 1980s, which favored these areas for R&D investments. Later, there was a movement of other

¹¹ Geographic location of technology clusters are discussed in the individual cases but the role of economic history as reflected in industry structure and portfolio of services provided is discussed in the cross-cases analyses section. The discussion on interaction between the different attributes is presented during the cross-case analyses. This is Step 4 of the evaluation procedure. The details of the comparisons based on the country characteristics are provided in Appendix A.

firms into these areas, resulting in the development of technology clusters supported by excellent R&D infrastructures. The IT and related services industry caters only to a few sectors of the economy, such as finance, telecommunications, e-business, and the federal government. Software services include system integration services, processing services, and hardware and software support, representing about 57% of total IT services revenues in 2004 (Botelho et al. 2005). To enter the global IT services market, most of the firms are now undergoing active internationalization efforts, with several focusing on Latin America, but others directly targeting the U.S. market.

Table 7 Globalization in Brazil

FDI Net Inflows (% GDP)		Trade Liberalization		Trade Flows (% GDP)							
		Average Tariff (%)		Imports			Exports				
2010	2005	2000	2009	After (1994)	Before (1987)	2010	2005	2000	2010	2005	2000
2.3	1.7	5.08	11	14.4	58.8	12	12	12	11	15	10

Source: The information on trade liberalization is from Goldberg and Pavcnik (2007). The information about trade flows and FDI is from World Development Indicators (WDI).

4.3.2. Russia

The Russian IT and related services industry is in its infancy. In 2008, India exported US\$40 billion in IT services, whereas Russia exported about US\$ 3.65 billion (Oshri et al. 2009). Following the same approach as in case of Brazil, first the role of institutions is discussed based on Step 1 in the evaluation procedure. Russia's economic history has been fraught with problems and instability since 1991. A number of policy reforms were initiated in the early 1990s, but it was not until 1999 that the economy saw a positive upturn and the technology sector was recognized as being crucial to support broader economic growth. Most of the positive GDP growth observed from 2000 onwards was dependent on the exports of natural resources though (Hironori 2009).

One of the first programs launched by the Russian government to support the IT and related services industry was the Electronic Russia Program, which operated from 2002 to 2009. Its main goal was to invest US\$2.7 billion to promote the informatization of Russia's government and society, by creating positive conditions for the growth of the software development business in the country, including venture capital and investment support. The implementation of this plan has been problematic, and firms in the IT and related sector have come to not expect much support from the programs run by the government (Hawk and McHenry 2005). In 2001 the government announced the creation of several tax-free IT development zones, but pulled its support from these plans in 2002 (American Chamber of Commerce 2001; Hawk and McHenry 2005). In early 2005, Russia's president promised construction of technology parks in the

country. By mid-2005, plans were put in place to construct six to ten technology parks in four different regions by 2010 (Ilyicyov and Novosti 2005). In 2007, construction for one was started, which is expected to be complete by about 2015. The other technology parks have not yet reached a significant size or achieved much impact, and some still are just plans on paper (Nassor 2008).

Next, the focus of my discussion moves to the two main mechanisms of knowledge creation and transfer: integration into the global market, and the role of diaspora. This is Step 3 of the evaluation procedure. Russia, like Brazil and China, has long been integrated into the global market (See Table 8.). It is interesting to note that until 2003 the average tariffs in Russia were about 15%. This was higher than Brazil or China in the same time period, and is indicative of the protectionist trade policies of the time. Over the years, FDI inflows have been steadily growing. In 2010, FDI was 2.8% of GDP, representing approximately US\$36.8 billion, which was much higher compared to Brazil and India, but less than China (World Development Indicators 2010).

Table 8 Globalization in Russia

FDI Net Inflows (% GDP)		Trade Liberalization		Trade Flows (% GDP)						
		Average Tariff (%)		Imports		Exports				
		Current (2009)	After (2003)	Before	2010	2005	2000	2010	2005	2000
2010	2005	2000								
2.8	1.7	1.04	11.5	14.5	22	22	24	30	35	44

Source: World Development Indicators and OECD report on emerging economies.

Russia has many expatriates that form a large diaspora of people in various developed countries around the world. The ties between the Russian diaspora and the business community have not developed very well though. Similar to the Chinese and Indian diasporas, the Russian diaspora is comprised of a large number of educated science, technology and business professionals. Up until recently, with the third wave of immigrants who came after 1990, there was little indication of active engagement on the part of the Russian diaspora with business opportunities in the people's homeland (Osipovich 2005).

This has changed in the ensuing years though. One example of the recent actions of the Russian diaspora is a non-profit association founded in 2002 called the American Business Association of Russian Professionals (AmBAR). This association has more than 2,500 Russian-speaking professional members, and is actively engaged in developing entrepreneurial networks to promote business and technology development in the Commonwealth of Independent States (CIS) countries from among the former Soviet republics. In the recent past, many of the expatriates have returned to Russia and are engaged in development of the IT and related services industry in various capacities. For instance, a Moscow-based firm called RUSEE, engaged in education and consulting on best practices in software development, was founded by alumnae of Carnegie Mellon University, who have retained ties with the university and the Software Engineering Institute (Cusumano 2006).

There are currently three main technology clusters in Russia: Moscow, St. Petersburg and Novosibirsk. Under the Soviet system, these three cities were the

hubs of the R&D institutions. About 80% of scientific institutions were located in Moscow, St. Petersburg and Novosibirsk at that time. This concentration originally arose in part due to the need for tight control by the government, and also as a result of relatively low levels of development in other areas. During that time, the primary objective of Soviet R&D was to support military and space programs, and to provide a degree of technological self-reliance (Radosevic 2003). After the breakup of the Soviet Union and the high inflation in the early 1990s, there was a scale-back in R&D investments. The R&D infrastructure and the institutional support remained, though on a much reduced scale. In 1991, when the developmental focus shifted to a market economy, these three locations became the obvious location choices for start-up technology firms because of the research infrastructure and the local university networks. Thus, the influences of economic history and geography have clearly played a key role in the development of technology clusters.

4.3.3. India

India is currently the world leader in the global IT and BPO services market, with a dominant share of 55% of the market (NASSCOM 2011). In 2011, aggregate revenues for IT software and services sector were estimated to be US\$76.1 billion, accounting for 6.4% of India's gross domestic product (GDP). The IT industry in India began in the 1970s, but the trigger that set India on its path to exponential growth was the IT services boom. This boom provided the initial thrust needed to carry India forward and establish the country's name as a brand

leader in the global market. It came in the form of technology pressures related to the Year 2000 (Arora et al. 2001; Arora and Athreye 2002).

Technology and systems maintenance pressures on the Western economies helped Indian firms to gain entry into multinational companies, but the transition from domestic to offshore delivery became possible because of the policy reforms that were started as early as 1984, when the government announced new policies related to computers. (See Table 9). Before these policy reforms were introduced, the Indian IT industry was highly regulated and plagued by many restrictions, such as compulsory licensing, tariffs, and multiple controls on private investment. These reforms were vital in changing the mindset of the Indian government; it previously focused on highly restrictive and controlling policies, but became more open to interacting with the industry heads and independent trade bodies (Ahluwalia 2002).

Table 9 Early Policies in Indian IT and Related Services Industry

Year	Policy	Detail
1972	Software export scheme	Hardware imports were permitted for the purpose of software development.
1984	New computer policy	Import procedures for hardware and software were simplified; import duties were reduced; and software was recognized as an industry.
1988	Scheme for software technology parks (STPs)	STPs were created for production of software for export.
1991	Economy-wide liberalization	Reductions in telecom charges, and further reductions to import duties on software and hardware were made;
1992	Tax policy reforms	Software exports were exempted from income tax under the Income Tax Act.

Next, based on the Step 3 of the evaluation procedure, I will describe two of the main mechanisms of knowledge transfer: the role of the diaspora and integration of India's economy into the world market. One of the main

contributing factors to the exponential growth of the IT services sector were the entrepreneurial efforts of private firms, and the interactions between the Indian business community and members of the Indian international diaspora in the developed countries. The private firms have established India as a place to go for high quality IT-related services. Since the early years of offshore outsourcing, different services providers have been collaborating to build a strong country brand image, and set up independent trade bodies like the National Association of Software and Services Companies (NASSCOM), for coordinating business and facilitating policy reforms. In addition, their collaboration has extended to enhancing the quality of talent pool, by proactively collaborating with academic institutes to provide hands-on training, internships, and workshops for faculty and students. Senior managers in the most successful private firms are alumnae of premier educational institutions in India or have received part of their education in developed countries, especially the U.S and the U.K., and they maintain close ties with their institutions and other classmates.

Within the BRIC countries, India stands out when the comparison is made based on the globalization measures. (See Table 10.) The tariff levels were extremely high at 117% before trade reform was implemented. Even after reform was carried out, it has been higher at 13%, compared to 9% in China and Brazil, and 11% in Russia. Over the years, although FDI investments have been growing in India, but they still only constitute about US\$34.6 billion, approximately 1.3% of GDP. This amount is lower than Russia at approximately US\$36.8 billion, and

China at around US\$78.2 billion. India's integration into the global market has not only been late but also slow as compared to other BRIC countries.

India's IT and related services market is driven by exports. In 2011, the total related revenue for these services exports was estimated to be about US\$59 billion (NASSCOM 2011). India predominantly exports to the U.S and western European countries; the U.S. is the largest importer of IT outsourcing services. First-generation Indians are also one of the largest groups of skilled immigrant labor in the U.S., and are associated with its high-tech industry. The Indian diaspora in the U.S. maintains close ties with India, and has been effective in setting up entrepreneurial networks and investing in the domestic economy. It also has been transferring technological knowhow and information about market opportunities, and facilitating policy reforms by collaborating closely with the Indian government and trade bodies (Saxenian 2007). The diaspora has played a pivotal role in the growth and development of IT and related services sector.

Next, I will explore the geographic location of the technology clusters. In the early stages, the regional development of IT and related services industry occurred in cities such as Bangalore, Mumbai, Delhi, and Hyderabad. The government set up software technologies parks in areas that already had established IT industries in the pre-reform era. Over a period of time, there was a gradual shift of firms from other related industries in these areas, which resulted in the agglomeration of IT and related industries around specific city centers in India. The consistent development efforts of the Indian government, competition among the firms, and also local presence of globally-prominent private firms not

only led to specialization of services within these clusters, but also their international recognition. Among them are Bangalore, the “Silicon Valley of Asia,” and Hyderabad.

Table 10 Globalization in India

FDI Net Inflows (% GDP)		Trade Liberalization		Trade Flows (% GDP)								
		Average Tariff (%)		Imports			Exports					
2010	2005	2000	2000	Current	After 2000	Before 1991	2010	2005	2000	2010	2005	2000
1.3	0.91	0.77	13	13	39	117	25	22	14	22	19	13

Source: The information on trade liberalization is from Goldberg and Pavcnik (2007). The information about trade flows and FDI is from World Development Indicators (WDI).

4.3.4. China

China is widely recognized as the manufacturing capital of the world. Among all the BRIC economies, it has had the fastest and most sustained rate of economic growth, and in 2010 it became the second largest economy in the world, with a GDP of US\$5.88 trillion (Barboza 2010). The growth and development of the IT and related services sector in China has been slow compared to other developing countries though. The primary reason behind this slow development has been the focus on manufacturing. Although the program for development of the IT and related services sector was launched in 1980, hardware was emphasized, and as a result, the IT and related services sector has shown much slower growth. (See Table 11.) Other influential factors behind the slow growth of the sector have been software piracy and the bundling of IT services with hardware, not stand-alone purchases (Li and Gao 2003).

Table 11 Early Policies in Chinese IT and Related Services Industry

Year	Policy	Detail
1988	Torch program to develop high-tech industrial zones	By 1999, 52 high-tech zones were established (for a range of technologies not exclusive to software). In 2000, 80% of software sales came from 2100 enterprises located within nineteen software parks.
1997	15th Party Congress accepts private enterprise	
1999	Promulgated policy measures to develop technology firms	Fund for innovation; preference in procurement, access to low interest credit; tax deduction for R&D expenditures; preferential tax treatment for imports of cutting-edge technologies and equipment.
Early 2000	State Development and Planning Commission (SDPC) announced ten national-level software bases to receive central government support.	

Source: Adapted from Tschang and Xue (2005).

The government of China has made sustained efforts to develop the software sector since it was recognized as critical for economic progress in China's tenth five-year plan from 2001 to 2005. During that time, a number of policy changes

were initiated to promote sectoral investment and develop other supporting resources, such as R&D, infrastructure and technical capabilities (U.S. Embassy 2002). One recent example of these sustained efforts to further promote development in software services and BPO is the Central Bank, the Ministry of Commerce, the Security and Insurance Regulatory Committee, and the State Administration of Foreign Exchange's issuance of a set of "Guidelines on Financial Support to the Service Outsourcing Industry" (China Sourcing 2010). These guidelines led to the creation of new channels for financing to the firms that provided outsourced IT services, and establishment of preferential insurance rates, and simplification of the settlement procedures for foreign exchange payments. As a result, the software sector began to grow slowly but steadily. In 2009, China's IT and related services industry generated revenue of US\$139.24 billion, but software exports still accounted for less than 25.6% of total software revenue.

Within the BRIC group, China stands out when globalization measures are taken into consideration (See Table 12.). Since the trade reforms occurred in 1985, China has shown a considerable decline in the rate of trade tariffs, and currently has the lowest rate at 9% among the BRIC group. From 2000 to 2005, China had the highest rates of FDI at 3.2% to 5.2%. So even after the decline that occurred since 2005 in the net inflow of FDI, it still has the highest level for this indicator among the BRICs at approximately US\$78.2 billion.

China, like India, has one of the largest groups of skilled, first-generation immigrants to the developed countries. The Chinese diaspora has also maintained ties with the business, scientific and government communities back home. Well-

known examples of how the diaspora has contributed to national growth and development are the semiconductor industries of Taiwan and China. This came through shared roots in Silicon Valley's professional and technical networks (Saxenian 2002). To assist information, technical and business exchange and network development between the Chinese diaspora and their domestic counterparts, the Chinese government has devoted resources in the form of conferences, joint research projects, investigation tours, and so on. It also has made concentrated efforts to attract Chinese science, technology and business expatriates to return home and start their own businesses. Some municipal governments have also set up venture park programs within the technology development zones to address the special needs of the returnees (Saxenian 2002).

Table 12 Globalization in China

FDI Net Inflows (% GDP)		Trade Liberalization		Trade Flows (% GDP)							
		Average Tariff (%)		Imports		Exports					
2010	2005	2000	Current as of 2009	After 2000	Before 1985	2010	2005	2000	2010	2005	2000
3.1	5.2	3.2	9	14.8	40	26	31	21	30	37	23

Source: World Development Indicators and OECD report on emerging economies.

Similar to other countries in the BRIC group, China's economic history has played an important role in the development of the IT and related services portfolio. But it is interesting to see how the technology clusters or the software technology parks (STPs) in China have developed. Although the Chinese government started setting up special economic zones for export development as early as the 1980s, STPs and policy changes specific to the software industry only were promulgated in 2000 (Lardy 2002). Since then, the government has promoted "China Sourcing" as a national brand, and has designated twenty cities as software hubs, including Beijing, Shanghai and Dalian. Different STPs are developing their own branding and value propositions. For instance, the Beijing STP is focused on supporting China's financial services industry, whereas those based in the northeast provinces have been trying to make the most of their geographic proximity and language ties to support software services in Japan and Korea.

The main thrust of the growth in China's IT and related services market has come from domestic demand. The IT services export market is still immature compared to other countries such as India. Meanwhile, the portfolio of IT services provided by Chinese firms has been limited and mostly clusters around the areas of system integration, product development, implementation and testing services (Tschang and Xue 2005). Recently, a big effort in services development has been made for BPO business.

China, like India, has one of the largest groups of skilled, first-generation immigrants to the developed countries. The Chinese diaspora has also maintained ties with the business, scientific and government communities back home. Well-known examples of how the diaspora has contributed to national growth and development are the semiconductor industries of Taiwan and China. This came through shared roots in Silicon Valley's professional and technical networks (Saxenian 2002). To assist information, technical and business exchange and network development between the Chinese diaspora and their domestic counterparts, the Chinese government has devoted resources in the form of conferences, joint research projects, investigation tours, and so on. It also has made concentrated efforts to attract Chinese science, technology and business expatriates to return home and start their own businesses. Some municipal governments have also set up venture park programs within the technology development zones to address the special needs of the returnees (Saxenian 2002). (See Table 13 for a summary of constructs).

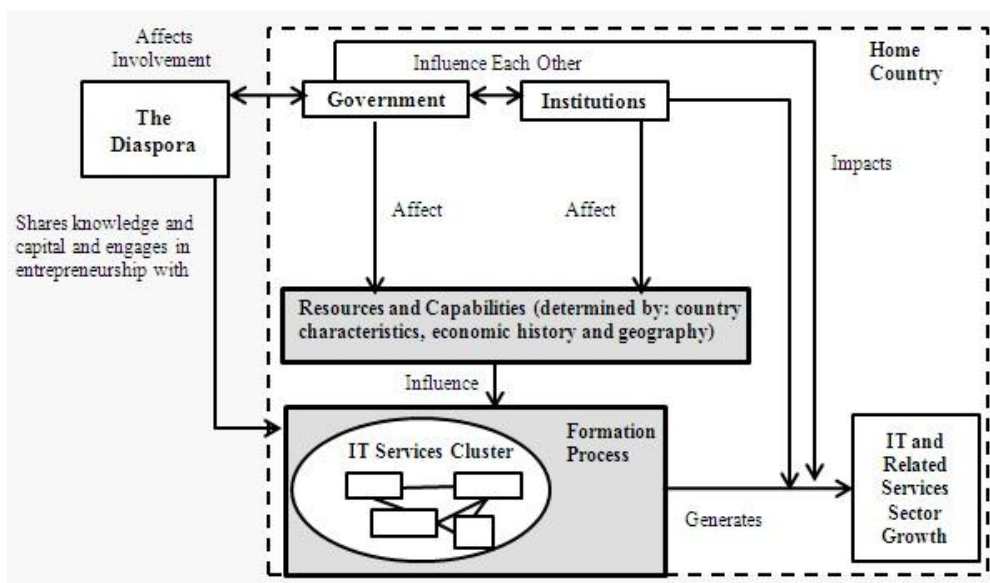
Table 13 Summary of Theoretical Constructs

Constructs	Brazil	Russia	India	China
Institutions	Lack of focus	Weak	Strong	Strong
Diaspora	Not much information is available.	Nascent Stages	Large	Large
Integration into Global Market (exports)	Well (24th). Exporter of both manufactured goods and primary commodities.	Well (13th). Exporter of natural resources.	Well (23rd). Exporter of services and some manufactured goods.	Well (1st). Exporter of manufactured goods.
Industry Structure	Small firms dominate. Focus on development of domestic market	Small firms dominate. Top firms are locally owned.	Large firms dominate. Top firms are locally owned and focus is on development of export market	Small firms dominate. Top firms are locally owned and focus has been on developing domestic market.
Geographic Concentration	Concentrated in South	Three technology clusters - Moscow, St. Petersburg, and Novosibirsk.	In or close to big cities with requisite infrastructure.	IT and related services sector focused in 19 (out of 52 technology parks) technology parks located closer to big cities.
Services	Systems integration, packaged software and services, processing services, hardware and software support	Systems integration, sophisticated custom software solutions and application development, telecommunications and embedded software development.	Back office support, business processes, design and high-level systems integration, application management, infrastructure support, SOA and web services	Systems integration, software product development, embedded software development and mobile technologies.

4.4. Evidence from Cross-Case Analysis

In the previous section, using single-case studies, I discussed the key constructs and the role they have played in the growth and development of IT and related services sector was discussed. Next, I present evidence from cross-case comparisons that support the propositions and describe the interactions between the key constructs.

Figure 14 The Key Constructs of Knowledge Network Theory



Adaptive Institutions Proposition (P1). Institutions have played a crucial role in all four countries. Marked differences in the development of the IT and related services sector are observed because of the initiatives of the institutions involved. For India and China, where the political and economic institutions have been adaptive and attuned to the needs of domestic industries, higher levels of growth and development in the IT and related services sector are observed. In Russia and Brazil, however, the institutions have failed to actively support and implement

effective related policy initiatives, thus lower levels of growth and development are observed.

In India, from the mid-1970s to the mid-1980s, there was a lot of policy experimentation with respect to the IT industry. One of the benefits was that the Indian government learned from its failures. So once the IT and related services industry started showing promise for growth and profitability, the policy initiatives moved from being top-down directives from the government to being much more effective and reactive instruments attuned to the needs of industry. They more fully supported the growth and development process. One of the reasons behind this transformation was frequent interaction that occurred among the Indian government, the independent trade body, NASSCOM, and the heads of private firms.

China's policy initiatives to support the development of its high-tech industry started in the early 1980s. Until the early 2000s, the focus was on hardware. It was only in 2001, when specific policy initiatives were affected to support the IT and related services industry. Since then, the government has played a crucial role in supporting the industry. In the late 1990s, the government's key projects to expand the country's infrastructure for e-commerce, various sector applications and government procurement of IT systems contributed to the development of the software industry. Lately, the Chinese government is developing the export market for the IT and related services sector, and so it too has begun to see exponential growth.

In Brazil, like China, the development of the software industry was foreshadowed by the development of the hardware industry. In the late 1980s, the IT market was mostly attuned to providing for the needs of the national enterprises. Consequently, software development and production were not a high priority. Most of the official incentives were provided to the hardware manufacturers. It was only in 1992, when the protectionist policies were abolished, that the government started paying attention to the IT and related services industry. The institutional efforts in Brazil have not been as focused as in India and China; the main thrust for growth is coming from NGOs and private firms. Additionally, because of high internal demand, Brazil has not pursued a pro-export IT and related services culture (Burzynski et al. 2010).

In Russia, the government's support has been weak, although there have been policy initiatives to support the IT industry. Their implementation has been unreliable and inconsistent, and, in many cases, only good on paper. As a consequence, the growth and development of the IT and related services sector has been slow. Whatever growth and development has been observed, it is mainly because of the leadership and initiatives of entrepreneurial private firms.

Next, I present the evidence that supports the Entrepreneurship Diaspora Network Proposition (P2). China has accrued maximum benefits from being integrated earlier into the global market. This is reflected by the inflow of foreign direct investment (FDI) in different sectors of economy and the level of exports. China is the world's largest exporter, followed by Russia (13th), India (23rd) and Brazil (24th). China is an exporter of manufactured goods, whereas India is an

exporter of services and some manufactured goods, Russia is an exporter of natural resources, and Brazil is an exporter of both manufactured goods and primary commodities (Central Intelligence Agency 2011). China and Russia are much more globally integrated compared to India and Brazil, which still have somewhat closed economies.

China and India have the largest diaspora among the developed countries, followed by Russia and then Brazil. Saxenian (2002; 2007) and Kapur and McHale (2005) have drawn attention to the fact that the Chinese and Indian diasporas have impacted the success of Silicon Valley's high-tech industry, and also the high-tech industry in their native countries. They have transferred knowledge and set up entrepreneurial networks. Their knowledge of the needs and capabilities of U.S.-based firms and firms based in their home countries has helped them play the role of facilitators and useful intermediaries in the search and matching process. This has also helped the firms in China and India to develop skills that are complementary to those of U.S.-based companies. The entrepreneurial networks have helped fund and support start-ups in their home countries. In comparison, the Russian and Brazilian diasporas are fragmented and smaller in size. Also, in Russia, the interaction between its diaspora and the Russian domestic business community is nascent. However, the benefits are becoming visible in the form of industry networks, venture capital support, lobbying efforts to garner government support, and the transfer of market knowledge to build complementary capabilities.

The senior management teams and consultants to most of the prominent trade organizations associated with the software and services sector in the BRIC countries are either alumnae of premier institutes and universities, or have spent part of their careers in developed countries and are still associated with or active in the business communities of developed countries.

The resources and capabilities to provide certain services are a direct result of the country characteristics, economic history and the geospatial clusters of industries and inter-industry and intra-industry interactions. Several studies have reported on a number of factors that directly or indirectly influence the capability of a country or region to have a thriving IT services industry (Arora et al. 2001; Arora and Athreye 2002; Heeks 1999). Two of the critical factors are infrastructure and human capital (Li and Gao 2003). (Additional details on these two factors are provided in Appendix A.)

The early development trajectories and industry structures of the different BRIC countries have influenced the portfolios of services they provide. For instance, small firms dominate the industry structures in Brazil, Russia and China. These firms have mainly developed niche applications that are tailored to meet the demand of the countries' respective domestic markets. They also are engaged in the tailoring of international products for local use. The largest software companies in Brazil, Russia and China have more than 1,000 employees, and these typically are also associated with the export of services (Cusumano 2006; Hawk and McHenry 2005; Saxenian 2003; Tschang and Xue 2005; Veloso et al. 2003). In India, large firms dominate the market, and they have upwards of

10,000 employees. Further, in Russia, India, and China, the top firms in the IT and related services market are owned locally, whereas in Brazil large foreign firms tend to dominate the market.

In China and Brazil, the main focus has been the domestic market, and even the early policy initiatives were directed toward the domestic market. As a result, the leading firms in China are system integrators, followed by product developers, and, more recently, embedded software developers (Tschang and Xue 2005). In Brazil, the leading firms provide packaged software and services for the most part, but also do system integration, and offer processing services (Botelho et al. 2005). In India, the early focus of the IT and related services sector was on exports. This was supported by the initial policy initiatives of the Indian government. As a result, the leading firms all export software services. They are also providers of traditional services such as customer interactive services, back office data processing, design and high-level systems integration, application management, service-oriented architecture and Web services, cloud computing, mobile services, and other new services (NASSCOM 2011). (See Table 14.)

Table 14 ICT Services Exports (% of total services exports)

	2000	2005	2010
Brazil	0.7	2.0	2.0
Russia	4.6	4.3	6.0
India	32.0	45.0	47.0
China	5.6	3.1	6.1

Source: World Development Indicators.

In Russia in the early 1990s, the Perestroika policy made it possible for radical change to occur in the country's hardware platforms, and within a few years PCs

almost completely replaced mainframe computers. New companies were set up to provide systems integration and software development services for the new platforms (Terekhov 2001). This, along with emerging support from Russia's institutions, led to the development of the current industry structure for custom software development. As a result, Russian companies are well known for developing sophisticated custom software solutions and applications, as well as telecommunications and embedded software, and software product development and deployment services (Russian Software Developers Association (RUSSOFT) 2010).

In the BRIC countries, most of the IT clusters are located in or closer to big cities, with the exception of China. These cities already had requisite infrastructure in the form of university networks, R&D infrastructure, or an existing IT industry in the pre-reform era. In Brazil, the IT and related services industry is concentrated in the south and southeast. In Russia, the industry is concentrated in several large cities: Moscow, St. Petersburg and Novosibirsk. In India during the early stages, it was concentrated in the big cities as well, including Bangalore and Hyderabad, and the National Capital Region. Now, it has spread out to include second-tier cities, such as Pune and Ahmadabad. In China, from 1988, the government focused on developing 52 technology zones that are geographically-distributed over the country, but the software industry is mainly located in 19 software technology parks, which are mostly close to or located in large cities.

Finally, I consider the evidence that supports the Knowledge Network Proposition (P3). This proposition provides an overarching perspective on interactions between the key constructs, of adaptive institutions, knowledge transfer mechanisms (diaspora based networks and integration into global markets) and resources and capabilities, which form the basis for the hybrid theory. From the above discussion it is clear that adaptive institutions have played an important role in providing an effective framework and support for the growth and development of the IT and related services sector in the BRIC countries. Although their initial policy initiatives came from their governments, successful implementation and subsequent adaptations leading to benefits for the IT and related services sector seem like they grew out of the consistent efforts of private firms in the BRIC countries, and the involvement of entrepreneurial members of the diasporas associated with these countries. In some cases, NGOs also were involved. An exception is China. Because of the structure of its political and economic institutions, most of the impetus came from the government. Based on the initiatives of the Chinese government to facilitate and support the interaction between the diaspora and the business community, it is clear that the contribution of the diaspora is valued. It has been critical for the growth and development of the sector.

The international diasporas of the BRIC countries have played a pivotal role by not only infusing capital into domestic market by supporting entrepreneurial activities but also by creating a mechanism for knowledge transfer. This mechanism has been natural and effective, and has had far-reaching effects. This

is most evident in India and China, but also to some extent in Russia. This mechanism, in conjunction with country characteristics, economic history, and geography, has helped in supporting the development of resources and capabilities that have led to new market opportunities and higher levels of technical growth. (See Table 15.)

Table 15 Summary of Propositions

Proposition	Brazil	Russia	India	China
Adaptive Institutions	Lack of focus. Policy implementation-oriented towards domestic market development. Major development thrust is from the NGO's.	Weak. Policy implementation-unreliable and inconsistent.	Strong. Institutions adaptive and attuned to the industry needs.	Growing stronger. Institutions adaptive and attuned to the industry needs.
Entrepreneurship Diaspora Network	Fragmented and smaller in size	Smaller in size and nascent stage.	Large. Impacted success of technology industry both in developed countries and home country	Large and consistent efforts are being made to develop these further. Impacted success of technology industry both in developed countries and home country.
Knowledge Network	Weak	Weak (improving)	Strong	Strong

4.5. Key Findings and Limitations of Chapter 4

The study sought to understand the reasons behind the growth and development of the IT and related services sector in the BRIC economies. The roles of

institutions, the individual countries' diasporas, and the related aspects of their country characteristics, geographic and economic histories were explored. A new hybrid theory called knowledge network theory that is based on an amalgam of prior theory, including adaptive institutions, entrepreneurial networks and industry capabilities. The main points of this theory are as follows. Developing countries will achieve higher levels of IT services growth when they have: (1) extensive diaspora-based entrepreneurial network resources; (2) adaptive institutions that maintain close interactions with the diasporas; and (3) capabilities to provide IT and relative services that have complementarities to what is required by the developed countries. I conducted a preliminary validation of my proposed knowledge network theory with single and cross-case analyses for the BRIC countries.

The main contribution of this research is a theoretical explanation of the growth and development of specialized services clusters across developing countries. Traditionally, it has been believed that effective institutions are key determinants of long-term growth of an economy. In the face of the ongoing shift around the world from resource-based economies to knowledge based economies, it is found that effective institutions by themselves are not sufficient to explain the observed growth. It is a combination of new knowledge, integration into global market, diaspora-based entrepreneurial networks, and economic history, country characteristics, and geography that contribute to the growth and development of IT services in the developing countries.

Next, I discuss some of the limitations of this study. I considered the most promising of the developing countries: the BRIC countries. There are likely to be differences in the growth and development processes of the IT and related services sector in other developing countries, however. Future research can analyze cases from other developing countries and enrich the overall understanding of the theoretical perspectives offered here.

This study sheds some light on the core reasons I believe are behind the growth of specialized services clusters, and the IT and related services sector. This is a very complex issue and multiple explanations are possible for the observed growth. Also, more research is required to fine-tune the hybrid theory that I presented. For instance, we need to understand in much more detail the role and contributions of the diaspora. It will also be beneficial to understand the mechanics and efforts involved in the development of diaspora-based entrepreneurship networks because of the value and impact these networks create for economic growth.

Chapter 5. Summary, Implications and Contributions

The essays included in this dissertation focus on the diffusion of IT outsourcing at firm and industry level and the development of specialized services hubs across the emerging economies. The first two studies focused on understanding the diffusion patterns of IT outsourcing propose and answer separate questions which address the more general question: How does IT outsourcing diffuse across firms in different industries and what are the influencing factors? The diffusion of IT outsourcing is evaluated from the perspective of client firms across different industries within the U.S. The third study provides a theoretical explanation for the development of specialized services hubs across emerging economies and focuses on the IT and related services sector of Brazil, Russia, India, and China. The main objective of this study is to develop an integrated theory to explain the growth and development of IT and related services outsourcing in different emerging economies, and the factors that are most influential in various places.

5.1. Summary of Findings

The first study answers the following questions: Can IT outsourcing be explained by pure diffusion process, or is there a contagion process involved? Do mega-deals (deals of more than US\$1 billion) affect the observed patterns of diffusion? What are the different sources of influence? First, I empirically examined whether IT outsourcing follows a pure diffusion process at the firm level, by estimating a lognormal distribution. This permits evaluation of whether there are contagion effects present in data. Random, independently-occurring large dollar mega-deals may act as precipitating events for outsourcing contagion,

and large firms may act as exemplars for smaller ones, reducing smaller firms' inhibition to outsource. Second, I tested two flexible S-curve diffusion models and the factors those influence the adoption of IT outsourcing at the industry level. I established the presence of hierarchical contagion effects in the diffusion of IT outsourcing and found that mixed influence model best explains the factors that influence the adoption of IT outsourcing at the industry level.

The second study answers the following questions: How does IT outsourcing spread? What are the underlying patterns? What is the role of industry similarity in the diffusion of IT outsourcing? The study uses the spatial analysis technique of space-time clustering to test for simultaneous space and time interactions between firms, based on IT outsourcing announcement data and headquarter location information. I further explored the role of industry similarities between industries to study the impact of scale and scope externalities on the diffusion of IT outsourcing within a space-time cluster. The space-time interactions were tested at the global and local level and the presence of these interactions was established at the global level. Further analysis was not sufficient to provide definitive evidence for the presence of space-time interactions at the local level. I could not establish the influence of scale and scope of externality in the diffusion of IT outsourcing because of various modeling issues and the sparseness of the available data.

The final study answers the question: What are the factors that are responsible for the development of IT and related services hubs? The main objective of this study is to develop an integrated theory to explain the growth and development of

IT and related services outsourcing in BRIC countries. Towards that end, the role of institutions (both political and economic), the individual countries' diasporas, and the related aspects of their country characteristics, geographic and economic histories are explored. A new hybrid theory that is based on an amalgamation of prior theories such as institutions theory, new growth theory, brain circulation theory and concepts of globalization, economic history, geography and country characteristics, is proposed. The main points of this theory are as follows.

- **Proposed Hybrid Theory (Knowledge Network Theory).** *Developing countries will achieve higher levels of IT services growth when they have: (1) extensive diaspora-based entrepreneurial network resources; (2) adaptive institutions that maintain close interactions with the diasporas; and (3) capabilities to provide IT and relative services that have complementarities to what is required by the developed countries.*

The new proposed theory is validated with single and cross-case analysis for the BRIC countries.

Together these three studies give us insights into the diffusion process and patterns of IT outsourcing across firms and industries and also provide theoretical explanation for how IT and related services hubs are developing across different emerging economies.

5.2. Implications

The research work on understanding the diffusion patterns of IT and business process outsourcing informs IS researchers about the patterns and underlying factors affecting the process of IT outsourcing diffusion, which has not been well

understood and appreciated. It also has major practical implications for both vendors and clients. These studies offer normative guidance for vendors and clients on how to make value-maximizing decisions during the contagion period of IT outsourcing. Vendors stand to gain by making public information about their contracts and deals, especially if their clients are high in profile, or their contract deals are high in value. To take advantage of the contagion effects, vendors should optimize their pricing strategy and better equip themselves by scaling their operations to meet the increased demand. Since understanding the diffusion process is crucial for the timing of outsourcing decisions, clients can take advantage of this knowledge too. They can leverage economies of scale, if they decide to outsource when the IT and business process outsourcing contagion is spreading.

The theory development work on providing an integrated theory to explain the growth and development of IT and related services outsourcing in emerging economies not only has implications for the IS research community but also has strategy and policy implications for developing countries. A key factor for growth is acquisition and effective use of new knowledge. Two ways to acquire new knowledge are through a nation's integration into the global market and close interactions with the nation's diaspora. Thus, policy changes to promote world market integration are critical, and should be undertaken with respect to trade, foreign direct investment, technology licensing and other policy areas.

Policy initiatives are also needed to attract the members of its diaspora to a home country. Governments should facilitate interactions between their country's

diaspora and its business community. Among the BRIC countries, China has been effective in doing this over the last few years, by making concentrated efforts to attract Chinese science, technology and business ex-patriates to return home and start their own businesses. Some municipal governments in China have made special policies and promotions to address the needs of returning expatriates.

Policy initiatives are also needed to develop adaptive and effective institutions, and support mechanisms for sustainable growth and development. This will aid the distribution of resources to maintain the physical and technical infrastructure, which are crucial for the growth and development of IT and related services sector. Another area where policy-makers need to focus is incentives for knowledge creation, such as R&D, education, and entrepreneurship.

5.3. Contributions

This research has made important contributions to the current body of research on IS, IT outsourcing, and IS theory development. The first key contribution of this dissertation is establishing the presence of hierarchical contagion effects in the diffusion of IT outsourcing by analyzing data at both industry and firm levels. The second contribution is that the work on diffusion of IT outsourcing offers normative guidance for vendors and clients on how to make value-maximizing decisions during the contagion period of IT outsourcing. The third main contribution of the work on diffusion of IT outsourcing comes from the data set and methods. A data set was created that provides a different vantage point for the analysis of contagion effects-driven IT outsourcing diffusion. The lognormal model and the space-time clustering techniques based on an empirical modeling

analogy from medical epidemiology and political science, and spatial analysis offer new analysis ideas. The final contribution is a theoretical explanation for the specialized services growth that is observed in the IT and related services sector of emerging economies. The proposed knowledge network theory suggests that the growth and development of the IT and related services sector is a result of close interactions among adaptive institutions. It is also based on new knowledge that is created, and which flows through a country's national diaspora of expatriate entrepreneurs, technologists and business leaders. In addition, relevant economic history and regional geography factors are important. This view diverges from the traditional view, wherein effective institutions are considered to be the key determinants of long-term economic growth.

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APPENDIX A

DATA ON HUMAN CAPITAL AND ICT INFRASTRUCTURE

Table A1 Education and Demographic Trends

	Adult Literacy Rate in % Population (Year)	Total Enrollment at Tertiary Level (Year)	Total Enrollment at Post- Secondary Level (Year)	Public Expenditure on Education (% of GDP)	Population under 15 (% of Total)
Brazil	90 (2008)	6,115,138 (2009)	NA	5.1 (2007)	25
Russia	94 (2009)	9,446,408 (2008)	158,040 (2008)	4.1(2008)	15
India	63 (2006)	14,862,962 (2007)	924,751 (2007)	NA	33
China	100 (2009)	29,295,841 (2009)	225,178 (2009)	NA	17

Note: World Development Indicators is the source of education data. Demographic information is from the Population Reference Bureau's 2011 World Population Data Sheet.

Table A2 Information and Communication Technologies (ICT) in BRIC Countries

	Network Readiness Index (NRI) Agg. Value	Fixed Broadband Internet Subscribers (per 100 people)	Mobile Phone Subscriptions (per 100 people)	Internet Users (per 100 people)
Brazil	56	7.23	104	40.7
Russia	77	11.08	168	43.4
India	48	0.94	64	7.8
China	36	9.44	64	34.4

Note: World Development Indicators database and World Economic Forum for NRI data. All values are for 2010.