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Janus Rising:
Information Technology Role in Facilitation of Organizational Ambidexterity and Identity

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Doctor of Philosophy

Business

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Abstract

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Information Technology (IT) permits new organizational possibilities – tolerating and thriving in complex organizational settings that result from the election of conflicting strategic objectives. As a critical resource in today's knowledge-driven, hypercompetitive environment, IT accrues several indirect benefits through intermediate value-creating organizational processes. Tolerating strategic tensions generated by competing demands on organizational attention and resources is one such process. The quest to attain competitive advantage through the concurrent pursuit of seemingly conflicting strategies or identities is a major source of these tensions. This dissertation examines the role of information systems in facilitating organizational ambidexterity and managing multiple organizational identities. In the first component, I selected to gather data from 352 manufacturing firms in high growth sectors in India - a novel empirical setting which provides an exemplar for the world's enterprises undergoing rapid structural changes in the 21st century. I find strong support for my assertion that an organization's IT resources and capabilities facilitate organizational ambidexterity, hitherto a challenging competitive possibility. In the second component, I examine the role of IT in enhancing post-acquisition integration of externally acquired explorative or exploitative innovation. I extend March's Exploration-Exploitation model in the context of acquisitions by introducing IT-enabled learning mechanisms. I offer theoretical propositions and find that post-acquisition integration strategies and IT-enabled learning mechanisms have different, but complementary impacts. In the third component of this dissertation research, I assert a causal model of IT capability in the management of multiple identities. I then develop a computer simulation model and find that an organization's IT capability leads to highest performance increases under conditions of low identity plurality, low identity synergy and low IT capability. Overall, I show that IT enables the management of seemingly paradoxical challenges that arise in the tolerance of the complexity inherent in effectively resolving strategic tensions. The results from this dissertation contribute towards a theory of IT-enabled management of strategic tensions and inform our understanding of the complex relationships and theoretical pathways from IT to competitive advantage. I validate the viability of IT-enabled organizational ambidexterity and IT-enabled management of multiple identities as competitive possibilities emergent in the 21st century.

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This dissertation marks the culmination of a 25 year journey; it embodies five years of effort, and more than a decade of planning. With its completion, I stand at the cusp of realizing a childhood dream, and embarking upon another. And it would not have been possible, but for the guidance, generosity, and support of several people, to whom I wish to express my heartfelt thanks.

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Thank you.

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As with all things, it is best to begin at the beginning.

1 Introduction

Janus. The two-headed Roman god of auspicious beginnings and transitions. With one face looking into the future, and the other looking at the past, he was able to do two seemingly conflicting activities simultaneously. It has long been the aspiration of organizations to tolerate the complexities of two faces. While this was not possible a hundred years ago, or maybe even twenty years ago, it is eminently possible today due to Information Technology (IT).

IT permits new organizational possibilities. One such possibility is the ability to tolerate and thrive in complex organizational settings that result from the election of conflicting strategic objectives. In the past, it has been the aspiration of many organizations to tolerate the complexities arising from managing conflicting principle practices at the same time. In the 21st century, IT uniquely enables organizations not just to seek operational efficiencies, but to leverage the simultaneous pursuit of seemingly conflicting strategies and identities as well. Thus, in the 21st century, IT enables firms to be like Janus.

Competing demands on organizational attention and resources borne from conflicting strategic objectives give rise to strategic tensions. There is an increasing interest in the organizational ability to tolerate such tensions and exhibit efficiency in face of conflicting objectives. Recent advances in the area of strategic management have identified *organizational ambidexterity* – an organization's ability to indulge in two seemingly conflicting or opposite strategies simultaneously (Tushman and O'Reilly 1996), and the pursuit of *multiple organizational identities*, as a prime source of strategic tensions and means by which firms develop competitive advantage and attain superior performance. Ergo, the tolerance of these tensions is a key organizational imperative, a means to attain competitive advantage, and a growing cause for organizational success or failure. While the pursuit of seemingly conflicting strategies or multiple organizational identities is the source of many tensions, Information Systems (IS) may be a succor to firms that follow such a path.

IT is a critical investment for firms in today's knowledge-driven, hypercompetitive environment. Investments towards IT are becoming more strategic in nature and larger in scale and scope. An increasing number of firms refer to their IT as the underlying cause of their success or failure. This trend of increasing IT investments is evidenced in the United States by the rise in corporate information technology stock per full-time employee from $779 in 1987 to $2,646 in 2004 (Brynjolfsson et al. 2005). In total, these investments, along with other supplementary investments, represent a capital stock of $1.8 trillion (Brynjolfsson et al. 2006). In 2011, worldwide IT spending by enterprises reached $2.6 trillion and is forecast to reach $2.7 trillion in 2012 (Gartner 2010; Gartner 2011).

Organizations invest in IT with an eye towards the tangible as well as intangible benefits of these investments. The business value of IT investments is a well developed and enduring research area in the field of Information Systems. Researchers have vigorously studied, examined and debated the benefits of IT investments across a multitude of studies. The tangible benefits of IT have been recognized by examining the impact of IT investments on operational and accounting based measures of firm performance (e.g. Banker et al. 2006; Hitt et al. 2002). Recognition of the intangible benefits arising from IT investments has been made by the use of forward looking measures of firm performance, such as Tobin's Q (e.g. Bharadwaj et al. 1999). These measures reflect the contribution of IT towards a firm's long-run performance and its intangibles. Studies have shown that $1 of investment in IT results in an increase in market value of more than $10, thereby suggesting that 90 percentage of the returns from IT investments are endowed within firm intangibles (Brynjolfsson et al. 2002; Saunders 2010).

Building upon the Resource Based View (RBV) of the firm (Barney 1991), researchers have conceptualized IT capability as a higher order dynamic capability consisting of a firm's ability to mobilize and deploy IT resources in combination with other capabilities or resources, which provides organizations with a myriad of benefits (Bharadwaj 2000; Santhanam and Hartono 2003). Much research and effort has been devoted to the examination of the threads that connect an organization's IT capability to competitive advantage and performance. Critical to this debate is the impact of information systems on intermediate organizational constructs that lead to eventual competitive advantage and superior performance (Melville et al. 2004). As these links become clearer, it is becoming apparent that IT endows both direct as well as indirect benefits to organizations through the effect of intermediate organizational constructs, many of which are intangible in nature. The tolerance of strategic tensions arising from organizational ambidexterity and multiple organizational identities is one such unexamined construct and emergent competitive possibility.

Organizational ambidexterity has been conceptualized as an organization's ability to indulge in two seemingly conflicting or opposite strategies simultaneously (Tushman and O'Reilly 1996). The dichotomy between strategies signifying the exploration of new possibilities and the exploitation of old certainties is well established in the academic literature, and reflects an instance of organizational ambidexterity. By nature, exploration and exploitation strategies require fundamentally different, inconsistent and contradictory organizational settings. Many paradoxical challenges and strategic tensions arise from these conflicting requirements of exploration and exploitation. While prior research in IS has considered exploitation and exploration strategies as mutually exclusive (e.g. Subramani 2004), strategic management scholars have established the simultaneous pursuit of exploration and exploitation strategies as a means of realizing a competitive advantage and enhancing firm performance. This research argues that simultaneous exploration and exploitation enables firms to be efficient in managing the business demands of today while simultaneously being adaptive to the changes and demands of tomorrow (Gibson and Birkinshaw 2004). This emerging research paradigm has focused upon two aspects of the ambidexterity construct – its impacts and its antecedents.

Organizational ambidexterity has attracted increasing attention from researchers in recent years. This increasing focus has resulted in a general agreement on the positive impacts of organizational ambidexterity. He and Wong (2004) were the first to show empirical support for the ambidexterity premise. Specifically, they found that the interaction between exploration and exploitation is positively related to sales growth and the relative imbalance between exploration and exploitation is negatively related to sales growth (He and Wong 2004). Others have found that ambidexterity enables long-run profitability and is critical to successful ongoing product development and innovation (Sheremata 2000; Tushman and O'Reilly 1996). Thus, organizational ambidexterity has been established as a means by which firms attain competitive advantage and superior firm performance. More recent work examines the effect of organizational mediators and environmental moderators in the relationship from ambidexterity to firm performance.

There is also emerging consensus that firms become ambidextrous through a variety of organizational (differentiated and integrated structural forms) and situational factors (top management ambidexterity, informal network, star performers, firm flexibility, and agility) (Raisch and Birkinshaw 2008; Tushman and O'Reilly 1996). Researchers argue that these factors enable ambidextrous organizations to reconcile and manage the internal tensions and conflicting demands which arise from pursuing such a path (Cao et al. 2009; Gibson and Birkinshaw 2004). Though systems have been mentioned as a construct of interest in the ambidexterity debate (Gibson and Birkinshaw 2004) and most established antecedents of ambidexterity are facilitated by IT, the role of IT has not been explicitly considered by strategy scholars. Consequently, IT and IS related constructs are absent from this nomological net. Though IS scholars have extended the ambidexterity concept to the areas of software development, IT management and green IT, only few initial studies of IT and organizational ambidexterity have appeared in IS scholarship (e.g. Im and Rai 2008; Lee et al. 2007; Prieto et al. 2007).

An organization's identity is conceptualized as another critical strategic asset, important in establishing a permanent or temporary competitive advantage (Fiol 1991; Fiol 2001). Organizational identities are defined as consisting of combinations of codes (rules, assumptions, beliefs and premises) that specify the properties an organization can possess. These properties limit the features and actions expected from the organization (Hsu and Hannan 2005; Pólos et al. 2002). Firms invest considerable resources in managing their identities and in resolving the conflicts and tensions that arise from conforming to multiple identities and the resultant expectations of multiple audiences. The failure to correctly project an identity (a case of mistaken identity) can be fatal to an organization (Whetten

2006). Thus, management of an organization's identity is an important managerial function and concern (Pratt and Foreman 2000).

Researchers have argued that organizations possess multiple identities, which may or may not be similar (Hsu and Hannan 2005). Organizations differ in the number of identities they project (termed *plurality*) and in the extent of similarity amongst their identities (termed as *synergy*). The presence of multiple organizational identities leads to multiple and conflicting demands being placed upon an organization. Effective management of an organization's identities by addressing the differing identity expectations of different audiences and thus resolving resultant tensions is critical to achieving higher performance (Pratt and Foreman 2000). Though many means by which this is accomplished have been identified, the role of IT in the process of managing multiple organizational identities is also yet to be scientifically examined.

This dissertation addresses these gaps in the IS and strategic management literature by examining the role of information systems in facilitating organizational ambidexterity and managing multiple organizational identities. I assert; and, through this dissertation, investigate IT as an antecedent to organizational ambidexterity and the management of multiple organizational identities.

I examine these themes through three components of this dissertation. First, I empirically investigate the antecedent relationship of IT with organizational ambidexterity. For this purpose, I have collected data in India from manufacturing sectors that witness high ambidexterity. In this research, I focus on two research questions: How do IT resources influence organizational ambidexterity? How does IT capability influence organizational ambidexterity? I then address the role of IT in facilitating a strategy aimed towards attaining ambidexterity externally, namely a strategy of using acquisitions as a means for exploration or exploitation. I develop an agent-based computational model to address the following research questions: In an acquisition, how do IT-enabled learning mechanisms impact the level of knowledge acquired from the target firm? In an acquisition, how do IT-enabled learning mechanisms, interact with the strategic choices of appropriating knowledge and culture from the smaller target firm into the larger acquiring firm, to lead to an increase in the knowledge acquired through the acquisition? Finally, I investigate how an organization's IT capability enables the management of its multiple organizational identities by offering propositions derived from theory and computational modeling, which address the following research questions: How does an organization's IT capability enable it to manage its multiple identities? How do the synergy and plurality of an organization's identities affect this process? By answering these questions, I demonstrate the primary assertion of this dissertation - that in the 21st century, IT enables firms to be like Janus.

1.1 Information Technology and Organizational Ambidexterity

In the broadest sense, organizational ambidexterity can be defined as "a firm's capability to simultaneously balance activities in a trade-off situation". In the spirit of this assertion, recent work has started to study several manifestations of organizational ambidexterity, including firms' abilities to simultaneously engage in seemingly contradictory technology sourcing, product development, diversification and market entry strategies. However, the bulk of prior research in the strategic management literature has conceptualized ambidexterity as an organization's capability to simultaneously engage in exploitation and exploration activities. This component of my dissertation explores this theme further; consequently, its main thesis is that IT facilitates organizational ambidexterity, as reflected through the dichotomous strategies of exploratory and exploitative innovation.

This component of my dissertation examines the antecedent role of IT in developing and enabling organizational ambidexterity. This theory of IT-enabled organizational ambidexterity proposes several underlying causal mechanisms through which an organization's IT resources and capabilities facilitate its simultaneous pursuit of conflicting strategies. Researchers acknowledge the equifinality of organizational ambidexterity and recognize the existence of multiple, mutually supportive pathways towards it (Andriopoulos and Lewis 2009). Accordingly, I present multiple arguments for mutually supporting causal links between IT and organizational ambidexterity that traverse through diverse intermediate constructs and processes. For this purpose, I offer two theoretical models based upon the notion that different antecedents to organizational ambidexterity may be enabled by a firm's IT resources and capabilities in differing ways.

The first set of hypotheses explore the relationship of IT resources and organizational ambidexterity, wherein I unpack the IT resource construct into underlying software, technical and hardware components. The conceptualization of IT capability as a higher order dynamic capability, comprising of lower order IT capabilities is a key theory of interest and provides a basis for orientation and theorizing towards the second set of hypotheses. Prior literature has classified IT capabilities and investments in many ways. I adopt the IT strategy categorization and view IT capabilities as falling into the automate, informate, and transform categories (Dehning et al. 2003; Schein 1992; Zuboff 1988). Applications of these three different types of IT, which act as proxies for different types of IT capabilities, lead to differing effects on organizational processes and capabilities, thereby leading to different impacts on firms and their performance (Barua et al. 1995; Dehning et al. 2003; Weill 1992). Thus, I posit that different types of IT capabilities that comprise a firm's IT portfolio lead to differing impacts on the ability of the firm to manage the paradoxical demands arising from an ambidextrous strategy. I use econometric analysis to test these two sets of hypotheses. As part of this analysis, I also unpack the ambidexterity construct into its two underlying dimensions – the balance dimension and the combined dimension of ambidexterity (Cao et al. 2009).

To test my theory, I selected to gather data from a novel empirical setting. India is undergoing a period of accelerated growth, with rapidly evolving organizational challenges and opportunities. Such a context provides an exemplar for the world's enterprises that are undergoing rapid structural changes in the 21st century. India's manufacturing sector, in particular, is characterized by high turbulence and hyper-competition. Manufacturing firms based in the fast growing Indian economy thus indulge in a variety of ambidextrous behavior to cope with the challenges of their environment. Some firms are able to juggle seemingly contradictory manufacturing strategies; others generate what the popular press has termed frugal innovation - an approach that involves pursuing both the trade-off strategies of maximizing product quality while minimizing costs. Frugal innovation has led to the development of the $35 Sakshat tablet computer, $2,500 Tata Nano car, $16 water purifier and $2,000 open-heart surgery (George et al. Forthcoming; Kinetz 2010). Other firms in this environment concurrently pursue the seemingly paradoxical strategies of exploitative and explorative innovation, an approach which simultaneously addresses needs of existing and emerging customers. In stable, low growth markets, such ambidextrous behavior is theorized to grant a competitive advantage. However, in fast growing emerging economies that witness double-digit growth rates, such a strategy is essential for the very survival of organizations. In markets that witness fast paced growth rates, organizations which are unable to simultaneously address the needs of existing and emerging customers quickly find that they are struggling for their very survival. Consequently, I gathered data from 352 firms located in India and hailing from high growth manufacturing sectors. Extant research does not consider national or cultural boundaries around the ambidexterity concept. By electing to gather data in India, my studies also address this gap in the literature (Raisch and Birkinshaw 2008).

Through my analysis, I find strong support for my primary assertion that an organization's IT facilitates organizational ambidexterity, hitherto a challenging competitive possibility. I find that IT technical resources, consisting of the technology skills held by the organization's IT employees and the knowledge and ability to deploy and manage this skill set, enable simultaneous explorative and exploitative innovation. I also find that IT technical, IT software and IT hardware resources have a positive synergistic effect on organizational ambidexterity. Surprisingly, I observe a negative relationship between IT software resources and organizational ambidexterity. My findings also indicate that this relationship is positively influenced by IT hardware resources. I posit that this finding reflects the ossification of processes and lower flexibility resulting from utilizing out-of-the-box software and hardware. My analysis also shows strong support for my second theorized model. I find that an organization's Transform IT capability, defined as a firm's ability to mobilize and deploy IT resources in combination with other capabilities or resources that leads to the redefining of business practices, has a strong positive effect on its ability to pursue ambidextrous strategies. I also observe that Automate and Informate IT capabilities impede ambidexterity; however, the negative relationship of Informate IT capability is lessened in magnitude by Transform IT capability. This supports the notion of ossification and reduced flexibility due to automation of business processes. Finally, I find that simultaneous explorative and exploitative innovation is best enabled by pursuing a strategy of balancing IT Automate, Informate and Transform capabilities.

1.2 Information Technology and Technology Acquisitions

Organizations pursue acquisitions as a means of exploration. Acquiring another firm stimulates the development of new ideas, capabilities and ways of thinking in the acquiring organization and thus generates broader knowledge (Haspeslagh and Jemison 1991; Leonard-Barton 1995; Levitt and March 1988; Vermeulen and Barkema 2001). Organizations have used acquisitions as way to gain technological knowledge, which the acquiring firm does not possess (Puranam et al. 2006; Puranam and Srikanth 2007) and thereby increase new product development (Graebner 2004; Graebner et al. 2010). It is also argued that organizations divert resources away from exploitation activities towards acquisition integration activities and thus acquisitions reduce exploitation efforts. Similarly, organizations may use acquisitions as a means to obtain exploitative innovation. Thus, acquisitions can kick start declining or stagnated internal explorative or exploitative innovation and activity (Higgins and Rodriguez 2006) and thereby help to rebalance exploration and exploitation within a firm.

Most extant research on ambidexterity has focused on resolving the paradoxical demands of ambidexterity internally within an organization. Some researchers have suggested externalizing either exploration or exploitation activities through outsourcing or alliances, but have found that strategic integration issues outweigh the potential benefits of such an approach (Benner and Tushman 2003). However, there is not much research that examines an approach of acquiring and integrating external knowledge as a means for enabling organizational ambidexterity. Raisch, Birkinshaw, Probst, and Tushman (2009) assert that this requires the integration of internal and external knowledge processes across organizational boundaries. Labeling this as a question of internal versus external ambidexterity, they suggest that external knowledge integration requires external brokerage, internal absorptive capacity, and is supported by social networks. They also suggest that the balancing of internal and external knowledge may entail a form of, hitherto unstudied, organizational ambidexterity.

The second component of this dissertation addresses this perspective of organizational ambidexterity. Specifically, I examine the role of IT-enabled learning mechanisms in enhancing post-acquisition integration of externally acquired exploratory or exploitative innovation and knowledge. The prime theoretical paradigm informing this perspective is that knowledge underlying key capabilities is inherent in the expertise of individuals comprising the firm, and not at the firm-level (Cyert and March 1963; Ericsson et al. 2007; Felin and Hesterly 2007; Prietula and Simon 1989). By enabling individual managers to act as knowledge brokers, IT enhances diffusion of knowledge across firm boundaries and facilitates the extended enterprise (Konsynski 1993). Similarly, IT plays a key part in knowledge capture, absorption, assimilation, integration, management and dissemination through the use of Web 2.0 based knowledge repositories such as knowledge management systems, corporate blogs and wikis. IT driven social networks that result from Web 2.0 based electronic communication technologies such as micro-blogs can also play a key part in this process. A consequent combination of strong ties, which facilitate knowledge integration, and bridging ties that enable the access of novel, diverse knowledge can enhance ambidexterity (Tiwana 2008). Thus, the interactions of IT, knowledge and organizational learning can play a key, and little understood, role in externally enhancing organizational ambidexterity. To shed light upon this issue, I develop theoretical propositions by extending March's Exploration-Exploitation model in the context of acquisitions by introducing IT-enabled learning mechanisms in a post-acquisition, integration setting.

Specifically, I extend the exploration-exploitation-acquisition (EEA) model of focused technology acquisitions (Kathuria et al. 2011a), which itself is based on the well-established exploration-exploitation model of organizational learning (March 1991). Such an approach establishes construct validity and build on prior science (Hawking 2002). I integrate two different IT-enabled learning mechanisms – communication technologies and knowledge repositories (Bray and Prietula 2007; Kane and Alavi 2007) - into the EEA model. I also extend the model to acquisitions made for the purposes of acquiring both explorative and exploitative innovation. This agent-based model of external ambidexterity focuses on the interactions of two established post-acquisition strategies - the appropriation of knowledge through the retention of employees and the appropriation of organizational culture through the adoption of organizational beliefs – with the two IT-enabled learning mechanisms.

I find strong support for my primary assertion that IT-enabled learning mechanisms facilitate external organizational ambidexterity – a new strategic possibility in the 21st century. My results show that the acquisition of explorative innovation is augmented by the post-integration strategies of knowledge and culture appropriation. For such acquisitions, I find that relatively lower appropriation of knowledge and relatively higher appropriation of culture yield greatest returns. Critically, I find that under all conditions of appropriation of knowledge and culture, knowledge repositories and communication technologies enhance the acquisition of explorative innovation. I also demonstrate that relatively low use of knowledge repositories and relatively moderate use of communication technologies produce maximum returns. I observe that the acquisition of exploitative innovation is augmented by the appropriation of culture and the use of communication technologies. On the other hand, the appropriation of knowledge and the use of knowledge repositories hinder the success of such acquisitions. I also uncover that relatively low use of knowledge repositories and relatively high use of communication technologies produce maximum returns. Finally, I find that knowledge repositories and communication technologies complement the effects of one another. Overall, I find that post-acquisition integration strategies and IT-enabled learning mechanisms have different individual and joint impacts on the external acquisition of exploration or exploitation.

1.3 Information Technology and Organizational Identities

The third component of my dissertation asserts that superior IT capabilities enable the management of multiple organizational identities. I bridge literature on organizational identity and firm-level IT business value by adopting the sociological or 'identity as the subjective view held by observers' perspective of organizational identity and the IT capability conceptualization of IT business value. Viewed through these lenses, organizational identities consist of combinations of codes (rules, assumptions, beliefs and premises) that specify the properties an organization can possess (Baron 2004). Here, I present a theory of IT-enabled management of multiple organizational identities. I identify three causal mechanisms through which a firm's IT capability enables it to manage its multiple identities. Managing multiple organizational identities requires organizations to consistently project a specific combination of codes, and thus communicate attractive organizational images, to given audiences through consistent behavior and communication. Organizations should also be able to project different combinations of codes to different audiences through flexible realignment of resources. I propose that an organization's IT capability can provide firms with these abilities. Thus, the main thesis of this work is that IT enables the management of multiple organizational identities. Firms that are heterogeneous due to their identity choice succeed with their choice of multiple identities due to their IT capability.

After asserting the causal nature of IT capability in the management of multiple identities, I develop a computer simulation model (Carley 2002a) to assess the outcomes of differing levels of IT capability across different levels of synergy and plurality of organizational identities. This flexible and powerful methodology enables the control and manipulation of constructs and their interactions (Davis et al. 2007), assessment of various strategic outcomes at a holistic level and an understanding of the underlying dynamics (Chang et al. 2010). I use my model, the IT Capability Organizational IDentity (ITCOID) model, as a mechanism for theory building and generating additional associated propositions. My results show that an organization's IT capability leads to the highest performance increases under conditions of low plurality, low synergy and low IT capability. These results provide unique insights into the role of IT capability in managing the multiple identities and reaffirm my core assertion – that a firm's IT capability enables it to manage the strategic tensions arising from multiple identities, thereby achieving competitive advantage and higher firm performance.

Overall, the results of the analysis across the three components of this dissertation support the reasoning that while the simultaneous pursuit of seemingly paradoxical strategies leads to multiple and conflicting demands being placed upon an organization, IT facilitates the tolerance of these resultant tensions and thereby aids organizations to achieve superior competitive performance in the 21st century. Thus, IT enables firms to be like Janus.

1.4 Conclusion

This dissertation consists of positivist studies that are epistemologically premised upon the existence of a priori fixed relationships within the identified phenomena (in this case, organizations). This philosophy of scientific enquiry revolves around the notions of

Occam's razor, cumulative science, falsification and deduction (Hawking 1988; Popper 1959). Thus, the relationships I examine are capable of being identified and tested through deductive logic. The ontological basis of this dissertation research is an objective physical and social world that exists independently of humans (Mingers 2004).

Through this introduction section, I have summarized the major components of my dissertation. The three parts of my dissertation inform one another and contribute towards the development of a theory of IT enabled management of strategic tensions. My dissertation addresses recent calls in IS scholarship to enhance our understanding of ebusiness strategy and strengthen our understanding of the impacts of IT on intermediate, strategic constructs (Melville et al. 2004; Ray et al. 2005). It showcases the intangible business value of IT, and hence, furthers the debate that the business value of IT investments is not only reflected in measures of firm performance, but also reflected by improvements in firm intangibles. This dissertation adds to the dialogue on the intangible business value of IT by asserting the role of IT-enabled tolerance of strategic tensions, through organizational ambidexterity and management of multiple organizational identities, in attaining superior competitive performance. My findings strengthen our understanding of the impact of IT on a key intangible, strategic construct that lies on the path leading from IT to competitive advantage. Thus, it informs the complex relationships and theoretical pathways from IT to competitive advantage. I provide insights into the relationship between underlying components of IT resources, capabilities and architectures and first-order effects of IT on intermediate variables. I also speak towards the 'IT as an improvisational capability' conceptualization by presenting ambidexterity as an IT-enabled capacity that be produced under high turbulence. My dissertation also contributes towards the mixed findings of currently scant research that addresses IT business value questions in emerging economy or small and medium enterprise contexts. Finally, my research also addresses gaps in the strategic management literature, a reference discipline, by establishing IT as a key antecedent to organizational ambidexterity and the management of multiple organizational identities. In their editorial piece in the ambidexterity focused special issue of Organization Science, Raisch, Birkinshaw, Probst, and Tushman (2009) identified four central, unresolved tensions in the field of organizational ambidexterity. This dissertation addresses different aspects of two of these research concerns, namely the debate regarding manifestation of ambidexterity at the individual versus organizational levels and the internal versus external perspectives of ambidexterity. This research also addresses calls to consider national or cultural boundaries around the ambidexterity and organizational identity concepts. Overall, by employing multiple methods, including computational simulation, agent-based models, structural equation modeling and econometric analysis, this dissertation research advances our knowledge in the area of intangible business value of IT by establishing the role of IT in enabling the management of seemingly paradoxical challenges that arise in the tolerance of the complexity inherent in effectively resolving strategic tensions.

The practical implications of this research are significant because of the growing need for organizations to tolerate complexities and exhibit efficiencies when faced with cooperating and conflicting demands arising from multiple identities and conflicting strategies. This research provides an interesting perspective on the relationship between major sources of firm outlay – IT, innovation and identity management. Whereas in the face of meager available resources managers might be tempted to forgo investments in their IT capability for the sake of investments in exploitative and explorative innovation or identity management activities, this study shows that investments in IT will enable a firm to do a better job at managing both its innovation processes and its identity, thereby deriving competitive advantage.

The rest of this manuscript is as follows. In the second chapter, I present a review of the literature on the firm-level business value of IT. I showcase the major research themes in this area - IT and productivity, IT and firm performance, IT and market value of firms, and IT and competitive advantage. Finally, I present the current state of research on IT capability, which is the prime lens that informs this dissertation.

In the third chapter, I summarize a second stream of literature that informs this dissertation – the emerging literature on organizational ambidexterity. After introducing the concept of ambidexterity, I present the exploration-exploitation paradox. I then discuss the challenges and advantages of simultaneously engaging in exploration and exploitation. Finally, I introduce several conceptualizations of organizational ambidexterity and present a synthesis of research on antecedents to ambidexterity.

In the fourth chapter, I develop my theory and associated hypotheses regarding the role of IT in the facilitation of organizational ambidexterity. I present my hypotheses that explore the relationship of IT resources and organizational ambidexterity. I elucidate the causal mechanisms by which software, technical and hardware IT resources facilitate ambidexterity. I also offer a model of the relationships of automate, informate, and transform IT capabilities with organizational ambidexterity.

In the fifth chapter of this dissertation, I describe the context and empirical setting for the first component of this research. I then provide a description of the questionnaire development. Third, I describe the data collection protocol and processes. Fourth, I discuss the steps taken to alleviate concerns regarding bias and error. Fifth, I describe the measures used to capture the constructs of interest. Sixth, I present the results of empirical tests of the proposed theoretical models. Finally, I present alternative analysis by unpacking the ambidexterity construct into its underlying balance dimension and combined dimensions and conduct other tests of robustness.

The sixth chapter commences the second component of this dissertation. In this section, I review prior research in the area of technology acquisitions. First, I present the formal definition of technology acquisitions. Then I discuss the role of acquisitions in enabling external ambidexterity. I present the theoretical background on knowledge that is relevant to technology acquisitions. Finally, I review risks and success factors of technology acquisitions.

The seventh chapter of this manuscript begins with a discussion of computational modeling, following which I describe March's original model of exploration and exploitation. I then present the exploration-exploitation acquisition model, which adds a second firm to March's original model and simulates the acquisition of a small technology firm by a large technology firm. I propose several extensions to this model. I then offer an experimental research design that enables me to explore the role of IT-enabled learning mechanisms in acquisitions that are used as a means to balance exploration and exploitation activities. Finally, I present the results of computational experiments and offer derivative propositions.

I commence the third component of this dissertation research in the eighth chapter. I introduce the concept of organizational identity and discuss two associated theoretical perspectives. Then I present definitions of organizational identity and synthesize research on its construction. I also review the strategies used by organizations to manage multiple organizational identities.

In the ninth chapter, I sequentially develop three theoretical propositions that form a causal model of IT capability as an antecedent to the management of multiple organizational identities. First, I present arguments regarding the role of IT in the communication of organizational images. Then I discuss how IT facilitates consistent behavior and communication. Finally, I posit the flexible realignment of resources as a means by which IT enables managing a multiplicity of identities.

In the tenth chapter, I develop a computational model to further investigate the role of IT capability in managing identities. First I provide a description of this model. Then I present computational experiments through which I vary the organization's IT capability, and the synergy and plurality of its organizational identities. Finally, I present my results from these experiments and the resultant derivative propositions.

In the eleventh chapter, I conclude this dissertation by summarizing the results, contributions, limitations and implications of this research. Through these chapters, I reveal conceptual and empirical support for the assertion that in the 21st century, IT enables firms to be like the two-headed Roman god of auspicious beginnings and transitions. Janus.

2 Firm-level Business Value of Information Technology

Multiple streams of theory inform this dissertation research. The main theory of interest is the theory of IT resources and IT capability, which resides within the vast literature on the firm-level business value of IT. In this section, I present a review of the extant literature by showcasing the major research themes in this area. First, I summarize the literature that relates IT and productivity. Then, I discuss the research on IT and firm performance. Third, I present a summary of the literature on IT and the market value of firms. Finally, I examine the extant work on IT and competitive advantage and present the current state of research on IT resources and capabilities, the prime lens that informs this dissertation.

2.1 Introduction

The study of the business value of information technology has intrigued scholars for the past four decades and continues to be an enduring and significant overarching question in IS research. The business value of IT has been investigated at various levels: while some researchers have focused on the impact of IT on country level statistics (e.g. Dewan and Kraemer 2000; Park et al. 2007), others have concentrated upon the industry or network level of analysis (e.g. Rai et al. 2006; Rai and Tang 2010). However, a significant and highly impactful stream of work has addressed questions regarding IT business value at the firm-level. This dissertation contributes towards this large area of IS scholarship.

2.2 IT and Firm Productivity

IT investments are defined as "investments in computers, telecommunications and related hardware, software and services"(p. 4) (Dedrick et al. 2003). The earliest studies of business value were productivity studies which focused on the productivity benefits offered by IT investments through automation of tasks and increased availability of information for decision making. Making use of mathematical production function models on aggregate measures of IT capital and labor investments and firm productivity, these studies attempted to determine the productivity benefits offered by IT. Early studies failed to find significant relationships between IT investments and a variety of productivity measures (e.g. Loveman 1994) and this phenomenon was termed the "productivity paradox". The 1990's witnessed a series of studies that aimed to address the productivity paradox and towards the end of that decade there was general consensus amongst the research community that the productivity paradox was largely resolved (e.g. Brynjolfsson and Hitt 1996; Brynjolfsson and Hitt 1998; Hitt and Brynjolfsson 1996).

These latter studies argued that earlier research failed to show positive effects of IT investments on firm productivity due to a multitude of reasons, including small sample sizes, improper IT investment data and productivity measurement problems (Brynjolfsson and Hitt 1998). Researchers also suggest that the effect of aggregated data makes it difficult to discern the impact of IT on productivity because the positive effects of IT investments on firms may be overshadowed by large negative payoffs for a few firms that make poor IT investments (Devaraj and Kohli 2003). Similarly, time lags, implying that the benefits of IT investments may take multiple years to be realized, and the lack of complementary investments are other reasons why early studies failed to detect an effect of IT on productivity (Brynjolfsson 1993). Productivity payoffs are particularly absent in early studies of service firms.

The availability of large sources of IT investment data (IT investment data was published by InformationWeek and ComputerWorld, which provided researchers with a large data source), coupled with IT investment data collected through primary sources, has enabled the application of more rigorous econometric techniques. Thus, researchers have been able to conclusively show that IT investments lead to higher firm productivity, with IT investments having higher marginal returns as compared to other firm investments (Brynjolfsson and Hitt 1996). Research also shows that these productivity benefits may be passed onto consumers in the form of greater consumer surplus, thereby reducing the impact of IT investments on firm profitability (Hitt and Brynjolfsson 1996). Recent work has also analyzed the indirect effects of IT investment on productivity (Mittal and Nault 2009).

2.3 IT and Firm Performance

Another distinct theme within the area of IT business value concentrates upon the ifs and hows of the impacts of IT on firm performance. Many studies examine the relationship of IT with tangible and intangible firm performance. These studies have utilized a variety of measures to conceptualize firm performance, which include improvements in operating performance, profitability and revenue growth (Rai and Patnayakuni 1997). Most of these studies have reported a positive relationship between the size of IT investment and firm performance (e.g. Barua et al. 1995). Researchers have also distinguished amongst various types of IT investments and have attempted to study the differential payoffs of these investments (Weill 1992). Others have examined the lag in IT payoffs (Dao et al. 2007). Other work has acknowledged the contribution of IT towards firm intangibles by examining the effect of IT on market-based measures of performance such as Tobin's Q (e.g. Bharadwaj et al. 1999).

Some IS researchers have examined specific information technologies and their effects on firm performance. For example, a series of studies on the business value of electronic data interchange (EDI) determined that EDI has operational and strategic benefits, in the presence of process reengineering, when it is integrated with partner systems (Lee et al. 1999; Mukhopadhyay and Kekre 2002; Mukhopadhyay et al. 1995; O'Callaghan et al. 1992). Similarly, relatively recent work has focused upon the impacts of Enterprise Systems (ES) on firm performance (Gattiker and Goodhue 2005; Hendricks et al. 2007; Ranganathan and Brown 2006). These studies have found that ES enable organizational integration, leading to improved operational benefits and financial performance (Cotteleer and Bendoly 2006). There are mixed findings regarding the long-term value of ES implementations. Some studies have found improved stock market valuations (e.g. Hitt et al. 2002; Ranganathan and Brown 2006), others have failed to show conclusive evidence of profit or performance improvements accruing from ES (e.g. Hendricks et al. 2007) due to the possible diminishing of returns over time (Hitt et al. 2002).

Using a different approach, other research has tried to ascertain firm-level differences that result in heterogeneous payoffs from investments in IT. Much of this literature has highlighted the complementary nature of IT investments, which results in an enhancement of the payoffs from IT investments in the presence of specific organizational characteristics (Bharadwaj et al. 2007; Chari et al. 2008). This complementary nature also results in IT investments enhancing the effect of these specific organizational characteristics. Some complementary characteristics that increase the payoffs from IT are business process design and fit, organizational structure and control mechanisms and employee competency and training (Dedrick et al. 2003; Melville et al. 2004). Others include management quality, commitment to IT initiatives, IT and business strategy alignment, organizational capital, employee involvement and management practices such as decentralization and quality management (Dedrick et al. 2003).

2.4 IT and Market Value of Firms

The market value of firms has been used as an indicator of the impact of IT by many studies that investigate the complementary nature of IT or of specific IT investments (Ranganathan and Brown 2006). With the efficient market hypothesis as the underlying theoretical rational, these studies have used market value based indicators of firm performance. While some of these studies have used Tobin's Q as the dependent variable to measure the present and future impact of IT (Bharadwaj et al. 1999), others have used an event study methodology which analyzes abnormal changes in a firm's stock price following an IT-related announcement. These include announcements for new IT investments (Dos Santos et al. 1993), specific IT investments (Chatterjee et al. 2002; Im et al. 2001; Subramani and Walden 2001) and Chief Information Officer related announcements (Chatterjee et al. 2001).

Overall, studies have shown that spending on IT leads to improvements in firm performance, as measured through a variety of market and accounting measures. Several studies have made links from IT investments to firm performance by way of several intermediate processes such as new product development, capacity utilization and inventory turnover (Banker et al. 2006; Barua et al. 2004; Barua et al. 1995; Mooney et al. 1996). IT also has positive impacts on exploration, exploitation, knowledge creation and innovation output (Kane and Alavi 2007; Kleis et al. Forthcoming). IT also enables firms to achieve advanced manufacturing processes, superior customer services, and new product and process development (Banker et al. 2006; Ray et al. 2005). While several intermediate constructs and processes have been identified, this work is yet incomplete, ongoing and emergent. I assert organizational ambidexterity and multiple organizational identities as two such intermediate processes, which lie on the path from IT investments to competitive advantage and, thereby, firm performance.

2.5 IT and Competitive Advantage

The impact of IT on a firm's competitiveness is a question of great interest to IS researchers. Early work utilized Porter's 5-Forces Model (Porter 1980) to suggest that efficient IT use would enable firms to change the competitive structure of the industry and, hence, gain competitive advantage (Cash and Konsynski 1985). Other work suggested that IT would provide a competitive advantage only in the presence of complementary resources (Clemons and Row 1991). More recent work in this area over the past decade has examined the ability of IT to provide a sustained competitive advantage to firms. Applying the resource-based view of the firm, these studies have argued that IT investments (as a whole or specific types) are valuable, rare, inimitable and non-substitutable (Barney 1991; Teece et al. 1997).

The theoretical foundations of the IS research that uses the resource-based view are as follows. Resources are observable, tangible or intangible, tradable, firm-specific assets that add value to firms. In general, resources are valuable, rare, inimitable and non-substitutable (Barney 1991; Makadok 2001). Capabilities are the abilities of firms to perform a set of tasks by using resources, to achieve a specific objective. Capabilities are unobservable, intangible and untradeable (Makadok 2001). Firms create capabilities at the strategic or operational level by combining different resources or resource bundles into unique configurations.

IT capability is conceptualized as a firm's ability to mobilize and deploy IT resources in combination with other capabilities or resources and its role as a source of sustained competitive advantage has been studied (Bharadwaj 2000; Melville et al. 2004; Santhanam and Hartono 2003). IT resources are inimitable because they are subject to one or more of causal ambiguity, time-compression diseconomies, embeddedness, and path dependencies (Barney 1991). As per this conceptualization, the IT capability resides at the strategic level and enables a firm to assemble, integrate and deploy IT resources in conjunction with other resources and capabilities to achieve competitive advantage.

IT has also been conceptualized as a dynamic capability or as a higher order capability within a hierarchy of capabilities (Barua et al. 2004; Bhatt et al. 2005). Management scholars have conceptualized dynamic capabilities as being embedded within the distinct ways that organizations integrate, build, and recombine competences and other capabilities flexibly across boundaries. As dynamic competencies are fundamental to long-term strategic advantage (Eisenhardt and Martin 2000; Kogut and Zander 1992; Teece et al. 1997), the conceptualizations of IT capability as a dynamic capability have asserted a similar effect of IT. More recent work has argued that IT capability is a form of an improvisational capability, which is distinct from a dynamic capability. This research reasons that improvisational capabilities refer to the capacity to spontaneously reconfigure existing resources to build new capabilities under highly unpredictable and novel environmental conditions (Pavlou and El Sawy 2010).

Other studies in this rich vein of research have examined IT competence and its role in the development of digital options (Overby et al. 2006; Sambamurthy et al. 2003; Sambamurthy et al. 2007). These studies define IT competence as the sum of an organization's IT resources and capabilities and argue that IT competence will enhance a firm's agility and thus provide competitive advantage in complex, turbulent environments.

Overall, these studies have argued that to create and sustain competitive advantage, firms must acquire unique IT resource bundles and complementary capabilities (Santhanam and Hartono 2003). My dissertation research applies this theoretical lens and contributes towards this perspective in IS research by identifying organizational ambidexterity and multiple organizational identities as two of the intermediate organizational constructs through which IT resource bundles and capabilities provide organizations with a competitive advantage.

2.6 Conclusion

Extant research findings on IT business value have some caveats. Data availability constraints have restricted the majority of firm-level studies of IT business value to large U.S. based organizations. The little research that has examined the business value of IT for foreign firms has found mixed results (e.g. Lal 2001; Lal 2002). Country level studies of IT business value attempt to offer an explanation for these results: due to low labor and high capital costs, labor-capital substitution payoffs do not occur in developing countries (Dewan and Kraemer 2000). Similarly, it has been theorized that due to the differing structure, business environment and risk profile of small and medium enterprises (SMEs), IT investments do not witness as profound a positive payoff as seen for large sized firms. Consequently, the scant research that examines SMEs has also found mixed payoffs to IT. This dissertation addresses both of these gaps by examining SMEs in a non-U.S. setting.

Overall, the firm-level business value of IT literature has been summarized in several prior studies (Dedrick et al. 2003; Kohli and Devaraj 2003). This literature has progressed from answering questions regarding *if* IT has business value to *how* IT has business value. Research has delved into the black box of IT and with the conceptualization of IT resources and capabilities, has begun to answer questions regarding how it can be leveraged to maximize its business value. Recent studies in this literature have attempted to examine the impact of IT on intermediate, intangible constructs that connect IT to competitive advantage and firm performance. This dissertation provides further advances in this direction.

In this section, I provided a synthesis of the research on the firm-level business value of information technology. In the following section, I will provide an overview of literature on organizational ambidexterity. These two streams of work – IT business value and organizational ambidexterity - provide a basis for the first component of this dissertation.

3 Organizational Ambidexterity

In the prior section, I presented a review of prior work in the area of firm-level IT business value. In this section, I summarize the second stream of literature that informs this dissertation, namely, the research on organizational ambidexterity. Towards this end, first I introduce the concept of ambidexterity. I then synthesize the research on the exploration-exploitation paradox and present a detailed explanation of these two concepts. I then present a discussion of the challenges and the advantages of simultaneously engaging in exploration and exploitation. Finally, I introduce several conceptualizations of organizational ambidexterity from extant literature and present a synthesis of the research on antecedents to ambidexterity.

3.1 Introduction

Ambidexterity is defined as the state of being ambidextrous. Ambidextrous literally means "being right on both sides" and refers to an ability to use both appendages equally adeptly (Rothaermel and Alexandre 2009). Naturally occurring ambidexterity is quite rare and advantageous to its possessor and has been the subject of human curiosity and enquiry for many centuries (Jackson 1905). Ambidexterity in humans is associated with enhanced magical ideation, increased creativity and greater lateral thinking (Barnett and Corballis 2002). In his 1905 manual, Jackson had emphatically declared "Ergo, simultaneous Ambidextral work must be harmless and healthful, as well as expedient and necessary." (Jackson 1905) (p. 179). Though human brains are ambidextrous in nature and can handle controlled and automated processes simultaneously (Wegner and Bargh 1998), only one in 100 people can use both of their hands with equal ease and effectiveness (London 2010). Similar to ambidexterity observed in nature, organizational ambidexterity is an organization's effectiveness in pursuing seemingly contradictory activities simultaneously (e.g. Raisch and Birkinshaw 2008). It is equally rare, difficult to master, and advantageous to its possessor.

3.2 Ambidexterity in the Broadest Sense

Firms face many paradoxical challenges. These include the challenges of retaining efficiency of business process while enhancing their flexibility and improvisation (Konsynski and Tiwana 2004), maintaining stable organizational configurations while transforming other configurations, exploiting existing competencies and exploring new ones (Vera and Crossan 2004), and generating new knowledge associated with new products and services for emerging markets while leveraging current competences and exploiting existing products and services (Danneels 2002). A firm's technology sourcing strategy also presents challenges regarding positions on the internal versus external technology sourcing continuum (Rothaermel and Alexandre 2009).

Though earlier research viewed these challenges as overwhelming tradeoffs, more recent thinking regards these as paradoxical challenges which can be overcome through a variety of mechanisms. Different streams of literature have referred to this phenomenon through a variety of labels, which include reconciliation, simultaneity, balancing and synchronization. However, the fundamental construct that these studies refer to in differing ways is the construct of organizational ambidexterity. Formally, organizational ambidexterity is the ability to generate competitive advantage by simultaneously engaging in seemingly contradictory and conflicting strategies such as alignment and adaptability (Gibson and Birkinshaw 2004), revolutionary and evolutionary change (Tushman and O'Reilly 1996), exploratory and exploitative innovation (Benner and Tushman 2003), continuity and change in organizational evolution (Miller et al. 1984), and stability and transformation in organizational adaptation. The ambidexterity perspective has also been applied to varied strategic situations including an organization's technology sourcing strategy (Rothaermel and Alexandre 2009), market entry strategy, alliance formation strategy (Tiwana 2008), long term inter-organizational relationships (Im and Rai 2008), and others. A key and recently oft studied instance of ambidexterity is the pursuit of exploration and exploitation strategies.

3.3 Ambidexterity and the Exploration-Exploitation Paradox

James March's (1991) seminal paper on organizational learning has been frequently cited as the genesis of the research on ambidexterity. Underlying the stream of research on ambidexterity is the debate regarding the conceptualization of exploration and exploitation being either two points on continuum or being orthogonal constructs. Previous to March's (1991) prescription that organizations pursue both exploration and exploitation for success, most research conceptualized exploration and exploitation as two activities that cannot be achieved simultaneously and thus asserted that organizations are required to choose between exploration or exploitation. Latter studies further developed the ideas put forth by March (1991) by arguing that a singular focus on either exploration or exploitation would lead to debilitating weaknesses. Specifically, researchers identified competency traps and organizational inertia as the untoward results of pursuing an exploitation only strategy (Leonard-Barton 1992). Similarly, an exploration only strategy would result in organizations trapped in an endless cycle of search, bereft of the rewards accrued from exploiting the new knowledge and opportunities (Siggelkow and Rivkin 2005). This conceptual development has eventually led to researchers considering exploration and exploitation as a paradox, instead of a trade-off. However, the first use of the term organizational ambidexterity, by Duncan (1976), predates this March motivated debate of orthogonality versus continuum. Fundamentally, the ambidexterity premise, as initially suggested by Tushman and O'Reilly

(1996), implies that to achieve superior performance, firms need to achieve a balance between the two broad types of core activities between which firms divide their resources and energies: exploration and exploitation.

Exploration and exploitation have been conceptualized as two distinct activities, which require different processes, systems, cultures and capabilities to pursue. The effects of these two activities on organizational performance and other intermediary constructs may also differ. This conceptual distinction has been used across a wide range of management research, including information systems (e.g. Kane and Alavi 2007; Prieto et al. 2007; Subramani 2004), marketing (e.g. Atuahene-Gima 2005), strategic management (e.g. Burgelman 1991) and organizational theory (e.g. Tushman and O'Reilly 1996). This distinction has also been applied to study a range of organizational phenomena, including alliances (e.g. Lavie and Rosenkopf 2006), innovation (e.g. Benner and Tushman 2003), knowledge search and creation (e.g. Katila and Ahuja 2002), and market entry (e.g. He and Wong 2004).

While the exploration and exploitation framework has been used in other fields, such as biology to characterize foraging and natural resource utilization behaviors (e.g. Pyke 1984) and cognitive science to describe search and learning under bounded rationality (Newell 1990; Newell and Simon 1972), several firm behaviors and strategies have also been categorized on either side of the exploration – exploitation dichotomy. In the organizational learning literature, researchers have referred to the distinctions between local search versus long jump learning and single-loop versus double-loop learning (Argyris and Schön 1978; Levinthal 1997). The organization theory and strategy literature distinguishes between mechanistic and organic structures, which are designed for efficiency versus flexibility, induced and autonomous processes, which result in a decrease versus an increase in variation, and evolutionary and revolutionary change in organizational evolution (Burgelman 2002; Burns and Stalker 1961; Tushman and O'Reilly 1996). The theory of complex adaptive systems refers to order versus chaos (Clippinger 1999). In his seminal paper, March (1991) summarizes many fundamental differences in organizational behavior due to the distinction between the exploration of new possibilities and exploitation of old certainties. This distinction is succinctly captured in Holland's (1992) statement "Deciding to what degree the present should be mortgaged for the future is a classic problem for all systems that adapt and learn" (p. 69).

3.4 Exploration

In his foundational paper, James March (1991) conceptualized exploration as those firm behaviors that exemplify search, discovery, variation and experimentation. Exploration is associated with risk taking, new routines, and divergent thinking (Baum et al. 2000; March 1991). Flexibility, decentralization, and loose cultures (Benner and Tushman 2003) have also been associated with exploration.

The returns from exploration are variable and more distant in time (March 1991). Thus, exploration activities may experience substantial successes or failures. Recent work has shown that the returns from exploration are advantageous even in multistage problems as an exploration process helps to identify signals of value at intermediate steps (Fang and Levinthal 2009). Across different research contexts, exploration has been variously associated with loosely coupled systems, path breaking, improvisation, competence-building, autonomy and chaos, and emerging markets and technologies

The literature on technology innovation has long considered the distinction between explorative and exploitative innovation as an instance of exploration and exploitation strategies. Radical innovation, which refers to fundamental changes leading to new products, services and concepts, has been described as explorative or exploratory innovation. Explorative innovations are aimed at meeting the needs of emerging customers or markets and require divergence from existing knowledge through the creation of new knowledge, technologies and competencies (Benner and Tushman 2003; Danneels 2002; Jansen et al. 2006).

3.5 Exploitation

March (1991) characterized exploitation as those firm behaviors that exemplify refinement, implementation, selection and efficiency. Exploitation has also been associated with existing routines and focus (Baum et al. 2000; March 1991). The returns from exploitation are certain and more closer in time (March 1991). Thus, exploitation activities experience more stable performance. Across other research contexts, exploitation has been associated with tightly coupled systems, path dependence, routinization, competence-leveraging, control and bureaucracy, and stable markets and technologies. Efficiency, centralization, and tight cultures (Benner and Tushman 2003) are other attributes of exploitation.

Exploitative innovation, also termed as incremental innovation, is an instance of an exploitation strategy which refers to minor changes to existing products, services and concepts. Exploitative innovations are aimed at meeting the needs of existing customers or markets and require the deepening of existing knowledge through the refinement of established knowledge, technology and competencies (Benner and Tushman 2003; Danneels 2002; Jansen et al. 2006).

3.6 Conflicting Demands

Exploration and exploitation require fundamentally different and inconsistent architectures and competencies, thereby creating paradoxical challenges (Jansen et al. 2009). Exploratory behavior can hamper an organization's speed to improve and refine existing competencies (March 1991). Failed efforts at exploration may result in changes and disruptions in successful organizational routines, with no significant payback from new opportunities. Similarly, exploitative behavior may result in structural inertia and thus hamper an organization's ability to adapt future changes and opportunities. Other paradoxical demands are raised because exploitation requires a short-term efficiency and control focus, which contradicts the long-term experimental focus and decentralized architecture of exploratory units (Floyd and Lane 2000).

Such tensions between exploration and exploitation place many conflicting demands upon an organization, which can threaten to tear it apart. Thus, previous to March's (1991) assertion that organizations must pursue both exploration and exploitation for success, most researchers conceptualized these as two strategies that cannot be achieved simultaneously and asserted that organizations are required to choose between them.

3.7 Advantages of Simultaneous Exploration- Exploitation

Latter studies further developed March's (1991) ideas by arguing that organizations that concentrate their energies and resources on either exploration or exploitation eventually face severe problems. Firms tend to get stuck in accelerating dynamics of exploration or exploitation as both processes are self-reinforcing (Levinthal and March 1993; March 1991).

Firms that have a heavy exploration focus tend to get stuck in cycles of search (Siggelkow and Rivkin 2005), without fully capturing the benefits of exploration, which is possible only by exploiting the new opportunity. Such organizations pursue constant, unrewarding change and are unable to garner returns from their superior knowledge (Levinthal and March 1993). For example, Xerox Corporation followed such an exploration-focused strategy in the 1970s. Their Palo Alto Research Center was responsible for the development of many ground breaking innovations in computer software and hardware, such as the graphical user interface, the mouse, and the first personal computer. However, Xerox was on the lookout for photocopier-related innovations, and they lacked the competencies to recognize and exploit these computing related innovations. Subsequently, they were unable to gain any benefits from the fruit of their exploratory efforts (Chesbrough and Rosenbloom 2002; Rothaermel and Alexandre 2009).

Firms with an over emphasis on exploitation tend to achieve an equilibrium-like state of practice over time that may or may not be "optimal" (Vermeulen and Barkema 2001). This is because when exploitation-focused organizations experience success in a specific competency, they engage in the activity more frequently, thereby not only further improving their competence, but also increasing their opportunity costs for exploration (Levinthal and March 1993). Though such firms may witness short-term successes, they are unable to sustain these successes in the face of environmental change. Over-exploitation results in an atrophy of core competencies, which eventually become core rigidities (Leonard-Barton 1992). This state of obsolescence, progressive rigidity and simplicity has been termed as a competency trap and results in an inability to respond to changes and eventual organizational demise (Levitt and March 1988; Vermeulen and Barkema 2001). An exploitation focus also leads to an immediate decline in payoffs in a multistage problem scenario (Fang and

Levinthal 2009). For example, Texas Instruments engaged in an exploitation focus to develop a core competency in low-cost handheld calculators. However, over time, its core competency in low-cost manufacturing turned into a core rigidity, resulting in an inability to compete in the face of changing customer preferences for differentiated calculators (Rothaermel and Alexandre 2009).

Combining the processes of exploration and exploitation not only helps organizations to overcome structural inertia that results from focusing on exploitation, but also keeps them from accelerating exploration without gaining benefits (Levinthal and March 1993). Scholars from the area of organizational evolution argue that too much of radical change (exploration) can lead to organizational chaos if it is not balanced by continuity (exploitation), while the inertia of continuity (exploitation) needs to be balanced by radical change (exploration) (Levinthal and March 1993; Sastry 1997). A means by which this can be practiced is through a self-generating innovation strategy wherein a firm obsoletes its older, successful innovations by selling them off and is forced to exploit newer developed innovations. This disrupts its current advantages and enables it to ride the crest of a series of temporary advantages (He and Wong 2004).

This theoretical lucidity has eventually led to researchers considering exploration and exploitation not as trade-offs, but as seemingly paradoxical strategies which are increasingly simultaneously possible in the 21st century. Consequently, recent work asserts that the long term success and survival of firms is contingent upon their ability to pursue both exploration and exploitation. In their commentary, Tushman and O'Reilly (2004; 1996) suggest that an ambidextrous organization is like a juggler, who can juggle the capability to compete in mature markets (exploit) and the capability to compete in emerging markets (explore). In later work, they again evoke the juggler metaphor to assert that ambidextrous organizations can juggle incremental (exploitation activities) and radical (exploration activities) innovation and thereby produce a steady stream of advantageous innovation (O'Reilly and Tushman 2004). Ambidexterity researchers have argued that dynamic capabilities are rooted in simultaneous exploration and exploitation and that the interaction of these two activities has a synergistic effect that provides competitive advantage which is beyond the advantage provided by each activity alone (Ancona et al. 2001; Colbert 2004; Katila and Ahuja 2002). Cao, Gedajlovic, and Zhang (2009) assert that a balance between exploration and exploitation activities reduces the performance damaging effects of over engaging in either activity and an increase in the combined magnitude of exploration and exploitation leads to higher firm performance through the generation of complementary resources that can be leveraged across either activity. Also, organizations that accomplish both a balance and a high magnitude of exploration and exploitation also benefit from additional synergistic effects. Organizational ambidexterity therefore is a key driver of competitive advantage and resultantly, superior firm performance. This assertion is supported by a multitude of conceptual and empirical research studies that have been conducted in the past decade which showed positive impacts of ambidexterity on product development, sales growth, and long term profitability (e.g. Cao et al. 2009; Gibson and Birkinshaw 2004; He and Wong 2004; Lubatkin et al. 2006; Sheremata 2000). The effect of ambidexterity on firm performance is moderated by a number of factors. An organization’s resource endowment, scope and market orientation are a few key moderators. Research has also found that ambidexterity has differential benefits to firms - a balance of exploration and exploitation is most effective for resource-constrained firms whereas a high combined magnitude of exploration and exploitation is most beneficial to firms with access to greater internal or external resources (Cao et al. 2009).

3.8 Conceptualizations of Ambidexterity

Organizational ambidexterity was first conceptualized as a firm's ability to manage tensions arising from simultaneous exploration and exploitation (Duncan 1976). Over the years, this conceptualization has been parsed and refined. Whereas some researchers who have defined ambidexterity attempted to provide a more nuanced definition, others have suggested alternative forms and names such as architectural ambidexterity, structural ambidexterity, contextual ambidexterity, temporal ambidexterity and sequential ambidexterity (Andriopoulos and Lewis 2009; Raisch et al. 2009). Some have argued that it is a higher order multidimensional construct whereas other researchers have conceptualized ambidexterity as a dynamic capability (Birkinshaw and Gibson 2004; Cao et al. 2009; O'Reilly and Tushman 2008). For example, Jansen et al (2009) recognize organizational ambidexterity as a dynamic capability which "refers to the routines and processes by which ambidextrous organizations mobilize, coordinate, and integrate dispersed contradictory efforts, and allocate, reallocate, combine, and recombine resources and assets across differentiated exploratory and exploitative units". They suggest that organizational ambidexterity is difficult to achieve, rare, not easily imitable and provides competitive advantage. They also submit that organizational ambidexterity is path dependent in its emergence, idiosyncratic in detail, and exhibits common features involving distinct integration mechanisms.

Table 1. A Few Definitions of Ambidexterity
"Organizational ambidexterity is a dynamic capability which refers to the routines and processes by which ambidextrous organizations mobilize, coordinate, and integrate dispersed contradictory efforts, and allocate, reallocate, combine, and recombine resources and assets across differentiated exploratory and exploitative units" (Jansen et al. 2009)
"Ambidextrous firms are aligned and efficient in their management of today's business demands while simultaneously adaptive to changes in the environment" (Raisch and Birkinshaw 2008)
"Ambidexterity is the ability to simultaneously pursue both incremental and discontinuous innovations" (Tushman and O'Reilly 1996)
"Ambidexterity is a firm's ability to operate complex organizational designs that provide for short-term efficiency and long-term innovation" (Raisch and Birkinshaw 2008)
"Ambidextrous organizations are capable of operating simultaneously to explore and exploit" (He and Wong 2004)
"Ambidextrous firms are capable of exploiting existing competences as well as exploring new opportunities with equal dexterity" (Lubatkin et al. 2006)
"Ambidexterity is an organization's ability to simultaneously balance different activities in a trade-off situation" (Rothaermel and Alexandre 2009)

Some researchers postulate that ambidextrous firms have a relatively balanced focus on exploration and exploitation, even though the magnitude of exploration and exploitation may be low. It has been suggested that there may be limits to ambidexterity, with extreme exploration or exploitation strategies liable to generate unmanageable tensions (He and Wong 2004). Conversely, some suggest that firms that have high focus on both exploration and exploitation are truly ambidextrous (Jansen et al. 2006; Lavie and Rosenkopf 2006; Lubatkin et al. 2006). Such conceptualizations present ambidexterity as a true balance, wherein an organization excels at both exploration and exploitation (Atuahene-Gima 2005). This conceptualization is contingent on the explanation that exploration and exploitation are orthogonal and independent and organizations can choose to simultaneously engage in high levels of both activities (Gupta et al. 2006). Cao, Gedajlovic, and Zhang (2009) were the first to explicitly conceptualize these distinctions in the ambidexterity construct. They submit that there exists a lack of clarity regarding whether ambidexterity concerns a relative balance between exploration and exploitation or if it concerns the magnitude of exploration and exploitation together. To support this assertion, they cite previous studies that incorporated both aspects in their operationalization of ambidexterity (e.g. Gibson and Birkinshaw 2004; He and Wong 2004; Lubatkin et al. 2006). Consequently, Cao, Gedajlovic, and Zhang (2009) conceptualize organizational ambidexterity as consisting of two distinct dimensions, termed the balance dimension and the combined dimension of ambidexterity. Table 1 provides a few definitions of the organizational ambidexterity construct that have been put forth in prior literature.

3.9 How Firms Achieve Ambidexterity

Ambidexterity theorists have conceptualized two temporal solutions by which organizations achieve a balance between exploration and exploitation. The first, variously termed punctuated equilibrium, sequential ambidexterity or dynamic ambidexterity, refers to a sequential pattern of long bursts of exploitation interspersed by short bursts of exploration (e.g. Burgelman 2002; Siggelkow and Levinthal 2003). The second refers to the practice of simultaneous pursuit of exploration and exploitation within an organization (Benner and Tushman 2003; Raisch et al. 2009). Under the first solution, a firm temporally shifts from an exploitation orientation to an exploration orientation and back to an exploitation orientation sequentially – much like how Google does with its 4 + 1 work week. Under the second temporal solution, a firm employs dedicated, autonomous units that are highly exploration oriented, while the rest of the firm is exploitation oriented. For example, Misys created a unit dedicated to generating long term returns from open source technology, which was separated from the rest of the immediate returns oriented organization (Tushman et al.

2011). Another popular solution to address the paradoxical demands of exploration and exploitation is the practice of externalizing either of these activities through outsourcing or alliances (Lavie and Rosenkopf 2006). Though externalization of exploration or exploitation also faces the problems of strategic integration, some studies suggest that it does not conceptually constitute ambidextrous behavior (Raisch and Birkinshaw 2008). Conversely, others assert that externalization is critical to the concept of ambidexterity (Raisch et al. 2009). Gupta, Smith, and Shalley (2006) submit that managing externalization and the required integration of two inconsistent alignments across two different firms is less complex than cycling through one alignment after the other within a single firm, which in turn is far less complex than simultaneously managing two inconsistent alignments and demands within a single organization.

Research has explored various antecedents to organizational ambidexterity. Firms can achieve ambidexterity through three broad categories of mechanisms – organizational structures, behavioral / situational contexts and through leadership processes (Tushman and O'Reilly 1996). Researchers have focused on structural solutions that allow organizations to simultaneously engage in paradoxical strategies and cope with their competing demands. Tushman and O'Reilly (1996) were the first to suggest structural mechanisms to enable ambidexterity. Most of the subsequent work has focused upon identifying different organizational structures, such as hybrid organic and mechanistic structures, which facilitate the two basic processes of structural differentiation and integration (Raisch and Birkinshaw 2008). Structural differentiation (which is the subdivision of organizational tasks into different units (Lawrence and Lorsch 1967)) enables ambidextrous organizations to maintain multiple competencies to address paradoxical demands (Gilbert 2005) by protecting existing competencies in exploitative units from interfering with emerging competences in exploratory units. Structural differentiation also ensures the freedom and flexibility required by explorative units to develop new knowledge and skills (Jansen et al. 2009). Thus, the coexistence of spatially dispersed exploratory and exploitative units within an organization is enabled by structural differentiation (Benner and Tushman 2003; Duncan 1976).

Integration enables organizations to combine exploration and exploitation efforts and achieve ambidexterity (Gilbert 2005; Smith and Tushman 2005). Jansen et al (2009) suggest four types of integration mechanisms along two dimensions: (1) senior team versus organizational and (2) formal versus informal integration mechanisms that provide means by which ambidextrous organizations deal with structural differentiation and thus mediate the relationship between structural differentiation and ambidexterity. They argue that senior team integration mechanisms provide for allocation of scarce resources and departure from existing competences and skills within exploratory units and establish cross-fertilization and strategic synergies with ongoing businesses in exploitative units. Organizational integration mechanisms enable the access and integration of knowledge sources flexibly across exploratory and exploitative units. Their findings suggest that the effect of structural differentiation on ambidexterity is mediated by informal senior team (i.e., senior team social integration) and formal organizational (i.e., cross-functional interfaces) integration mechanisms. They also find that connectedness, which is dependent on the density of an organization's social network, has a direct impact on organizational ambidexterity. Other researchers suggest different mechanisms, including coordination at senior management level and shared corporate culture, to achieve strategic integration (O'Reilly and Tushman 2004).

Individual behaviors in an organization are shaped by systems, processes and beliefs (Ghoshal and Bartlett 1994). Such factors are referred to as context and according to the second group of studies, termed contextual studies of ambidexterity, can facilitate organizational ambidexterity. Gibson and Birkinshaw (2004) label the behavioral capacity for ambidexterity as contextual ambidexterity. This set of studies demonstrates that contextual ambidexterity is antecedent upon a combination of meta-routines, shared vision, and a balance of discipline, stretch, support and trust. Though systems are considered part of an organization's context, none of these studies explicitly address the relationship of IS with ambidexterity.

A third, rich vein of ambidexterity research has examined leadership or managerial antecedents of ambidexterity. The role of senior management is critical in the development of organizational ambidexterity (Tushman et al. 2011). Leadership processes play a key supporting role in both structural as well as contextual ambidexterity (Gibson and Birkinshaw 2004; Smith and Tushman 2005). Organizations can also develop ambidexterity due to the composition of founding teams and senior management. A mix of old comers and new comers in the top management team, or a mix of diverse or common prior affiliations in the founding team can facilitate ambidexterity (Perretti and Negro 2006). Some researchers argue that ambidexterity manifests itself at an individual level. They assert that senior managers, who are ambidextrous at an individual level, enable organizational ambidexterity (e.g. Mom et al. 2009). It has also been shown that organizations in which the middle management focuses on developing different solutions, and the top management leverages selected solutions, are ambidextrous. More recent work has examined the role of ambidextrous middle-managers in enabling organizational ambidexterity. For example, Taylor and Helfat (2009) highlight the important role of middle managers in creating and maintaining organizational linkages between exploratory new core technology and exploitative old complementary assets in a technological transition.

3.10 Conclusion

Overall, the recent advances in organizational research have provided empirical support and greater conceptual nuance to the construct of organizational ambidexterity. This ever widening stream of literature has shown empirical support for the competitive advantage and firm performance implications of ambidexterity. This notion, which was initially referred to as the ambidexterity premise, and later became known as the ambidexterity hypothesis, is now a generally accepted as a supportable assertion. This stream of literature has also progressed beyond structural antecedents and has begun to examine contextual, leadership and social antecedents of ambidexterity.

The common underlying effect of these structural, organizational and managerial antecedents is that they allow ambidextrous organizations to manage conflicting tensions and demands through acts of balancing, harmonization, reconciliation, and separation. However, several of the critical processes underlying these antecedents, such as differentiation and integration, are enabled or facilitated by IT. This assertion is reflected theoretically in the IS research literature and anecdotally in the majority of empirical ambidexterity studies being conducted in the post-dot com age. Though systems are mentioned as part of an organization's context, none of these studies have explicitly addressed the relationship of IT with ambidexterity. Thus, to the best of my knowledge, no previous study in the ambidexterity literature has conceptualized IT as an antecedent to ambidexterity. This dissertation represents the first effort to fill this gap in the extant literature.

Thus far in this dissertation, I have provided a review of the two main theory bases that inform the first component of my research. In the next two sections, I will first develop theory regarding IT as antecedent to organizational ambidexterity. I will then provide a description of the empirical approach taken to test these hypotheses and the results of these tests.

4 Impacts of IT on Organizational Ambidexterity

In previous sections, I reviewed the extant academic literature on the firm-level business value of IT and organizational ambidexterity. In this section, I weave together these two streams of inquiry by developing a theory and associated hypotheses regarding the role of IT in the facilitation of organizational ambidexterity. First I present hypotheses that explore the relationship of IT resources and organizational ambidexterity. In this set of hypotheses, I unpack the IT resources construct into underlying software, technical and hardware components. Then I develop a research model elucidating the relationships of automate, informate, and transform IT capabilities with organizational ambidexterity.

4.1 Introduction

Antecedents to the development of organizational ambidexterity and the management of resultant conflicting demands and tensions have been established in the extant literature. Many of these antecedents may be enabled by IT in differing ways. I assert several underlying causal mechanisms through which an organization's IT resources and capabilities facilitate its simultaneous pursuit of conflicting exploratory and exploitative innovation strategies. Overall, researchers acknowledge the equifinality of organizational ambidexterity and recognize the existence of multiple, mutually supportive pathways towards it (Andriopoulos and Lewis 2009). Accordingly, I present multiple arguments for a set of mutually supporting causal links between different types of IT resources and capabilities and organizational ambidexterity that traverse through diverse intermediate constructs and processes. To develop a nuanced understanding of the mechanisms involved in the development of organizational ambidexterity, it is critical to think in levels. The tensions between contrary strategies may be felt at one level (e.g. individual), and these tensions may be resolved at another (e.g. team). Thus, ambidexterity may be held at one level, and resolved at another higher level (Raisch and Birkinshaw 2008). Ambidextrous organizations successfully manage paradoxes at multiple levels and the interactions across levels reinforce one another (Andriopoulos and Lewis 2009). Ergo, organizational level antecedents of ambidexterity may help resolve tensions held at lower levels within the organization. I assert that an organization's IT resources and capabilities act a similar manner, across levels, to enable organizational ambidexterity.

4.2 Influence of IT Resources

According to the resource based view, resources are observable, tangible or intangible, tradable, firm-specific assets that add value to firms. In general, resources are valuable, rare, inimitable and non-substitutable (Barney 1991; Makadok 2001). IT resources are valuable and non-substitutable as they are comprised of historical and ongoing investments in IT assets. IT resources are inimitable because they are subject to one or more of causal ambiguity, time-compression diseconomies, embeddedness, and path dependencies (Barney 1991). As per this conceptualization, a firm's IT capability resides at the strategic level and enables it to assemble, integrate and deploy IT resources in conjunction with other resources and capabilities, to achieve competitive advantage (Bharadwaj 2000).

Consistent with prior treatments, I conceptualize an organization's IT resources as being decomposed into three underlying components – a software component, a technical component and a hardware component. In the next sections, I provide my logic for asserting the positive effect of the three components of IT resources on organizational ambidexterity. In summary, I propose that different IT resources act through the mechanisms of greater communication and knowledge transmission channels, connectedness, integration and organizational agility and flexibility, to enable ambidexterity. Since the overall IT resources of a firm are composed of its underlying components, I propose that due to the combined effects of its components, a firm's IT resources have a positive influence on organizational ambidexterity. Building on this rationale, I hypothesize:

Hypothesis 1 (H1): IT resources are positively related to organizational ambidexterity.

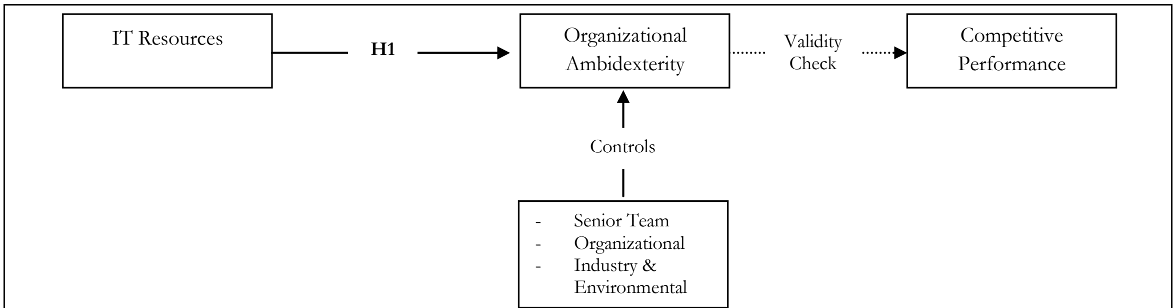


Figure 1. First Hypothesized Model: Impact of IT Resources on Ambidexterity

4.2.1 Influence of Software IT Resources

The software component of an organization's IT resources consists of its IT applications, systems, pre-packaged software, custom designed software, and hosted applications. This component also includes the data resources of the organization, such as database systems and data warehouses. I submit that the software component of an organization's IT resources is responsible for enabling enhanced communication flows, knowledge flows and connectedness, which facilitate organizational ambidexterity.

Research has shown that a combination of top-down and bottom-up knowledge flows within an organization can enable managers to engage in ambidextrous behavior. Consequently, the greater these knowledge flows within an organization, the higher the ambidexterity of the organization (Mom et al. 2007). Also, direct transmission channels are required for knowledge integration to occur (Kostava and Zaheer 1999). Knowledge integration is a critical prerequisite for exploratory units to leverage existing technological and market knowledge which is a result of exploitation activities (Hill and Rothaermel 2003). Thus, *greater communication and knowledge transmission channels* facilitate ambidexterity. Organizations with superior IT software resources experience higher levels of intra-firm communication and collaboration through the use of portals, electronic communication technologies and visibility technologies (Sambamurthy et al. 2003). Higher levels of IT software resources lead to a greater and seamless flow of information through the organization due to the increase in the number and density of transmission channels (Sambamurthy et al. 2003). Information technologies facilitate an increase in the frequency and effectiveness of intra-organizational communication, thereby leading to improved explorative and exploitative innovation (Kleis et al. Forthcoming). For example, Merck witnessed improved drug discovery due to an increase in knowledge flows and connectivity following the implementation of a knowledge management system (Ravichandran and Lertwongsatien 2005).

In a similar way, *connectedness* is a direct antecedent to achieving ambidexterity (Jansen et al. 2009). Connectedness is related to the density of a firm's social network (Nahapiet and Ghoshal 1998) and facilitates knowledge exchange (Jaworski and Kohli 1993) by providing a common base of understanding through which the transfer and integration of new ideas can be achieved (Hansen 2002).

Firms with superior IT software resources experience greater connectedness through the formation of electronic social networks and through the enhanced use of electronic communication technologies. Technologies such as knowledge directories and repositories, electronic communities of practice, groupware, electronic mail, chat, video conferencing and web 2.0 tools enhance the connectedness of organizations. Overall, organizations with superior IT software resources experience more strong and loose ties among their employees (Sambamurthy et al. 2003). As a consequence, I expect that the software component of IT resources enables organizations to mobilize and coordinate dispersed contradictory efforts across exploratory and exploitative units and thus directly facilitate ambidexterity. Hence I hypothesize:

Hypothesis 2 (H2): Software IT resources are positively related to organizational ambidexterity.

4.2.2 Influence of IT Technical Resources

The technical component of an organization's IT resources consists of the technology skills, related to hardware, software and services, held by the organization's IT employees. This component consists of not only the technological knowledge itself, but also the knowledge and ability to deploy and manage this knowledge and skill set. I expect that organizations with superior technical IT resources are more likely to be ambidextrous due to greater organizational integration and flexibility. This is driven by higher knowledge of IT and underlying business processes.

The *integration* of spatially dispersed explorative and exploitative efforts across an organization is a means to achieve ambidexterity (Gilbert 2005; Smith and Tushman 2005). To create valuable new configurations of exploratory and exploitative innovation, organizations must generate and connect previously unconnected ideas and knowledge or recombine previously connected knowledge in new and novel ways (Kogut and Zander 1992). Thus, mere co-presence of exploratory and exploitative activities in structurally differentiated organizational units does not ensure simultaneous pursuit of exploration and exploitation (Jansen et al. 2009). Jansen et al (2009) submit that achieving ambidexterity requires the subsequent integration and application of differentiated exploratory and exploitative efforts without corrupting the internal structures and processes within each unit's area of operation (Gilbert 2006; O'Reilly and Tushman 2008). This allows organizations to address and maintain multiple inconsistent demands to successfully achieve exploration and exploitation activities.

Organizations with superior IT technical resources are able to integrate dispersed exploratory and exploitative efforts from across and within the organization's boundaries due to a richer understanding of underlying processes and technologies. More tightly integrated business processes and technology enhance inter and intra organizational integration (Ranganathan and Brown 2006). I reason that better technical IT resources also enable deeper understanding of the firm's processes and existing knowledge stocks, thereby enhancing the ability for resource and process reconfigurations that result in deeper integration. Technical IT resources enhance the reach and richness of organizational knowledge and information flows, thereby achieving greater organizational integration and thus enabling ambidextrous behavior (Sambamurthy et al. 2003). For example, Boeing's deep understanding and resultant automation of its design processes, enabled it speed up its exploration and exploitation efforts during the development of the 777 model (Ravichandran and Lertwongsatien 2005).

To obtain competitive advantage, organizations need to manage the underlying tensions between the exploration and exploitation paradox on a continuous basis (Andriopoulos and Lewis 2009; He and Wong 2004). This calls for an *agile and flexible organization* that can embrace constant change. Ambidextrous organizations have to constantly reconfigure their activities and orchestrate their resources between shifting demands (Tushman et al. 2011). An effective management of conflicting demands calls for the ability to rapidly switch attention between these demands. Addressing such needs requires a firm to possess flexible resources and routines, which can be redeployed quickly and correctly. An organization's technical IT resources play a key role in enabling organizational agility (Bharadwaj 2000; Overby et al. 2006; Sambamurthy et al. 2007). By enhancing entrepreneurial alertness, IT allows a firm to be more cognizant of internal and external demands (Sambamurthy et al. 2003). Increased organizational speed and flexibility also result from the modularization and atomization of business processes that can be facilitated by superior IT technical resources (Sambamurthy et al. 2003). Service-oriented forms of delivery for IT services lend themselves to greater organizational flexibility, reconfigurability and agility. Several organizations cite service oriented architectures (SOA) and web services as a primary reason driving increased market responsiveness, which entails elements of agility and flexibility. In summary, I expect that the technical component of IT resources enables organizations to integrate, combine and recombine seemingly contradictory efforts across exploratory and exploitative units and thus directly facilitate ambidexterity. Building on the forgoing discussion, I hypothesize:

Hypothesis 3 (H3): Technical IT resources are positively related to organizational ambidexterity.

4.2.3 Influence of IT Hardware Resources

The hardware component of an organization's IT resources consists of physical IT hardware assets comprising of computers, communication technologies, technical platforms and databases. While the hardware component of an organization's IT resources is a major business resource, I expect that it alone does not impart any effect towards organizational ambidexterity. This is because the effects of IT hardware are felt more when it is integrated together into a coherent platform by the effect of the software and technical components of IT (Bharadwaj 2000). Thus, I expect that organizations with superior hardware IT resources are more likely to be able to leverage the other components of their IT resources more efficiently and effectively. I expect that the hardware component of IT resources enhances the effect of software IT resources on ambidexterity. This is because superior hardware IT resources result in higher connectedness and more active transmission of top-down and bottom-up knowledge flows and communication. Also, superior IT hardware resources result in an increase in the velocity of information that can be transmitted through the organization. This facilitates increased communication and coordination across distributed organizational units and enhances the development of shared understanding and cohesion. This influences the integration of knowledge and outcomes between exploration and exploitation oriented parts of an organization, thereby complementing the effect of technical IT resources on organizational ambidexterity.

Past research has viewed resource synergies as critical drivers of overlying resource bundles and capabilities. Similarly, a firm's IT resources also derive collaborative and integrative benefits from its three underlying components. Due to resource synergies, the individual components of a firm's IT resources mutually reinforce one another and have a combined effect (Karimi et al. 2007; Lucas 1999). I posit that the combination of the software, technical and hardware components of a firm's IT resources has a synergistic effect on organizational ambidexterity. The hardware component of a firm's IT resources together with the software and technical components are critical in developing IT-enabled capabilities across organizations. Deficiencies in the IT hardware of an organization lead to reduced impacts of the overall IT resources and capability of an organization. For example, a deficient IT hardware architecture severely hampers an organization's ability to deliver solutions and degrades inter and intra organizational connectivity (Karimi et al. 2007). Thus, in summary, I propose that IT hardware resources complement the individual and joint impacts of software IT resources and technical IT resources towards ambidexterity by enhancing the knowledge flows, communication flows and integration required to attain a balance between these two activities. Based on the foregoing discussion, I offer the following three hypotheses:

Hypothesis 4a (H4a): Hardware IT resources strengthen the influence of software IT resources on organizational ambidexterity.

Hypothesis 4b (H4b): Hardware IT resources strengthen the influence of technical IT resources on organizational ambidexterity.

Hypothesis 4c (H4c): The synergy between software, technical and hardware is positively related to organizational ambidexterity.

Figure 2 illustrates the proposed component-level model for the influence of IT resources on organizational ambidexterity.

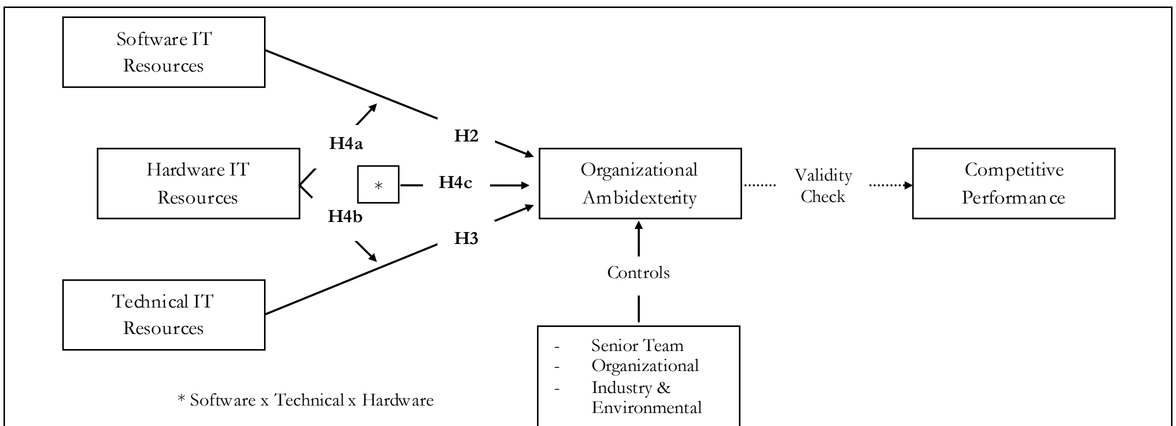


Figure 2. First Hypothesized Model: Impact of IT Resource Components on Ambidexterity

4.3 Influence of IT Automate, Informate and Transform Capabilities

Bharadwaj (2000) defines IT capability as a firm's ability to mobilize and deploy IT resources in combination with other capabilities or resources. Consistent with this treatment, I conceptualize IT capability as a dynamic capability that enables the assembly, integration and deployment of IT resources in combination and re-combination with other organizational resources and capabilities. As a dynamic capability, an organization's IT capability also plays a key role in resolving the paradoxical situation arising from the concurrent pursuit of exploration and exploitation. IT capability facilitates the organization to mobilize, integrate, and deploy operational capabilities at spatially dispersed exploratory and exploitative units, which is a necessary and critical requirement in achieving ambidexterity (Jansen et al. 2009).

The conceptualization of IT capability as a higher order capability, comprising of lower order IT capabilities is a key theory of interest and provides a basis for orientation and prior theorizing for this theoretical model. Prior literature has classified IT capabilities in many ways. IT capabilities have been conceptualized as infrastructure, human IT and intangibles (Bharadwaj 2000); as managerial, technical, and infrastructure (Dehning and Stratopoulos 2003); and as IT Infrastructure, IT Business Expertise, Relationship Infrastructure, and Organizational Learning (Bhatt et al. 2005). IT investments have also been categorized in different ways. Different categorizations have been based upon IT spending (money spent on IT), IT strategy (nature of IT) and IT management (management of IT). For example, IT systems have been classified into transactional, informative and strategic by Weill (1992) and into control, coordination and efficiency by Pinsonneault and Kraemer (1997).

In this examination, I adopt the IT strategy categorization and view IT capabilities as falling into the following three categories (Dehning et al. 2003; Schein 1992; Zuboff 1988): 1) Automate (automating business processes); 2) Informate (facilitating access to information by managers and employees); and, 3) Transform (redefining business and industry practices, processes and relationships). Prior research has viewed these categorizations as part of the IT strategic role applied at both the firm and industry level (Dehning et al. 2003). I define IT Automate Capability as *a firm's ability to mobilize and deploy IT resources in combination with other capabilities or resources to facilitate an automation of its existing business processes*. IT Informate Capability is defined as *a firm's ability to mobilize and deploy IT resources in combination with other capabilities or resources that leads to greater access of information across the organization*. IT Transform Capability is defined as *a firm's ability to mobilize and deploy IT resources in combination with other capabilities or resources that leads to the redefining of business practices.*

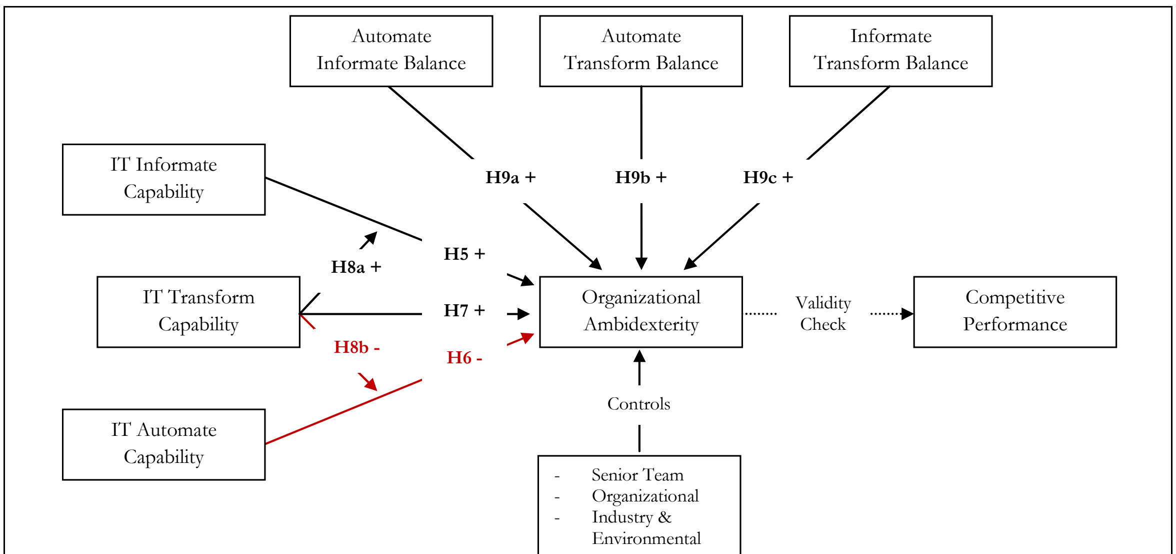


Figure 3. Second Model: Impact of IT Capabilities on Ambidexterity

Investments into different types of IT, which act as proxies for different types of IT capabilities, lead to differing effects on firms and their performance (Barua et al. 1995). Thus, I posit that different types of IT capabilities that comprise a firm's IT portfolio lead to differing impacts on the ability of the firm to manage the paradoxical demands arising from an ambidextrous strategy. Figure 3 illustrates the second proposed model. The rationale and hypotheses follow.

4.3.1 Influence of IT Informate Capability

IT Informate capability facilitates the sharing, reach, richness, accessibility and availability of knowledge (Alavi and Leidner 2001; Zahra and George 2002), thereby enabling the rapid transformations required to address conflicting demands. Informate IT also improves the accuracy and timeliness of information regarding changing and conflicting internal and external demands which results in improved resource allocation decisions (Sheth and Sisodia 1995). For example, the implementation of EDI at various organizations, including Chrysler, in the last decade of the 20th century was credited with enhancing Informate IT capability, resulting in improve information accuracy and timeliness (Lucas 1999; Mukhopadhyay et al. 1995; O'Callaghan et al. 1992). IT Informate capability facilitates enhanced decision making and coordination processes and thus improved responsiveness and resource utilization (Mooney et al. 1996). It also enhances communication, coordination, information search, processing and realignment of a firm's resources (Bharadwaj et al. 1999). Thus, I expect that organizations with a high Informate IT capability possess high connectedness and are also able to actively transmit top-down and bottom-up knowledge flows and communication. For example, Merck witnessed improved drug discovery due to an increase in knowledge flows and connectivity following the enhancement of its IT Informate capability through the implementation of a knowledge management system (Ravichandran and Lertwongsatien 2005). Finally, the role of Informate capability in enhancing organizational integration has been established (Ranganathan and Brown 2006). Hence, I hypothesize:

Hypothesis 5 (H5): IT Informate capability is positively related to organizational ambidexterity.

4.3.2 Influence of IT Automate Capability

On one hand, an organization's Automate IT capability directly improves its exploitation processes through efficiency gains, due to cost reductions and productivity enhancements through automation. Amazon and Netflix are two oft cited examples of organizations that have reaped several cost and productivity benefits from their Automate IT capability. Automate IT simplifies, accelerates and coalesces repetitive business processes. This enables firms to speed up and improve their existing processes and thus improve their existing products and services through exploitative innovation. For example, by automating its design processes, Boeing was able to speed up its exploitation efforts during the development of the 777 model (Ravichandran and Lertwongsatien 2005). On the other hand, automation of existing processes also reduces organizational flexibility and the ability to respond to paradoxical external stimuli in a flexible and improvisational manner. Thus, I expect that a focus on IT Automate capability can be detrimental to organizational ambidexterity. Based on the above rationale, I hypothesize:

Hypothesis 6 (H6): IT Automate capability is negatively related to organizational ambidexterity.

4.3.3 Influence of IT Transform Capability

An organization's IT Transform capability endows it with the ability to instill radical changes to processes, routines and the firm's business model. Previously, the transformational capability of IT has been positively associated with exploration. However, IT Transform capability and its resultant radical innovations can also lead to better, flexibility, responsiveness and agility, as evidenced by the success of Oticon in creating a flexible organization (Lucas 1999). IT Transform capability also supports enterprise-wide integration, collaboration and communication through changes to processes and routines. Thus, in the long run, a strong Transform IT capability may also lead to an improvement in a firm's ambidexterity. However, Transform IT capability also enhances the effects of IT Automate and IT Informate capabilities due to the agility it lends to the processes of integration. The resultant greater responsiveness also increases the effect and speed of knowledge flows, thereby improving the effectiveness of IT Informate and Automate capabilities. IT Transform capabilities also lead to fundamental changes to business processes, which enable the efficiency of automated processes. Ergo, I expect that IT Transform capability will enhance the effect of IT Informate capability on organizational ambidexterity. I also expect that this capability will reduce the ambidexterity impeding effects of IT Automate capability due to gains in organizational flexibility. Hence I hypothesize:

Hypothesis 7 (H7): IT Transform capability is positively related to organizational ambidexterity.

Hypothesis 8a (H8a): IT Transform capability strengthens the influence of IT Informate capability on organizational ambidexterity.

Hypothesis 8b (H8b): IT Transform capability weakens the influence of IT Automate capability on organizational ambidexterity.

4.3.4 Joint Influence

As aforementioned, IT Automate capability has direct positive impacts on an organization's pursuit of exploitation activities. IT Informate capability enhances the richness of information available in the organization. This includes information regarding environmental changes, market and innovation opportunities, and competitive moves. Thus, IT Informate capability has a direct positive effect on an organization's exploration activities. Overall, a balance in an organization's Automate and Informate IT capabilities is expected to lead to improvements in existing processes and routines and in the quality, correctness and timeliness of environmental information. Also, since Automate and Transform IT directly impact exploitation and exploration respectively, a balance of these capabilities is expected to directly influence ambidexterity. Similarly, I expect a balance of Informate IT and Transform IT capabilities to positively facilitate organizational ambidexterity.

Hence I hypothesize:

Hypothesis 9a (H9a): The relative balance of Automate and Informate IT capability is positively related to organizational ambidexterity.

Hypothesis 9b (H9b): The relative balance of Automate and Transform IT capability is positively related to organizational ambidexterity.

Hypothesis 9c (H9c): The relative balance of Informate and Transform IT capability is positively related to organizational ambidexterity.

4.4 Conclusion

In this section, I developed a theory and associated hypotheses regarding the role of IT in the facilitation of organizational ambidexterity. First, I unpacked the IT resources construct into underlying software, technical and hardware components and proposed a set of hypotheses regarding their differing individual and joint impacts on organizational ambidexterity. Second, I hypothesized a model consisting of IT automate, informate and transform capabilities and their individual and joint relationships with organizational ambidexterity. Overall, I identified four mechanisms, namely enhanced knowledge and communication flows, greater connectedness, inter and intra organizational integration, and enhanced flexibility, through which IT resources and capabilities facilitate organizational ambidexterity

In the following section, I describe research methods and the results of empirically testing the above formulated theoretical models and hypotheses.

5 Methods and Results for IT Impact on Ambidexterity

Till this point in this manuscript, I have synthesized the previous research on the firm-level business value of IT and on organizational ambidexterity. I have also developed theory regarding the antecedent relationship of IT with organizational ambidexterity. For this purpose, I have proposed two different research models and associated sets of hypotheses. In this section, I describe research methods, research design and the results of empirical tests of these theoretical models.

5.1 Introduction

In this section, I first describe the context and empirical setting for this research. The proposed setting of this study is manufacturing firms located in India, which hail from industry sectors that have witnessed high growth in the past three years. A variety of research methods have been used across the different academic studies on ambidexterity. These include survey questionnaire based studies; single and multiple case studies; and secondary data based studies. Since most firms in the sample frame are privately held and hence do not provide publically available data, I use a questionnaire survey to gather the data for this study. Thus, in this section, I also provide a description of the questionnaire development. Third, I describe the data collection protocol and processes. Fourth, I discuss the steps taken to alleviate concerns regarding nonresponse bias, informant bias, common method bias and measurement error. Fifth, I describe the measures used to capture the constructs of interest. Sixth, I describe a research design which employs econometric models to empirically test the theoretical models. Finally, I elucidate the results of these tests, affirm the robustness of the results to various perturbations, and discuss their implications.

5.2 Setting

The context for this component of my dissertation is an important empirical setting. With over with 1.2 billion citizens, India is the world's second most populous country and its largest democracy. India has been the world's second fastest growing major economy in the past decade and is now the third largest economy by purchasing power parity calculation. After initiating economic reforms, India has witnessed a growth in foreign direct investment from $155 million in 1991 to $6.6 billion in 2006 to $27 billion in 2009 (GoI 2011; Kathuria et al. 2011b). Despite several business challenges and infrastructural constraints, India's economy has grown by more than 9 percentage per year for most of the 2000's (Cappelli et al. 2010).

The systematic examination of organizations hailing from developing economies such as India gains great importance in light of the rapid globalization and digitization of today. On one hand, the fast consumption driven growth of the Indian economy offers many opportunities for organizations hailing from developed countries. However, to navigate the complex competitive terrain of the Indian marketplace, these organizations must learn the ambidextrous ways of incumbent firms. On the other hand, firms hailing from India also pose potential competitive threats to firms from developed countries on their home turf. This is borne by the increasing number of Indian multinational companies that have made their presence felt in developed markets. For example, the Tata Group acquired Tetley Tea in 2000, Corus Steel in 2007 and Jaguar Land Rover in 2008 while Hindalco acquired fellow aluminum producer Novelis in 2007 (Cappelli et al. 2010; Sheth 2008). The success of Indian IT companies in developed markets is also well documented. Further, country-specific determinants play a key role in driving country specific competitive advantages (Porter 1990). It is pertinent for firms and researchers in developed countries to understand the unique characteristics and ambidextrous ways of Indian companies. Finally, the rapid transformations, and constantly evolving market challenges and opportunities witnessed by organizations in high growth economies provide an exemplar for the world's enterprises undergoing rapid structural changes in the 21st century.

Most pertinently, the manufacturing sector of this fast growing economy is characterized by high turbulence and hyper competition. Firms based in this environment indulge in the concurrent pursuit of the trade-off strategies of exploitative (incremental) and explorative (radical) innovation. Such ambidextrous behavior is theorized to grant a competitive advantage in stable, low growth markets. However, such a strategy, which simultaneously addresses needs of existing and emerging customers, is essential for the very survival of organizations in faster growing markets, such as the Indian economy. The prevalence of ambidexterity in the Indian context also possibly results in the *jugaad* phenomenon, a Hindi word that describes improvisation under resource constraints to find a way around problems, often using trial and error methods (Cappelli et al. 2010; Radjou et al. 2012). The unique Indian context that requires the ability to improvise to create value within a tough, resource-constrained environment leads to organizations consistently innovating to find creative solutions and workarounds.

I conducted a survey to collect data regarding innovation and IT from manufacturing firms located in India. These firms hail from five sectors that have witnessed the double digit growth rates over the past three years - Air Conditioners and Refrigeration, Auto Ancillaries, Electronic Home Appliances, Hand Tools and Telecom Equipments industries. For example, telecom subscriptions in India have grown by a compound annual growth rate of 44.66 percentage between 2005 and 2010 and consequently, the telecom equipment market is estimated to be growing at 20-25 percentage per annum (TRAI 2010). Similarly, the car market and consequently, the auto components market, has grown by at least 13 percentage for the past two years (MacRae 2011).

Firms from these selected sectors provide a rich, diverse and interesting setting for this study. There is little IS research that is based in an emerging country context in general and in India in particular. This gains greater importance in the 21st century due to the rapidly evolving economies and consequently increasing IT spending of emerging countries. For example, emerging markets are expected to contribute 31 percentage, totaling $1.22 trillion, towards worldwide IT spending in 2012 (Gartner 2012). Further, due to data constraints, there are few studies that examine small and medium sized firms. Ergo, this choice of setting will fill important gaps in extant literature.

The ambidexterity literature also benefits from a study in this setting. On one hand, in a hostile environment, ambidexterity is a strategic necessity and thus a pre-requisite to firm survival (Raisch and Birkinshaw 2008). On the other hand, the prevalence of lesser resources and smaller firm scope, as experienced by small and medium manufacturing firms, impedes ambidexterity (Lubatkin et al. 2006). My examination of small, medium and large firms in a hostile environment therefore is a step towards resolving these two contradictory implications of current research. Also, technological and institutional uncertainty is high in a transitional economy like India. Strategic choices made by firms under conditions of high uncertainty are different. Thus, manufacturing firms from India are expected to witness a large variance in their ambidexterity due to variances in their degree of exploration and exploitation (Cao et al. 2009). Due this reason, several prior ambidexterity studies have been situated in similar emerging economy contexts such as China, Malaysia and Taiwan (e.g. Cao et al. 2009; He and Wong 2004).

As put forth in the prior section on theoretical development, I examine ambidexterity at the organizational level. Most prior studies of this construct have focused upon the organizational-level of analysis as well. Thus, to test my hypotheses, I employed two survey instruments, designed to collect independent, dependent and control variables from senior management at respondent firms. This survey data was supplemented by firm information sourced from the Registrar of Companies website maintained by the Ministry of Corporate Affairs of the Government of India.

5.3 Questionnaire Development

To measure the constructs in the theorized models, I developed and internally tested two survey instruments. For this purpose, I followed the process prescribed in recognized papers and texts (e.g. Boudreau et al. 2001; Groves et al. 2009; Straub 1989). The first questionnaire was designed to collect the dependent variables concerning innovation and business strategy and control variables concerning business performance (relative to competition) and environment (e.g. competitiveness of industry) from the top ranking executive responsible for strategy formulation (Chief Executive Officer (CEO) or equivalent). This is based on prior research which has shown that the CEO of a firm is like to be most knowledgeable of its strategy such as innovation orientation (McEvily and Zaheer 1999). The second questionnaire was designed to collect independent variables concerning IT investment, portfolio, architecture, and strategy information from the top ranking executive responsible for IT (Chief Information Officer (CIO) or equivalent). For this purpose, I borrowed questions from existing scales after a thorough review of relevant bodies of literature.

The initial questionnaires were refined through a pre-test that was conducted with five practitioners based in India. After they filled out prototype questionnaires, these practitioners were interviewed and asked questions on their interpretation of the items. They reviewed the questionnaires and commented on content validity, appearance, terminology, clarity of instructions, organization and response format. Since English usage in India differs from English usage in the United States, these interviews also helped in localizing the questionnaires. Adjustments were made to the questionnaires based on the comments received in the pre-test phase.

To avoid miscomprehension of the questionnaires, a pilot test was conducted in India to further localize the content and language. Practitioners hailing from twelve different organizations were asked to respond to the questionnaires and provide a review of the content. The participants of the pilot study represented a broad cross-section of the sample frame and included Chief Executive Officers and Chief Information Officers from large, medium and small manufacturing organizations. These organizations included Indian firms, wholly owned foreign subsidiaries and joint ventures from all industrial sub-sectors in my sample frame. The back-translation method, established in prior studies, was deemed inappropriate for this setting and hence was not used to localize the language of the questionnaires (Cao et al. 2009; Li and Atuahene-Gima 2001). This is because unlike the previous settings where this method has been used, there is no common local language used across all of India, except the language of commerce, which is English. In the pilot testing phase, the language of the questionnaires was further localized to ensure that the questions were clear and interpreted as intended. Responses from this phase of questionnaire development were used to assess if variances of the constructs were sufficiently captured by the measures. As a result of this process, more improvements were made to the questionnaires through refinement of items and instructions, and localization of the language.

Overall, collecting data in India was a challenging undertaking. Since general awareness of academic research is low among the potential respondents, the primary challenge was of establishing legitimacy and trust. The pilot study thus also enabled me to refine my data collection protocol and incorporate several trust building mechanisms into this process. Appendix 3 presents excerpts from a representative sample of the field notes and results of a few interviews conducted during the pilot study.

5.4 Data Collection

For the purpose of data collection, I engaged the services of an India based management consulting firm, which has considerable experience and expertise in similar data collection efforts for academic research purposes. I chose to administer a paper based survey instead of using an online survey due to the following reasons. First, administration of an online survey would restrict the response to those firms that have internet access. Internet penetration in India is currently only 8.2 percentage of the population and though penetration across organizations would be higher, targeting only this sub-sample could potentially bias my data. Second, there would be no way to verify if the organization met the eligibility criteria and the authenticity of the respondents. Third, there are potential data security problems with online surveys. This mode has been shown to discourage participation due to confidentiality concerns (Smith 1997). The data collection process consisted of three steps.

First, I developed a list of potential participants for the study. The sample frame for this research consists of manufacturing organizations located in India across five industrial sectors - Auto Ancillaries; Home Appliances, Air Conditioners and Refrigeration; Telecom Equipments and Hand Tools. Due to the absence of a single, consolidated national level database for industry sector-wise manufacturing organizations, I developed my list through the following process. I approached the three major national level industry and trade associations of India, namely the Associated Chambers of Commerce and Industry of India (ASSOCHAM), the Confederation of Indian Industry (CII), and the Federation of Indian Chambers of Commerce and Industry (FICCI). I also approached eight industry level associations for the target sectors, i.e. the Automotive Component Manufacturers Association of India (ACMA), the Auto Component Industry - SME Rating Agency of India Ltd (SMERA), the Consumer Electronics and Appliances Manufacturers Association of India (CEAMA), the Electronic Industries Association of India (ELCINA), the All India Airconditioning and Refrigeration Association (AIACRA), the Indian Society of Heating, Refrigerating and Air Conditioning Engineers (ISHRAE), the Telecom Equipment Manufacturers Association of India (TEMA), the Ludhiana Hand Tools Association (LHTA). I collected membership directories from these eleven industry and trade associations. I also collected six State/Town level business directories from Maharashtra (the Maharashtra Industries Directory by Marathe Infotech), Karnataka (Karnataka Business Directory by Ultimate), Tamilnadu (Tamil Nadu Business Directory by Ultimate), the PHD Chambers of Commerce and Industry, the Gujarat Chamber of Commerce and Industry, the Gurgaon Chamber of Commerce and Industry, and the Mahratta Chamber of Commerce, Industry and Agriculture of Pune. After consolidating information from these seventeen different sources, I was able to create a list of potential participating organizations that contained the mailing address and name of key contact for each organization.

In the second step of the data collection procedure, participation was solicited from the list of potential respondent organizations. For this purpose, prior established procedures were followed. Initially, an introduction letter from the university explaining the purpose and objectives of the research and soliciting responses was mailed to the CEOs of the organizations. Seven to ten days after mailing the introduction letter, a second letter was mailed. This letter was from the local partner and it further explained the benefits of the study, provided answers to a list of frequently asked questions and provided details and credentials of the research team conducting the study. One week after mailing the second letter, follow-up phone calls were made to each organization.

As an incentive to participate, organizations were offered a copy of an executive summary of the findings after completion of the research. To assure organizations of the confidentiality and privacy of their individual responses, a data security protocol, consisting of the following steps, was communicated and followed. First, companies were assigned identifying numbers and the information connecting companies and numbers was securely stored in a separate location within a password protected file. Second, the names of companies and designation of key respondents was replaced within the database with assigned numerical identifiers that are indecipherable without the code file. Third, firms were assured that only aggregate results would be reported in the study and no facts that identify their organization would appear when this research is presented or published in academic conferences or journals. The local partner also offered to be available to physically meet with potential respondents to clarify any doubts regarding questions or the purpose of the study and to alleviate any privacy or confidentiality concerns.

Organizations that agreed to participate in the study were asked to nominate a key contact person. The contact was asked to identify the correct respondents in their organization. After verification of this information, the contact was mailed a packet containing two separate sealed envelopes addressed to the respondents, instructions and a pre-addressed envelope. The contact was requested to disburse the sealed envelopes to the respondents. These two envelopes contained the relevant questionnaires, description of the study and instructions. The contact was asked to collect the filled in questionnaires and mail them back to the local partner's India office.

In the third step of the data collection procedure, follow-up telephone calls were made to organizations from which the filled in questionnaires were not received one week after dispatch of the packet to the key contact. Consultants from the local partner also offered to physically visit the organization to collect the filled in questionnaires. This data collection process lasted from April 2011 to September 2011.

As aforementioned, there is no single verified and authenticated source for details about organizations that may potentially be part of the sample frame. Membership directories from seventeen different sources were used to create a list of 2180 potential participating organizations. These source directories are non-verified and non-authenticated lists. Thus, a critical aspect of the data collection procedure was to determine eligibility of prospective respondents. This list was refined by removing duplicate entries through verification of the provided organization information via the company website, different secondary news sources and the Registrar of Companies website maintained by the Ministry of Corporate Affairs of the Government of India. 54 duplicate entries were identified. Hence, a total of 2126 introduction letters were sent to organizations.

Table 2. Response Rate Calculation

Step	**Total**
Potential Sample Pool	2180
Duplicate Entries	54
Total Introduction Letters Sent	2126
Undelivered Invitations	138
Ineligible Companies	117
Non-verifiable Companies	512
Total Verified Sample Pool	**1359**
Refused Participation	628
Questionnaires Sent	731
Non-Reponses	379
Total Usable Responses	**352**

Out of the 2126 introduction letters mailed to firms, 138 letters were returned because the organization no longer existed. In follow-up telephone calls, organizations were asked to verify their primary industry and contact information. 117 organizations stated that they were not manufacturing firms and were either trading entities or simple workshops. The existence of 512 organizations could not be verified as they were non-contactable. These organizations did not respond to letters sent to their physical address, did not answer multiple telephone calls and did not have a website. Removing these organizations from the sample pool resulted in a verified sample pool of 1359 organizations. 628 of these organizations refused to participate in the study and thus did not provide details of a key contact. The remaining organizations were sent questionnaires. 379 of these questionnaires were not returned or returned blank or incomplete. This resulted in a total of 352 usable responses, representing a response rate of 25.9 percent (352/1359). Table 2 lists these details.

The response rate compares favorably with trends in organizational research. In their analysis of 17 top journals in management studies, Baruch and Holtom (2008) found that in 2005, studies which utilize organizational-level data have an average response rate of 35 percentage (with standard deviation of 18.2). However, the response rate is statistically significantly lower for studies that are conducted outside the United States due to cultural differences. Further, response rates from countries with high average power distance (Hofstede 1980) are lower than countries with low average power distance (Harzing 2000). Given the high power distance score for India (77) as compared to the United States (40), a response rate of 25.9 percent is valid.

Out of the 352 respondents, the majority were from the auto ancillaries sector (76.4 percent). Nearly 70 percent of respondents were privately held Indian companies. 72 percent had 500 or lesser employees and a third of the firms had a workforce of 100 or less. More than half of the respondents were from 'North' region of India, which refers to the states and union territories of Punjab, Haryana, Delhi, Uttar Pradesh, Madhya Pradesh, Chandigarh and Uttarakhand. This reflects the prevalence of geographical clusters of the industry sectors. Overall, the firms in the study have an average age of 26.1 years (s.d. =

17.9) and have an average of 752.5 full-time employees (s.d. = 2083.9). Table A1 in Appendix 1 lists these respondent statistics in detail.

The data entry was conducted by two research assistants who were well trained in data entry procedures. Several steps were taken to ensure that there were no errors committed during the data entry process. First, data entry took place in an Excel spreadsheet, which was populated with a series of checksum formulae. Second, each data point was entered by one assistant, and then audited by the other. Third, another research assistant was engaged to solely systematically audit all the data entered into the Excel sheet. Finally, I personally re-entered data from twenty percent of the surveys selected at random, and validated the quality of the initial data entry.

5.5 Alleviating Bias Concerns

To mitigate the potential for non-response bias, informant bias, common method bias, and measurement error, I took the following steps.

To assess non-response and response bias, I tracked the order of responses and found no significant differences between early and late responders (Kanuk and Berenson 1975). I also assessed that there were no differences in firm age ($t = -0.29$, $p > 0.77$, not significant), firm size ($t = -0.30$, $p > 0.77$, not significant), competitive performance ($t = 1.52$, $p > 0.13$, not significant), and other factors across responses that were collected after the first and second follow-ups, and those that required physical field visits by the local partner. I checked for and found insignificant correlations between response order and response groups with firm age and firm size. I also checked for differences of firm age and firm size across industries and found no statistically significant patterns ($p > 0.25$, not significant). Finally, since firms that returned only one questionnaire would get excluded from the final sample during analysis of the data, I performed a selection bias test to determine if the included firms are significantly different from excluded firms (Lord 1967; Oh and Pinsonneault 2007). For this purpose, I conducted a t test which found that the means of all variables are statistically equal across both groups.

To assess non-response bias, I contacted CEO's and/or CIOs from firms that did not respond to our request for participation. Most of these executives specified that the lack of time or an adverse company policy regarding surveys is the primary reason for not participating in our study. This indicates the absence of any underlying issue that would result in non-response bias.

Common method bias was mitigated by the use of the following procedures. First, as detailed earlier, the independent and dependent variables were collected from different respondents. Second, I used different types of scales to measure different constructs. For example, I used 7 point scales to measure most variables, whereas competitive performance was measured using an 11 point scale. Third, the control variable for major industry was collected from both respondents and showed high inter-rater reliability through calculation of Cohen's Kappa (Cohen 1960), which was greater than the threshold value of 0.70 (Landis and Koch 1977). Fourth, I conducted the Harman's one-factor test (Podsakoff and Organ 1986). The largest factor in the unrotated factor solution only explained 19 percentage of the covariance. The absence of a single factor that accounts for the majority of covariance in the unrotated factor solution enabled me to rule out common source issues. Fifth, I conducted a marker variable test, using an unrelated variable (IT Business Alignment) to refine the model correlations. This variable had almost zero correlations with the primary constructs (Lindell and Whitney 2001). Sixth, I observed that no items exhibited extremely high correlations which were greater than 0.90 (Malhotra et al. 2006).

Finally, I employed factor analysis and Cronbach's alpha on all the measures to assess convergent validity, discriminant validity, and internal consistency and reliability. As noted earlier, all items were adapted from prior research and thus had prior established reliability and theoretical consistency. All Cronbach's alpha (Cronbach 1951) values were above or just slightly below the suggested threshold of 0.70 (Nunnally 1967). Factor loadings were clean, with items loading on their respective factors and not loading on one another, and had eigenvalues above the recommended threshold of one. Also interfactor correlations (> 0.65 as seen in Table 3, Table 4, and Table 5) and variance inflation factor values (<10 as seen in Table A7 of Appendix 1) for all hypothesized and control variables were assessed to confirm the absence of multicollinearity problems.

5.6 Measures

To identify appropriate measures, I performed a thorough review of the extant literature. The following measures are used to assess the constructs of interest. All the measures have been adapted from prior research. The detailed items are provided in Appendix 2. Table A2 in Appendix 1 also provides a summary of the key constructs and their corresponding measures.

5.6.1 Measure of IT Resources

I measure IT resources directly from IT investment data captured through the survey questionnaire. For this purpose, I captured IT investment as a percentage of sales revenue for past two and current financial years. Thus, the average of IT investment over three years is a proxy for IT resources. The percentage of IT investment dedicated to hardware, averaged over three years, is a proxy for the hardware component of IT resources. The percentage of IT investment dedicated to software, averaged over three years, is a measure of the software component of IT resources. Finally, the sum of percentage of IT investment dedicated to IT related training and IT services (averaged over three years), is the measure for the technical component of IT resources.

5.6.2 Measures of Automate, Informate and Transform Capabilities

To measure Automate, Informate and Transform capabilities, I captured details of organizations' IT portfolio. Based on extensive analysis of prior literature (e.g. Banker et al. 2006), initial interviews with industry practitioners, and feedback from pre-test and pilot study participants, I developed a list of IT systems that are most commonly used in the manufacturing sector in India. For this purpose, I initially adapted the list of core IT systems used in the manufacturing industry that was used by Oh and Pinsonneault (2007). From this list, respondents were asked to select the IT systems that are operational in their firm. Respondents were asked to name any other IT applications that fall outside this list of systems. In their responses, respondents only named two additional IT applications that were not part of the original list, which is provided in Table A3 presented in Appendix 1. These applications were Structural Design systems and Tool Design systems.

To operationalize the measures of Automate, Informate and Transform capabilities, I used the approach followed in prior literature (e.g. Chi et al. 2010; Joshi et al. 2010). First, each IT application on the list of commonly used IT applications was categorized into one of the three capabilities. For this initial classification, I followed the criterion used in prior studies and assessed the main business benefits of a particular IT application (e.g. Dehning et al. 2003). I used this as a basis for classifying the application into Automate, Informate or

Transform capability. I used four coders for this process. The coders consisted of two fellow academics, one industry expert and me. To maintain intra and inter coder consistency, I followed the coding approach detailed in prior literature. Initially each coder independently assessed each system. Any differences in the coding were resolved through discussions. Since Cohen's Kappa (Cohen 1960) only measures agreement between two raters, I used the Fleiss Kappa (Fleiss 1971) measure of inter rater agreement. Specifically, I used a free-marginal kappa implementation as the coders were not asked to assign a certain number of applications to each capability (Brennan and Prediger 1981). The kappa value of 0.77 exceeded the suggested 0.75 threshold value (Landis and Koch 1977). Overall, this process ensured the reliability of this coding process. A similar process was used to categorize the IT applications that were outside the original list into these three capabilities.

Second, I calculated the total number of selected applications for each capability and converted this number into a 7 point scale by following the hierarchy indexing procedure used in prior literature (e.g. Oh and Pinsonneault 2007). As per this procedure, first I calculated the proportion of selected IT systems for each capability to the total number of IT applications for that capability. I then multiplied this ratio by 7, thus creating a scale directly comparable to the Likert scale used for measuring ambidexterity.

5.6.3 Measure of Ambidexterity

Like many previous studies (e.g. Gibson and Birkinshaw 2004; Gupta et al. 2006; Jansen et al. 2009), I consider exploration and exploitation as orthogonal constructs. I follow an approach similar to these studies. Such studies measure ambidexterity using two steps – in the first step, exploration and exploitation are measured independently, and in the second step, these two measures are combined to create a single measure of ambidexterity.

However, due to a lack of clarity regarding the precise conceptualization of ambidexterity, there is a lack of consensus regarding the use of measures to operationalize this construct (Cao et al. 2009). Most prior research studies that use the organizational ambidexterity construct have used an organization's innovation orientation or intent as an operationalization. An organization's intent is not a dynamic construct and is path dependent upon past resource deployments and processes (Cao et al. 2009; Leonard-Barton 1992); thus exploration and exploitation intent are stable over time and thus do not change rapidly over a period of three years. Prior studies have considered the value of ambidexterity captured for a given year as remaining static over the previous two years (e.g. Cao et al. 2009; He and Wong 2004). I concur with this conceptualization.

Thus, the ambidexterity construct is a higher-level construct comprising of the lower-level exploration and exploitation constructs. I operationalize organizational ambidexterity as an organization's innovation orientation or intent. In a two-step approach, first, I measure exploration and exploitation independently. In the second step, I construct the measure for ambidexterity.

5.6.3.1 Measures of Exploration

A proxy for exploration used extensively in prior research is exploratory innovation. A measure of exploratory innovation captures the extent to which organizations pursue radical innovations for emerging customers, markets or product-market domains and depart from existing knowledge (Benner and Tushman 2003; He and Wong 2004; Smith and Tushman 2005). I constructed a five-item measure by adapting the measures from He and Wong (2004) and Jansen, Tempelaar, Van den Bosch, and Volberda (2009) for this purpose. The reliability of this scale, originally developed by He and Wong (2004), has been established and this scale has been used by subsequent studies (e.g. Cao et al. 2009; Lubatkin et al. 2006).

Prior research has also used measures of radical innovation output as a proxy for exploration. However, recent studies argue that this measure in inappropriate because innovation radicalness is an industry level ex-post outcome measure, whereas exploration is an organizational-level construct reflecting ex-ante intent (He and Wong 2004). Another proxy of exploration used in prior literature is search scope, which is the propensity to cite different patents (Katila and Ahuja 2002). However, this measure is not appropriate for my proposed study as Indian small and medium manufacturing firms have little, if any patents. Gupta, Smith and Shalley (2006) also propose alternative measures of exploration, exploitation and ambidexterity, which were deemed inappropriate for this study.

5.6.3.2 Measures of Exploitation

Similar to exploration, a common proxy for exploitation has been firm-level exploitative innovation. I constructed a five-item measure by adapting the measures from Jansen, Van den Bosch, and Volberda (2006) and He and Wong (2004) and thus captured the extent to which organizations pursue incremental innovations for current customers, improve current product-market positions and build on existing knowledge (Benner and Tushman 2003; He and Wong 2004; Smith and Tushman 2005). I did not use measures of incremental innovation output as a proxy for exploitation due to reasons given the in prior section. Similarly, another proxy of exploitation used in prior literature is search depth, which is the propensity to cite certain patents repeatedly (Katila and Ahuja 2002). As aforementioned, this measure was deemed as not appropriate for this study.

5.6.3.3 Constructing the Measure of Ambidexterity

Previous research has followed different approaches to construct a measure for ambidexterity. Some researchers have constructed this measure by simply adding the measures of exploratory and exploitative innovation (e.g. Lubatkin et al. 2006). Others have followed a multiplicative approach (e.g. Gibson and Birkinshaw 2004). These two are good proxies for ambidexterity if one considers a firm with high exploration and exploitation as ambidextrous. Such a measure presents ambidexterity as a true balance, wherein an organization excels at both exploration and exploitation (Atuahene-Gima 2005). Other studies have subtracted the exploration and exploitation measures to create a measure of ambidexterity (e.g. He and Wong 2004). Such a measure of ambidexterity is suitable for a conceptualization of ambidexterity wherein an ambidextrous firm places equal emphasis on exploration and exploitation and thus has a relatively balanced focus with less emphasis on magnitude of exploration and exploitation. These measures are consonant with the 'fit as moderating' and 'fit as mediating' concepts of strategic fit (He and Wong 2004; Venkatraman 1989). These also confirm to the combined and balance dimensions of ambidexterity as conceptualized by Cao, Gedajlovic, and Zhang (2009). Edwards (1994) suggests procedures and a test that can be followed to create a measure of ambidexterity from the measures of exploratory and exploitative innovation. This procedure has been pursued in other studies of ambidexterity (e.g. Lubatkin et al. 2006) and is detailed in the following paragraph. I incorporated both these operationalizations of ambidexterity in my analysis by following these procedures.

As per Edwards (1994) test, I compare regression models of all possible different formulations of ambidexterity (sum, product, and absolute difference) to identify the appropriate measure. Due to the prior established relationship between ambidexterity and competitive advantage, I use competitive performance as the dependent variable for this analysis (Gibson and Birkinshaw 2004; He and Wong 2004). Competitive performance is a five-item measure, adapted from prior IS literature, that "reflects a firm's ability to capture market share, remain profitable, keep growing, and be innovative and cost-efficient in comparison to its major competitors" (Rai and Tang 2010). Though the scales offered by Gupta and Govindarajan (1986) are well established and include sales growth, profit growth, market share growth, operational efficiency, cash flow from market operations, market reputation, these are not fit for this study as these scales measure firm performance and not competitive performance. Further, privately held firms based in India are hesitant to provide such details.

The consolidated measure of firm performance was constructed by calculating the weights of the items using a principal components factor analysis (Edwards 2001). The weighted sum of the dimensions provided the dependent variable for this analysis. Since there are three possible formulations of the ambidexterity measure, I performed and compared four separate regression analyses. Exploratory and exploitative innovation were used as separate independent variables in the first base model. In the second model, exploration and exploitation were combined into a single independent variable by adding exploration and exploitation. In the third model, the independent variable was the product of the exploration and exploitation measures, which was be mean-centered to avoid multicollinearity (Aiken and West 1991). In the final model, exploitation was subtracted from exploration to construct the ambidexterity measure. I calculated F –values, based on R^2 differences of the three models and the base model. As per the Edwards (1994) test, the model that provides least loss of explanatory power as measured through the F -test should be chosen as the measure of ambidexterity. Thus, I chose the absolute difference of exploration and exploitation as the measure of ambidexterity for this component of this dissertation as it provided maximum explanatory power (adjusted $R^2 = 0.154$; $p < 0.05$) and also performed the best when using the F-test ($p < 0.05$). The absolute difference ranged from 0.02 to 9.827. To facilitate ease of analysis and interpretation, I reversed the absolute difference by subtracting the difference score from ten so that a higher value indicates higher ambidexterity.

5.6.4 Control Variables

As detailed in earlier sections, prior research has identified a number of other antecedents to organizational ambidexterity. I measured and controlled for a number of these antecedents in my analysis. The first set of controls account for top management (founding team and senior team) heterogeneity. For this purpose, I measured senior team size by capturing the number of executives responsible for strategy formulation and implementation (Jansen et al. 2009). I also captured founding team size. Larger founding and senior teams could have more heterogeneity and thus positively impact ambidexterity.

The second set of controls is for organizational-level antecedents. The first of these controls was firm size, measured as the natural logarithm of number of full-time employees (Cao et al. 2009). Second, was firm age, measured as the natural logarithm of number of years from the firm's founding. This is because larger firms have greater resources (but are potentially less flexible) and older firms are more inclined towards exploitation (Cao et al. 2009; Gilbert 2005). Further, a stream of research dating back to Schumpeter (1912) argues that smaller firms are harbingers of creative destruction as they carry new explorative forms of technology. I also controlled for the ownership structure of the firm as privately held firms may have inherently different strategic goals compared to other firms in the Indian context.

The third set of controls captured the industry and environment effects that may influence the pursuit of exploratory and exploitative innovation (Floyd and Lane 2000; He and Wong 2004; Levinthal and March 1993). Thus, I included industry sector dummies and measures of environmental dynamism and environmental competitiveness. Environmental dynamism was measured using four-items and captured the rate of change and turbulence of the environment (Jansen et al. 2006). Environmental competitiveness was captured through a five-item measure which assessed the competitive pressures that a firm has to deal with (Jansen et al. 2006). Finally, I controlled for the state in India where the firm is located to account for clustering effects and uneven economic development.

5.6.5 Measure Construction

Table 3. Major Construct Correlations

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Ambidexterity(1)	1							
Senior Team(2)	0.08	1						
Founding Team(3)	-0.053	0.526***	1					
ln(Firm Age)(4)	-0.009	0.095*	0.007	1				
ln(Firm Size)(5)	0.097*	0.381***	0.229***	0.276***	1			
Env. Comp.(6)	0.11**	0.001	-0.071	-0.076	-0.062	1		
Env. Dyna.(7)	0.108**	0.127**	-0.013	-0.035	0.158***	0.359***	1	
Comp. Perf.(8)	0.364***	0.056	-0.02	0.047	0.204***	-0.002	0.153***	1

Pairwise correlations. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

To create the final individual measures for each study, I conducted a principal components factor analysis with varimax rotation and pairwise deletion to establish the item loadings. I dropped items that had low loadings and high cross-loadings. The rotated factor solution for the first theoretical model, after dropping three items, is provided in Table A4 of Appendix 1. This analysis clearly replicated the intended factor structure, with all five factors having eigenvalues greater than 1, factor loadings above 0.50 and cross-loadings below 0.38.

Table 4. Construct Correlations for IT Resources

	IT Hardware Resources	IT Software Resources	IT Technical Resources
IT Hardware Resources	1		
IT Software Resources	0.586***	1	
IT Technical Resources	0.536***	0.43***	1
Ambidexterity	-0.113**	-0.158***	0.114**
Senior Team Size	0.06	0.081	0.103*
Founding Team Size	0.02	0.012	0.007
ln (Firm Age)	-0.052	-0.016	-0.023
ln (Firm Size)	0.086	0.113**	0.076
Env. Competitiveness	-0.13**	-0.08	-0.11**
Environmental Dynamism	-0.029	-0.059	-0.108**
Competitive Performance	0.057	0.017	0.015

Pairwise correlations. *** p < 0.01, ** p < 0.05, * p < 0.1

Table 5. Construct Correlations for IT Capabilities			
	Automate IT Capability	Informate IT Capability	Transform IT Capability
Automate IT Capability	1		
Informate IT Capability	0.723***	1	
Transform IT Capability	0.645***	0.854***	1
Ambidexterity	-0.235***	-0.198***	-0.029
Senior Team Size	0.154***	0.133**	0.151***
Founding Team Size	0.168***	0.13**	0.164***
ln (Firm Age)	0.052	0.094*	0.102*
ln (Firm Size)	0.312***	0.381***	0.435***
Env. Competitiveness	-0.147***	-0.17***	-0.079
Environmental Dynamism	0.023	0.101*	0.126**
Competitive Performance	-0.057	-0.062	0.022
Pairwise correlations. *** p < 0.01, ** p < 0.05, * p < 0.1			

As aforementioned, the final measure construction confirmed the absence of multicollinearity problems as interfactor correlations (presented in Table 3, Table 4, Table 5 above and in Table A13 and Table A14 in Appendix 1) were lesser than 0.65 .

Table 6. Descriptive Statistics		
Construct	**Mean**	**S.D.**
IT Resources	1.41	2.29
IT Hardware Resources	0.53	0.87
IT Software Resources	0.34	0.6
IT Technical Resources	0.16	0.51
Automate IT Capability	3.86	1.28
Informate IT Capability	3.21	1.55
Transform IT Capability	1.83	1.18
Ambidexterity	7.04	2.34
Senior Team Size	10.04	17.12
Founding Team Size	4.71	11.48
ln (Firm Age)	3.01	0.79
ln (Firm Size)	5.36	1.52
Env. Competitiveness	15.5	2.71
Environmental Dynamism	17.53	2.63
Competitive Performance	1.51	0.7

5.7 Research Design

For the purpose of testing the first two theoretical models, I employed ordinary least squares (OLS) regression analysis. A Breusch-Pagan test ($p > 0.05$) could not rule out the presence of heteroskedasticity (Breusch and Pagan 1979). Homoskedasticity, or constant variance of regression error terms, is a key assumption of OLS regression. If this assumption is violated, though the regression estimator is unbiased and consistent, it is less efficient. This can lead to Type I error inflation or reduced statistical power for coefficient hypothesis tests. Thus correcting for heteroskedasticity is necessary while conducting OLS. For this purpose, I used heteroskedasticity-consistent standard error estimators of OLS parameter estimates. While these are of four types, I opted to use HC0 or Huber/White standard errors across the analysis (Huber 1967; White 1982) as these are best used for large sample sizes, while HC1, HC2, and HC3 estimators are better used for smaller samples. The regression analysis was conducted using STATA 11, which has in-built procedures for estimating standard errors using all of the HC methods. I replicated this analysis in SPSS 20 after implementing heteroskedasticity correction capabilities through the macro provided by Hayes and Cai (2007).

Another advantage of using the Huber/White standard errors is its ability to correct for any potential clustering of the data. Besides homoskedasticity, another key assumption of OLS regression is independence of error terms. It is plausible that there may be variance within the observations for each state or industry in my data. While addressing such clustering was not the original intent of the Huber/White standard errors, the ability of this approach to do so is well recognized and documented (Froot 1989; Williams 2000).

I followed a hierarchical moderated regression analysis approach to evaluate the hypotheses. First, in the base model, I regress the measure of organizational ambidexterity on the three sets of control variables. In the next three models, I test the first hypothesized model regarding the influence of IT resources on organizational ambidexterity. Thus, in the second model, I introduce the IT resources term. In the third model, I test the main effects of the components of IT resources. Finally, I introduce the interaction terms in the fourth model.

I follow a similar approach to test the second theoretical model regarding the influence of IT capabilities on organizational ambidexterity. In the fifth regression model, I test the hypothesized main effects of IT automate, informate and transform capabilities by introducing these terms into the base model. In the sixth regression model, I introduce the three hypothesized balance terms. In the seventh and final model, I add the interaction terms to the prior main effects model. These models are given below:

Model 1: $Ambi_i = ß_0 + \varphi_1 TControls_i + \varphi_2 OControls_i + \varphi_3 IEControls_i + \varepsilon_i$

Model 2: $Ambi_i = ß_0 + ß_1 ITres_i + \varphi_1 TControls_i + \varphi_2 OControls_i + \varphi_3 IEControls_i + \varepsilon_i$

Model 3: $Ambi_i = ß_0 + ß_1 ITsoft_i + ß_2 ITtech_i + \gamma_1 IThard_i + \varphi_1 TControls_i + \varphi_2 OControls_i + \varphi_3 IEControls_i + \varepsilon_i$

Model 4: $Ambi_i = ß_0 + ß_1 ITsoft_i + ß_2 ITtech_i + ß_3(ITsoft_i * IThard_i) + ß_4(ITtech_i * IThard_i)$ $ß_5(ITsoft_i * ITtech_i * IThard_i) + \gamma_1 IThard_i + \gamma_2(ITtech_i * IThard_i) + \varphi_1 TControls_i + \varphi_2 OControls_i + \varphi_3 IEControls_i + \varepsilon_i$

Model 5: $Ambi_i = ß_0 + ß_6 ITauto_i + ß_7 ITinfor_i + ß_8 ITtrans_i + \varphi_1 TControls_i + \varphi_2 OControls_i + \varphi_3 IEControls_i + \varepsilon_i$

Model 6: $Ambi_i = ß_0 + ß_9(ITtrans_i – ITauto_i) + ß_{10}(ITinfor_i – ITauto_i) + ß_{11}(ITtrans_i – ITinfor_i) + \varphi_1 TControls_i + \varphi_2 OControls_i + \varphi_3 IEControls_i + \varepsilon_i$

Model 7: $Ambi_i = ß_0 + ß_6 ITauto_i + ß_7 ITinfor_i + ß_8 ITtrans_i + ß_{12}(ITtrans_i * ITinfor_i) + ß_{13}(ITtrans_i * ITauto_i) + \varphi_1 TControls_i + \varphi_2 OControls_i + \varphi_3 IEControls_i + \varepsilon_i$

where *Ambi* is organizational ambidexterity; *ITres* is IT resources; *ITsoft, ITtech, IThard* are the software, technical and hardware components of IT resources respectively; *ITauto*, *ITinfor*, *ITtrans* are IT automate, informate and transform capabilities respectively. (*ITtrans* – *ITinfor*) and (*ITtrans* – *ITinfor*) measure the relative balance or imbalance of IT informate and transform investments in a year. *TControls*, *OControls* and *IEControls* are senior team level, organizational level, and industry and environmental level controls respectively.

5.8 Results

Table 7 reports the abbreviated regression results for the first hypothesized model. Table 8 reports the abbreviated regression results for the second hypothesized model. The detailed results for these models are presented in Table A5 and Table A6 in Appendix 1. To reduce multicollinearity concerns and ease interpretation of the results, I mean centered and multiplied the main variables to form the interaction terms for all the analysis (Aiken and West 1991; Edwards and Lambert 2007).

Table 7. Abbreviated Regression Results for First Hypothesized Model

Variables	Model 1	Model 2	Model 3	Model 4
IT Resources		-0.099**		
		(0.044)		
Hardware IT Resources			-0.280^	-0.131
			(0.181)	(0.187)
Software IT Resources			-0.574***	-0.493**
			(0.179)	(0.216)
Technical IT Resources			0.698***	0.736**
			(0.249)	(0.327)
Software x Hardware IT Resources				-0.340**
				(0.155)
Technical x Hardware IT Resources				-0.049
				(0.203)
Hardware x Software x Technical IT				0.129*
				(0.074)
Constant	3.908***	4.032***	3.792***	3.801***
	(1.116)	(1.192)	(1.187)	(1.228)
Observations	323	318	313	313
R-squared	0.336	0.345	0.368	0.374
Adj. R-squared	0.277	0.284	0.303	0.303

Robust standard errors in parentheses

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$ for two-tailed test; ^ $p < 0.1$ for one-tailed test

Estimation of the base model indicates that there are differences in ambidexterity due to geographical location. Results from Model 2 indicate that IT Resources are negatively related to organizational ambidexterity ($b = -0.099$, $p < 0.05$), thereby not supporting hypothesis 1.

Model 3 evaluates the main effects of hardware, software and technical IT resources. These results indicate that technical IT resources have a positive effect on ambidexterity ($b = 0.698$, $p < 0.01$). However, software IT resources have a significant negative effect ($b = -0.574$, $p < 0.01$). This observed effect is contrary to the hypothesized positive relationship. As predicted, hardware IT resources do not have a significant main effect on ambidexterity ($b = -0.280$, $p > 0.10$, not significant). Though the main affect of hardware IT resources is significant at a 10 percent level for a one-sided test, the relationship is opposite to the hypothesized direction. Overall, results from Model 3 provide strong support for hypothesis 3, but no support for hypothesis 1 or hypothesis 2.

Model 4 includes all the hypothesized interaction terms. The results from this model provide support hypothesis 4c, but not for hypothesis 4a or hypothesis 4b. I find that the interaction of technical and hardware IT resources is negative, but not significant ($b = -0.049$, $p > 0.80$, not significant). In contrast, the interaction of software and hardware IT resources is significant, but negative and thus opposite to the hypothesized direction ($b = -0.340$, $p < 0.05$). The results illustrate a positive, but weakly significant three way interaction of software, technical and hardware IT resources ($b = 0.1290$, $p < 0.10$). These results are consistent irrespective of whether the interactions are entered individually or as a block in the analysis.

Table 8. Abbreviated Regression Results for Second Hypothesized Model

Variables	Model 1	Model 5	Model 6	Model 7
IT Automate Capability		-0.283*		-0.348**
		(0.145)		(0.163)
IT Informate Capability		-0.395**		-0.353**
		(0.156)		(0.157)
IT Transform Capability		0.664***		0.816***
		(0.188)		(0.209)
Balance of IT Transform & Informate			0.512***	
			(0.165)	
Balance of IT Transform & Automate			0.224^	
			(0.154)	
Balance of IT Automate & Informate			0.269^	
			(0.189)	
IT Transform x IT Informate Capability				-0.192**
				(0.092)
IT Transform x IT Automate Capability				0.138
				(0.134)
Constant	3.908***	5.635***	-1.017	5.676***
	(1.116)	(1.195)	(1.823)	(1.209)
Observations	323	323	323	323
R-squared	0.336	0.373	0.380	0.385
Adj. R-squared	0.277	0.310	0.319	0.320

Robust standard errors in parentheses

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$ for two-tailed test; ^ $p < 0.1$ for one-tailed test

In the full model (Model 4), the negative relationship between software IT resources and organizational ambidexterity remains significant at a reduced level ($p < 0.05$). This compares with Model 3, where the relationship is negative and significant at the 1 percent level in the absence of the interaction terms. Similarly, the positive effect of technical IT resources on ambidexterity remains significant, albeit at a reduced level ($p < 0.05$), in the full model.

Evaluation of the second hypothesized model, regarding the influence of IT capabilities on organizational ambidexterity indicates support for most of the hypothesized relationships, though at differing levels of significance.

Model 5 evaluates the main effects of Automate, Informate and Transform IT capabilities. These results indicate that as predicted, Transform IT capability has a strong positive effect on ambidexterity ($b = 0. 664$, $p < 0.01$). Similarly, as hypothesized, Automate IT capability has a significant negative main effect on ambidexterity ($b = -0.283$, $p < 0.10$). However, contrary to the hypothesized positive relationship, Informate IT capability has a significant negative effect ($b = -0.395$, $p < 0.05$) on organizational ambidexterity. Overall, results from Model 5 provide strong support for hypothesis 6 and hypothesis 7, but no support for hypothesis 5.

The balance relationships are tested in Model 6. Results from this analysis indicate that the balance of Transform IT and Informate IT capabilities has a strongly significant positive effect on organizational ambidexterity ($b = 0.512$, $p < 0.01$). The balance of Transform IT and Automate IT capabilities is observed to be weakly significant at a 10 percent level for a one-sided test ($b = 0.224$, $p < 0.10$, one-sided test). Similarly, the balance of Automate IT and Informate IT capabilities is weakly significant using a one-sided test (b

= 0.269, $p < 0.10$, one-sided test). However, both these relationships follow the hypothesized directionality. Therefore evaluation of Model 6 suggests strong support for hypothesis 9a and weak support for hypotheses 9b and 9c.

Model 7 includes the two hypothesized interaction terms. The results from this model provide support hypothesis 8a, but not for hypothesis 8b. I find that the interaction of Transform and Informate IT capability is negative and significant ($b = -0.192$, $p < 0.05$). In contrast, the interaction of Transform and Automate IT capabilities is not significant ($b = -0.138$, $p > 0.30$, not significant). The results illustrate a positive influence of Transform IT capability on the relationship between IT Informate capability and organizational ambidexterity. These results are consistent irrespective of whether the interactions are entered individually or as a block in the analysis.

In Model 7, the hypothesized negative relationship (H6) between Automate IT capability and organizational ambidexterity remains significant at a higher level of significance ($p < 0.05$). Similarly, the positive effect of Transform IT capability (H7) on ambidexterity remains significant at the same level ($p < 0.01$). I also observe that the negative relationship between IT Informate and ambidexterity remains negative at a similar level significance level ($p < 0.05$) as in the absence of the interaction terms.

As specified earlier, I assessed variance inflation factor values (reported in Table A7 of Appendix 1) for all of the models to confirm the absence of multicollinearity.

5.8.1 Post-hoc Analysis

Previously, I noted the causal nature of a firm's IT resources and capabilities with regards to its ambidexterity. For this purpose, I built on literature that conceptualized organizational ambidexterity as the simultaneous pursuit of exploration and exploitation. However, Cao, Gedajlovic, and Zhang (2009) assert that much of this prior literature is ambiguous with regards to the exact nature and nuance of the ambidexterity construct. In order to resolve these ambiguities, they propose that ambidexterity consists of two distinct, but related underlying dimensions – balance and combined dimensions. The balance dimension of ambidexterity refers to the relative balance between exploration and exploitation. The combined dimension of ambidexterity refers to the combined magnitude of exploration and exploitation. For example, if an organization has a score of 40 out of 100 for exploration activities and 40 out of 100 for exploitation activities, it is deemed to have a high balance dimension of ambidexterity and a low combined dimension of ambidexterity. Conversely, an organization with a score of 100 out of 100 for exploration activities and 40 out of 10 for exploitation activities is conceptualized as having a low balance dimension of ambidexterity and a high combined dimension of ambidexterity. Cao, Gedajlovic, and Zhang (2009) assert that these two dimensions have distinct independent effects on firm performance, and yet are also mutually supportive. Organizations with high level of the balance dimension are able to mitigate the risks of obsolescence and failure to appropriate returns from exploration. High level of the combined dimension enables organizations to develop complementary resources that can be leveraged across both exploration and exploitation. Firms that witness concurrently high levels of both dimensions of ambidexterity benefit from the synergistic effects of balance and combined dimensions. Overall, the combined and balance dimensions of ambidexterity have differing performance impacts for different types of organizations under different environmental conditions. Thus, the conceptualization of ambidexterity along these two dimensions allows for greater precision in exploring theoretical relationships and contingencies (Cao et al. 2009). While prior work has considered these two dimensions as two possible formulations of the ambidexterity construct, this study suggests it is pertinent to consider the effect of IT resources and capabilities upon both these dimensions independently.

Recall that earlier, I described the Edwards (2001) methodology followed by prior research to determine the correct formulation of the ambidexterity construct. Following this methodology, I had identified the absolute difference between explorative and exploitative innovation as the most apt formulation of ambidexterity for this study. This construction of the ambidexterity construct reflects the balance dimension of Cao, Gedajlovic, and Zhang's (2009) work. As per this conceptualization, to complete my investigation of the relationship of IT resources and capabilities with organizational ambidexterity, I replicated my analysis for the combined dimension of ambidexterity. For this purpose, I used the mean-centered product of the measures of explorative and exploitative innovation as the dependent variable for my analysis.

The results of this analysis bring forth two main observations. First, this analysis confirms the validity of the process followed earlier to select the pertinent measure of ambidexterity. As seen in Table 9, which reports the abbreviated results for the first hypothesized model, the base model shows a negative R^2 value. Similarly, the full model containing all predictors and covariates has a very low significance value. A similar pattern is observed in Table 10, which reports the abbreviated results for the second hypothesized model.

Table 9. Abbreviated Results for First Hypothesized Model using Combined Dimension

Variables	**Model 1**	**Model 2**	**Model 3**	**Model 4**
IT Resources		-0.260^		
		(0.172)		
Hardware IT Resources			0.086	0.240
			(0.648)	(0.910)
Software IT Resources			-2.391***	-1.254*
			(0.602)	(0.656)
Technical IT Resources			1.806*	1.304
			(0.970)	(1.477)
Software x Hardware IT Resources				-1.186^
				(0.781)
Technical x Hardware IT Resources				0.156
				(0.306)
Hardware x Software x Technical IT				0.209
				(0.260)
Constant	-5.022	-5.787*	-6.455*	-6.728**
	(3.569)	(3.473)	(3.387)	(3.398)
Observations	323	318	313	313
R-squared	0.075	0.078	0.102	0.108
Adj. R-squared	-0.00583	-0.00730	0.00951	0.00644

Robust standard errors in parentheses

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$ for two-tailed test; ^ $p < 0.1$ for one-tailed test

Table 10. Abbreviated Results for Second Hypothesized Model using Combined Dimension

Variables	Model 1	Model 5	Model 6	Model 7
IT Automate Capability		-0.593^		-0.434
		(0.448)		(0.516)
IT Informate Capability		-0.540		-0.543
		(0.466)		(0.495)
IT Transform Capability		1.150*		1.056*
		(0.622)		(0.626)
Balance of IT Transform & Informate			0.875**	
			(0.433)	
Balance of IT Transform & Automate			0.483	
			(0.393)	
Balance of IT Automate & Informate			0.830^	
			(0.528)	
IT Transform x IT Informate Capability				-0.102
				(0.318)
IT Transform x IT Automate Capability				0.372
				(0.471)
Constant	-5.022	-1.928	-15.89***	-2.881
	(3.569)	(3.953)	(5.687)	(4.489)
Observations	323	323	323	323
R-squared	0.075	0.086	0.094	0.089
Adj. R-squared	-0.00583	-0.00401	0.00469	-0.00798

Robust standard errors in parentheses

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$ for two-tailed test; ^ $p < 0.1$ for one-tailed test

Second, the results of this analysis are qualitatively similar to the results of my primary analysis. The regression coefficients have the same directionality and similar or slightly lesser levels of significance, across both sets of analysis for the two hypothesized models. For example, technical IT resources ($b = 1.806$, $p < 0.1$) and transform IT capability ($b = 1.15$, $p < 0.1$) have significant main effects in model 2 and model 5 respectively.

Thus, I am able to replicate the results of my prior analysis with an alternative specification of the ambidexterity construct. This analysis also sheds light on the nature of the ambidexterity construct. These results demonstrate that while the underlying dimensions of ambidexterity may have differing firm performance implications, the causal mechanisms that affect them are similar.

5.8.2 Robustness Checks

As noted, I undertook various steps to ameliorate concerns regarding non-response bias, response bias, common method bias, and measurement error. To further ensure the robustness of the results, I conducted several types of post-hoc robustness checks. First, the use of cross-sectional data calls for tests to rule out reverse causality. I used procedures laid out by Landis and Dunlap (2000) to assess reverse causality as I am unable to use the Granger test due to the presence of moderators in my models (Granger 1969). Thus, I set organizational ambidexterity and interaction of ambidexterity and IT hardware resources as independent variables and assessed IT software and IT technical resources as dependent variables in a regression analysis. The absence of significant reverse interaction terms ($p > 0.4$) suggests that reverse causality is not a concern in the first theorized model regarding the influence of IT resources on organizational ambidexterity. Similarly, for the second theorized model, I set organizational ambidexterity and the interaction of ambidexterity and Transform IT capability as independent variables and assessed Automate IT as the dependent variable in a regression analysis. Again, the absence of significant reverse interaction terms ($p > 0.8$) suggests that reverse causality is not a concern when assessing the influence of IT capabilities on organizational ambidexterity.

Second, I replicated my analysis using an alternative measure of performance. This measure assesses the real performance of the firm (as compared with the original measure which assesses the comparative performance of the firm) over the past financial year over four indicators – growth in sales, returns on sales, returns of assets and growth in returns on assets. Consistent with my prior results, I found support for H3, i.e. IT technical resources significantly enhance ambidexterity. I also observed significantly positive support for H4c, suggesting a synergistic effect of IT software, IT technical and IT hardware resources. In my alternative specification, I also found that software IT resources impede ambidexterity and this relationship is moderated by IT hardware resources.

I also found consistent results for the second hypothesized model. Thus, I observed support for H6, H7, and H8a i.e. while Automate IT capability hinders ambidexterity, Transform IT capability directly facilitates and reduces the negative effect of Automate IT capability. The alternative specification also showed support for the ambidexterity increasing effects of the relative balance of the three IT capabilities.

Third, I repeated my analysis across a sub-sample of the data. Specifically, I ran the analysis across all the models for only the respondents hailing from the auto ancillaries sector. The abbreviated results for the first hypothesized model are depicted in Table A8 in Appendix 1. While this sub-sample analysis only shows statistically significant support on a two-tailed test for the main effect of technical IT resources, the results of my prior analysis are qualitatively supported when coefficient t values are assessed using a one-tailed test of significance.

Table A9 of Appendix 1 lists the results of repeating the analysis for the second hypothesized model for only the sub-sample of auto ancillaries. The results from these tests replicate the statistically significant coefficients of IT Transform capability, IT Informate capability and the balance of IT Transform and IT Informate capability, which were observed for the complete sample. However, this analysis does not replicate the other statistically significant results observed in the full sample. This increases confidence that the results are not driven by the sample composition and thus can be generalized.

Finally, I considered higher thresholds for factor and cross-factor loadings during the principle components analysis and dropped more items. I replicated my analysis with the more parsimonious models and found similar results. I also constructed my multi-item measures by adding the item values, rather than using weighted values. This perturbation also did not change my qualitative results. Overall, my post-hoc analysis provides strong support for my research findings.

Table 11 summarizes my results. In summary, I have found strong empirical support for five of the hypotheses (H3, H4c, H6, H7, and H9a). I have also found weak support for three of the hypotheses (H8a, H9b, and H9c). These results strongly indicate that different IT resources distinctly facilitate or impede organizational ambidexterity in differing ways.

Table 11. Summary of Hypothesis Testing Results	
Hypothesis	**Result**
H1: IT resources positively related	Opposite **
H2: Software IT resources positively related	Opposite ***
H3: Technical IT resources positively related	Supported ***
H4a: Hardware IT resources strengthen influence of software IT resources	Opposite **
H4b: HardwareIT resources strengthen influence of technical IT resources	Not Significant
H4c: Synergy between resources positively related	Supported *
H5: IT Informate capability positively related	Opposite **
H6: IT Automate capability negatively related	Supported *
H7: IT Transform capability positively related	Supported ***
H8a: IT Transform capability strengthens influence of IT Informate capability	Supported **
H8b: IT Transform capability weakens influence of IT Automate capability	Not Significant
H9a: Balance of Automate and Informate IT capability positively related	Weakly Supported^
H9b: Balance of Automate and Transform IT capability positively related	Weakly Supported^
H9c: Balance of Informate and Transform IT capability positively related	Significant ***
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$ for two-tailed test; ^ $p < 0.1$ for one-tailed test	

5.9 Discussion

In the prior chapters and sections of this study, I described how IT-enabled organizational ambidexterity, the simultaneous leverage of seemingly conflicting strategies, is a means to attain competitive advantage emergent in the 21st century. The concurrent pursuit of explorative and exploitative innovation, hitherto conceptualized as ends of a continuum, is an instance of ambidexterity. These two strategies are synergistic and have mutually-supportive performance enhancing impacts. I noted the various antecedents to ambidexterity established in the extant literature and have identified the absence of IT in this causal network. I also highlighted several gaps in the IT business value literature. While the direct impacts of IT on tangible measures of firm performance and competitive advantage have been established in many studies, others have acknowledged the intangible benefits accruing from IT. IT resources and capabilities, in consort with complementary resource bundles and capabilities, endow competitive advantage to firms through the impact of intermediate, value-creating processes (Melville et al. 2004; Ray et al. 2005). I have presented organizational ambidexterity is one such intermediate process, that lies upon the path to competitive advantage.

I have proposed that IT-enabled organizational ambidexterity can provide an alternative explanation for the indirect performance-enhancing impacts of IT resources and capabilities. Towards this purpose, I have found support for my primary thesis that IT resources and capabilities influence organizational ambidexterity. I have found that different IT resources and capabilities act in differing ways to support and hinder ambidexterity. I have demonstrated support for my hypothesis that Technical IT resources, which consist of the technological skills, knowledge and ability to deploy and manage this knowledge and skill set, held by the organization's IT employees, positively influence organizational ambidexterity (H3). I had proposed that organizations with superior technical IT resources are more likely to be ambidextrous due to greater organizational integration and flexibility which is driven by higher knowledge of IT and underlying business processes. Similarly, I have uncovered support for the hypothesized positive effect of Transform IT capability on ambidexterity (H7). I had asserted that Transform IT capability facilitates organizational ambidexterity due to enhanced inter and intra organizational integration and improved organizational responsiveness and flexibility.

These results lead me to suggest that previously asserted antecedents to ambidexterity are actually intermediate effects that are enabled by IT resources and capabilities (Jansen et al. 2009; Jansen et al. 2006). Moreover, I have also found strong empirical support for the hypothesized synergetic effect of hardware IT resources with IT software and IT technical resources (H4c). Ergo, hardware IT resources, which consist of physical IT hardware assets comprising of computers, communication technologies, technical platforms and databases, enhance the effect of software IT and technical IT resources on ambidexterity. This is because superior hardware IT resources result in higher connectedness, integration, and more active transmission of top-down and bottom-up knowledge flows and communication. This finding, along with the lack of a direct effect of hardware IT resources speaks towards prior literature that asserts IT hardware infrastructure as having an integrative effect, with other forms of IT resources and capabilities, on firm performance (Bharadwaj 2000).

I have also found support for my hypotheses regarding the positive influence of balancing IT capabilities. I have found that organizations that maintain a balance of Automate and Informate IT capability (H9a), Automate and Transform IT capability (H9b), and Informate and Transform IT capability (H9c), are more ambidextrous. This supports the reasoning that a balance of capabilities not only balances their direct impacts on exploration and exploitation activities, but also leads to improvements in organizational information exchange and flexibility. On a similar note, I have found support for the assertion that Automate IT capability will hamper organizational ambidexterity due to its strong direct influence on exploitation (H6). Overall, these findings help me to advance the literature that speaks towards the indirect effects of IT on competitive advantage.

Interestingly, I have found a significant, negative influence of software IT resources on organizational ambidexterity. Software IT resources consist of IT applications, systems, pre-packaged software, custom designed software, and hosted applications, positively influences organizational ambidexterity. Previously, I had submitted that this resource facilitates ambidexterity as it enhances communication flows, knowledge flows, and inter and intra organizational connectedness. Similarly, I had asserted that Informate IT capability positively influences ambidexterity due to enhancing effects on knowledge flows and connectedness. I have also found a significant, negative effect of Informate IT capability on organizational ambidexterity. A possible explanation of these results may lie in my measure of ambidexterity. My analysis identified ambidextrous firms as those which concurrently operate two similar sized and conflicting resource setups and orientations. In such a scenario, the firm would benefit more from the mechanisms of integration and flexibility, rather than knowledge flows and connectedness. This is because enhanced integration would play a key role in enabling a balance between two activities that require increased amounts of differentiation within the organization. Exploitation improves a firm's ability to explore by making it more aware of its existing pools of knowledge and resources. Similarly, exploration improves a firm's ability to exploit by making it aware of new pools of knowledge and resources. Exploration also results in an increase in the overall knowledge and resources available for the process of exploitation (Cao et al. 2009). However, taking advantage of these cross effects requires greater amounts of organizational integration. Further, organizational flexibility and responsiveness play a key role in enabling this process. Dynamic ambidexterity, which involves sequentially moving attention from exploration to exploitation and back, is another means by which firms attain high balance between the activities of explorative and exploitative innovation. This process also benefits from enhanced flexibility and responsiveness.

This chain of logic may help explain the ambidexterity impeding properties of software IT resources and Informate IT capability observed in this context. Informate (and automate) IT capability reflects an ossification of existing business processes, thereby impeding organizational flexibility. For example, Mrs. Fields Cookies was a much celebrated example of a firm that utilized its Informate IT capability for centralized control of a highly successful chain of cookie stores in the 20^{th} century. However, the gains in control were offset by reduced flexibility, which lead to an inability to react to changes in its environment and business strategy (Lucas 1999). Similarly, since the manufacturing industry in India is at an early stage in terms of its IT-enabled evolution, the software and hardware solutions being utilized are standardized, out-of-the-box solutions which merely automate and computerize existing processes, without providing any transformative benefits. While this may encourage the replication and transfer of best practices within and across firms (Frei et al. 1999; Galunic and Rodan 1998), eventually software IT resources also result in ossification of existing processes and reduction in organizational flexibility. Technical IT resources may compensate for this ossification by developing workarounds and *jugaads*, thereby enhancing ambidexterity.

Overall, I have reasoned that IT resources of a firm are composed of its underlying components and these underlying components act through different mechanisms to facilitate ambidexterity. I have found mixed effects of the underlying components of IT resources on organizational ambidexterity. Thus, not surprisingly, contrary to my hypothesized relationship (H1), I have found that IT resources, when measured at the aggregate level, hamper ambidexterity. Similarly, I have also unearthed mixed effects of IT capabilities. In sum, I have demonstrated that in the 21st century, IT enables firms to be like Janus.

5.10 Conclusion

Thus far in this manuscript, I have covered the first component of my dissertation research. In the previous sections, I presented a review of prior research in the areas of firm-level IT business value and organizational ambidexterity. I then developed two theoretical models that assert the causal relationship of an organization's IT resources and capabilities with its simultaneous pursuit of explorative and exploitative innovation, i.e. organizational ambidexterity.

In this section, I concluded the first component of this dissertation. First, I presented the context for this research. Second, I described the questionnaire development process and explained the measures that I employed to assess key constructs. I then elucidated the research design that I employed to find empirical support for my core assertion, that an IT is a key antecedent to organizational ambidexterity. Finally, I showcased the results of my analysis. The following section will commence the second component of this dissertation. In this section, I will review the extant literature on technology acquisitions.

6 Technology Acquisitions

In the prior sections, I presented the first component of this dissertation research by detailing the methods, research design, and results of tests for two theoretical models and associated hypotheses regarding the antecedent relationship of IT with organizational ambidexterity. In this section, I commence the second component of this dissertation. This component of my dissertation addresses the external perspective of organizational ambidexterity. Specifically, I examine the role of IT in enhancing post-acquisition integration of externally acquired exploratory or exploitative innovation and knowledge. To shed light upon this issue, I develop theoretical propositions by extending March's Exploration-Exploitation model in the context of acquisitions by introducing IT-enabled learning mechanisms in a post-acquisition, integration setting.

In the following subsections, I review and synthesize prior research from the area of technology acquisitions - a third stream of literature that informs this dissertation. For this purpose, first I introduce the concept of technology acquisitions and present the formal definition of this construct. Second, I discuss the role of acquisitions in enabling external ambidexterity. Third, I present the theoretical background on knowledge and discuss the various types of knowledge that are relevant to our discussion of technology acquisitions. Finally, I put forth the risks and success factors prevalent in technology acquisitions that have been identified in prior research.

6.1 Introduction

Acquisitions involve the purchase and integration of an organization into another. In a recent interview, the CEO of Infosys Technologies, a leading IT outsourcing vendor, stated "We are looking at acquisitions for strategic reasons - to fill a gap in our service portfolio … a typical size or the cut-off limit will be 10 per cent of our revenue …" (Paul and Kulkarni 2009). Similarly, Wipro Technologies, another IT service provider, is actively searching for small sized acquisition targets to fill gaps in its service portfolio (Sims 2010). While Infosys and Wipro have been seeking acquisitions, Cognizant, another IT vendor, has successfully used an acquisition strategy to usurp their market positions. This has involved acquiring specific technology and service skills, competencies and capabilities through focused, small-sized acquisitions. Cognizant's acquisition of Zaffera to gain capabilities in the area of SAP Retail Consulting is the most recent in a series of such acquisitions aimed at gaining specific knowledge (Cognizant 2011). The pursuit of acquisitions for the purposes of acquiring new skills, expertise, competencies and technologies is not a new strategy. While gain of market share, geographical expansion and economies of scale are some reasons why firms indulge in acquisitions, the desire to gain new technological knowhow and capabilities also underlies many acquisition decisions, especially in fast paced or high technology industries (Chaudhuri and Tabrizi 1999; Ranft and Lord 2000). Such acquisitions are termed technology acquisitions, and are many times preferred to time consuming internal development, or risk prone strategic alliances or other contractual arrangements (Grimpe 2007; Hagedoorn and Duysters 2002; Hung and Tang 2008; Ranft and Lord 2002).

6.2 Definition

Formally, technology acquisitions are defined as "acquisitions of small, technology based firms by large, established firms for the purpose of acquiring technological capabilities", (page 263) (Puranam et al. 2006). Through technology acquisitions, acquiring firms obtain new technologies, highly productive and innovative teams, and the skills and expertise of acquired employees (Kozin and Young 1994). These acquisitions introduce new ideas and divergent beliefs into an organization and through the process of organizational learning, enable greater innovation and broader knowledge in the acquiring firm (Levinthal and March 1993; Levitt and March 1988; March 1991). Extensive prior research has identified technology acquisitions as an established strategy to acquire advanced know-how and spur innovation (e.g. Hagedoorn and Schakenraad 1994). Several researchers, including Grimpe (2007) and Graebner (2004), consider acquisitions as "critical means" for firms to gain technological capabilities. Since technology embodies knowledge–based resources, the acquisition of technological capabilities is equivalent to the acquisition of knowledge (Conner and Prahalad 1996).

6.3 External Ambidexterity and Acquisitions

While most extant research on ambidexterity has focused on ambidexterity internally in an organization, some has started to examine external ambidexterity. These researchers have suggested externalizing either exploration or exploitation activities through outsourcing or alliances. However, it has been found that strategic integration issues outweigh the potential benefits of such approaches (Benner and Tushman 2003). There is little research that examines acquisitions as a means for balancing exploration and exploitation and hence enabling organizational ambidexterity. Raisch, Birkinshaw, Probst, and Tushman (2009) assert this as external ambidexterity and suggest that integration of external knowledge requires external brokerage, internal absorptive capacity and social networks. They also suggest that ambidexterity requires the balance and integration of internal and external knowledge across organizational boundaries.

Acquisitions that are pursued as a means to gain technological knowledge (Makri et al. 2010; Puranam et al. 2006; Puranam and Srikanth 2007) and increase new product development (Graebner 2004; Graebner et al. 2010) result in the external gain of exploration.

Acquiring another firm stimulates the development of new ideas, capabilities and ways of thinking in the acquiring organization (Haspeslagh and Jemison 1991; Leonard-Barton 1995; Vermeulen and Barkema 2001), all of which are hallmarks of exploratory innovation. It is also argued that organizations divert resources away from exploitation activities towards acquisition integration activities and thus acquisitions reduce exploitation efforts. Thus, acquisitions can kick start declining or stagnated internal innovation and exploration activity (Higgins and Rodriguez 2006) and thereby help to rebalance exploration and exploitation within a firm. In general, it has been believed that firms that use acquisitions as a source of innovation often display high levels of exploitation, while firms that are targets of technology acquisitions engage in intense innovation, discovery, and search for novelty (Ranft and Lord 2002). However recent work reveals that several technology acquisitions involve exploitative innovation as the primary purpose and outcome (Phene et al. 2012).

6.4 Knowledge in Technology Acquisitions

Since acquisition of knowledge is the primary objective behind technology acquisitions (Makri et al. 2010), the extant research on this construct informs our understanding of technology acquisitions. The concepts of knowledge, organizational learning and organizational memory have different, yet complementary meanings for different groups of researchers. The history of research on these topics can be traced back to Adam Smith's mention of learning through specialization in his treatise (Smith 1776/1937) and Alfred Marshall's discussion of regional knowledge transfers and spillovers in his monograph (Marshall 1890/1920). Over time, the construct of knowledge has received many different treatments in extant literature. The nature of this treatment is dependent upon the theoretical paradigm that the researchers hail from. In the IS literature, the definition of knowledge has been most commonly derived from the Knowledge-Based View of the Firm, which is based on the resource-based view of the firm (Barney 1991).

This theory suggests that knowledge, which is embedded in organizational culture, routines, artifacts, as well as in individual employees, is the most strategically valuable resource of a firm, is applied for production of a firm's products and services, and eventually influences organizational performance (Argote and Ingram 2000; Grant 1996; Liebeskind 1996). Formally, knowledge has been defined as the information (or justified true belief) possessed by an individual about external reality, that, when combined with other personal dimensions such as experience and reflection, becomes a basis for action (Argote et al. 2003; Grover and Davenport 2001; March 1991; Nonaka 1994; Slaughter and Kirsch 2006).

The knowledge within a firm can be classified into explicit and tacit knowledge. Explicit knowledge is articulated and codified knowledge in symbolic form. Tacit knowledge is cognitive, comprises of skills, beliefs and accumulated experiences and is acquired by and stored within individuals. Knowledge that resides in the collective is termed as socially complex knowledge and consists of a group's norms, relationships, information and decision flows (Alavi and Leidner 2001; Nonaka 1994; Polanyi 1967). Socially complex knowledge is particularly fragile and is lost when individuals or teams leave a firm (Ranft and Lord 2000). The value of socially complex knowledge is apparent in a group of employees who may appear to be an aggregation of high performing individuals, but actually rely on the intangible knowledge embedded in the shared experience of working together (Berman et al. 2002). When such a group of employees is disbanded, this fragile form of knowledge breaks apart and is lost.

Another perspective is the Bodiless View of Knowledge (Carley 2002b). As per this view, organizations are synthetic agents and are composed of intelligent, adaptive and computation agents. The behavior of organizations is a function of networks of tasks, resources, knowledge and agents. The knowledge network within an organization consists of employees (agents) and the common knowledge embedded within their relationships. On an abstract level, this can be visualized as a bi-directional graph, wherein knowledge resides both at the nodes (the employees) and at the edges (connections between the employees). Learning in this view occurs in two ways: Structural Learning which due to changes to the social network, because knowledge exists within and between agents and groups of agents; and, Experiential Learning (which is fragile) which occurs due to changes in the knowledge network by the experience and learning of individual agents. Past experience serves as a reference point that shapes both the decision-making process and the decisions that are ultimately made (March and Simon 1958). The loss of the individuals who had the experience thus leads to a loss of that learning. In our abstraction, structural learning can be visualized as replacements of nodes and edges whereas experiential learning can be visualized as increases in the weights of the nodes and edges. These increases to the weights are lost when nodes or edges are replaced and these losses are propagated through the network, thereby implying the frailty of experiential learning and therein, socially complex knowledge. Similar to this point of view, March's conceptualization of organizational culture encompasses this form of knowledge that is inherent in the collective (March 1991).

In this dissertation, I adopt the view of knowledge as that which is embodied within the cognitive process of individuals, defining what they know and their routines and interactions (Argote and Ingram 2000; Argote et al. 2003). Thus, an individual's capability, experience, skill underlying acquired individual expertise, and knowledge of others' expertise for effective group functioning is defined by that individual's knowledge (Ericsson et al. 2007). Thus this definition of knowledge, put forth by Argote and Ingram (2000), incorporates cognitive aspects of personal knowledge, experience, intuition and practices.

6.5 Risks in Technology Acquisitions

There exists an increasing pool of research literature that examines technology acquisitions. Much of this research concentrates on exploring the antecedents to the success of technology acquisitions, which has been evaluated through different measures of financial performance or innovation. Researchers have identified the post-acquisition integration process as the critical factor in acquisition success. Problems arise in this phase due to misfit of cultures, strategies, systems or due to the loss of key personnel. Thus, research in this area has progressed along two themes: transfer of knowledge gained in the acquired firm through the retention of acquired employees, and appropriation of the historical-situational context of the pattern of work within which that knowledge was developed and applied - the acquired firm's culture.

Much research concentrates upon the knowledge transfer and cultural appropriation effects of organizational structural forms of integration. Structural integration can range from complete absorption to complete autonomy (Zollo and Singh 2004). Technology acquisitions make two conflicting demands on structural integration: the need for greater absorption to enable coordination of exploitation of capabilities and technologies, and the need for greater autonomy to enhance exploration (Puranam et al. 2006). Researchers have identified different integration strategies by which acquiring firms can attain a balance between these two demands. These include greater face-to-face communication with acquired employees; focus on the role of acquired leaders; and hybrid integration strategies that provide high autonomy to innovative departments (e.g. Research and Development) and tightly absorb other departments (e.g. sales and marketing) (Graebner 2004; Ranft and Lord 2002; Schweizer 2005). Other researchers have argued that this coordination-autonomy dilemma should be resolved based on the objectives of the acquiring firm. A desire to leverage only existing knowledge can be best served by complete absorption whereas a desire to profit from future innovations requires complete autonomy (Puranam and Srikanth 2007). A hybrid strategy of autonomy and integration will allow knowledge transfer *and* cultural integration (Schweizer 2005).

Retention of employees acquired during a technology acquisition has been identified as crucial to its success because much of the technical knowledge of a firm resides within and between key individuals (Prietula and Simon 1989). The loss of key employees, mission critical organizational know-how or disruption of organizational routines leads to destruction of the target firm's knowledge (Ranft and Lord 2000; Ranft and Lord 2002). Many highly skilled and hard working employees are attracted towards smaller firms, which are the targets of technology acquisitions (Puranam et al. 2009; Zenger 1994). When these firms are acquired, some of these employees are driven to leave the larger acquiring firm. The innovative capabilities and technological know-how of these employees are critical to successful explorative or exploitative innovation efforts. Research along this theme has also identified the positive impacts of retaining key employees and highly productive teams (Cannella and Hambrick 1993). These findings resonate with other literature, which has identified employee turnover as a key source of new knowledge in firms as well as a source of loss of knowledge assets (Carley 1992; Coff 1997; March 1991).

6.6 Success of Technology Acquisitions

The success of technology acquisitions lies in managing the risks inherent in this approach of balancing exploration and exploitation. The key driver of successful post-acquisition integration is the transfer of the target firm's knowledge and culture to the acquirer and its maintenance thereafter (Felin and Hesterly 2007; Kozin and Young 1994). For example, Walter, Lechner, and Kellermanns (2007) found that biotechnology firms failed to acquire scientific and technical knowledge through technology acquisitions due to their inability to transfer and apply the requisite knowledge. While the transfer of explicit knowledge, in the form of documents, databases, and so forth is relatively easier and hence has lower risk of error, greater challenges lie in the transfer of more tacit and socially complex forms of knowledge (Ranft and Lord 2002). Hence the two chief risks in technology acquisitions, retention of employees and appropriation of culture, also provide the main means for success.

It is well established that the transfer of knowledge is facilitated by employees (Almeida and Kogut 1999; Groysberg et al. 2008) and the movement of knowledge workers is a means of transfer and dispersion of knowledge assets (Puranam and Srikanth 2007). Thus, retention of employees reflects the extent to which knowledge is successfully transferred to the acquiring firm and is a key means for ensuring success of these acquisitions. Organizational culture plays a key role in sustaining the contribution of and returns from this knowledge over time. On a similar note, the identification of socially complex knowledge within the target firm and the transfer and maintenance of these appropriate beliefs within the acquiring firm is another cause for the success of technology acquisitions. This form of knowledge embodies organizational culture by representing attitudes, norms, patterns of decision making, and information flows (Badaracco 1991; Ranft and Lord 2002). Thus research that uses terms such as "cultural fit" and "culture clash" (e.g. Donahue 2001) also alludes to the need to transfer and adopt organizational culture. Structural integration also reflects the extent to which the culture of the acquired firm is appropriated by the acquiring firm.

Many firms are aware that the effectiveness of their high-level strategic decision (of undergoing a technology acquisition) is contingent upon the subsequent critical operational issues (of post-acquisition knowledge and cultural integration) (Siggelkow and Rivkin 2009). For example, Cisco Systems, which made 57 technology acquisitions in the eight years prior to 2001, cites employee retention as the first objective and barometer of success for its individual acquisitions (Harding et al. 2004; Tempest and Kasper 2000). Similarly, GE's "Pathfinder model" for merger and acquisitions specifically considers cultural-integration and people retention issues (Harding et al. 2004). On the other hand, HP faced problems in integrating knowledge and culture during its acquisition of Compaq (Burgelman and McKinney 2006).

6.7 Conclusion

Overall, technology acquisitions are a means by which organizations can balance their exploration and exploitation activities. In general, these acquisitions have been identified in the context of a larger, exploitation oriented firm that acquires a small, exploration oriented firm (Puranam et al. 2009). Consequently, this signifies a strategy wherein exploitation oriented organizations acquire exploratory innovation through acquisitions. However, technology acquisitions may also be used by exploration oriented firms to balance their exploitative innovation (Phene et al. 2012).

The success of this strategy relies on the acquiring organization's ability to identify, transfer and maintain the knowledge of the target firm and maximize the returns on this knowledge by maintaining the culture of the acquired firm. Several post-acquisition integration strategies are used by acquiring organizations to achieve this objective. Acquiring firms attempt to maximize the retention of acquired employees in a bid to minimize the loss of tacit forms of knowledge. However, there are several conflicting consequences of some of these approaches. For example, if a firm engages in strong exploitation, it is more resistant to post-acquisition turnover (Ton and Huckman 2008), but this would also result in less influence of the acquired knowledge.

Several previous studies have empirically studied the integration of small, innovative technology firms into larger acquiring firm (e.g. Christensen 2006; Ranft 2006). Firms vary in their ability to adapt to employee suggestions for change (exploration) and their ability to pressure employees to adopt current practices (exploitation). Technology acquisitions pose several challenges to acquiring firms, which must find the right degrees exploration and exploitation within and between themselves and the target firms. My research uses computational modeling to answer several unanswered questions regarding the role of information technology in facilitating these acquisitions.

In this section, I presented a synthesis of the research literature on technology acquisitions. In the following section, I introduce the methodology of computation simulation. I then present March's (1991) model of organizational learning and a subsequent extension - the Exploration-Exploitation Acquisition model (Kathuria et al. 2011a). I then answer calls to create novel theory through computation modeling (Davis et al. 2007; Harrison et al. 2007), by extending this model. This new computational model and procedures enable me to investigate and develop theoretical propositions regarding the implications of different levels of exploration and exploitation and two IT-enabled learning mechanisms on the success of using technology acquisitions as a means to achieving ambidexterity externally.

7 Computational Model of IT and Technology Acquisitions

In the previous section, I discussed the prior work on technology acquisitions. In this section, first I present a description of computational modeling, which is my methodology of choice for this investigation. I then discuss March's original model of exploration and exploitation. Third, I describe the exploration-exploitation acquisition model, which adds a second firm to March's original model and simulates the acquisition of a small technology firm by a large technology firm. Fourth, I elucidate several extensions to the exploration-exploitation acquisition model. Fifth, I describe computational experiments that enable me to explore aspects of organizational learning in the presence of IT-enabled learning mechanisms when the two firms are merged via retention of employees in the large firm or transition of culture (transfer of beliefs, practices, procedure, norms and social skills) from the small firm to the large firm via partial integration of the small firm's organizational code. Utilizing the results of these computational manipulations, I develop ten theoretical propositions. I find that post-acquisition integration strategies and IT-enabled learning mechanisms have different individual and joint impacts on the external acquisition of exploration or exploitation. Overall I find strong support for my primary assertion that IT-enabled learning mechanisms facilitate external organizational ambidexterity – a new strategic possibility in the 21st century.

7.1 Introduction

Firms use technology acquisitions as a means to acquire external innovation and hence balance their exploratory and exploitative innovation processes. However, acquisitions in general, and technology acquisitions in particular, are fraught with risks and failures and the strategic management and finance literatures reveal that returns to shareholders (of the acquiring firm) have an overall mean near zero (e.g. Capron and Pistre

2002; King et al. 2004; Moeller et al. 2005). While the success of technology acquisitions is contingent on a variety of factors, research has identified chief amongst them, two strategic choices regarding integration – retention of employees and appropriation of beliefs. While there has been some research regarding the individual and combined effects of these two strategies, the underlying micro processes have not received sufficient attention. Nor has research considered the effects of IT interventions in the post-integration stage. I examine the role of two IT-enabled learning mechanisms in conjunction with these two strategies. Knowledge repositories and electronic communication technologies present two learning mechanisms that can separately and collectively influence the outcomes of technology acquisitions. The individual characteristics of these two mechanisms, the organizational environment, the strategic choices regarding the integration process and the external environment, can all play a role in these acquisitions.

Most extant literature consists of observational studies, wherein it is difficult to isolate the specific impacts of these highly entangled constructs and complex firm behaviors. While it is difficult to conduct experimental or quasi-experimental designs on this scale, an agent-based model of technology acquisitions can help address these theoretical gaps while accommodating empirical limitations. Thus, motivated by the theoretical paradigm that knowledge underlying key capabilities does not reside at the firm level, but rather in the expertise of key individuals comprising the firm (Cyert and March 1963; Ericsson et al. 2007; Felin and Hesterly 2007; Prietula and Simon 1989), I consider the Exploration-Exploitation Acquisition model as the basis for this investigation. Since this model is itself based upon March's model of exploration and exploitation model, I also answer the call to extend March's model beyond a single firm (Miller et al. 2006) while establishing construct validity and building on prior, sufficiently robust, science (Hawking 2002; Huxley 1965).

7.2 Computational Simulation

Multi causal relationships and synergistic results are the norm within any successful organizational setup. For example, the knowledge of a team is more than the sum of the knowledge of its constituents. In this setting, computational simulations offer a novel and exciting way to understand the process driving these emergent phenomena. Further, the underlying processes in these settings are complex, dynamic, adaptive, non-linear and behavior is emergent from interactions between and within agents comprising these units. As such, these units and agents are inherently computational (Carley 1999). Computational simulations are thus tools to bridge the gap between micro-theory, micro-experience and macro-theory, macro experience (Thomsen et al. 1999). They are singularly suitable for a variety of uses in management research. By providing a third way of doing science, this methodology combines the strengths of the deductive and inductive approaches of science.

7.2.1 Definition

A computational simulation is a process-oriented dynamic model that is instantiated on a computer. Formally, it is a type of Turing Machine, in which the discrete-state machine represents the performance of individuals who are interacting to achieve a common goal (Ashworth and Carley 2007). A simulation model entails inputs, transformation processes, outputs, and various linkages between these (Ashworth and Carley 2007). The development of a computational model is a process of theory development. Similar to the development of novel theory, the process of simulation development requires the development of assumptions, model construction, and predictions. The simulation model itself is the theory - it embodies the theoretical ideas of the researcher (Harrison et al. 2007). By abstracting organizational processes, simulations allow researchers to concentrate their efforts on studying the processes engaged in by adaptive and rational agents, i.e. employees and groups of employees of the organization (Axelrod 1997). Simulations enable the scientific study of organizational phenomena through the use of virtual experiments, in which the data for each cell in experimental design is generated by the simulation (Carley 1999).

7.2.2 Advantages

Computational simulations can be specified at multiple levels of formality and abstraction and can include complex temporal dynamics. Thus this methodology enables researchers to describe processes and trace behavior over time. As abstractions, computational simulations exemplify the principle of Occam's Razor and the KISS fundamental (Riolo et al. 2001). The complexity of simulations lies in their results, not in the model itself (Axelrod 1997). By asserting theory through a computational model, researchers can represent it in the code. Resultantly, many research papers that use this methodology provide extracts of the computational source code (e.g. Cohen et al. 1972; Cyert and March 1963). Also, while it may be difficult or impractical to find empirical test cases for all possible values across a parameter space, computational simulations enable the explicit manipulation of all variables of interest across all theoretically possible conditions.

7.2.3 Disadvantages

Simulation methodology predates computers; subsequently so do the misunderstandings surrounding this eloquent technique. A computer is symbol system, it is goal-seeking and processes information, thus is perfectly suited to the simulation method. Though a computer can only do what it is told to do and hence is in its code, a simulation is no better than its assumptions (Simon 1996). Thus, a simulation is even more restricted than a mere block of computer code. It is through these assumptions and restrictions that purpose and validity is provided to a simulation. These assumptions are specified in detail, can be replicated, can be calibrated to historical data, and tested against current data. The sensitivity of these assumptions to various extreme values can be analyzed (Epstein 2008).

To be effective, a computational simulation also requires validation and verification (Burton 2003; Burton and Obel 1995). Good computational simulation research achieves validity, usability and extendibility (Axelrod 1997). The validity of the research is extolled through its balance of purpose, the experimental design and through the computational model. The realism of the assumptions, and input parameter space, within context of its purpose further enhance its validity. However greater realism and complexity is also a threat to construct validity as it makes the model more difficult to devise and limits its generalizability (Burton and Obel 1995). Finally, derivative models are an ode to the traditions of cumulative science (Axelrod 1997; Axtell et al. 1996).

7.2.4 Usage

Dating from the publication of *A Behavioral Theory of the Firm* (Cyert and March 1963), computational simulations have been used to great effect in the area of organization science. The use of this methodology has lead to the development of several seminal theories, such as the garbage can model (Cohen et al. 1972), adaptive search (Levinthal and March 1981), and the exploration-exploitation model (March 1991). Table A10 of Appendix 1 provides details of more examples of management research that has used different types of computational simulation approaches. Over the past years, computational models of increasing sophistication have been published in the academic literature (Carley 2002a). There is also an increasing use of this research methodology in the area of information systems (e.g. Bray and Prietula 2007; Chang et al. 2010; Kane and Alavi 2007). Overall, computational simulations have been used for the purposes of discovery, explanation, theory development, hypothesis development, and hypothesis testing (Burton and Obel 2011).

7.3 March's Original Model

March's (1991) original model of organizational learning abstracted the balance between the exploration of new alternatives and the exploitation of existing competencies by incorporating the mutual learning of an organization and the individuals (agents) who comprise it. This model includes an unobservable external reality that consists of several orthogonal dimensions and is independent of all agent and organizational beliefs. This reality depicts the true state of nature represented as the optimal set of beliefs. Agents may hold similar, dissimilar or no beliefs about a particular dimension of external reality. On one hand, organizations learn from their members through the process of Exploration (defined as *the effectiveness of influencing a change in organizational beliefs*) which is realized in the parameter p_2. This organizational knowledge is realized as an organizational code, which is a collective understanding of external reality derived from agent beliefs and can be conceptualized as *knowledge stored in organizational procedures, practices, norms, beliefs, rules and forms*. On the other hand, the members of the organizations adapt to the organization's knowledge or code through the process of Exploitation (defined as *the effectiveness of socialization to the organizational beliefs*) which is realized in the parameter p_1.

March defines knowledge level as the percentage of dimensions of the organizational code or individual's beliefs that match the values of the corresponding dimensions of external reality. Organizational knowledge level and individual knowledge levels change as a result of the processes of exploration and exploitation. These rates of learning have differing effects on organizational knowledge.

March found that the knowledge of organizations and their members converge over time to a state of equilibrium. The equilibrium value of knowledge is highest under conditions of high exploration and low exploitation. In the context of the model, this implies that when organizations learn rapidly from their members, who in turn, learn slowly from the organization, knowledge is of the highest level. March showed that higher values of equilibrium and hence organizational knowledge are driven by two major processes: greater diversity among the knowledge of members, and, diverse learning rates of individuals. Low socialization (exploitation) and high adaptation (exploration) processes result in the diversity of individual knowledge to being maintained for a longer period of time, which in turn grants the organization more time and opportunities to adopt these diverse beliefs. Over time, with an increase in the knowledge of organizational members, the diversity of their knowledge decreases and hence they become homogenous. Eventually, this process results in the attainment of the equilibrium state.

March incorporated two extensions in his model: personnel turnover and environmental turbulence. Personnel turnover, which he defined as the probability of an organizational member being replaced by a new agent with random beliefs, is realized in the parameter p_3. March found that moderate employee turnover leads to the introduction of diverse beliefs into the organization, thereby increasing diversity of individual level knowledge and driving the learning processes forward. This results in improved equilibrium knowledge, even in the presence of high socialization.

Environmental turbulence, which March defined as the probability of change in a dimension of external reality, is realized in the parameter p_4. March found that turbulence in the environment leads to the mutual learning processes degenerating into a random walk.

However, this breakdown of the learning processes due to environmental turbulence can be avoided by employee turnover, which leads to constant updating of organizational beliefs to mirror those of the rapidly changing external reality.

March's model is a succinct abstraction of the processes of exploration and exploitation in organizational learning and provides a key foundational framework for subsequent work. The qualitative results of the model hold independent of the number of dimensions in external reality and the number of agents comprising the organization. There is a rich stream of theoretical and empirical literature that extends and supports his original model (e.g. Benner and Tushman 2003; Bray and Prietula 2007; Groysberg and Lee 2009; Kane and Alavi 2007; Lee and Lee 2003; Miller et al. 2006).

7.4 The Exploration Exploitation Acquisition Model

March's original model considers a single firm. Kathuria, Fontaine and Prietula (2011a) extend this model to consider two firms involved in a technology acquisition – a large sized, exploitation-oriented acquiring firm and a smaller sized, exploration-oriented target firm. Terming their model as the Exploration-Exploitation Acquisition (EEA) model, the authors study the effect of the transfer of knowledge and culture across organizational boundaries – two parameters that have been identified as critical to acquisition success in research literature. They do so by introducing two additional parameters into the EEA model which reflect the post-integration strategies of appropriating knowledge and culture from the target firm into the acquiring firm.

In the EEA model, Kathuria et al. (2011a) reinterpret several of March's original constructs. However, the underlying operationalizations are true to the original model. Organizational code, which is the set of beliefs held by the firm, is interpreted as the organization's current culture. Similar to March, an organization that has a code (culture) that is a closer match to reality is a better performer. The exploitation parameter (p_1) of the March model is interpreted as cultural conformity of the firm and defined as the probability that a given belief held by an agent will switch to conform to that of the current culture. The exploration parameter (p_2) of the March model is interpreted as cultural adaptation of the firm and defined as the probability that a given belief comprising the current culture of the organization will switch to adopt the beliefs held by the agents.

The EEA model considers two organizations, one representing a large acquiring firm and the other a small target firm, that operate under the same reality. It includes two parameters that are in addition to the original specifications of March's model. These are the appropriation of knowledge (p_k) and the appropriation of culture (p_c) - strategic choices that embody the integration processes prevalent in technology acquisitions. The appropriation of knowledge is defined as the probability that a given agent from the target firm will be retained by the acquiring firm during the acquisition. Thus, higher levels of appropriation of knowledge result in more of the target firm's employees, and their knowledge, being added to the acquiring firm. The appropriation of culture is defined as the probability that a given component of the culture of the target firm will be adopted by the acquiring firm. Thus, higher levels of appropriation of culture result in more of the acquiring firm's culture being replaced by the cultural beliefs of the target firm.

The EEA model is run for three different phases. In a *pre-acquisition phase*, the two separate firms are run independently under a March-like set up until they both reach equilibrium. This ensures that the code (culture) of each firm achieves a steady state. During the *acquisition phase*, the acquiring firm performs the acquisition of the target firm.

This is accomplished by the addition of some randomly selected employees from the target firm, as defined by the parameter p_k, and, by changes to some components of its culture to match those of the target firm, as defined by the parameter p_c. Employees from the target firm are randomly selected for retention because managers are not omniscient and instead exhibit bounded rationality (Levitt and March 1988; March and Simon 1958; Simon 1991). Finally, in the *post-acquisition* phase, the acquiring firm is run until it achieves equilibrium.

7.5 Extensions to the EEA Model

The EEA model provides an excellent sandbox by which I can address the issue of utilizing acquisitions as a means to externally accomplish ambidexterity. Using the EEA model for this investigation presents several advantages. This model is grounded on March's well-established exploration-exploitation model. The structures, parameters, initial values, and computational protocol of the original model are retained, which enables the validation and extension of the original constructs (Burton and Obel 1995). This also establishes the model's construct validity and enables me to build on prior, sufficiently robust, science (Hawking 2002). Building on existing theoretically-based computational models is also an effective way to validate existing work and develop a cumulative research tradition (Prietula and Watson 2000). Consequently, I implement several reinterpretations and extensions of the EEA model. The detailed features of the Extended EEA model for IT-enabled external ambidexterity are presented in Appendix 4.

7.5.1 Reinterpretation

Since I wish to study the role of acquisitions as a means of attaining a balance between exploration and exploitation activities, I reinterpret the EEA model in the original terms of March's model of organizational learning. Hence, while I keep the operationalizations constant, the conceptualization of the constructs mirrors those of March. Thus, I interpret organizational code as knowledge and beliefs stored in organizational procedures, practices, norms, beliefs, common terminologies, procedures facilitating coordination and communication, rules and forms. Thus, organizational code may or may not be explicitly documented, but explicated and endorsed in some form and enforced with some extant social pressure (e.g. Crémer 1993; Guetzkow 1997).

Similar to March's original conceptualization, I define exploration as the effectiveness of influencing a change in organizational beliefs and exploitation as the effectiveness of socialization to the organizational beliefs. The two acquisition parameters of p_c and p_k are the acquiring firm's *intent to appropriate the beliefs* of the target firm and the acquiring firm's *intent to appropriate knowledge* of the target firm respectively. These two acquisition parameters therefore simulate the transfer and integration of organizational culture and knowledge. Knowledge that is tacit and resides within each individual of the target firm is transferred via the retention of the employees from the target firm. Knowledge that is socially complex and culture, which reflects the operative and influential artifacts, beliefs, norms and practices of the acquired firm is transferred via the acceptance of the target firm's preferred work practices, ways of interacting, tools and routines within the organizational code of the acquirer.

7.5.2 Extension of Scope

The EEA model was developed to consider the implications of technology acquisitions. Firms with high degree of technology innovations exhibit high exploration whereas firms that refine existing technologies exhibit high exploitation (March 1991). Further, organizations that utilize acquisitions as a means for innovation tend to be caught in self-reinforcing and accelerating cycles of rigidity (Vermeulen and Barkema 2001), known as competency traps, due to their propensity to refine existing processes and know-how (Levinthal and March 1993). Thus, in general, a technology acquisition represents an acquisition of an exploration-oriented target firm by an exploitation-oriented acquirer. Therefore, the original model EEA model consists of a large, exploitation-oriented acquiring firm and a smaller, exploration-oriented target firm. However, I wish to consider the external acquisition of both explorative as well as exploitative innovation. Consequently, I extend the scope of the EEA model beyond its original remit and consider two scenarios – the acquisition of an exploration-oriented target firm by an exploitation-oriented acquirer and an acquisition of an exploitation-oriented target firm by an exploration-oriented acquirer.

7.5.3 IT-enabled Learning Mechanisms

Organizational Learning is the dynamic process of creating new knowledge and transferring it to where it is needed and used. This results in the creation of new knowledge. The Knowledge Transformation Cycle facilitates the process of organizational learning (Carlile and Rebentisch 2003). Employees access knowledge, transform it according to their experiences and then contribute the transformed knowledge during later use by themselves or others in the organization. This cycle can be open or closed - in a closed cycle, all employees have access to the same knowledge, which is then transformed and retransformed by the same population. This leads to quick convergence of the knowledge. In an open cycle, there is slow convergence. These two cycles portray the processes of Exploration and Exploitation, which together make up organizational learning. Exploration thus involves the development of new knowledge or replacement of existing knowledge whereas exploitation involves incremental learning focused on diffusion, refinement and reuse of existing knowledge.

Knowledge acquired through a technology acquisition includes knowledge personified in artifacts and knowledge embedded in individuals and their relationships with each another. Tacit dimensions of knowledge also include knowledge pertaining to the exploitation of existing artifacts and the innovative capability of recombining existing knowledge into new knowledge (Kogut and Zander 1992; Puranam and Srikanth 2007). Thus, the transfer of this knowledge and its further application through the process of organizational learning is crucial to the success of technology acquisitions.

Knowledge transfer is the transmission of knowledge from a source to a recipient, which learns and applies the knowledge and hence is affected by the experience of the source (Argote and Ingram 2000; Schultze and Leidner 2002; Slaughter and Kirsch 2006). It is one of the four processes of knowledge management and can be achieved through technological or human mechanisms (Alavi and Leidner 2001). IT-enabled learning mechanisms and other forms of knowledge technologies facilitate inter and intra organizational knowledge transfer (Barrett and Konsynski 1982; Drucker 1988; Wasko and Faraj 2005). The second generation of internet based services, termed Web 2.0 technologies, which are interactive, dynamic and more user centric, are better at facilitating knowledge transfer than traditional enterprise technologies (Parameswaran and Whinston 2007). Web 2.0 based knowledge repositories, which entail elements of knowledge management systems and wikis, enable knowledge creation, transfer, storage, retrieval and application. Another means of achieving knowledge transfer is through the use of Web 2.0 based electronic communication technologies that combine elements of email systems, messaging systems, enterprise social networks, micro blogging and status updates.

Much research has been directed at examining the knowledge management capabilities of IT in general and the impact and adoption of knowledge management systems in particular (Grover and Davenport 2001). Whereas some scholars have shown an improvement in firm performance due to the use of knowledge management systems (Choi 2003; Gold et al. 2001; Massey et al. 2002; Tanriverdi 2005), others have argued that social and technical barriers to knowledge sharing and use of knowledge management systems have diminished their impact on knowledge management initiatives (Cross and Baird 2000; Kankanhalli et al. 2005; Ko et al. 2005). More recent work has identified several benefits of Web 2.0 based knowledge repositories, which include enhanced collaboration, customer centricity, research process and idea propagation (Kane and Fichman 2009; McAfee and Brynjolfsson 2008; Wagner and Majchrzak 2007). Research has also addressed questions on how to enhance use of knowledge management systems and increase knowledge management behaviors (Becerra-Fernandez and Sabherwal 2001; Levin and Cross 2004; Olivera et al. 2008).

On a similar note, researchers have addressed questions regarding the impacts of electronic communication technologies such as email and instant messaging systems. Much of this work has considered first generation technologies, wherein knowledge is shared by the knowledge holder with a specific recipient. More recent Web 2.0 based communication technologies, such as Yammer and other tools, follow a publish and subscribe model, wherein many recipients may choose to receive knowledge shared by one. Critical to our discussion of technology acquisitions, is the fact that the transfer of technical information is difficult, unless the recipient of the information already shares much of same tacit knowledge as the transmitter (Cohen and Levinthal 1990). Communication technologies can enable the sharing of tacit knowledge that will facilitate this transfer of information. For example, such an effect of communication technologies resulted in high dividends during the development of the B-2 Stealth Bomber (Argyres 1999) and resulted in improved product development at Nortel Networks (Massey et al. 2002). The use of communication technologies also drives the development of social networks. Thus, these technologies can lead to the creation of strong ties, which facilitate knowledge integration, and bridging ties, that enable the access of novel, diverse knowledge (Tiwana 2008).

The positive impacts of knowledge repositories and communication technologies on organizational learning have been determined in recent extensions to March's model of exploration of new possibilities and the exploitation of old certainties (e.g. Bray and Prietula 2007; Kane and Alavi 2007). This research has found that the use of communication technologies has an effect that is similar to exploration, whereas the use of knowledge repositories leads to effects similar to exploitation (Kane and Alavi 2007). Learning is essential for the successful transfer of knowledge and the key role of individuals in the process of organizational learning has been well documented (Schultze and Leidner 2002). To increase organizational learning and knowledge retention, adoption of knowledge management technologies will increase in the 21st century, especially amongst the knowledge driven industries where technology acquisitions take place. Knowledge repositories and communication technologies represent two key knowledge management technologies which are prevalent in practice and reflect the theoretical notions of organizational memory and exchange (Levine and Prietula Forthcoming). While recent work has addressed the impact of these asocial and social forms of knowledge transfer on firm performance (Levine and

Prietula Forthcoming), research is yet to consider the impact of knowledge repositories and communication technologies in particular and information technologies in general, on the knowledge transfer across organizational boundaries and inter-organizational learning that occurs during technology acquisitions. Though a few nascent steps have been taken in this direction, there are many unanswered research questions that beg our attention.

I answer some of these questions by extending the EEA model to incorporate two forms of IT-enabled learning mechanisms – knowledge repositories and communication technologies. Similar to Kane and Alavi (2007), I define an IT-enabled learning mechanism as referring to both the underlying technology itself as well as the organizational capabilities and structures enabled by the technology. I follow the implementations used in prior literature to model these two extensions. Specifically, I model a single knowledge repository within the acquiring organization. The use of Web 2.0 based communication technologies is implemented by enabling agent to agent learning within the acquiring organization.

Figure 4 depicts the extended exploration-exploitation acquisition model for external ambidexterity. The red portions signify the significant extensions made to the original EEA model.

The Extended EEA model was programmed as an agent-based model using Microsoft's VB.NET framework. The model runs required nearly 2100 hours of computation time and 9 million input output requests. For this purpose, I established twenty parallel instances on Amazon's Web Services (specifically, the Amazon Elastic Compute Cloud). Representative program code of the Extended EEA model is presented in Appendix 4 and a screenshot of the program is presented in Figure 5.

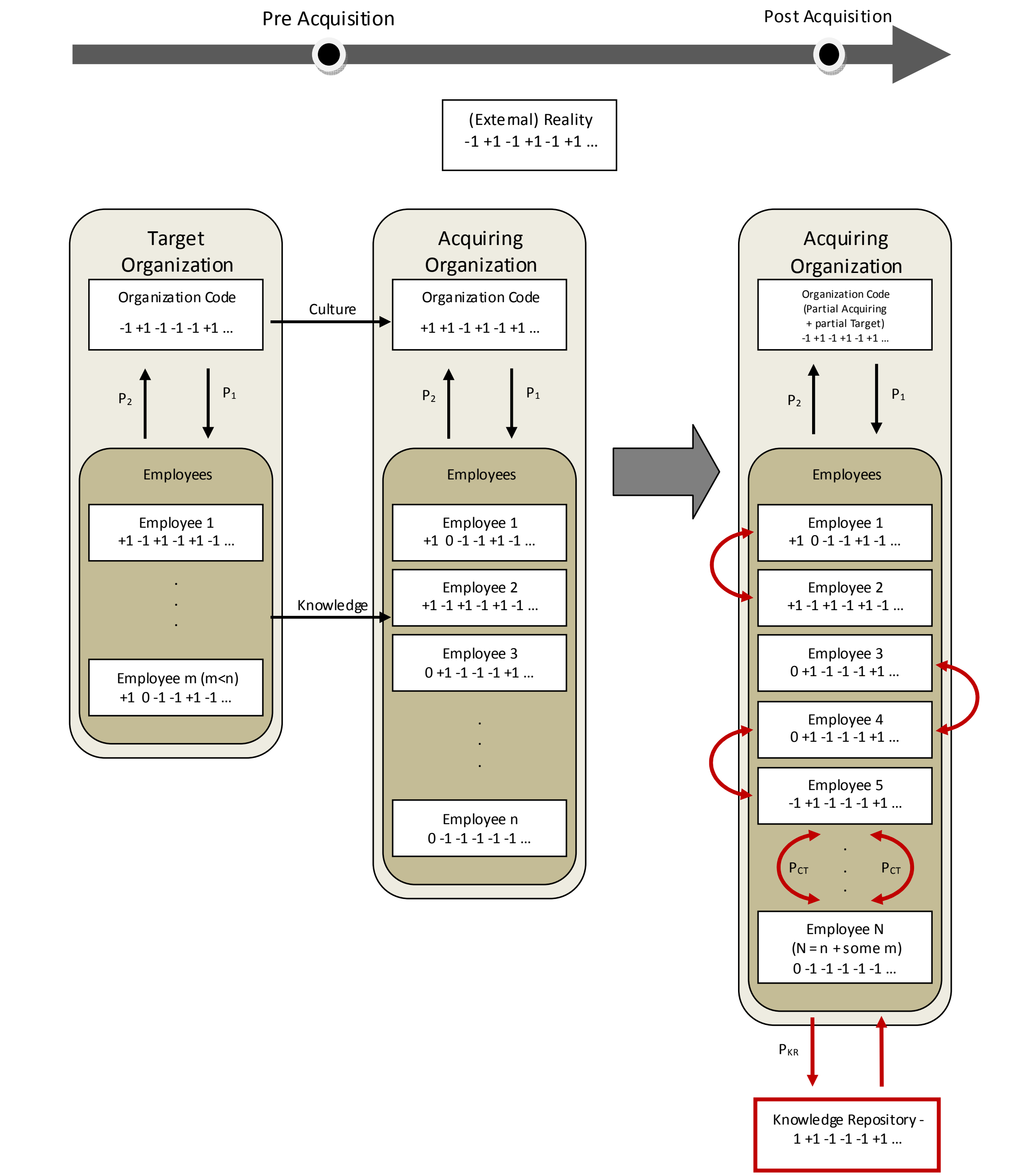


Figure 4. The Extended Exploration-Exploitation Acquisition Model

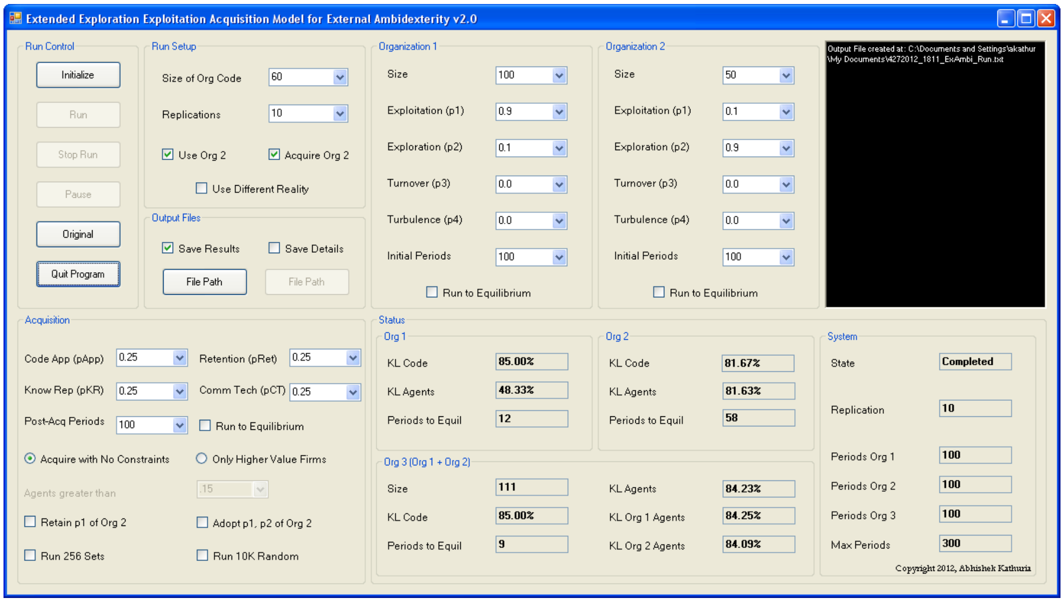


Figure 5. Screenshot of the Extended EEA Model

To model the use of knowledge repositories and communication technologies, I extend the EEA model to allow individuals to learn from one another through the use of these technologies. This extension is theoretically consistent with March's (1991) original formulation as he modeled learning at the individual and not the organizational level and spoke of the possibility of individuals to interact with and learn from each another (p. 75).

Prior research studies have incorporated knowledge repositories into March's model through different ways. Bray and Prietula (2007) modeled a single organizational-level repository towards which only experts could contribute, but from which all employees could learn. They manipulated two variables - the first variable specified the ratio of experts who contribute to the repository and the second variable specified the influence of the system on individuals. Kane and Alavi (2007) followed a different approach and modeled multiple team-level repositories. Knowledge could be contributed by all employees, but would be vetted by experts before inclusion into the repository. Employees could learn from all repositories that contained superior knowledge. In this implementation, the influence of the repository was modeled as an individual's ability to learn and thus reflected in the value of p_1.

In their implementation of electronic communication technologies, Kane and Alavi (2007) randomly assigned individuals to different sub-networks within the organization and enabled individuals to learn from other individuals in their sub-network. Since the structure of the networks had no impact on their findings, they utilized a simple network structure. They modeled this as a lean learning mechanism by specifying that individuals could learn only a randomly selected portion of knowledge dimensions from others through the use of this technology. The effectiveness of learning was modeled as an individual level parameter and hence reflected in the value of p_1.

I follow similar implementation for both learning mechanisms. To avoid confounding effects and to focus my analysis, I control for the number of knowledge sources and only maintain a single, globally accessible organizational-level knowledge repository. Similarly, I do not introduce specific network structures into the model and instead enable individual level learning in the *post-acquisition* phase through ten random organization-wide networks. As detailed above, the learning rate from mechanisms has been given different treatments. Since I conceptualize p_1 as an organizational-level property, I concur with the approach of defining technology level learning rates. This is also theoretically consistent with the notion that different IT-enabled learning mechanisms have different rates of effectiveness. Thus, I define the *effectiveness of knowledge repository* (p_{kr}) as the probability that a given component of knowledge from the knowledge repository will be adopted by an agent. I also define the *effectiveness of communication technologies* (p_{ct}) as the probability that a given component of knowledge will be adopted by an agent through the use of communication technologies.

I introduce both IT-enabled learning mechanisms in the *post-acquisition* phase of the Extended EEA model. In my specification, I allow only retained employees to contribute knowledge towards the knowledge repository through the consolidation of the majority view. This reflects the self-organizing properties of wikis and knowledge management systems. All individuals (thus both original and retained employees) will be able to access the knowledge repository and the parameter p_{kr} will determine if an individual adopts a specific dimension of knowledge from the repository. I model communication technologies by creating ten random sub-groups across all the employees of the acquiring organization. Employees will learn from those with whom they have a direct connection. Since individuals learn from those whom they perceive as having superior knowledge (Perry-Smith and Shalley 2003), employees will adopt the majority view of those who have superior relative knowledge. In the spirit of March, while an agent's specific beliefs about a dimension of knowledge remain unobservable to all, the prior performance of agents is a result of prior choices and endogenous to the model, and is therefore visible and attributable. Thus, recursively applying the choice algorithm enables individual overall knowledge levels to be known to other agents. The parameter p_{ct} determines if an individual adopts a specific dimension of knowledge through the use of communication technologies. This parameter will also incorporate the lack of richness of this learning mechanism.

These reinterpretations of and extensions to March's model and its derivative EEA model are theoretically consistent, intuitive and with precedent. These extensions also preserve the parsimony of the original models. Through a series of computational studies, I manipulate the focal constructs in an exploratory fashion. The analysis of these computational experiments permits comparison to prior work in the field and therefore calibration for external validity and replicability, and enables me to generate propositions with implications for practice, theory, and subsequent research (Carley 2009; Harrison et al. 2007; Prietula 2011).

7.6 Computational Experiments

To investigate the role of IT-enabled learning mechanisms in technology acquisitions, I followed a procedure similar to that in prior literature. I ran the Extended EEA model for 100 time periods each, across the *pre-acquisition, acquisition and post-acquisition phases*. In the pre-acquisition phase, a larger, March-type acquiring firm consisting of 100 agents, and a smaller, March-type target firm consisting of 50 agents are run independently. Doing so ensures that the acquiring and target firms both reach equilibrium (or a steady state of code and individual agent beliefs), before the acquisition, as per March's original specifications. In the acquisition phase, a number (as defined by the appropriation of knowledge parameter p_k) of randomly selected employees from the target firm are added to the acquiring firm, and a number (as defined by the appropriation of culture parameter p_c) of randomly selected dimensions of the acquiring firm's organizational code are changed to match those of the target firm. In the post-acquisition phase, the retained employees initially contribute their majority view towards the knowledge repository. The merged firm is run for another 100 periods, which ensures that the acquiring firm will reach equilibrium after the acquisition process. During each of the runs in the post-acquisition phase, all employees adopt a number (as defined by the effectiveness of knowledge repository and communication technologies parameters p_{kr} and p_{ct} respectively) of randomly selected dimensions from the knowledge repository and from their social network.

The exploration and exploitation processes followed during both the pre and post acquisition phases are derived directly from March's original model. I retain the computational protocol and initial values of March's original manipulations. The procedures of the acquisitions phase are based upon prior theoretical literature. This approach enables me to initially validate and subsequently extend all constructs contained in March's original model and the original EEA model (Burton and Obel 1995). Therefore, prior to conducting any new computational experiments, I replicated the results of these two papers.

7.6.1 Validation of Original Findings

First I validated the original findings of March's model by observing the results at the end of the *pre-acquisition phase*. Consistent with March's original observations, there is a statistically significant difference in knowledge of the target and acquiring firms. If the target firm is exploration oriented and the acquiring firm is exploitation oriented, I find that as expected, the target firm possesses higher knowledge than the acquiring firm ($t = -434.93$, $p < .001$). This is because an exploration strategy leads to slow initial learning, but higher long-term knowledge and an exploitation strategy leads to short-term gains, but lower long-term knowledge. Similarly, if the target firm is exploitation oriented and the acquiring firm is exploration oriented, as expected, the target firm possesses lower knowledge than the acquiring firm ($t = 896.75$, $p < .001$). These results remain unchanged for two firms of equal size. As a measure of robustness, these analyses were repeated using non-parametric Mann-Whitney U tests which are more resistant to non-normal distributions and possess greater power than t tests (Conover and Iman 1981). The results of these tests were also conclusive ($p < 0.01$). The addition of environmental turbulence and personnel turnover also produced effects consistent with March's original observations. Thus, while the addition of environmental turbulence resulted in a reduction in knowledge levels for both types of firms, the addition of personnel turnover helped firms to adapt to changes in the environment and thus return to their prior, closed system knowledge levels.

I then validated the findings of the original EEA model. For this purpose, I examined if the main and interaction effects of stochastic appropriations of organizational code and retention of employees from the target firm are statistically significant. I manipulated four levels of appropriation of knowledge (p_k = 0.0, 0.25, 0.50, 1.00) crossed with four levels of appropriation of culture (p_c = 0.0, 0.25, 0.50, 1.00) for 400 simulations each. Consistent with prior results, I found significant main effects for appropriation of knowledge ($F(3, 10499) = 168.5$, $p < .001$) and culture ($F(3, 10499) = 56.3$, $p < .001$). Post-hoc analysis using the Tukey HSD method (Tukey 1953) provided evidence for marginally decreasing returns on appropriation of knowledge and non-decreasing linear returns on the appropriation of culture ($p < .001$). The dependent variable for these analyses was relative performance gain, which is defined as the difference between how well the average knowledge of all the agents of the acquiring firm matched reality (i.e., the percent of the dimensions) before and after acquisition.

7.6.2 Experimental Design

The use of multiple IT-enabled learning mechanisms has non-linear and synergistic effects (Kane and Alavi 2007). To ascertain the separate and combined effects of knowledge repositories and electronic communication technologies on technology acquisitions, I performed a set of experiments wherein I conducted analyses at the organizational-level. I manipulated four constructs – the two IT-enabled learning mechanisms and the two integration strategies (p_k, p_c, p_{kr} and p_{cl}), across four levels (0.0, 0.25, 0.50, 0.75) corresponding to none, low, medium and high.

Table 12. Simulation Parameters for Extended EEA Model

Parameter & Definition	Description	Values
p_k | Intent to appropriate knowledge	Probability that a given agent of the target firm will be retained by the acquiring firm	0.00, 0.25, 0.50, 0.75
p_c | Intent to appropriate beliefs	Probability that a given belief of the target firm will be adopted by the acquiring firm	0.00, 0.25, 0.50, 0.75
p_{kr} | Effectiveness of knowledge repository	Probability that a given component of knowledge from the knowledge repository will be adopted by an agent	0.00, 0.25, 0.50, 0.75
p_{ct} | Effectiveness of communication technologies	Probability that a given component of knowledge will be adopted by an agent through the use of IT-enabled communication technologies	0.00, 0.25, 0.50, 0.75
p_1 | Exploitation	Probability that a given component of organizational beliefs will be adopted by an agent.	0.10, 0.90
p_2 | Exploration	Probability that a given component of agent knowledge will be adopted by the organization.	0.90, 0.10
p_3 | Personnel turnover	Probability of an organizational member being replaced by a new agent with random beliefs	0.00, 0.05
p_4 | Environmental turbulence	Probability of change in a dimension of external reality	0.00, 0.05

Thus, I conducted a primary experiment with a 4 x 4 x 4 x 4 factorial design to discern the impact of knowledge repositories and communication technologies on the subsequent knowledge levels (performance) of the acquiring firm. I repeated this experiment and subsequent analysis across two scenarios – the acquisition of exploratory innovation and the acquisition of exploitative innovation, thereby achieving a recursive 4 x 4 x 4 x 4 design. The first scenario modelled the acquisition of exploratory innovation by simulating the acquisition of an exploration oriented target firm by an exploitation oriented acquiring firm. The second scenario modelled the acquisition of exploitative innovation by simulating the acquisition of an exploitation oriented target firm by an exploration oriented acquiring firm.

In the first set of analysis, I considered the individual effect of knowledge repositories on knowledge and cultural appropriation strategies. For this purpose, I evaluated the impact of changing the value of the p_{kr} parameter on the equilibrium knowledge level of the acquiring firm, across all baseline values of p_k and p_c. In the second set of analysis, I considered the individual effect of communication technologies on appropriation and retention strategies. The third analysis evaluated the joint impact of p_{kr} and p_{ct}. Formally, the dependent variable for all three analyses was *relative knowledge gain*, defined as the percentage average difference in agent knowledge dimensions that match reality, pre and post-acquisition for the acquiring firm. This systematic manipulation of each mechanism across different configurations enabled me to gain an understanding of the effects of the mechanisms, and how they work in conjunction with one another.

I further extended the model and conducted a secondary experiment by examining the effects of personnel turnover and environmental turbulence as reflected in the parameters p_3 and p_4 respectively. In the March and EEA models, the presence of environmental turbulence in the absence of personnel turnover (p_4 = 0.02, p_3 = 0.00) led to long-term degenerative and inadaptable organizational knowledge. The addition of personnel turnover in the presence of environmental turbulence (p_4 = 0.04, p_3 = 0.04) avoided this scenario. Since the EEA model reports equilibrium values of knowledge and only interim values of knowledge are impacted by the presence of absence of p_3 and p_4, the model's sensitivity to personnel turnover or environmental turbulence was not substantial.

Therefore the authors elected to focus on the primary constructs of exploration and exploitation and did not manipulate either of these constructs. Due to similar reasoning, I manipulated both these constructs at a binary level. Thus, in the primary experiment, I had no turnover and turbulence whereas in the subsequent secondary iteration, I introduced extreme high values of both turnover and turbulence into the system (p_4 = 0.05, p_3 = 0.05). As explained earlier, this also helped to validate the model against prior findings of the original models.

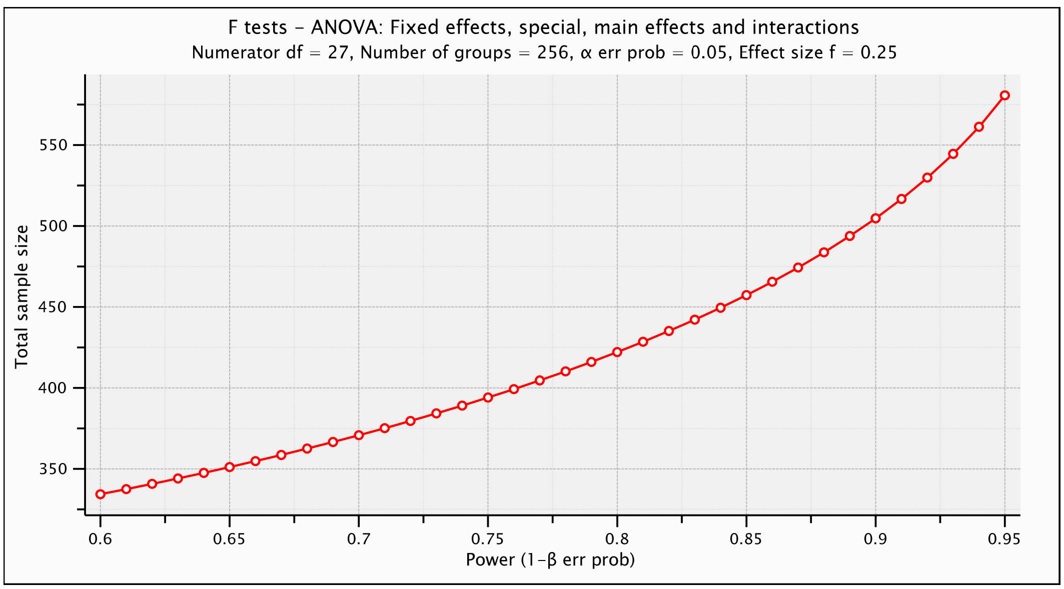


Figure 6. Power Analysis for 4x4x4x4 Factorial Design

To determine the number of runs per experimental condition, I conducted a-priori power analysis using G*Power 3. A priori analyses is an efficient method for controlling statistical power and best suited for studies such as computational simulations, where data collection is not dependent upon critical temporal and monetary resources (Faul et al. 2007).

To achieve a power of 0.80, for a medium sized effect f = .25, at α = .05, a sample of 423 is required to test for three-way interaction effects (Cohen 1988; Faul et al. 2009; Faul et al. 2007). I rounded down this value and therefore conducted 400 replications within each cell of the experimental design. This provides a power of 0.99 for the main effects of the IT-enabled learning mechanisms, a power of 0.95 for simple interaction effects, and a power of 0.76 for three-way interaction effects.

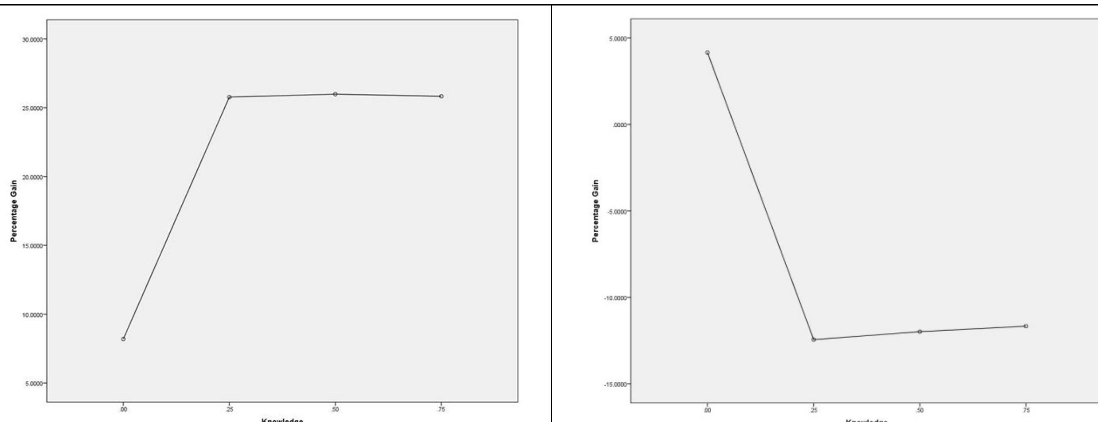
7.6.3 Experimental Setup

For the first experiment, I manipulated the two IT-enabled learning mechanisms and the two integration strategies (p_k, p_c, p_{kr} and p_{ct}), across four levels (0.0, 0.25, 0.50, 0.75) for two scenarios. The first scenario models the acquisition of explorative innovation, i.e. the acquisition of an exploration oriented target firm (p_1 = 0.10, p_2 = 0.90) by an exploitation oriented firm (p_1 = 0.90, p_2 = 0.10). In the second scenario, an exploitation oriented target firm (p_1 = 0.90, p_2 = 0.10) is acquired by an exploration oriented firm (p_1 = 0.10, p_2 = 0.90), which models the acquisition of exploitative innovation. To establish a baseline for my comparisons, I first determined the main effects of the two integration strategies. I then individually determined the effects of the two IT-enabled learning mechanisms. Finally, I investigated the joint effects of knowledge repository use and use of communication technologies.

The full factorial model was analyzed using an analysis of variance (ANOVA). The results for this analysis in the scenario of acquiring explorative innovation are provided in Table A11 of Appendix 1. The results for the analysis of the scenario of acquiring exploitative innovation are provided in Table A12. A key observation of note is that the model explains four times the variance for the acquisition of exploitative innovation (adjusted $R^2 = 0.815$) as compared to the acquisition of explorative innovation (adjusted $R^2 = 0.227$). Post-hoc analysis using the Tukey HSD method (Tukey 1953) was performed for all the main and interaction effects.

A Levene's test (Levene 1960) suggested lack of variance homogeneity for the scenario of acquiring explorative innovation. In such situations, post-hoc analysis using the Games and Howell test (Games and Howell 1976) is considered more robust for small to moderate sample sizes. Due to the large sample size, the result of comparing post-hoc means using this test were similar to those of using the Tukey HSD method (Bathke 2004). For the purpose of brevity, tables containing the results of these analyses are omitted from this manuscript. Relevant post-hoc Tukey HSD results have been reported in-text over the subsequent sections.

7.6.4 The Impact of Integration Strategies



Acquiring Explorative Innovation | **Acquiring Exploitative Innovation**

Figure 7. Main Effects for Appropriation of Knowledge

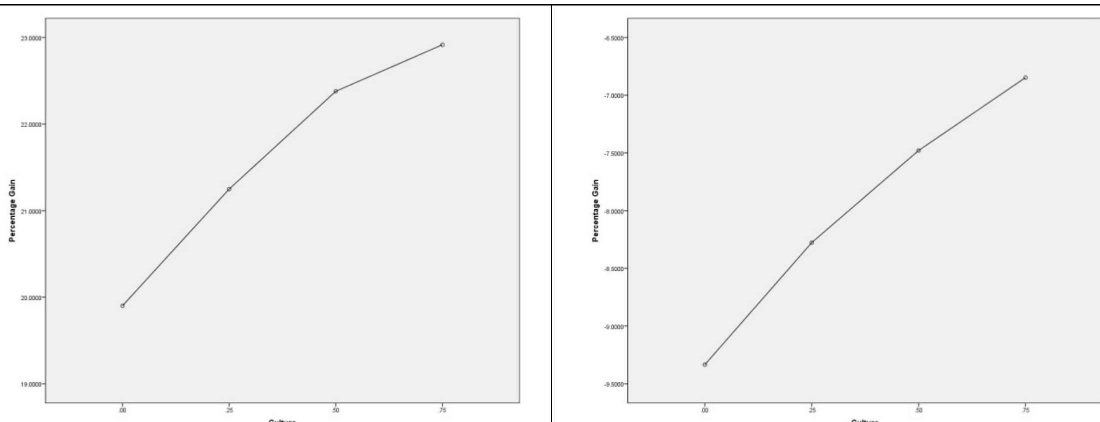
What was the impact of appropriating knowledge (retaining employees) from an exploration oriented target firm? This scenario mirrors the manipulations of the original EEA model (Kathuria et al. 2011a). In the absence of IT-enabled learning mechanisms, there was a positive main effect of appropriating knowledge, with decreasing marginal returns. Figure 7 (left side panel) represents the manipulation of knowledge over the average effect for all levels of the non-manipulated factors (appropriation of culture, use of knowledge repository, and use of communication technologies). As seen in this figure, retaining individuals from the target firm leads to more knowledge gain. However, there is no discernable increase in returns at medium or high levels of knowledge appropriation.

What was the impact of appropriating knowledge from an exploitation oriented target firm? In such a scenario, there was a negative main effect of appropriating knowledge, with increasing linear returns at medium or high levels of knowledge appropriation. This can be seen in Figure 7 (right side panel).

Statistical results support these observations. There was a significant main effect for appropriation of knowledge from the target firm while acquiring both explorative ($F(3, 101199) = 7269.5$, $p < .001$) and exploitative ($F(3, 102399) = 36434.2$, $p < .001$) innovation. A post-hoc analysis using Tukey HSD method (Tukey 1953) supported the observation of significant gains between 0 and 25 percentage knowledge appropriation levels ($p < .001$), but not between 25 and 50 percent ($p = .43$, not significant) or between 50 and 75 percent ($p = .70$, not significant) during the acquisition of an exploration oriented target firm. This analysis also provided evidence of significant negative gains between 0 and 25 percent ($p < .001$), which are less negative at 25 and 50 percentage ($p < .001$), and between 50 and 75 percent (p < .001) levels of knowledge appropriation during the acquisition of an exploitation oriented target firm. The following propositions are offered:

Proposition 1: Appropriation of knowledge will augment the acquisition of explorative innovation, with lower appropriation yielding greatest returns.

Proposition 2: Appropriation of knowledge will impede the acquisition of exploitative innovation, with higher appropriation yielding greatest (least negative) returns.



Acquiring Explorative Innovation | **Acquiring Exploitative Innovation**

Figure 8. Main Effects for Appropriation of Culture

What was the impact of appropriating culture (adopting organizational code) from an exploration oriented target firm? Again, this setup and its results mirror the manipulations of Kathuria et al. (2011a). In the absence of IT-enabled learning mechanisms, there was a positive main effect of appropriating culture, with linear returns. Figure 8 (left side panel) represents the manipulation of culture over the average effect for all levels of the non-manipulated factors (appropriation of knowledge, use of knowledge repository, and use of communication technologies). As seen in this figure, adopting culture from the target firm leads to more knowledge gain. There was a similar, linearly increasing impact of appropriating culture from an exploitation oriented target firm, as seen in the right side panel of Figure 8. However, the returns were consistently negative across all levels.

These observations are supported by statistical results. There was a significant main effect for appropriation of culture from both an exploration oriented target firm ($F(3, 101199) = 167.6$, $p < .001$) and an exploitation oriented target firm ($F(3, 102399) = 639.8$, $p < .001$) innovation. A post-hoc analysis using Tukey HSD method (Tukey 1953) also supports the interpretation that the percentage gains are significant ($p < .001$) between all levels for both scenarios.

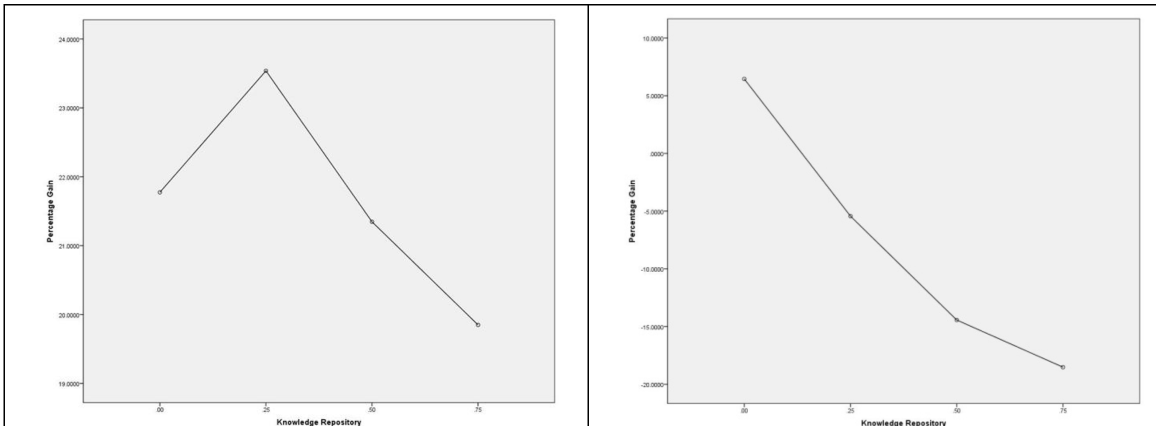
Based on these results, the following propositions are offered:

Proposition 3: Appropriation of culture will augment the acquisition of explorative innovation, with higher appropriation yielding greatest returns.

Proposition 4: Appropriation of culture will augment the acquisition of exploitative innovation, with higher appropriation yielding greatest (least negative) returns.

7.6.5 The Impact of a Knowledge Repository

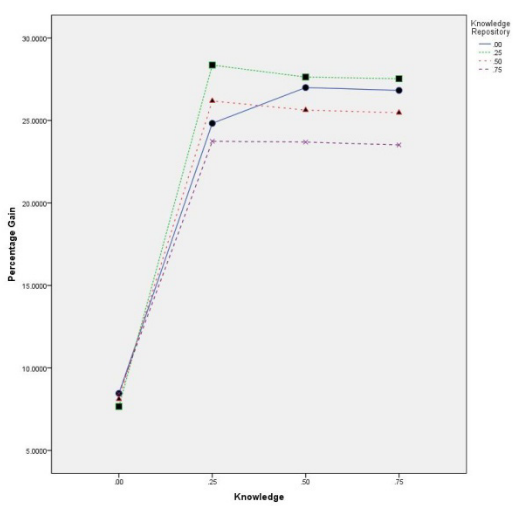
What was the effect of using a knowledge repository on post-acquisition knowledge? Figure 9 illustrates the main effects of the manipulation of knowledge repository usage over the average effect for all levels of the non-manipulated factors (appropriation of knowledge, appropriation of culture, and use of communication technologies). As observed in the left side panel of this figure, when an exploration oriented target firm is acquired, the use of a knowledge repository has a decreasing pattern. A low level of knowledge repository usage corresponds to the highest gain in knowledge; increasing the usage of the knowledge repository results in increasingly negative returns. When acquiring exploitative innovation via an exploitation oriented target firm, the use of a knowledge repository has linear, negative returns towards knowledge gain.



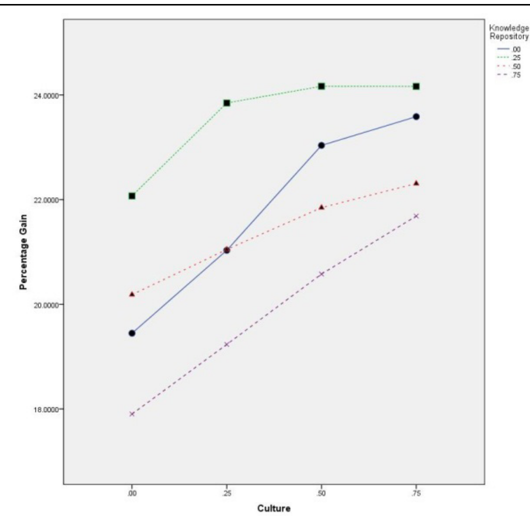
Acquiring Explorative Innovation	**Acquiring Exploitative Innovation**

Figure 9. Main Effects for Knowledge Repository

What was the impact of using the knowledge repository under different levels of appropriation of knowledge and appropriation of culture? Figure 10 depicts the interaction effects of the two integration strategies with knowledge repository use, under the condition of acquiring explorative innovation. Several observations are of note. First, a low level of knowledge repository use (25 percent, dotted green line) provides the highest percentage gain in knowledge, across all levels of appropriation of knowledge and appropriation of culture. Second, the use of a knowledge repository (at all levels) has decreasing returns across increasing levels of appropriation of knowledge or culture. Third, at a low level of appropriation of knowledge, returns to the use of a knowledge repository are the greatest. These returns decrease as higher levels of knowledge are appropriated. Fourth, returns to the use of a knowledge repository are greatest at a high level of appropriation of culture.



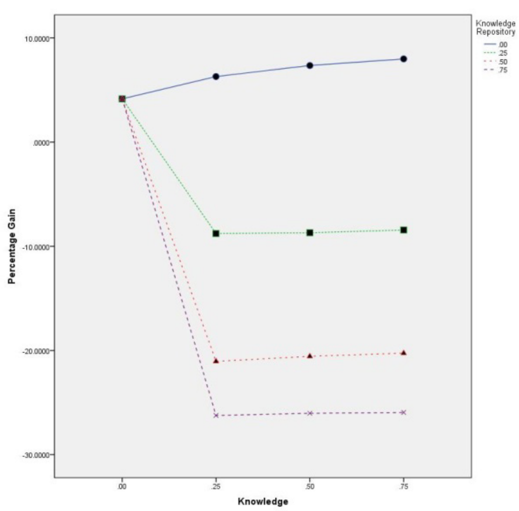
With Appropriation of Knowledge



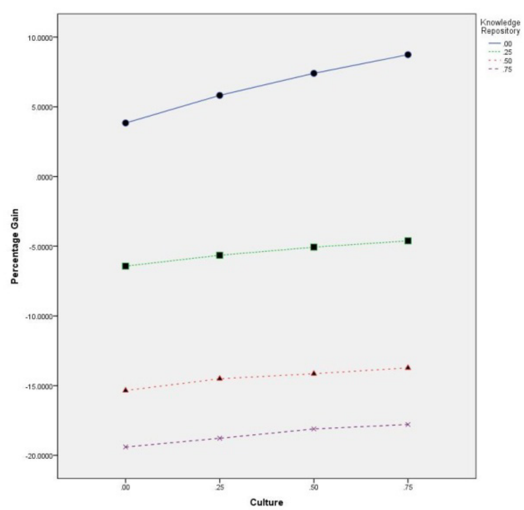
With Appropriation of Culture

Figure 10. Interaction Effects for Knowledge Repository when Acquiring Explorative Innovation

Figure 11 depicts the interaction effects of the two integration strategies with knowledge repository use, under the condition of acquiring exploitative innovation. Recall that the main effect of knowledge repository use under this scenario reveals linear negative returns. The manipulation of usage of the knowledge repository under differing levels of appropriation of knowledge and appropriation of culture reveals similar observations. First, a low level of knowledge repository use (25 percent, dotted green line) provides the least negative gains in knowledge and thus relatively highest performance, across all levels of appropriation of knowledge and appropriation of culture. Second, the use of a knowledge repository (at all levels) has linearly increasing returns across increasing levels of appropriation of knowledge or culture. However, these increases in returns are very low in magnitude. These returns decrease as higher levels of knowledge are appropriated. Third, returns to the use of a knowledge repository are greatest at a high level of appropriation of culture.



With Appropriation of Knowledge



With Appropriation of Culture

Figure 11. Interaction Effects for Knowledge Repository when Acquiring Exploitative Innovation

These observations are supported by statistical evidence. There is a significant main effect for the use of a knowledge repository, both when acquiring explorative innovation ($F(3, 101199) = 162.2$, $p < .001$) and when acquiring exploitative innovation ($F(3, 102399) = 67994.1$, $p < .001$). When acquiring an exploitation oriented target firm, this main effect is consistently decreasing across all levels ($p < .001$) (Tukey 1953). Thus, gains at 25 percentage are more than those at 0 percent, while gains at 50 percent are lesser than 25 percent and 75 percent are lesser than those at the 50 percentage level. When acquiring an exploration oriented target firm, gains are significant and consistently decreasing across all levels: 0 percent to 25 percent ($p < .001$), 25 percent to 50 percent ($p < .001$) and 50 percent to 75 percent ($p < .001$) (Tukey 1953).

There are also significant interaction effects of the use of a knowledge repository and the appropriation of knowledge ($F(9, 101199) = 28.4$, $p < .001$) and the appropriation of culture ($F(9, 101199) = 8.8$, $p < .001$) when acquiring explorative innovation. Tukey HSD post-hoc analysis confirms the observations of significant negative returns under increasing levels of knowledge appropriation ($p < .01$) and significant percentage gains across all levels of culture ($p < .01$) (Tukey 1953). Similar significant interaction effects are observed when acquiring exploitative innovation. While the interaction of knowledge repository use and appropriation of knowledge ($F(9, 102399) = 28.4$, $p < .001$) is significant, post-hoc analysis reveals that gains from 25 percent to 50 percent and 50 percent to 75 percentage levels are not significant (Tukey 1953). The interaction of usage of knowledge repository and appropriation of culture is ($F(9, 102399) = 67.0$, $p < .001$) and there are significant gains across the 25 to 50 percentage levels ($p < .01$), but not across the 50 to 75 percentage levels (Tukey 1953). These results enable me to offer the following propositions:

Proposition 5: Use of a knowledge repository will augment the acquisition of explorative innovation under all conditions of appropriation of knowledge and appropriation of culture, with low use yielding greatest returns under all conditions of appropriation of knowledge and appropriation of culture.

Proposition 6: Use of a knowledge repository will impede the acquisition of exploitative innovation under all conditions of appropriation of knowledge and appropriation of culture, with low use yielding greatest (least negative) returns under all conditions of appropriation of knowledge and appropriation of culture.

7.6.6 The Impact of Communication Technologies

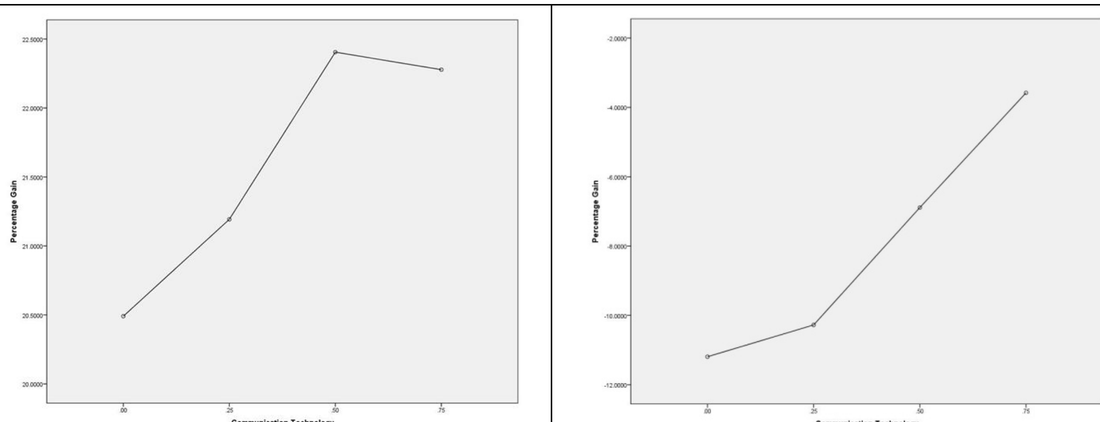


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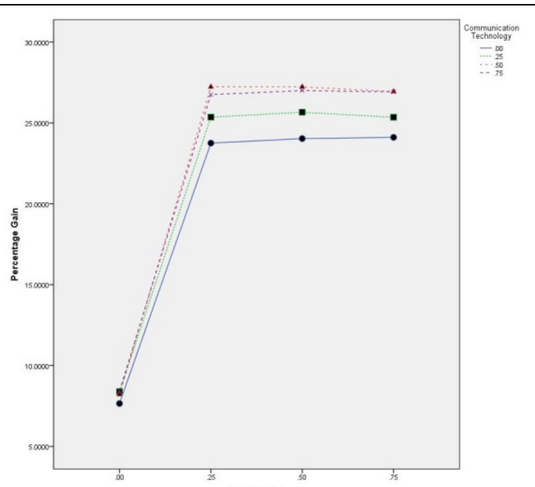
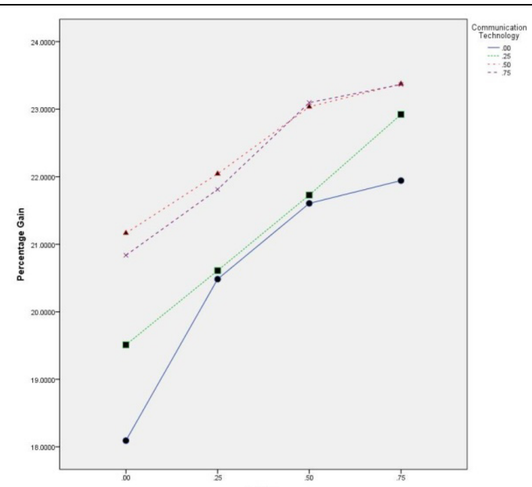
Figure 12. Main Effects for Communication Technology

What was the effect of using communication technologies on post-acquisition knowledge? Figure 12 illustrates the main effects of the manipulation of communication technology effectiveness over the average effect for all levels of the non-manipulated factors (appropriation of knowledge, appropriation of culture, and use of knowledge repository). As observed in the left side panel of this figure, when acquiring explorative innovation via the acquisition of an exploration oriented target firm, the use of communication technologies yields increasing gains. The gains are highest when communication technologies are used moderately; thus the growth pattern has a distinctly concave shape. When acquiring exploitative innovation, the use of communication technologies has linearly increasing returns. However, these returns are consistently negative across all levels of communication technology usage.



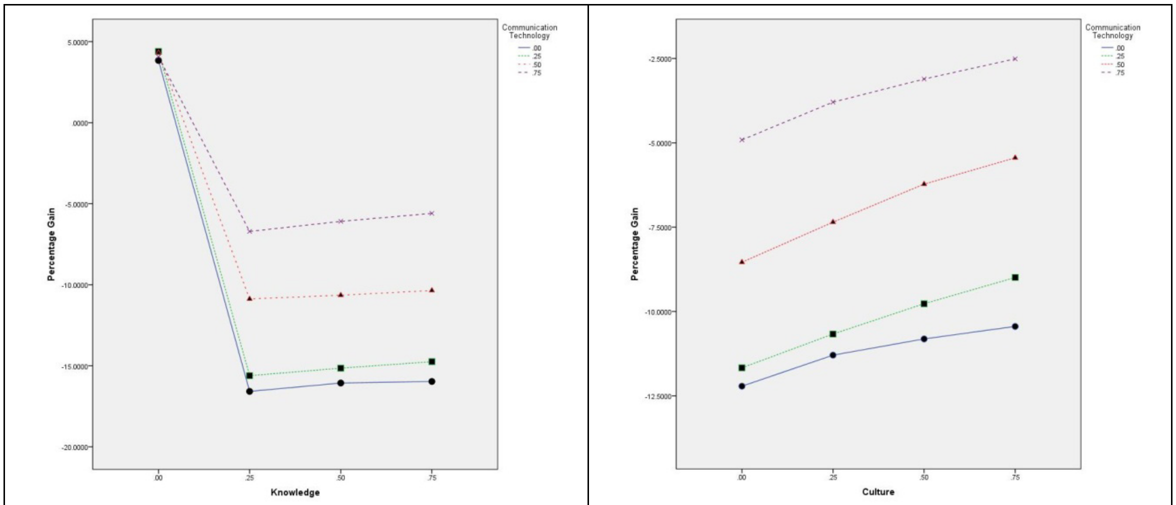
With Appropriation of Knowledge



With Appropriation of Culture

Figure 13. Interaction Effects for Communication Technology when Acquiring Explorative Innovation

What was the impact of using communication technologies under different levels of appropriation of knowledge and appropriation of culture under the condition of acquiring explorative innovation? Figure 13 depicts the interaction effects of the two integration strategies with communication technology use in such a scenario. Four observations are of particular merit. First, a low level of communication technology use (25 percent, dotted green line) provides the lowest percentage gain in post-acquisition knowledge, across all levels of appropriation of knowledge and appropriation of culture. Second, the returns from moderate and high levels of usage of communication technologies are the highest and nearly similar across all levels of knowledge and culture appropriation. Third, the relative gains from use of communication technology do not vary across increasing levels of appropriation of knowledge. Fourth, gains from communication technologies increase with the proportion of culture appropriated from the target firm.



With Appropriation of Knowledge | **With Appropriation of Culture**

Figure 14. Interaction Effects for Communication Technology when Acquiring Exploitative Innovation

What was the impact of using communication technologies under different levels of appropriation of knowledge and appropriation of culture while acquiring exploitative innovation? Figure 14 depicts the interaction effects of the two integration strategies with effectiveness of communication technologies. Several insights can be gained from the manipulation of communication technology use under varying levels of knowledge and culture appropriation. First, the use of communication technologies has consistently negative returns in all situations. Second, a high level of communication technology use (75 percent, dashed purple line) provides the highest percentage gain in post-acquisition knowledge, across all levels of appropriation of knowledge and appropriation of culture. Third, the use of communication technologies has linearly increasing returns across increasing levels of appropriation of knowledge or culture. Thus, gains from communication technologies increase with the proportion of knowledge (culture) appropriated from the target firm and are greatest at high levels of appropriation of knowledge (culture).

These observations are supported by a simple main effect for use of communication technology when acquiring an exploration oriented target firm ($F(3, 101199) = 118.4$, $p < .001$). Post hoc analysis supports the observation of significant gains across all levels, with a not significant decrease in gains when moving from the 50 percent to the 75 percent level ($p = .79$, not significant) (Tukey 1953). A significant main effect was also observed when acquiring an exploitation oriented target firm ($F(3, 102399) = 6686.4$, $p < .001$). A post-hoc analysis using the Tukey HSD method reveals significant positive gains between all levels: 0 percent to 25 percent ($p < .001$), 25 percent to 50 percent ($p < .001$) and 50 percent to 100 percent ($p < .001$).

Statistical results also provide evidence for significant interaction effects of the use of communication technologies and the appropriation of knowledge ($F(9, 101199) = 11.6$, $p < .001$) and the appropriation of culture ($F(9, 101199) = 2.2$, $p < .05$) when acquiring explorative innovation. The observation of significant gains in returns under increasing levels of appropriation of culture is supported at the 50 to 75 percentage level for a high level of communication technology use ($p < .01$), while post-hoc analysis is able to a significant gain in returns only at the 50 to 75 percentage levels of knowledge under high and moderate use of communication technology (Tukey 1953). When acquiring exploitative innovation, significant interaction effects are evidenced between use of communication technologies and appropriation of knowledge ($F(9, 102399) = 739.2$, $p < .001$) and use of communication technologies and appropriation of culture ($F(9, 102399) = 9.2$, $p < .001$). Post-hoc analysis suggests that gains are positive and significant at $p < .01$ across all levels of appropriation of knowledge (0 percent to 25 percent, 25 percent to 50 percent, and 50 percent to 75 percent) for low and high use of communication technologies and at $p < .01$ across all levels of appropriation of culture and use of communication technologies (Tukey 1953). These results are embodied in the following propositions:

Proposition 7: Use of communication technologies will augment the acquisition of explorative innovation under all conditions of appropriation of knowledge and appropriation of culture, with moderate and high use yielding equivalent greatest returns under all conditions of appropriation of knowledge and under high appropriation of culture, and moderate use yielding greatest returns under low appropriation of culture.

Proposition 8: Use of communication technologies will augment the acquisition of exploitative innovation under all conditions of appropriation of knowledge and appropriation of culture, with high use yielding greatest (least negative) returns under all conditions of appropriation of knowledge and appropriation of culture.

7.6.7 The Joint Impact of IT-enabled Learning Mechanisms

What was the impact of using a knowledge repository under different levels of communication technology use? As seen in Figure 15 and Figure 18, the relative gains from the use of a knowledge repository vary with different levels of use of communication technologies. This is supported by significant interaction effects, both when acquiring explorative innovation (F(9, 101199) = 40.6, p < .001) and when acquiring exploitative innovation (F(9, 102399) = 3146.6, p < .001).

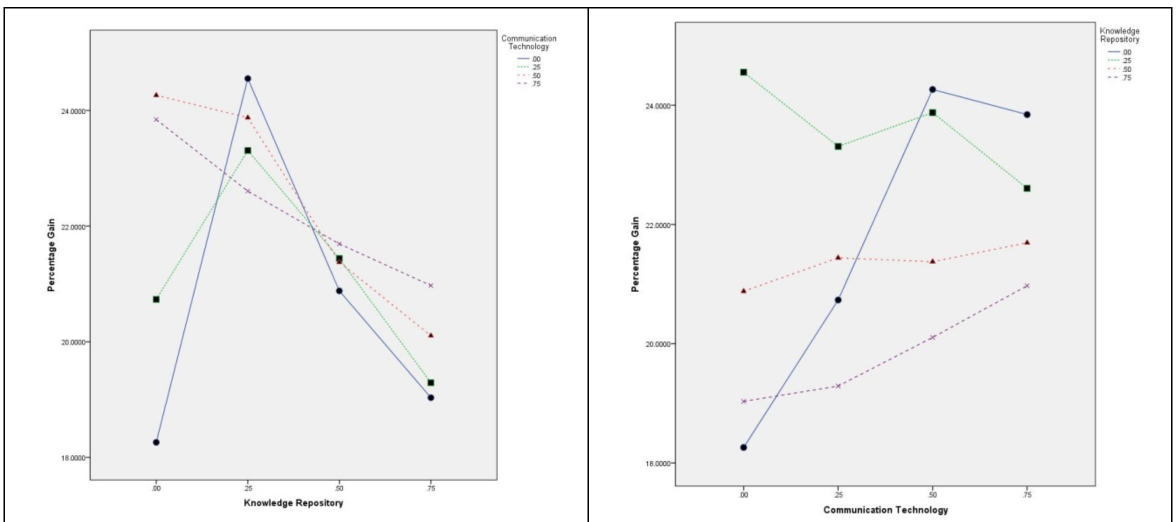


Figure 15. Interaction Effects of IT-enabled Learning Mechanisms when Acquiring Explorative Innovation

Figure 15 illustrates the interaction effect of the two IT-enabled learning mechanisms when acquiring explorative innovation. When acquiring an exploration oriented target firm, the use of a knowledge repository in concert with communication technologies yields significantly better returns than when using either IT-enabled learning mechanism alone. This effect is particularly strong in two situations. These observations are replicated when analyzing the interaction effect of the IT-enabled learning mechanisms across different levels of appropriation of knowledge and appropriation of culture.

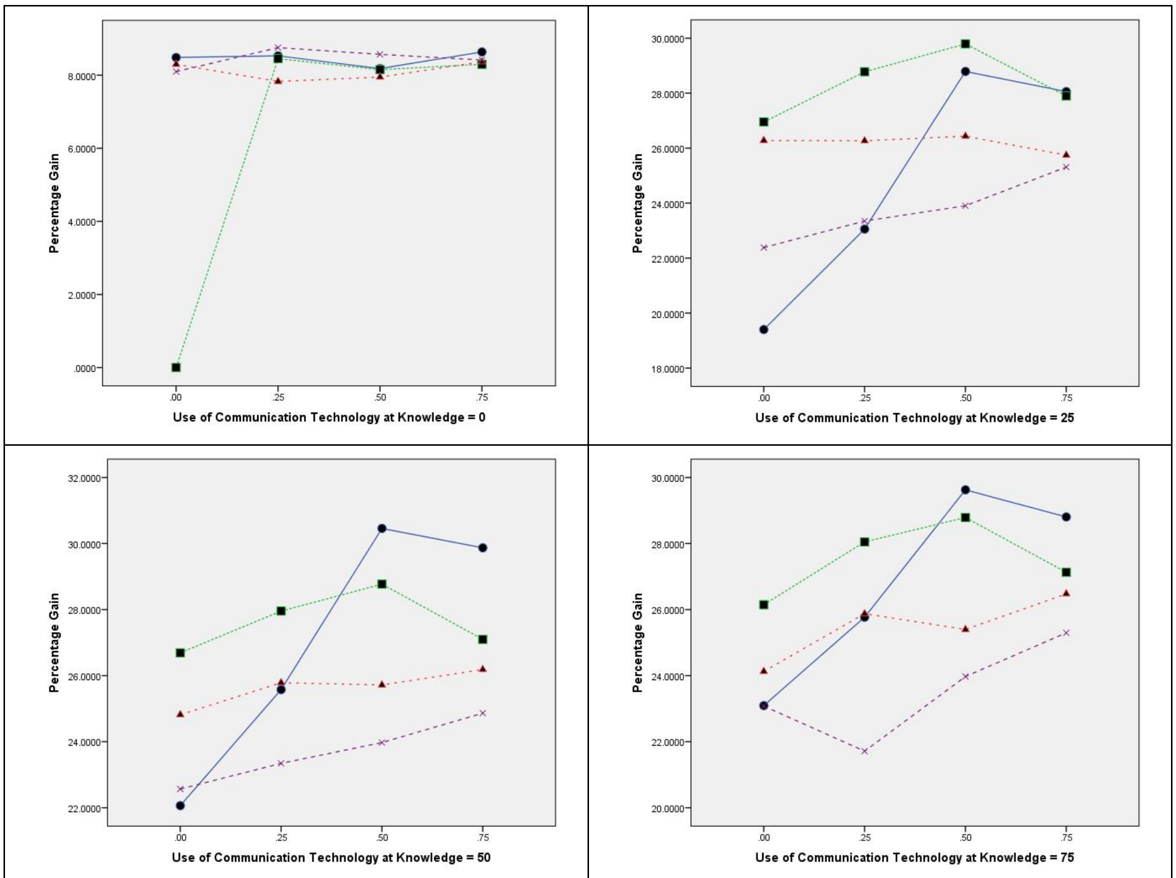


Figure 16. Interaction Effects for Knowledge Repository, Communication Technology, and Knowledge when Acquiring Explorative Innovation

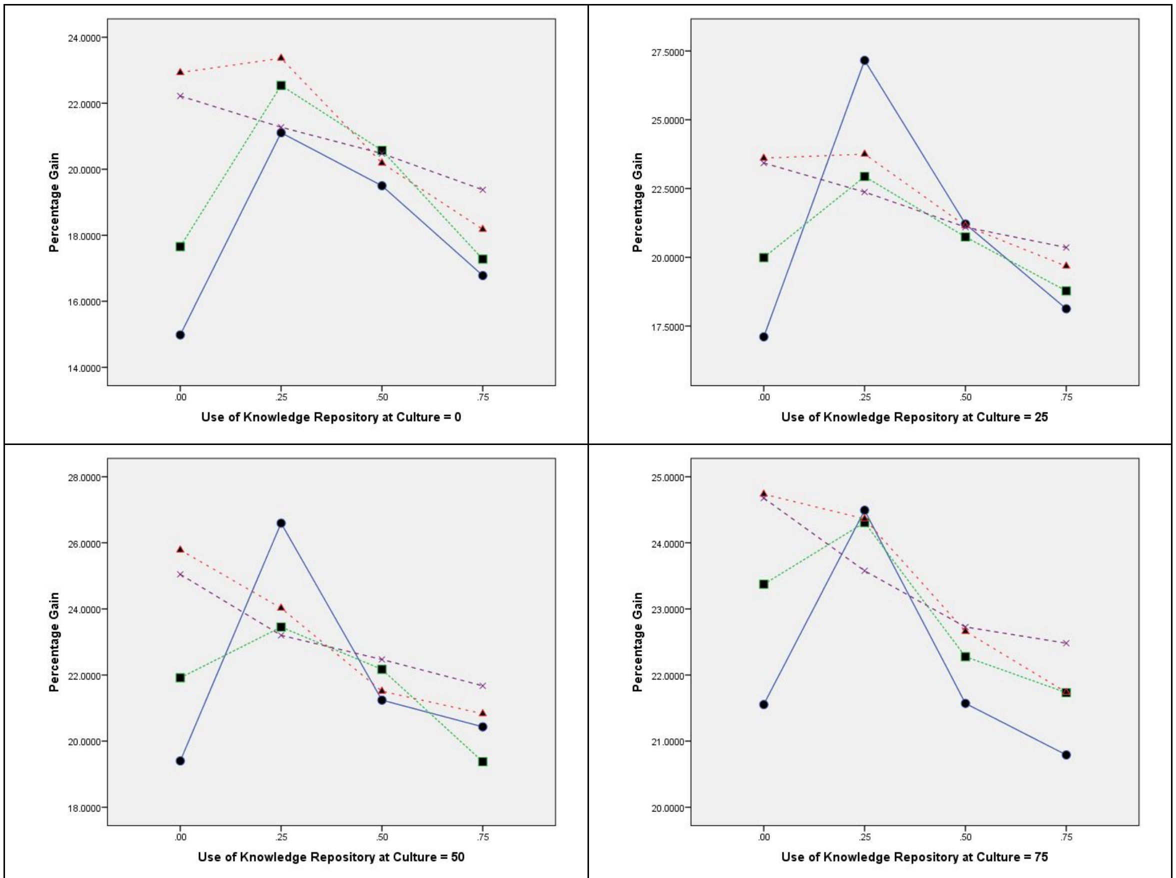


Figure 17. Interaction Effects for Knowledge Repository, Communication Technology, and Culture when Acquiring Explorative Innovation

First, at low levels of communication technology use, low use of a knowledge repository yields optimum gains. Figure 16 illustrates the knowledge gains from different levels of use of a knowledge repository (depicted as lines), across different levels of communication technology use, for different levels of appropriation of knowledge. There is a consistent pattern across all four panels of this figure, wherein at low levels of communication technology use (25 percent), a low level of knowledge repository use (green dotted line) yields maximum returns. Second, at moderate and high levels of use of a knowledge repository, a high level of communication technology use yields the highest performance gains. Figure 17 shows the knowledge gains from different levels of communication technology use (illustrated as lines), across different levels of knowledge repository use, for different levels of appropriation of culture. Again, the observation holds across all four panels of this figure, whereby a high level of communication technology use (dashed purple line) yield greatest returns at moderate (50 percent) and high levels (75 percent) of use of a knowledge repository.

Figure 18 illustrates the interaction effect of the two IT-enabled learning mechanisms when acquiring exploitative innovation. When acquiring an exploitation oriented target firm, the gains from use of a knowledge repository are significantly increased as higher levels of communication technologies are used. This observation is replicated when analyzing the interaction effect of the IT-enabled learning mechanisms across different levels of appropriation of knowledge and appropriation of culture.

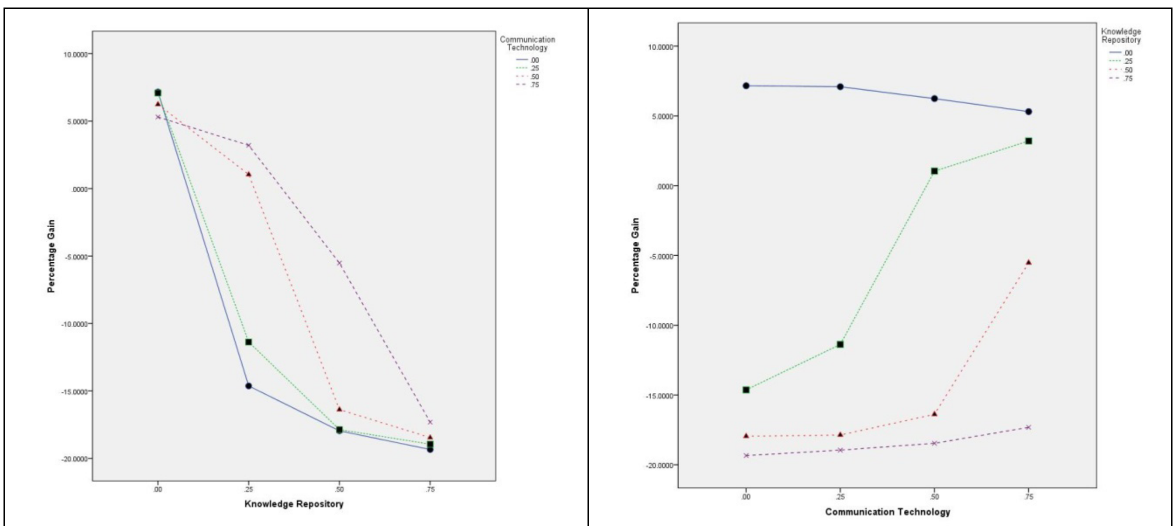


Figure 18. Interaction Effects of IT-enabled Learning Mechanisms when Acquiring Exploitative Innovation

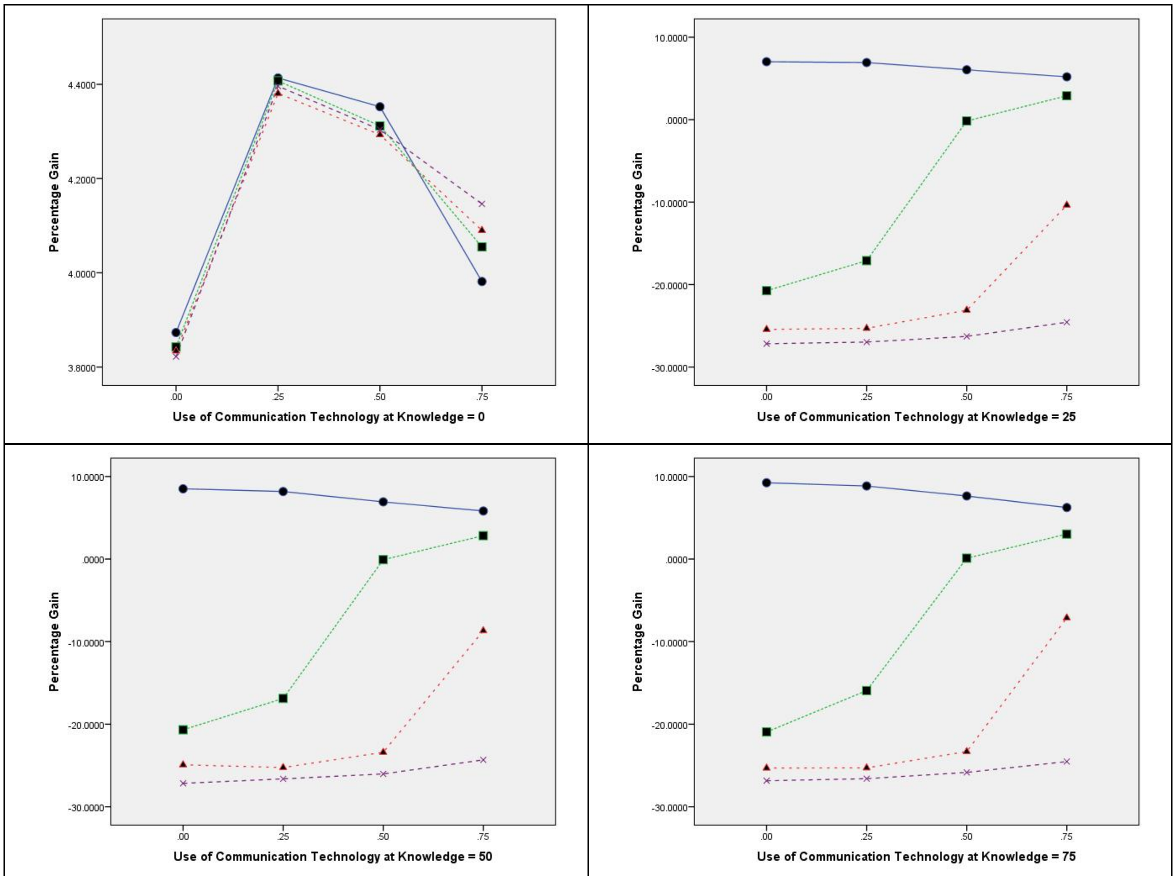


Figure 19. Interaction Effects for Knowledge Repository, Communication Technology, and Knowledge when Acquiring Exploitative Innovation

Figure 19 illustrates gains from knowledge repository use (depicted as lines) across different levels of communication technology use, for different levels of appropriation of knowledge. There is a consistent pattern across three panels of this figure, wherein at high levels of communication technology use (75 percent), all levels of knowledge repository use yield maximum returns. Thus, at low levels of knowledge repository use, high levels of communication technology use yield maximum returns. Figure 20 shows the knowledge gains from communication technology use (illustrated as lines) across different levels of knowledge repository use, for different levels of appropriation of culture. The pattern is repeated across all four panels of this figure, wherein a high level of communication technology use (dashed purple line) yields greatest returns at all levels of knowledge repository use. A second, related observation of merit is that gains from communication technology use are maximized at low (25 percent) levels of use of a knowledge repository.

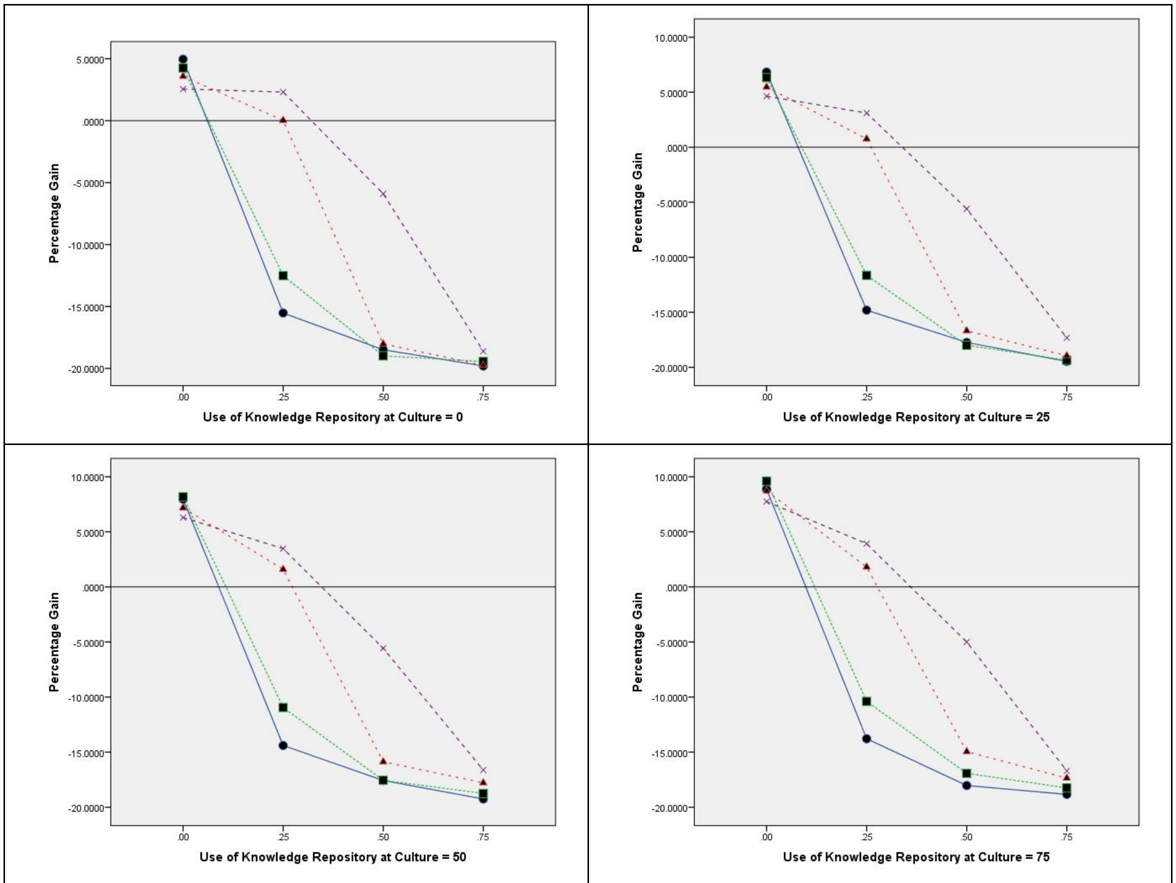


Figure 20. Interaction Effects for Knowledge Repository, Communication Technology, and Culture when Acquiring Exploitative Innovation

These observations enable me to offer the following propositions:

Proposition 9: The marginal contribution from use of communication technologies decreases as use of a knowledge repository increases when acquiring either explorative or exploitative innovation.

Proposition 10: The marginal contribution from use of a knowledge repository increases as use of communication technologies increases when acquiring either explorative or exploitative innovation.

7.6.8 The Impact of Turnover and Turbulence

What was the impact of environmental turbulence and employee turnover on the effects of the two IT-enabled learning mechanisms and the two integration strategies? For the first experiment, I manipulated these constructs (p_k, p_c, p_{kr} and p_{cl}), across four levels (0.0, 0.25, 0.50, 0.75) for the acquisition of explorative innovation and the acquisition of exploitative innovation. To validate my model further and determine the validity of my prior results in an open system, I introduced extreme high values of both turnover and turbulence (p_4 = 0.05, p_3 = 0.05). For this purpose, I performed two analyses.

First, I replicated the first experiment with turbulence and turnover. Thus, I manipulated the two IT-enabled learning mechanisms and the two integration strategies (p_k, p_c, p_{kr} and p_{cl}), across four levels (0.0, 0.25, 0.50, 0.75) for both acquisition scenarios while maintaining high values for turnover and turbulence. The results in the presence of turnover and turbulence were qualitatively similar to those obtained in the absence of these two parameters. Thus, I again found significant main effects for both integration strategies and both IT-enabled learning mechanisms under conditions of acquiring explorative and exploitative innovation. I also found interaction effects similar to those found in the closed system.

Second, I compared the relative knowledge gain across both types of systems. For this purpose, I compared the results of extreme values of the two IT-enabled learning mechanisms and the two integration strategies. When acquiring an exploration oriented firm, there was a marginally statistically significant difference between a closed and an open system ($t = -1.43$, $p = .154$, not significant for a two-tailed test). Thus, turnover and turbulence had a marginal effect when acquiring exploratory innovation. However, when acquiring an exploitation oriented target firm, a higher mean value of knowledge gain was observed in an open system ($t = -9.08$, $p < .001$). Thus, turnover and turbulence resulted in an increase in the overall knowledge levels witnessed in the system and strengthening of prior observed relationships. This therefore enables me to validate that my results hold in an open system, consisting of turbulence and turnover, which more closely models a real world situation as compared to a closed system.

7.6.9 Other Validation Concerns

Traditional validation techniques do not work with simulation models due to the high complexity and multi-causal nature of the model. Further, it is difficult to capture real world data and generate the complete response surface of the model (Carley 2009). My computational model builds upon the model of organizational learning by March (1991) and the exploration-exploitation model, and hence has high validity. The Extended EEA model exhibits computational validity through balance of purpose, experimental design and model (Burton 2003; Burton and Obel 1995). My assumptions and extensions to the original model are grounded in theory and thereby have theoretical integration. I also ensure validation in parts and conditional validation. I provide validation of reasoning by proceeding with intellective simulations (presentation of results of input of extreme values into the model), validation of representation and validation of usefulness. Through these processes, I ensure consistency with real world phenomena. As a final measure of validity, I have replicated the results of March's original experiment, and the experiments of the EEA model, and thus exhibit numerical equivalence, the strongest level of equivalence.

7.7 Discussion

Over the last two chapters of this dissertation, I have described how organizations pursue acquisitions as a source of exploration or exploitation. Such acquisitions provide a means for firms to gain knowledge which they do not possess (Puranam et al. 2006; Puranam and Srikanth 2007) and stimulate the development of new ideas and thus generate broader long-term knowledge (Leonard-Barton 1995; Levitt and March 1988). Acquisitions also help rebalance exploration and exploitation within a firm by providing impetus to existing, but stagnated internal exploration or exploitation (Higgins and Rodriguez 2006). As an instance of organizational ambidexterity (Raisch et al. 2009), this strategy enables firms to attain a competitive advantage. I asserted that IT-enabled learning mechanisms augment the gains from such acquisitions, thereby making external ambidexterity an emergent possibility in the 21st century. Or in other words, in the 21st century, IT enables firms to be like Janus.

To examine this assertion, I conducted computational experiments based upon an extension to the March model of exploration and exploitation. Specifically, I extended the model in context of acquisitions by introducing two different IT-enabled learning mechanisms – communication technologies and knowledge repositories (Bray and Prietula 2007; Kane and Alavi 2007). Research suggests that Web 2.0 based knowledge repositories such as knowledge management systems, corporate blogs and wikis play a key role in knowledge capture, assimilation, management and dissemination. Web 2.0 based electronic communication technologies such as micro-blogs also play an increasingly key role in knowledge dissemination with an organization. I modeled the impact of these two types of IT-enabled learning mechanisms in a post-acquisition, integration setting. Through this agent-based model of external ambidexterity, I examined the individual and joint impacts of four constructs on the success of technology acquisitions: the post-acquisition strategy of appropriation of knowledge through the retention of employees, the post-acquisition strategy of appropriation of culture through the adoption of organizational beliefs, and the two IT-enabled learning mechanisms. While extant research indicated that all four of these constructs matter, the precise relationship between them and their individual and joint impacts on post-acquisition performance conditions was unclear, as many confounding factors in prior observational studies made comparisons difficult across different levels.

Overall, besides contributing towards the emergent literature on organizational ambidexterity and the literature that speaks towards the indirect effects of IT on competitive advantage, this study contributes to the mergers and acquisitions literatures in finance, strategy, and information systems. Prior research in the areas of finance and strategic management has identified several antecedents to the success of mergers and acquisitions in general, and technology acquisitions in particular. However, these antecedents do not fully explain value creation or destruction mechanisms in these acquisitions due to the absence of fine-grained measures and data (Capron and Pistre 2002; King et al. 2004; Moeller et al. 2005). My findings contribute towards this literature by presenting the individual and joint effects of appropriation of knowledge and appropriation of culture as two value creating mechanisms, and knowledge repositories and communication technologies as two value enhancing mechanisms in technology acquisitions. These findings are particularly strong for the case of acquiring explorative innovation through technology acquisitions. A summary of the derived propositions is presented in Table 13.

Table 13. Summary of Propositions on External Ambidexterity
P1: Appropriation of knowledge will augment the acquisition of explorative innovation, with lower appropriation yielding greatest returns.
P2: Appropriation of knowledge will impede the acquisition of exploitative innovation, with higher appropriation yielding greatest (least negative) returns.
P3: Appropriation of culture will augment the acquisition of explorative innovation, with higher appropriation yielding greatest returns.
P4: Appropriation of culture will augment the acquisition of exploitative innovation, with higher appropriation yielding greatest (least negative) returns.
P5: Use of a knowledge repository will augment the acquisition of explorative innovation under all conditions of appropriation of knowledge and appropriation of culture, with low use yielding greatest returns under all conditions of appropriation of knowledge and appropriation of culture.
P6: Use of a knowledge repository will impede the acquisition of exploitative innovation under all conditions of appropriation of knowledge and appropriation of culture, with low use yielding greatest (least negative) returns under all conditions of appropriation of knowledge and appropriation of culture.
P7: Use of communication technologies will augment the acquisition of explorative innovation under all conditions of appropriation of knowledge and appropriation of culture, with moderate and high use yielding equivalent greatest returns under all conditions of appropriation of knowledge and under high appropriation of culture, and moderate use yielding greatest returns under low appropriation of culture.
P8: Use of communication technologies will augment the acquisition of exploitative innovation under all conditions of appropriation of knowledge and appropriation of culture, with high use yielding greatest (least negative) returns under all conditions of appropriation of knowledge and appropriation of culture.
P9: The marginal contribution from use of communication technologies decreases as use of a knowledge repository increases when acquiring either explorative or exploitative innovation.
P10: The marginal contribution from use of a knowledge repository increases as use of communication technologies increases when acquiring either explorative or exploitative innovation.

My findings regarding the *appropriation of knowledge* suggest that the acquisition of explorative innovation benefits from this integration strategy. I have found that relatively lower appropriation of knowledge (via lower retention of employees from the target firm) yields the greatest relative gain in post-acquisition performance when acquiring explorative innovation. On the contrary, I have found that when acquiring exploitative innovation, the appropriation of knowledge results in decreased yields from the acquisition. In such a situation, the least negative returns accrue when appropriating a higher level of knowledge. I also found that the marginal returns to knowledge appropriation are nonlinear when balancing exploration or exploitation. These findings add to the debate regarding the impact of knowledge in prior literature. There is agreement across the areas of finance, strategy and information systems that personnel retention is critical in the post-acquisition transfer of specialized knowledge, such as that regarding IT applications and tools (Niederman and Baker 2009). However, previous research argues that in technology acquisitions, the majority of knowledge that the acquiring firm desires may be specialized and reside in specific areas of the target firm, such as technical knowledge that resides in the Research and Development area or market knowledge residing in the sales force (Birkinshaw 1999). This implies that appropriation of higher levels of knowledge will yield decreasing returns as retaining employees from other parts of the target firm might not yield specific technological knowledge that is important to the acquiring firm (Ranft and Lord 2002). Research also suggests that the integration of highly complex knowledge, such as IT skills and competencies, within large collaborative environments is fraught with decreasing marginal returns. On the other hand, other research asserts lower levels of knowledge appropriation undermine capability development in the acquiring firm (Meyer and Lieb-Doczy 2003). My findings suggest both positions may hold true – it is the nature of the acquisition that determines the impact of knowledge appropriation. When an exploitation oriented firm acquires an exploration oriented target firm, lower numbers of retained employees introduce divergent views that they are able to sustain even while being subjected to stronger pressures to adopt the acquiring firm's beliefs, leading to higher long term knowledge development. On the other hand, when an exploration oriented firm acquires an exploitation oriented target firm, higher numbers of retained employees are able to sustain divergent, though relatively incorrect views for a longer time.

These findings imply that firms may consider adopting a selective employee retention strategy when acquiring explorative innovation to balance their in-house exploitative innovation efforts. Similarly, firms may consider adopting full employee retention strategy when acquiring exploitative innovation to balance their in-house explorative innovation efforts.

My findings regarding the *appropriation of culture* demonstrate that the acquisition of both explorative and exploitative innovation benefits from this integration strategy. Appropriation of culture has been identified as an antecedent to the success of mergers and acquisitions in general, and to the success of technology acquisitions in particular (Stahl and Voigt 2008; Weber and Camerer 2003). My findings align with the results of this prior research and shed light on how differing magnitudes of cultural appropriation impact relative post-acquisition performance. These findings also resonate with and have implications towards prior research that finds that organizational context and workplace characteristics matter to knowledge workers as adopting culture, practices and beliefs facilitates common language, values and principles (Ahuja et al. 2007; Tanriverdi and Uysal 2010).

I have found that relatively higher appropriation of culture (via adoption of organizational beliefs from the target firm) yields the greatest relative gain in post-acquisition performance when acquiring explorative innovation. Similarly, I have discerned that when acquiring exploitative innovation, the appropriation of culture results in increasing yields from the acquisition. Appropriating a higher level of culture also yields maximum returns in this scenario. I also found that the marginal returns to the appropriation of culture are linear when acquiring either explorative or exploitative innovation. These findings suggest that culture plays a key role in technology acquisitions, irrespective of the nature of the acquisition. When an exploitation oriented firm acquires an exploration oriented target firm, the adoption of a higher number of relatively superior beliefs from the target firm leads to higher long term knowledge development. On the other hand, when an exploration oriented firm acquires an exploitation oriented target firm, adoption of greater levels of beliefs from the target firm introduces divergent ideas, which produces higher knowledge in the long term by expanding the search space of knowledge within the organization (Carley 1992; Rivkin and Siggelkow 2007). These findings imply that when acquiring explorative or exploitative innovation to balance their in-house exploitative or explorative innovation efforts, firms may consider adopting a complete culture appropriation strategy. This also suggests strategic choices of resource constraint driven appropriation of low levels of knowledge versus returns maximization driven appropriation of high levels of culture.

My findings regarding the *effectiveness of a knowledge repository* suggest the acquisition of explorative innovation benefits from the use of this IT-enabled learning mechanism under all conditions of appropriation of knowledge and appropriation of culture. Similar to the appropriation of knowledge, I have found that relatively lower use of knowledge repository yields the greatest relative gain in post-acquisition performance when acquiring explorative innovation. This finding holds across all conditions of the two integration strategies of appropriation of knowledge and appropriation of culture. On the contrary, I have found that when acquiring exploitative innovation, the use of a knowledge repository results in decreased yields from the acquisition, under all condition of knowledge and culture appropriation. Similar to the scenario of acquiring explorative innovation, relatively lower use of knowledge repositories yields the greatest relative gain (accrues the least negative returns) in post-acquisition performance when acquiring exploitative innovation. I have also found that when balancing exploration or exploitation, the increasing use of a knowledge repository has decreasing returns. These results speak towards the debate in the literature on the effectiveness of the knowledge management capabilities of information systems (Grover and Davenport 2001). Research has suggesting that barriers to use are responsible for the reported mixed results regarding the effectiveness of such systems (Choi 2003; Kankanhalli et al. 2005; Tanriverdi 2005). My findings suggest that knowledge repositories and similar systems have a limited effectiveness. Recall that I had earlier found that organizational ambidexterity is impeded by software IT resources and Informate IT capability. I had postulated that this is due to ossification of existing business processes and practices, which results in decreased organizational flexibility. A similar effect may be caused by Web 2.0 based knowledge repositories, which entail elements of knowledge management systems and wikis. Though these systems enable knowledge creation, transfer, storage, retrieval and application, they maintain a static, time-invariant snapshot of organizational beliefs and knowledge. For example, GE Capital India deployed a Web 2.0 based knowledge repository, entitled EDGE, as the primary repository of all important corporate information. Content on EDGE does not time out unless specifically removed by the administrator. When used in the context of a technology acquisition, such a system over time may impede the development of new knowledge and the integration of acquired explorative or exploitative innovation.

However, these findings also imply that at low levels of appropriation of knowledge, the use of a knowledge repository can improve the yield from an acquisition of an exploration oriented target firm. This implies that a low level usage of a knowledge repository can substitute for higher levels of employee retention in an acquisition. Thus, instead of focusing efforts on attempting to retain higher numbers of acquired employees, firms can focus their energies on deploying a knowledge repository to capture the knowledge of a small number of acquired employees. Low use of this repository by the firm's employees will yield greater payoffs than expending valuable resources in accommodating greater numbers of acquired employees within the firm.

My findings regarding the *effectiveness of communication technologies* highlight that the acquisition of explorative and exploitative innovation benefit from the use of this IT-enabled learning mechanism under all conditions of appropriation of knowledge and appropriation of culture. I have found that relatively high use of communication technologies yields the greatest relative gain in post-acquisition performance when acquiring exploitative innovation. This finding holds across all conditions of the two integration strategies of appropriation of knowledge and appropriation of culture. On the contrary, I have found that when acquiring explorative innovation, the moderate and high use of communication technologies results in equivalent highest yields from the acquisition, under all conditions of knowledge appropriation and high appropriation of culture. However, a moderate use of communication technologies yields the highest returns under low appropriation of culture, when acquiring explorative innovation. Overall, I have found that when acquiring an exploitation oriented firm, the increasing use of communication technologies has increasing returns, while returns are highest at a moderate level of effectiveness of communication technologies when acquiring an exploration oriented firm. I also found that the marginal contribution from use of communication technologies decreases as use of a knowledge repository increases when acquiring either explorative or exploitative innovation, while the marginal contribution from use of a knowledge repository increases as use of communication technologies increases when acquiring either explorative or exploitative innovation.

Prior research suggests that communication technologies are an exploration oriented IT-enabled learning mechanism, which sustains divergent views within the organization (Kane and Alavi 2007). My results speak towards this research and suggest that higher yields do not occur across all scenarios. This also ties in with prior research that argues that the use of organizational memory and collaboration enhancing information technologies may impede knowledge sharing if not used appropriately within a portfolio of technologies (Kankanhalli et al. 2005; Robey et al. 2000). These findings also speak towards my previously reported results. I had found that enhanced inter and intra organizational integration results in technical IT resources and Transform IT capability facilitating organizational ambidexterity. Communication technologies also result in higher integration of the acquired knowledge and thus improved returns from a technology acquisition.

These results imply that firms may choose to incentivize the level of use of a Web 2.0 based communication technology based on the purpose of the acquisition and the choice of integration strategy. When acquiring explorative innovation, the effectiveness of a low culture appropriation strategy may be enhanced by moderate use of communication technologies. In all other scenarios and when acquiring exploitative innovation, firms may receive greater benefits from pursuing a high use of communication technologies. Further, the use of communication technologies can substitute for higher levels of employee retention or cultural adoption in an acquisition. Low levels of knowledge repository usage can further enhance the effectiveness of a Web 2.0 based communication technology.

Overall, I have found that post-acquisition integration strategies and IT-enabled learning mechanisms have different impacts on the external acquisition of exploration or exploitation. A combination of low appropriation of knowledge, high appropriation of culture, low use of a knowledge repository and moderate use of communication technologies yield highest returns when an exploitation oriented firm acquires an exploration oriented firm. On the other hand, a combination of high appropriation of knowledge, high appropriation of culture, low use of a knowledge repository and high use of communication technologies yield highest returns when an exploration oriented firm acquires an exploitation oriented firm.

These insights have implications for not only the information systems research streams on mergers and acquisitions, IT integration and knowledge management, but also for the much larger research stream on technology acquisitions in the strategic management literature. Much of the extant research considers the effectiveness of integration strategies. For example, recent work asserts that acquiring organizations need to take two decisions: 'which employees to retain' and 'whose practices to use' (Tanriverdi and Uysal 2010). My findings demonstrate that not only do appropriation of knowledge and culture enhance the success of acquisitions, but IT-enabled learning mechanisms can provide complementary strategies.

7.8 Conclusion

The use of acquisitions to balance explorative and exploitative innovation activities is a key means by which firms achieve organizational ambidexterity. I posited that IT-enabled learning mechanisms such as the use of knowledge repositories and communication technologies can enhance the effectiveness of the knowledge transfer decisions taken by the acquiring firm during the acquisition process. Acquiring firms can choose to vary the number of employees they retain from target firms, and thereby vary the amount of knowledge acquired through the acquisition. Similarly, they can choose to vary the amount of organizational beliefs they adopt from the target firm and hence vary the amount of culture adopted through the acquisition. Besides the immediate changes that occur to organizational beliefs through adoption of beliefs from the target firm, changes may also happen over time as a consequence of retention of employees. As Jim March said, "organizations do not learn, people do". The complementary sets of knowledge of the employees, and the knowledge embedded within them get aggregated within an organization. Organizations learn by the learning of their members, through the incoming of new members with new knowledge and through internal learning and transmission of information (Simon 1991). These gradual changes occur due to the process of the organizational beliefs reflecting the differing beliefs of the retained individuals. IT-enabled learning mechanisms can speed up or slow down these processes and thus impact the success of technology acquisitions.

My extension of March's model across organizational boundaries enabled a systematic examination of the effect of two IT-enabled learning mechanisms – knowledge repositories and electronic communication technologies, in conjunction with two transfer strategies - bottom-up knowledge transfer through retention of employees from the target firm, and top-down knowledge transfer through appropriation of culture from the target firm. This extension of the EEA model follows the traditions of cumulative research and affords the study of the links between these four constructs and March's original constructs of exploration, exploitation, personnel turnover and environmental turbulence.

In this and the previous section, I have covered the second component of my dissertation. In the previous section, I presented a review of prior research in the area technology acquisitions. In this section, I presented a discussion on computational modeling. This was followed by a description of March's model of organizational learning and the exploration-exploitation acquisition model. I then described the extended exploration-exploitation acquisition model and an experimental research design. I added a second firm to March's model and simulated the acquisition of a small technology firm by a large technology firm, for the purpose of balancing explorative and exploitative innovation. This approach enabled me to investigate the effects of IT-enabled learning mechanisms on the success of such a strategy. I presented the results of computational experiments which illuminated several insights and discussed the implications of my findings.

In the following section, I will commence the third component of this dissertation by reviewing the extant literature on organizational identity.

8 Organizational Identity

In the previous section, I explicated a computational approach in which I developed an Extended Exploration Exploitation Acquisition model and conducted computation experiments to investigate the role of IT-enabled learning mechanisms in the success of technology acquisitions. I now commence the third component of this dissertation research. First, I present a review of the literature on Organizational Identity, the third major stream of research literature that informs this dissertation. Second, I assert three theoretically developed propositions that describe the causal nature of IT capability on an organization's ability to manage multiple organizational identities. Third, I develop a computational model of IT capability and multiple organizational identities and derive propositions from computational experiments. Finally, I discuss my results and their contributions and implications.

In this section, I first introduce the concept of organizational identity. Second, I present the two main theoretical perspectives prevalent in management research regarding organizational identity. Then I highlight various definitions of the organizational identity construct from previous literature and synthesize previous research on the construction of organizational identities. Fourth, I present details on multiple organizational identities and the strategies that organizations use to manage their multiplicity of identity. Finally, I assert the theoretical view that I take in this research and provide a distinction between my conceptualization of organizational identity and similar constructs.

8.1 Introduction

Organizational identity is defined as a set of codes held by an audience that limits the features and actions expected from the organization (Hsu and Hannan 2005; Pólos et al.

2002). As a critical asset that enables competitive advantage (Fiol 1991; Fiol 2001), management of an organization's identity(ies) is an important managerial function and concern (Pratt and Foreman 2000). The value of organizational identity was unearthed over fifty years ago by Ted Levitt in his seminal article (Levitt 1960). Herein, he stated that railway companies identified themselves as railway companies, and not transportation companies, and thus failed to survive the advent of motorized and jet transportation.

Given its criticality to organizations, identity has been a subject of scientific enquiry across different fields, including strategy, organizational ecology, marketing, communications, economics, and sociology. Many researchers have addressed existential questions regarding organizational identity; others have examined the role of antecedents to the process of identity formation (Pratt and Rafaeli 1997). How identity is formed/constructed/negotiated, enacted/deployed, and reacted to are other threads of inquiry that have been pursued. Research has also investigated the effects of a salient, single identity as well as the effects of multiple identities (e.g. Fiol 2001). Studies have examined the merits of focused identities for specialist organizations versus robust identities for generalists (e.g. Swaminathan 2001).

8.2 Two Perspectives of Organizational Identity

Though organizational identity has been studied by management scholars for many years, the treatment of this construct has been inconsistent (Whetten 2006). Scholars have approached the concept of organizational identity primarily from two perspectives. The first perspective treats organizational identity as an objective property of organizations. The other perspective treats organizational identity as a belief, held by observers, about an organization. Thus, this perspective considers organizational identity to be a subjective property of an organization. These two perspectives also differ with regards to their understanding of the permanence of organizational identity. Some scholars consider organizational identity to be permanent and stable whereas others consider it to be easily alterable. Scholars also disagree on whether organizational identity is a single concept or if it consists of multiple and disparate dimensions (Whetten 2006).

In a key foundational paper, Albert and Whetten (1985) introduced the organizational identity construct. They described organizational identity as that which is central, distinctive and enduring about an organization and thus distinguishes it from others. According to this conceptualization of organizational identity, it is a set of shared beliefs that is held by the members of the organization about it. An organization's mission, its goals, practices and values enhance the notion of an organization's identity.

The other treatment of the organizational identity construct, which is also referred to as the sociological treatment of organizational identity (Baron 2004; Pólos et al. 2002), distinguishes itself from the Albert and Whetten view on the basis of belongingness to a unique social space. As per this conceptualization, belonging to an industry, membership of an accrediting body, or use of an organizational form, bestow an identity upon an organization. Organizational identity is thus a set of default expectations held by audiences regarding the organization's properties and the constraints upon these properties (Hsu and Hannan 2005; Pólos et al. 2002).

8.3 Definition and Construction of Organizational Identity

Different academic disciplines have defined organizational identity and its associated constructs in different ways, according to the position it has within their nomological net. The definition of organizational identity is intertwined with the conceptualization of how it is formed. Please refer to Table 14 for more examples of definitions of organizational identity.

Table 14. A Few Definitions of Organizational Identity
"that which is central, distinctive and enduring about an organization " (Albert and Whetten 1985)
"a cognitive image held by a member of an organization" (Dutton et al. 1994)
"a collectively held frame within which organizational participants make sense of their world" (Weick 1995)
"the set of beliefs or meanings that answer the question 'Who am I' or 'Who are we'" (Foreman and Whetten 2002; Mead 1934)
"a negotiated, interactive, reflexive concept that, at its essence, amounts to an organizational work-in-progress" (Gioia et al. 2000)
"the perception of oneness with or belongingness to an organization, where the individual defines him or herself in terms of the organization(s) in which he or she is a member" (Mael and Ashforth 1992)
"answers the question 'Who are we' in relation to larger contexts of cultural meaning" (Fiol et al. 1998)
"allows the organization to draw coherence from its past and establish future direction" (Kimberly 1987)

Organizational identity is constructed amongst an organization's stakeholders, who are defined as all those who have expectations of gain from its successful operation (Donaldson and Preston 1995). Thus, stakeholders include customers, employees, managers, suppliers and shareholders. Organizational identity is contested and negotiated through iterative interactions between stakeholders and managers. As a result of these interactions, identities can differ in their sharpness, resonance, focus, authenticity and strength (Baron 2004). Some conceptualizations of organizational identity view it as fluid and dynamic, thus an enabler of organizational adaptation to change (Gioia et al. 2000). Increasing organizational communications, enhancing visibility of stakeholders' organizational affiliations and embedding of stakeholders within the organizational community improve organizational identity construction (Scott and Lane 2000). The level of identity congruence between the identity perceptions and expectations of stakeholders affects stakeholder commitment to the organization and its form (Foreman and Whetten 2002). The communication climate and perceived external prestige are other factors that aid in the process of identity creation (Bartels et al. 2007).

8.4 Multiple Organizational Identities

Organizations have been conceptualized as capable of possessing multiple identities. Several research settings exemplify the existence of multiple identities, including non-profit firms, universities and wineries (Albert and Whetten 1985; Golden-Biddle and Rao 1997). It has been suggested that the management of these multiple identities is a primary function of organizational managers (Padgett and Ansell 1993). Thus, the existence and management of multiple identities within a single organization is an area of agreement across both perspectives of organizational identity theory. However, the two perspectives differ on the conceptualization of multiple organizational identities. Albert and Whetten (1985) view multiple organizational identities from an ideographic and holographic multiplicity standpoint. Multiple ideographic identities exist when different identities are associated with different collectives in different parts of the organization. Multiple holographic identities exist when each different identity is held by all parts of the organization. Building on this conceptualization, Pratt and Foreman (2000) posit that "organizations have multiple organizational identities when different conceptualizations exist regarding what is central, distinctive, and enduring about the organization". The term hybrid-identity organization has also been used to refer to organizations with multiple identities (e.g. Foreman and Whetten 2002). The sociological perspective adds external stakeholders to this conceptualization and thus posits that multiple organizational identities exist when organizations have low institutional consolidation of identity across different audiences. Organizational identity is a flexible and malleable concept (Gioia et al. 2000). This mutability of organizational identity is also multi-dimensional. Organizations can possess multiple organizational identities that they can project to different groups of stakeholders, thereby enabling their environmental adaptability. For example, Tata Motors reaps high benefits from maintaining distinct identities across its high-end brands such as the Jaguar XJ sports car, which retails for over $120,000, and its low-end offerings such as the Nano, which retails at $2500 (Radjou et al. 2012).

Maintaining multiple organizational identities has disadvantages and advantages. A prime problem concerning multiple identities is the potential of conflicting or opposing demands these identities may place upon the organization (Golden-Biddle and Rao 1997). This leads to the rise of strategic tensions, which may result in organizational inaction or indecisiveness, leading to a paralysis of the strategic decision making process. Alternatively, these opposing demands may lead to either intra-organizational conflict or to resource wastage due to extended intra-organizational negotiations. At the worst, an organization may risk antagonizing one audience of stakeholders at the cost of appeasing another. However, multiple identities are not always opposing and in competition (Corman and Cheney 1998). The management of multiple identities has many potential strategic benefits (Padgett and Ansell 1993). Chief among these is the ability of the organization to deal with different demands of different audiences and thus meet the expectations of multiple stakeholders. This superior response flexibility endows an organization with a competitive advantage (Gioia et al. 2000; Pratt and Foreman 2000). Response flexibility is not constrained to responses to current demands; at times multiple identities have future strategic value and thus provide options in attending to future demands that may be raised upon the organization.

Organizations manage multiple identities through a variety of strategies. Managerial communication is key to the process of identification; three communication strategies employed by managers to manage multiple identities are: comparison, use of logic, and use of support to justify identity choices (Larson and Pepper 2003). Pratt and Foreman (2000) identified four strategies along the dimensions of plurality (number of identities) and synergy (cohesiveness of identities) by which managers manage multiple identities. These strategies are compartmentalization, aggregation, deletion and integration. Other strategies include use of compensation schemes, restructuring and changes in personnel, socialization of members to myths, sequential attention to multiple identities and physical or spatial separation of sub-identities (Albert and Whetten 1985; Pratt and Foreman 2000; Pratt and Rafaeli 1997).

8.5 Conclusion

For the purpose of this research, I adopt the perspective that organizational identity is the subjective view held by its observers. Thus, the conception of organizational identity as 'consisting of codes or sets of rules, specifying the features an organization is expected to possess' speaks to my cause (Hsu and Hannan 2005; Pólos et al. 2002). Organizational identity is therefore inherent in the expectations, assumptions, and beliefs held by internal and external agents. An audience is a homogenous set of such agents and an organization with multiple identities has low institutional consolidation amongst its identities and thus projects different identities to different audiences (Hsu and Hannan 2005). I also note that organizational identity involves interactions of internal and external stakeholders and thus is not determined solely within an organization (Gioia et al. 2000).

The metaphor of a juggler has been used to describe ambidextrous organizations, which can juggle exploitation activities, or the capability to compete in mature markets or incrementally innovate, and exploration activities, or the capability to compete in emerging markets or radically innovate (O'Reilly and Tushman 2004; Tushman and O'Reilly 1996). An organization that manages multiple identities can be described using an analogy of an actor who uses different masks to portray different roles in a street play. As the actor faces different sections of the audience, she must be adept at flipping masks, and moving without interruption, from one act to another. The juggler metaphor can also apply to this situation, albeit with a small change. An organization managing multiple identities is like an expert juggler, juggling not two, but multiple balls, ergo which can juggle *multiple* identities, not just *two* strategies.

At this stage, it is pertinent that I draw the boundaries between organizational identity and other similar constructs. Organizational image has been conceptualized as both within as well as outside the organizational identity construct. I follow the prior conceptualization and view organizational identity as a set of images. The contrasting conceptualization views organizational image as a projected representation of the organization that is targeted at outsiders (Dutton and Dukerich 1991; Whetten 2006; Whetten and Mackey 2002).

On a similar line, I view organizational identity to be a self-referencing aspect of organizational culture. This is contrary to Whetten's (2006) treatment of culture as a distinguishing property of organizational identity.

Finally, I view corporate reputation as distinct from the organizational identity construct and follow the definition given by Fombrun (2001) wherein reputation represents past actions and future prospects that enable assessment of an organization by its key resource providers.

9 IT Capability and Multiple Organizational Identity

In the previous section, I presented a review of the extant literature on organizational identity. In this section, I present arguments on the role of IT capability in the successful management of organizational identities. Antecedents to the construction of organizational identity and management of multiple identities have been established in the extant literature. In the following sub-sections, I develop three theoretical propositions that form a causal model of IT capability as an antecedent to the management of multiple organizational identities.

9.1 Introduction

Research on IT capabilities suggests that organizations that achieve competitive advantage through IT do so as they are able to effectively combine their IT resources to create an IT capability that is superior to others (Bharadwaj 2000). I present theoretical arguments to reaffirm my core assertion – that an organization with a superior IT capability is able to manage the strategic tensions arising from multiple identities, thereby achieving competitive advantage and higher firm performance.

9.2 Communication of Organizational Images

Communication of attractive organizational images to an audience is a key antecedent to the formation of multiple identities (Scott and Lane 2000). This communication takes many forms and includes media exposure, advertisements, marketing communications and all other forms of customer communications and engagements. The level of communication an audience is subjected to, and how positive that communication is, are antecedent to the creation of accessible and salient identities. The amount of advertising and marketing activities a firm engages in is also antecedent to identity formation. These communications serve to establish consistent and interactive interactions with internal and external stakeholders, thereby enabling identity formation (Fombrun 1996; Gioia et al. 2000).

Superior IT capability (in comparison to other firms) enables firms to communicate attractive organizational images to external stakeholders. It helps firms to manage all stages of customer relationships (initiation, maintenance and termination stages) (Reinartz et al. 2004) through enhanced customer orientation and consistency of customer interaction, resulting in improved customer knowledge and satisfaction. These effects are increased through information sharing across supply chains (Mithas et al. 2005). This enables customer intimacy and empowers employees to respond to requests in manners consistent with identity (Lado et al. 1992), thereby projecting attractive organizational images. IT capability enables redirection of active and consistent communication towards more visible stakeholders, thereby addressing the needs of important constituents of different internal and external audiences. IT plays a key role in the projection of organizational images by enhancing communication, coordination, information search, processing and flows and by enabling realignment of a firm's resources (Bharadwaj et al. 1999). Based on these rationales, I present my first proposition as follows:

Proposition 11: A superior IT capability will improve management of multiple organizational identities through the projection of attractive organizational images.

9.3 Consistency of Organizational Behavior and Communication

Consistency of organizational behavior and communication is another important aspect in the construction and deployment of multiple organizational identities. Audiences seek consistency in the organizational identity that they are presented due to a psychological need to make sense of the organization and the need to determine what the organization actually is and how to interact with it (Albert and Whetten 1985; Ashforth and Mael 1996; Brickson 2000; Brickson 2005; Brickson 2007; Scott and Lane 2000). This consistency in the organizational identity is brought about by the consistent behavior and communication of the organization in its dealings with others. Consistency of processes, product quality, innovation, and firm performance also lead to the ability to project multiple salient identities to different audiences.

The role of IT in enhancing product and service quality has been well established in IS research. This quality enhancement is achieved by a reduction in process variance (Frei et al. 1999), which implies an increase in process consistency, which is also an important prerequisite in the successful projection of multiple organizational identities. As discussed, consistency of organizational behavior is an important factor in the successful deployment of multiple organizational identities. This includes consistency of past economic activity and performance, processes and product and service quality, all of which are enabled by a superior IT capability. Superior IT capability enhances the consistency of organizational signals by ensuring consistency in product and service quality and reduction in variance (Bharadwaj et al. 1999). Finally, the effect of IT investments on firm financial performance is also well established. IT leads to consistent and higher performance as measured through various financial parameters (Dao et al. 2007; Weill 1992). Based on these rationales, I submit the following proposition:

Proposition 12: A superior IT capability will improve management of multiple organizational identities through consistent organizational behavior and communication.

9.4 Flexibility of Organizational Resources and Routines

To effectively manage multiple organizational identities, organizations rapidly switch between their multiple identities. Multi-dimensional flexibility and malleability of organizational identity is especially important in highly turbulent and competitive markets (Brown and Eisenhardt 1997; Gioia et al. 2000). Efficient management of multiple identities requires flexible resources and routines, which can be redeployed quickly and correctly.

IT capability enables such organizational speed, agility and flexibility (Bharadwaj 2000; Overby et al. 2006; Sambamurthy et al. 2003; Sambamurthy et al. 2007). Superior IT capability facilitates sharing, reach, richness, accessibility and availability of knowledge (Alavi and Leidner 2001; Sambamurthy et al. 2003; Zahra and George 2002), thereby facilitating rapid transformations required to project different identities to different audiences. It improves resource allocation decisions by enhancing accuracy and timeliness of information regarding changing and conflicting stakeholder demands. IT capability also enables enhanced decision making and coordination processes and thus enhanced responsiveness and resource utilization (Mooney et al. 1996). IT simplifies and accelerates repetitive business processes, thereby enabling firms to develop and deploy the complex business processes required to manage multiple organizational identities. Synthesizing these arguments, I propose the following as my third proposition.

Proposition 13: A superior IT capability will improve management of multiple organizational identities through flexible organizational resources and routines.

9.5 Conclusion

The above propositions provide unique insights into the role of IT capability in managing the multiple identities. My theoretical arguments are summarized as follows: Organizations deploy and manage multiple organizational identities by projecting consistently positive organizational images and behavior towards relevant stakeholders. An organization's IT capability promotes the projection of these attractive organizational images through consistent and interactive interactions with different audiences, thereby enabling the formation and management of multiple identities. An organization's IT capability enables consistency in organizational behavior and communication, thereby enhancing the projection and differentiation between the different identities of the organization. IT capability also positively enables firms to change organizational routines and codes in a flexible manner, thereby enhancing their ability to respond to external stimuli in a way that is consistent with the identity projected towards that specific audience. Thus organizations are able to quickly and reflexively shift between their various identities. Figure 21 summarizes this theoretical model. Overall, an organization's superior IT capability endows it with the ability to manage the strategic tensions that arise from projecting multiple organizational identities. Or in other words, IT enables an organization to be like Janus.

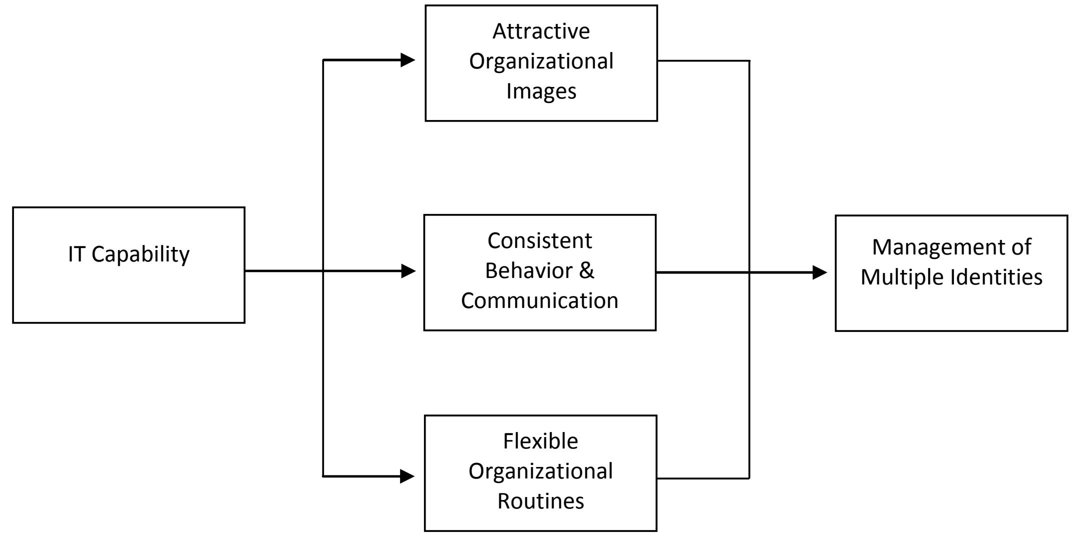


Figure 21. Causal model of IT Capability and Management of Multiple Identities

In the following section, I present a computational model for IT and organizational identities. After calibrating for external validity and replicability, I provide analyses of computational experiments. Subsequently, I generate propositions with implications for practice, theory, and subsequent research (Carley 2009; Harrison et al. 2007). Through this computational model, I focus on the interplay between a firm's IT capability and organizational identity – the strategic choices that embody how an organization seeks to manage its identity through the use of IT. Specifically, I examine the performance implications of two dimensions of an organization's multiple identities – the number of identities it has, and the degree of similarity within its identities – and its level of IT capability.

10 Computational Model of IT and Organizational Identities

In the prior section, I have identified three causal mechanisms through which a firm's IT capability acts upon its ability to manage its multiple organizational identities. To provide further insights into how differing levels of IT capability affect an organization's management of its identities, I developed an agent-based computer simulation model, the *IT Capability Organizational IDentity (ITCOID)* model. In this section, first I provide a description of the *ITCOID* model. Then I present details of computational experiments that I conducted, wherein I varied the levels of three constructs of interest: the organization's IT capability, and the synergy and plurality of its organizational identities. Finally, I present my results from these experiments and discuss the resultant derivative propositions.

10.1 Introduction

Computational simulation models are dynamic instantiations of theoretical models that incorporate causal changes in parameters over a temporal interval. By specifying models at different levels of complexity and formality, researchers can examine complex dynamics, such as those inherent in business processes, across time. Hence they are a well established research methodology, with a long tradition in management research (e.g. Cohen et al. 1972; Cyert and March 1963; March 1991).

An agent-based model is singularly suitable for my research context as these models provide the capability to manipulate the complex environment of the study and perform a range of analysis across different settings. I am able to define and manipulate a set of theoretically coherent and dynamically operating constructs, namely IT capability, identity plurality and identity synergy, at an appropriate level of abstraction. The explicit manipulation of these constructs over a large parameter space enables me to detect outcomes and behavior over time, which would be difficult to achieve in real world settings.

10.2 The ITCOID Model

Using an agent-based model, I examined how an organization's IT capability can enable it to pursue an optimum identity multiplicity strategy. Organization's can choose two mechanisms to achieve identity multiplicity - identity plurality and identity synergy (Pratt and Foreman 2000).

Identity plurality refers to the actual number of identities an organization maintains. Maintaining a low number of identities, or a low identity plurality strategy, leaves an organization with inadequate response strategies in complex environments. On the contrary, organizations with too many identities, i.e. those following a high identity plurality strategy, suffer from overload and conflict (Pratt and Foreman 2000). Like individuals, an organization has an optimum number of identities, which balances the advantage of being able to respond to different environmental demands and the disadvantage of the conflicting requirements of conforming to these identities. Higher investments in IT, and thereby in the organization's IT capability, can either increase this optimum number or the advantages accruing from a specific number of identities. Thus, organizations can gain an increase in their response strategies by having identity plurality, while not being dragged down by the burden of conflicting demands.

Identity synergy refers to the degree of convergence or divergence among an organization's identities and thus the level of agreement among its audiences about codes and expectations regarding identity (Hsu and Hannan 2005; Pratt and Foreman 2000). Organizations with a high degree of divergence among their identities, i.e. having low identity synergy, suffer from an inability to meet all strategic requirements due to confusion and ambiguity. However, low identity synergy can also be a source of power due to the range of future strategic options available to the organization (Padgett and Ansell 1993). High identity synergy, i.e. a high degree of convergence among identities, while increasing the potential of higher identity conflicts, also provides the scope for fulfilling multiple identity demands with lesser resources. Thus, similar to the case of identity plurality, an organization has an optimum degree of convergence among its identities, which can be increased by a superior IT capability.

Together, identity plurality and identity synergy signify strategic choices that an organization has towards attaining an optimum level of identity multiplicity. Low plurality or high synergy may lead to an inability to meet all strategic requirements, whereas high plurality or low synergy may result in organizational conflicts or paralysis due to competing demands (Pratt and Foreman 2000; Pratt and Rafaeli 1997). An organization's IT capability, acting through the three prior identified causal mechanisms enables an increase in this optimum level of identity multiplicity.

I incorporated these concepts into the *ITCOID* model through the following features. I modeled an organization with multiple organizational identities represented as a vectors $I_{1,y}$, $I_{2,y}$, … $I_{x,y}$, and an IT capability, ITc, represented as an integer. An identity vector has y = 50 dimensions, each of which represent the codes which specify the expectation from that identity. This conceptualization is theoretically valid with Baron's (2004) definition of organizational identity as consisting of combinations of codes (rules, assumptions, beliefs and premises) that specify the properties the organization can possess and is inherent in the expectations, assumptions, and beliefs held by internal and external agents. Identity plurality is represented by the number of vectors, x, associated with the organization. Identity synergy is the average hamming distance for all identity vector pairs, or the average number of different dimensions per identity calculated as sum of XOR of each $I_{x,y}$ for the organization. For example, an organization with two identities represented as $(0, 0, 0 \ldots 0)_{1,50}$ and $(1, 1, 1 \ldots 1)_{2,50}$ has the maximum identity synergy in this system. Here $(0, 0, 0 \ldots 0)_{1,50}$ XOR $(1, 1, 1 \ldots 1)_{2,50}$ is $(1, 1, 1 \ldots 1)$, which totals 50.

I ran the *ITCOID* model across multiple periods of time. At each time period, one of the organization's identities is randomly selected as the identity it is expected to confirm towards during that time period. Thus, at each time period, the organization attempts to project an identity that confirms to expectations. However, changing the projected identity entails a cost which is a non-linearly increasing function of the number of dimensions whose value is changed. The increasing non-linearity is a result of the progressive costs of overcoming rigidity (Hsu and Hannan 2005). The cost the organization can incur during a time period is limited by the value of its IT capability. Projecting an identity which meets the expectations of an audience generates revenue which is a non-linear increasing function of the number of dimensions that match between the projected identity and the expected identity. Thus, after each time period, the organization makes a profit, which is the difference between the revenue and cost for that period. I also incorporated an increase or decrease in the payoff function (which I define as *historical valuation*) based upon the payoff in the prior time period. I anchor this on prior theory which asserts that satisfaction or violation of identity codes affect the direction and strength of an audience's valuation of an organization. Thus, observed violations of a code cause devaluation and observed conformance cause an increase in valuations of the organization by an audience (Hsu and

Hannan 2005). When audiences share identity codes and expectations and thus the organization has high identity synergy, devaluations are stronger (Baron et al. 2001).

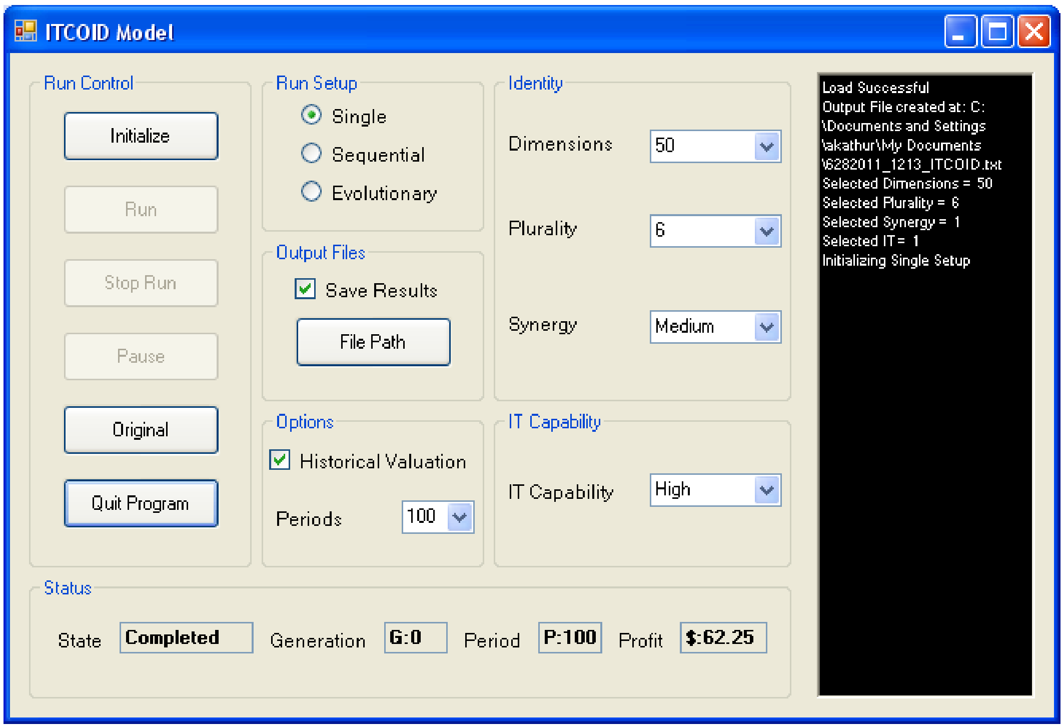


Figure 22. Screenshot of the ITCOID Model

I constructed the *ITCOID* model using VB.NET and ran it for different combinations of the input variables, with each combination being run for a number of replications to increase the reliability of our results. The initial conditions for each run were randomized to ensure that the results were not due to specific initial conditions at the commencement of the run. The main program code for the *ITCOID* model is provided in Appendix 5. Figure 22 is a screenshot of the ITCOID model.

10.3 Computational Experiment

I ran a computational experiment with a 3 x 3 x 2 factorial design. The first factor, identity plurality had three possible values – high, medium, and low, corresponding to 9, 6 and 3 organizational identities respectively. The second factor, identity synergy had three possible values of high, medium and low, corresponding to 12, 25 and 38 different dimensions respectively. The third factor, IT capability had two possible values – high and low, corresponding to 17 and 34 respectively.

For each cell in the design, I conducted 100 replications. I arrived at this number of replications based on a-priori power analysis that was conducted using G* Power (Cohen 1988; Faul et al. 2009; Faul et al. 2007). Each replication consisted of 100 time periods in which the specified setup was run. Each setup was initialized by assigning the organization with high, medium or low identity plurality and high or low IT capability. High, medium or low values of synergy were accomplished by the following method. First, each dimension of the first organizational identity vector was assigned with 0 or 1 values from a uniform distribution. These values were copied to the other identity vectors. I then randomly selected the required number (12, 25 or 38) of dimensions. For each selected dimension, I flipped the value for a random number (between 1 and plurality – 1) of the identity vectors. The initially projected identity was also randomly assigned and the historical valuation was assigned an initial value of 1. Table 15 details the different values assigned to various parameters in the simulation.

Table 15. Simulation Parameters		
Parameter	**Description**	**Values**
Identity Dimensions	Number of codes in an identity that specify features and properties that an organization is expected to possess or confirm to.	50 (we tested for a number of values across a large range from 25 to 200)
Identity Plurality	Number of identities projected by the organization	9, 6, 3
Identity Synergy	Degree of similarity among the organization's identities	12, 25, 38
IT Capability	IT capability of the organization	17, 34 (we tested specific setups across the entire range of values from 1 to 50)

At each time period, the cost, revenue, profit and historical valuation were calculated as follows: First, one of the organization's identities was randomly selected as the expected identity and for each dimension of the projected identity, if it differed from expected identity and total cost was lesser than the value of IT capability, its value was flipped. The total cost for changing the value of n dimensions was calculated as the sum of an arithmetic series:

$$Cost_t = {}^{n}\!/_{2}\ [2 + (n-1) \times 0.01]$$

Similarly, revenue for the time period was calculated as:

$$Revenue_t = {}^{n}\!/_{2}\ [2 + (n-1) \times 0.01]$$

where n is the number of dimensions of the projected identity which match the expected identity. Profit was calculated as the difference of revenue and cost for that period, multiplied by the historical valuation. Finally, the historical valuation was updated as per the following formula:

$$\begin{aligned} Historical\ Value_t \\ &= Historical\ Value_{t-1} \\ &\times [1 - (n^2/Identity\ Dimensions \times Identity\ Synergy)] \end{aligned}$$

To calibrate my model, I adhered to recent IS literature (Chang et al. 2010) and went through several iterations of model development in which I used other numerical values for the model parameters. For example, I changed the cost and revenue calculation functions to an exponential base. I also experimented with different values of initial start conditions. I also ran numerous experiments with different scales for IT capability, identity synergy and the number of identity dimensions. Despite making these changes, I did not observe any changes in the patterns, trends and qualitative results, thereby achieving calibration of my model (March 1991).

10.4 Results

What is the effect of a higher IT capability on an organization's ability to manage its multiple organizational identities under different conditions of identity plurality and identity synergy? Figure 23 illustrates the relative improvements in performance (measured as profit) across different levels of identity plurality and identity synergy. This figure depicts the manipulation of the indicated factor (synergy, black lines; plurality, grey lines) over the average effect for all levels of the non-manipulated factor (synergy, plurality) for the different levels of IT capability.

I observed several important findings from the computational experiment. First, I observed differing returns to identity plurality and identity synergy. As seen in the figure, the higher the degree of similarity among an organization's identities, the more the profit ensued. These gains were significant in proportion and exhibited a distinct linearity, with no changes in the marginal returns. On the contrary, an increase in the number of identities projected by an organization did not offer as high a benefit. Though there were gains to increasing plurality, these returns were much less in proportion and exhibited a slight non-linearity.

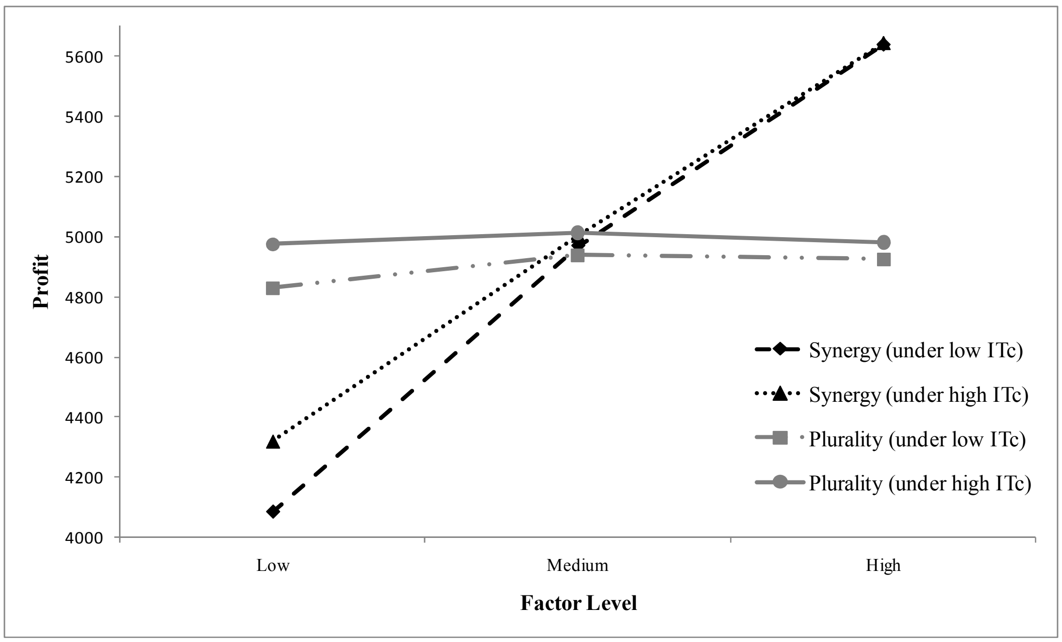


Figure 23. Simple Effects for Plurality and Synergy under IT Capability

The statistical results support these observations. There were significant main effects for identity synergy ($F(17, 1782) = 26217.5$, $p < .001$) and identity plurality ($F(17, 1782) = 72.7$, $p < .001$), where the effects for plurality were lower in magnitude to the effects for synergy. Post-hoc analysis using Tukey HSD method provided supporting evidence that for identity synergy, there were significant gains between low and medium levels ($p < .001$), and medium and high levels ($p < .001$). The post-hoc analysis also provided evidence of gains between all levels of plurality (low to medium, and medium to high), but at lower significance levels ($p < .01$).

Second, I found that IT capability leads to an increase in performance across all levels of identity plurality and identity synergy. This confirmed the assertions of my prior theorizing and model development. Again, this finding was supported by statistical results, wherein significant mains effects of IT capability were evidenced ($F(17, 1782) = 318.8$, $p < .001$).

Third, I observed that the relative gains from IT capability vary with the levels of identity plurality and identity synergy. This is supported by the significant interaction effects between IT capability and identity plurality ($F(17, 1782) = 28.8$, $p < .001$) and between IT capability and identity synergy ($F(17, 1782) = 200.3$, $p < .001$).

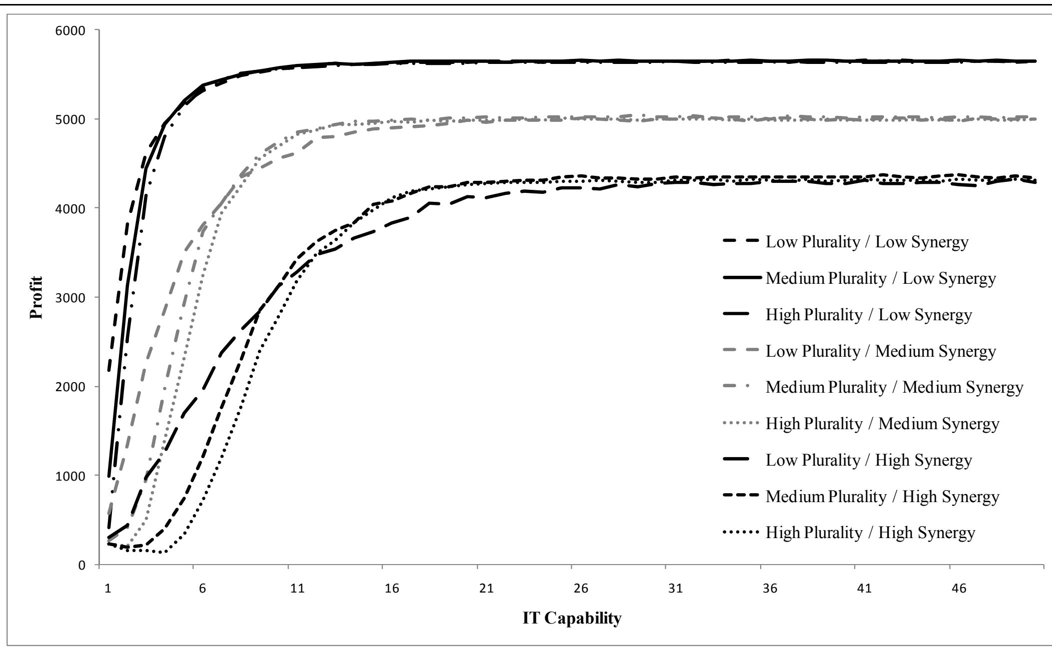


Figure 24. Simple Effects for Plurality and Synergy under IT Capability

To illustrate that these results are not a consequence of my choice of focal parameter values, I conducted additional experiments (graphically represented in Figure 24) across the entire spectrum of values for IT capability and made three observations of note. First, I observed that across all cases, low synergy yielded highest performance whereas high synergy had the lowest performance yields. Second, for all three values of synergy, at low levels of IT capability, low plurality provided maximum returns. At higher levels of IT capability, returns to high plurality became higher. Third, an increase in IT capability provided highest benefits at low values. For example, the change in performance when IT capability increased from 40 to 45 was negligible for all cases, where as there was a high increase in performance when IT capability was increased from 5 to 10. The point at which marginal returns to increases in IT capability tended to zero was different from differing combinations of synergy and plurality.

To ensure the robustness of the results, I followed the process indicated by March (1991) in his seminal paper on the exploration – exploitation model. To make certain that changes in non-focal environmental parameters only affect quantitative values and not qualitative results associated with changes in variables of interest (Chang et al. 2010), I conducted additional experiments with different values for the number of dimensions in the identity vectors. As expected, despite changes in specific quantitative results, the overall qualitative trends and patterns were the same across different values of identity dimensions.

Summarizing the above observations, I find three results of particular merit. First, an increase in IT capability adds disproportionally more gains under conditions of low synergy when compared to conditions with medium or high synergy. Second, an increase in IT capability also adds disproportionally more gains under conditions of low plurality when compared to conditions with medium or high plurality. Third, an increase in IT capability adds disproportionally more gains under conditions of low IT capability when compared to conditions with high IT capability. These findings lead me to offer my final three propositions:

Proposition 14: A superior IT capability will improve management of multiple organizational identities under conditions of low identity plurality.

Proposition 15: A superior IT capability will improve management of multiple organizational identities under conditions of low identity synergy.

Proposition 16: Marginal returns of IT capability towards managing multiple organizational identities will be improved under conditions of low IT capability.

10.5 Discussion

Multiple organizational identities are the source of many cooperating and competing demands. While organizational identity management has been an enduring managerial and academic concern, there is an increasing and growing interest in the ability of organizations to tolerate strategic tensions arising from the complexity conflicting requirements. In this study, I examined the role of IT capability in managing multiple organizational identities and thus tolerating strategic complexities and tensions. I asserted a causal model through which I identified three causal mechanisms for the role of a firm's IT capability in managing its multiple organizational identities. I also developed an agent-based computer simulation model, the *ITCOID* model, to conduct computational experiments to investigate the effect of IT capability on the performance outcomes of organizations with various levels of identity plurality (number of identities) and identity synergy (extent of similarity among identities) – strategic choices that embody the management of identity by organizations.

I proposed that an organization's IT capability enables it to project consistently positive organizational images towards relevant audiences and stakeholders. I asserted the role of IT capability in enabling consistency across organizational behavior and communication. I also identified the role of IT capability in positively enabling flexible changes to organizational codes and routines. Through these three causal mechanisms, organizations are able to project, deploy and create a differentiation between their multiple identities. Organizations are also able to quickly shift between their various identities by changing the identity they are projecting. These mechanisms allow organizations to respond to external stimuli in manners consistent with the expected identity. Conformity to identity expectations have been shown to have firm performance implications, including the financial valuations of firms in capital markets (Hsu and Hannan 2005). Organization's abilities to manage their multiple identities may thus be one of the intermediate constructs through which IT has an intangible impact on Tobin's Q and other measures of competitive advantage and firm performance.

Table 16. Summary of Propositions on Management of Multiple Identities
P11: A superior IT capability will improve management of multiple organizational identities through the projection of attractive organizational images.
P12: A superior IT capability will improve management of multiple organizational identities through consistent organizational behavior and communication.
P13: A superior IT capability will improve management of multiple organizational identities through flexible organizational resources and routines.
P14: A superior IT capability will improve management of multiple organizational identities under conditions of low identity plurality.
P15: A superior IT capability will improve management of multiple organizational identities under conditions of low identity synergy.
P16: Marginal returns of IT capability towards managing multiple organizational identities will be improved under conditions of low IT capability.

These assertions were supported by the findings from my computational experiments. In the *ITCOID* model, I found that an increase in IT capability lead to an increase in performance across all levels of identity plurality and identity synergy. However, these increases were not equal across all values of plurality and synergy. These gains varied with the levels of identity plurality and identity synergy, with highest performance increases witnessed under conditions of low plurality and low synergy. I also found that there are differing returns to identity plurality and identity synergy, with gains due to increases in synergy being more significant in proportion when compared to gains attributed to increasing plurality. I offered six propositions that reflect my findings. These are presented in Table 16. In short, I showed further evidence that in the 21st century, IT enables firms to be like Janus.

These findings offer interesting insights into the conclusions of prior research. For example, Cosimo de' Medici in Renaissance Florence was found to have derived power from the strategic manipulation of multiple identities. He possessed *many* and *different* identities, which enabled him to maintain a wide range of strategic options (Padgett and Ansell 1993). My findings enable us to posit that rather than the sheer number of identities, it was the difference between his many identities that enabled the success of Cosimo.

These findings also shed light on the success and failures of equally diversified firms. While prior literature has examined the role of IT in enabling greater diversification, the role of IT in successful diversification and the role of the degree of similarity among diversified identities of the organization in successful diversification, my findings point towards a hitherto unexamined moderation effect. These findings explain how the impact of IT capability on the success of a diversified firm is felt more by firms that have lesser similarity between their different diversified identities. Similarly, my results allude to the IT capability being a key factor in the success of highly diversified firms.

Finally, the finding that IT capability acts the most effectively in conditions of low plurality and low synergy finds resonance in extant literature. Firms with low synergy differ greatly across their various identities. They are able to utilize more of the gains provided by their IT capability due to their higher requirements for flexible and responsive codes, routines and processes. Termed as generalist identities in prior literature, they have been credited with the ability to tolerate greater variance in environmental conditions (Hsu and Hannan 2005). The increased impact of IT on these firms can explain these observations. Surprisingly, I find that firms with low identity plurality benefit more from a higher IT capability. Literature on simple and complex identities provides us with an explanation – firms with lesser number of identities gain greater benefits from the projection and differentiation among their identities that their IT capability facilitates. Overall, the decreasing marginal returns of IT capability align with my prior findings of ambidexterity impeding effects of IT software resources and Informate IT capability due to reduced flexibility and ossification.

10.6 Conclusion

In this chapter, I developed the *ITCOID* model and provided details of subsequent computational experiments. Through these manipulations, I derived propositions that regarding an organization's IT capability, and the synergy and plurality of its organizational identities. The propositions generated through this component of this dissertation informs our understanding of the intangible business value of IT and its role in reducing strategic tensions arising from the management of multiple organizational identities. These findings display nomological and ecological validity. This study also benefits from the strengths of developing theory through a computational modeling approach, namely, high internal and construct validity, strong specification of boundary conditions and systematic experimentation (Davis et al. 2007). In the following section, I conclude this dissertation by presenting the contributions, limitations, and implications of this research.

11 Conclusion

Through this manuscript, I have presented the three components of my dissertation research. My dissertation will contribute towards the development of a theory of IT enabled management of strategic tensions by investigating the role of information systems in facilitating organizational ambidexterity and managing multiple organizational identities. In this concluding chapter, I summarize the results of this dissertation, present its contributions towards theory, discuss limitations which highlight areas that merit future investigation, and discern the practical implications of this research.

11.1 Summary of Results

Through this dissertation research, I have found strong support for my three primary assertions. First, I have observed that an organization's IT facilitates organizational ambidexterity, hitherto a challenging competitive possibility. Second, I have found strong evidence for my assertion that IT-enabled learning mechanisms facilitate external organizational ambidexterity – a new strategic opportunity in the 21st century. Third, I have found support for the assertion that a firm's IT capability enables it to manage the strategic tensions arising from multiple identities, thereby achieving competitive advantage and higher firm performance. I have also found that certain IT resources, capabilities and systems either impede organizational ambidexterity or have reducing marginal returns towards external ambidexterity or the management of multiple identities. Overall, the results of the three components of this dissertation support the reasoning that while the simultaneous pursuit of seemingly paradoxical strategies leads to multiple and conflicting demands being placed upon an organization, the tolerance of these resultant tensions enables organizations to achieve superior competitive performance in the 21st century. Or be like Janus.

Table 17. Summary of Key Findings
Software IT resources impede, while Technical IT resources facilitate organizational ambidexterity
Hardware IT resources facilitate organizational ambidexterity by weakening the influence of software IT resources
The synergy between IT resources facilitates organizational ambidexterity
IT Informate and IT Automate capability impede, while IT Transform capability facilitates organizational ambidexterity
IT Transform capability facilitates organizational ambidexterity by weakening the influence of IT Informate capability
The balance of Automate and Informate IT capability and Automate and Transform IT capability weakly facilitate organizational ambidexterity
Balance of Informate and Transform IT capability facilitates organizational ambidexterity
Appropriation of knowledge both facilitates and impedes external ambidexterity by augmenting the acquisition of explorative innovation and hindering the acquisition of exploitative innovation
Appropriation of culture facilitates external ambidexterity by augmenting the acquisition of explorative and exploitative innovation
Use of a knowledge repository both facilitates and impedes external ambidexterity by augmenting the acquisition of explorative innovation and hindering the acquisition of exploitative innovation
Use of communication technologies facilitates external ambidexterity by augmenting the acquisition of explorative and exploitative innovation
IT capability facilitates management of multiple organizational identities through the projection of attractive organizational images.
IT capability facilitates management of multiple organizational identities through consistent organizational behavior and communication.
IT capability facilitates management of multiple organizational identities through flexible organizational resources and routines.
IT capability facilitates management of multiple organizational identities under conditions of low identity plurality and identity synergy.
Marginal returns of IT capability towards managing multiple organizational identities are improved under conditions of low IT capability.

Specifically, my results in the first component of this dissertation showed that IT technical resources enable organizational ambidexterity. I also found that IT technical, IT software and IT hardware resources have a positive synergistic effect on simultaneous explorative and exploitative innovation. I observed a negative relationship between IT software resources and ambidexterity, which is positively influenced by IT hardware resources. I posited that this is due to the ossification of processes and lower flexibility resulting from utilizing out-of-the-box software and hardware. A similar reasoning is offered for the finding that Automate and Informate IT capabilities have a negative relationship with ambidexterity, which is weakened by Transform IT capability. I also found a strong direct positive effect of Transform IT capability on ambidexterity. My results also showed that a strategy of balancing IT Automate, Informate and Transform capabilities facilitates organizational ambidexterity. Table 17 summarizes these and other key findings of this dissertation.

Overall, the results from the second component of this dissertation showed that post-acquisition integration strategies and IT-enabled learning mechanisms have different individual and joint impacts on the external acquisition of exploration or exploitation. I showed that in acquisitions that are undertaken to balance explorative and exploitative innovation, knowledge repositories and communication technologies enhance the appropriation of external knowledge. I found that the two IT-enabled learning mechanisms enhance the effectiveness of two integration strategies. Specifically, I observed that the acquisition of explorative innovation is augmented by both the post-integration strategies of knowledge and culture appropriation and both the IT-enabled learning mechanisms of knowledge repositories and communication technologies. I also found that for such acquisitions, lower appropriation of knowledge, relatively higher appropriation of culture, relatively low use of knowledge repositories, and relatively moderate use of communication technologies yield greatest returns. I observed that the acquisition of exploitative innovation is augmented by the appropriation of culture and use of communication technologies and impeded by the appropriation of knowledge and use of knowledge repositories. I found that for such a strategy of balancing internal exploration with externally acquired exploitation, relatively low use of knowledge repositories and relatively high use of communication technologies produce maximum returns. Finally, besides these individual effects, I found synergistic effects of these two IT-enabled learning mechanisms under all conditions. I observed that knowledge repositories and communication technologies complement the effects of one another; while the marginal contribution from communication technologies decreases knowledge repository use increases, the marginal contribution from knowledge repository use increases as communication technology use increases.

In the third component of this dissertation, I identified three causal mechanisms through which a firm's IT capability enables it to manage its multiple identities, and proposed that an organization's IT capability can provide firms with these abilities. I theoretically asserted that successfully managing multiple organizational identities requires organizations to communicate attractive organizational images, to given audiences through consistent behavior and communication through flexible realignment of resources. My results from computational experiments uncovered that an organization's IT capability leads to highest performance increases under conditions of low plurality, low synergy and low IT capability.

11.2 Contributions

This dissertation makes several critical contributions to research. First, it is one of the early studies to conceptualize, and operationalize organizational ambidexterity in the context of IS research. Ergo, my results also have serious implications for prior IS research that considers exploration and exploitation as two ends of a continuum. There is an ongoing debate in the strategic management literature regarding the conceptualization of exploration and exploitation either as trade-offs or as orthogonal concepts. Much of extant IS research speaks towards the first perspective and thus this dissertation opens new avenues for further research and revisiting of many of these studies. For example, Subramani (2004) theorized complementary patterns use of supply chain technologies for exploration and exploitation and found different implications on supplier investments and benefits. My results suggest that organizations which balance their use of supply chain technologies across exploration and exploitation activities may benefit more than firms with a singular focus.

Second, I showcase the intangible business value of IT in the context of developing world SME's. This study enables me to account for some of the previously unexplained variance in IT payoffs in these contexts. For example, prior literature has found mixed results when examining IT payoffs in India (Lal 2001; Lal 2002). Similar to these results, I find negative effects of IT on organizational ambidexterity when IT resources are measured at an aggregate level. The results reported here provide a strong indication that in such environments, the impacts of IT may not be felt directly, but rather indirectly through specific strategically necessary processes. Further, the impacts of IT are nuanced and thus only visible at finer levels of inquiry and detail. This research also sheds light on IT impacts on SMEs. Prior literature has implied that resource-constraints do not allow SMEs to build complementary resource bundles, thereby leading to lower IT payoffs. My results suggest that an alternative explanation may be that IT impacts are subsumed at intermediate levels. I also further the contention that the business value of IT is not only reflected in measures of firm performance, but also reflected by improvements in firm intangibles.

Third, I advance the literatures on IT resources and capabilities and the role of IT in enhancing organizational innovation (e.g. Kleis et al. Forthcoming). While this prior work finds that IT capital enhances the creation of knowledge output and incremental innovations through improved knowledge management and increased collaboration (Joshi et al. 2010; Teo et al. 2007), it does not find any relationship between IT and breakthrough innovations (Kleis et al. Forthcoming). My results shed further light upon the relationship from leading from IT to competitive performance via innovation intent and innovation output. This dissertation suggests that even though IT may not have a direct impact on breakthrough innovation, it helps organizations to balance their incremental and breakthrough innovation outputs, thereby helping them survive in the long run. My findings also speak towards the theoretical perspective that the first-order effects of IT are expected to be felt at the level of intermediate variables that mediate or moderate the overall relationship of IT with firm performance (Barua et al. 1995; Melville et al. 2004; Subramani 2004). By showing that an organization's IT resources and capabilities play a key role in resolving the paradoxical situation arising from the concurrent pursuit of exploration and exploitation or multiple identities, I add another piece to the puzzle that explains how IT impacts competitive advantage. My findings also resonate with recent advances that conceptualize IT as an improvisational capability that enables organizations to spontaneously reconfigure existing resources to build new capabilities under highly unpredictable and novel environmental conditions (Pavlou and El Sawy 2010). My results indicate ambidexterity or the management of multiple organizational identities as capabilities that can be built under high turbulence.

Further, my findings contribute towards the literature by demonstrating the value of IT resources and capabilities after controlling for the contingencies of turbulence and competitiveness.

Fourth, as one of the initial studies on the effects of IT on organizational ambidexterity, I contribute by extending the literature in the strategic management research area and introducing the IT construct into the nomological net of organizational ambidexterity. While prior work has identified several structure, context and leadership based antecedents to organizational ambidexterity (Raisch and Birkinshaw 2008; Tushman and O'Reilly 1996), I extend the boundaries of this discussion by establishing the critical role of IT, which uniquely enables ambidexterity.

Fifth, I find that in a hostile environment, contrary to prior research, larger size has no significant impact on ambidexterity (Lubatkin et al. 2006). Therefore I contribute towards resolving the contradictions in prior research regarding the impediments of smaller size and resultant resource constraints towards ambidexterity versus its strategic necessity in highly dynamic environments (Raisch et al. 2009). This suggests avenues for further inquiry that will identify specific contingencies under which these relationships hold.

Sixth, to my knowledge, this dissertation is one of the first research efforts to explicitly address the question of external ambidexterity through acquisitions. Though this issue has been raised as an unaddressed gap in the literature, prior work in the area of ambidexterity has only examined alliances. Similarly, prior work in the area of technology acquisitions only views the antecedents and innovation outcomes of these acquisitions. This research merges these two streams of inquiry. It also addresses the sparsely heeded necessity for integrative research around the concepts of knowledge and organizational learning that was highlighted nearly a decade ago (Argote et al. 2003).

Seventh, this dissertation speaks towards the unresolved contradictions in prior research regarding the effects of combining IT-enabled learning mechanisms. Organizations are increasingly using a smorgasbord of information systems and understanding how they work together is critical to understanding the overall effect of IT on firm outcomes (Sambamurthy et al. 2003). While some researchers prescribe a combination of mechanisms to generate superior performance, others suggest an avoidance of such an approach and yet others advocate the decision of combining or not combining IT-enabled learning mechanisms is conditional on the external environment (Kane and Alavi 2007). I find that in the case of acquisitions, the effect of combining IT-enabled learning mechanisms is contingent upon the objective of the acquisition.

Eighth, this dissertation contributes towards the mergers and acquisitions literature across the areas of finance and strategic management. Though this literature has identified several antecedents to the success of mergers and acquisitions, it does not explain the value creation or destruction mechanisms. I findings suggest the individual and joint effects of appropriation of knowledge and appropriation of culture as value creating mechanisms, and the individual and joint effects of knowledge repositories and communication technologies as value enhancing mechanisms in technology acquisitions.

Ninth, I contribute towards resolving the contradictory prescriptions of prior literature with regards to knowledge appropriation in technology acquisitions. Some literature suggests decreasing returns to knowledge appropriation as knowledge is present in specific areas of the target firm, while other research asserts increasing returns to knowledge appropriation (Meyer and Lieb-Doczy 2003; Ranft and Lord 2002). My findings suggest that both arguments hold, depending upon the nature of the technology acquisition.

Tenth, my results speak towards the debate regarding the knowledge management capacity of information systems. My findings suggest that knowledge repositories and similar systems have a limited effectiveness, due to factors other than barriers to use (Grover and Davenport 2001; Kankanhalli et al. 2005).

Eleventh, this research makes a methodological contribution by affirming the applicability of the March framework to inter-organizational phenomena. It also answers the call to extend the March model beyond the boundaries of a single organization (Miller et al. 2006). Overall, this dissertation further opens to door to future research that can adapt March's model of exploration and exploitation to other inter-organizational settings, such as alliances.

Twelfth, prior work has addressed issues of personal and group identity (e.g. Adam et al. 2006; Erat et al. 2006; Kotlarsky and Oshri 2005) as well as formation of organizational identities in the context of IT (e.g. Gal et al. 2008). However, in my knowledge, this is one of the few studies to conceptualize the construct of multiple organizational identities in the context of information systems research. It answers the call to use the identity concept in IS research (Gal and Kjaergaard 2009) and contributes by extending the literature in both the strategic management and information systems research areas. It adds to previous IS literature on identities and the sociological conceptualization of organizational identity. It speaks towards IT being an explanation of how firms are able to manage multiple organizational identities.

Finally, this dissertation furthers the debate between the institutional perspective and the organizational impression management perspective (Elsbach and Sutton 1992; Oliver 1991) by conceptualizing IT as a tool by which managers can manipulate an organization's multiple identities and present different images to different audiences. Also, this research speaks towards the literature on the boundaries of identities and their fusion and erosion (Rao et al. 2005).

Overall, this dissertation contributes towards research in the area of information systems. It showcases the intangible business value of IT and hence furthers the debate that the business value of IT is not only reflected in measures of firm performance, but also reflected by improvements in firm intangibles. Thus, it enhances our understanding of ebusiness strategy and strengthens our perception of the impacts of IT on intermediate, strategic constructs. This dissertation furthers our understanding of the complex relationships and paths that lead from IT to competitive advantage. My dissertation also addresses gaps in the strategic management literature, a reference discipline. This research addresses calls to consider national or cultural boundaries around the ambidexterity, organizational identity and IT resources and IT capability concepts. Hence, to summarize, this dissertation employ multiple methods, including computational simulation, agent-based models, and econometric analysis, to advance our knowledge in the area of intangible business value of IT.

11.3 Limitations

Like all research, this dissertation suffers from limitations that may stimulate further research in this area. Several points must be considered when assessing the results reported in this manuscript.

First, the measures of IT investment and organizational ambidexterity are restricted to a specific setting. Further research can use more innovative and publically available sources of data. This will enable an expansion of the sample to larger firms and validation of these results in other settings.

Second, the choice of setting for this study may restrict its generalization to other settings and contexts. For example, firms in this study have either only manufacturing or both manufacturing and service operations. However, there are no pure service firms. Thus, while this study encompasses differences due to the mix of manufacturing and service operations (McLaughlin et al. 1991), further research can add service organizations into the examination of IT and organizational ambidexterity.

Third, my measures of IT Automate, Informate and Transform capabilities differ from the approach followed in prior literature. Unlike other studies that gather primary data, I do not ask respondents to indicate the extent to which the IT capabilities are present in their organization. While this subjective approach to measuring IT capabilities has its merits and precedents, the many studies that use secondary data extol the virtues of an objective assessment of IT capabilities (e.g. Chi et al. 2010; Joshi et al. 2010). By measuring the actual presence of an IT application being use in the firm, I hope to avoid the personal biases that may be present in a subjective assessment (Collopy 1996; Oh and Pinsonneault 2007). When questionnaire items concern objective rather than subjective data, the threat of bias due to perceptions of respondents is removed (Crampton and Wagner 1994).

Fourth, though I attempt to draw conclusions regarding different types of IT capabilities, these capabilities can be categorized in other ways. Perhaps, categorizing IT capabilities in other ways may shed further light upon the nature of the relationship between

IT and ambidexterity. Future research can also consider how heterogeneity in organizational ability to leverage these capabilities (Mithas et al. 2011) influences this relationship.

Fifth, the scope of the first component of this dissertation is limited to studying the existence of a relationship between IT resources and capabilities and organizational ambidexterity. This decision was taken to ensure the parsimony of the research model. Questions regarding the exact nature and nuances of this relationship can be addressed in further studies. For example, future research may examine possible environmental or organizational factors that mediate or moderate this relationship. Also, recent work finds that a firm's technological capability enhances exploitation at an increasing pace, while it has an inverted U-shaped relationship with exploration (Zhou and Wu 2010). Consequently, future research may also examine the implications of these results by studying the curvilinear effects of IT capability on ambidexterity and the differences from other forms of technological capabilities.

Sixth, the scope of the second component of this dissertation is limited to studying individual and joint effects of two IT-enabled learning mechanisms in the presence of two integration strategies. Appropriation of beliefs and retention of employees are the two prominent, but not the only factors that determine the success of technology acquisitions. Similarly, knowledge repositories and communication technologies are two, albeit most prominent, of the many possible IT-enabled learning mechanisms that can possibly used in these situations. Questions that address other relationships of other possible parameters can be taken up in further research.

Seventh, this research is limited to considering the main and interaction effects of the focal parameters in the context of technology acquisitions. Future research can consider the implications and sensitivity of the results to changes in the ratio of the size of the two organizations, varying environmental turbulence and varying employee turnover. This model can also be extended to incorporate interdependence amongst dimensions of reality or choices subject to bounded rationality.

Eighth, the Extended EEA model and the *ITCOID* model are simplified representations of real world settings. There are risks of oversimplifying and idealizing processes that are in reality are complex and imperfect. However, I have attempted to mitigate these risks through a thorough validation and calibration process. Further, I base the Extended EEA model on a well-established computational model and anchor my extensions on previous empirical, theoretical and computational research. There are also limitations of my inability to model a larger scope or all the possible environmental parameters. Future research can attempt to incorporate other mechanisms and environmental factors by extending these computational models.

Ninth, the scope of the third component of this research is limited to studying the relationship between IT capability and the ability of firms to successfully manage multiple organizational identities of varied numbers and similarity. Questions that inquire into the different types of IT capabilities that make up this relationship can be addressed in further studies.

Tenth, the *ITCOID* model does not incorporate changes within existing organizational identities. Identities can change over time, albeit slowly, having profound impacts on their bearers, as evidenced by identity changes in the brewing industry and food cooperatives in America (Hsu and Hannan 2005). Future research can delve into questions arising from changes in organizational identities and the role played by IT in resolving these complexities. The *ITCOID* model can also be extended to study these phenomena.

11.4 Managerial Implications

The implications of this dissertation research for managerial practice are immense. In the 21st century, managers have to contend with constant and accelerating waves of change, much of which are driven by advances in information technology. IT also provides managers with the tools to deal with these challenges. IT-enabled internal and external ambidexterity and IT-enabled management of multiple identities are two such possibilities that are emergent in the current century. My findings indicate that in highly turbulent and competitive environments, managers should concentrate upon balancing seemingly contradictory strategies. Prior research states that this approach is contingent upon resource availability, i.e. organizations with lower resources benefit most from such an approach (Cao et al. 2009). My findings indicate that managers should prioritize their investments in IT services and training and follow a balanced approach towards building IT capabilities to maximize their potential benefits from electing to pursue this approach. My conclusions also suggest that managers seeking to balance internal exploration or exploitation through the gain of exploitative or explorative innovation via an acquisition should carefully consider the use of IT-enabled learning mechanisms to complement their integration strategies. Overall, the results specifically highlight the importance of IT in enabling a balanced innovation outlook, which is critical for survival in the rapidly changing competitive environment of today.

While managers may turn to IT to cope with the growing need for organizations to tolerate complexities and exhibit efficiencies when faced with cooperating and conflicting demands arising from conflicting strategies and multiple identities, the findings of this dissertation imply that organizational ambidexterity, organizational identity and other intangible strategic assets, capabilities and intermediate constructs are key pieces that should be considered while evaluating the effects of IT on firms.

The strategic implications of IT include enhanced firm intangibles, which may result in a further indirect effect of IT on overall firm competitive advantage and performance. While these findings call for future academic research to explore more nuances of the relationship between IT and intermediate organizational constructs and firm intangibles, in more varied settings, for business executives and top management, this dissertation provides an interesting perspective on the relationship between major sources of firm outlay – IT, innovation and identity management. Whereas in the face of meager available resources, managers might be tempted to forgo investments in IT, for the sake of investments in exploitative and explorative innovation activities or identity management activities, this dissertation research shows that advances in IT resources and capabilities enable a firm to do a better job at managing both its innovation and identity management processes, thereby deriving competitive advantage.

11.5 Conclusion

In this dissertation, I build upon and contribute towards research on IT business value, organizational ambidexterity and organizational identity. I contribute towards the development of a theory of IT-enabled management of strategic tensions that arise from the concurrent pursuit of conflicting objectives. I explicitly theorize the different causal mechanisms through which the underlying components of a firm's IT resources and IT capabilities facilitate ambidexterity. I also explicate the complex individual and joint effects of IT-enabled learning mechanisms upon the success of external ambidexterity. This research also provides unique insights into the role of IT capability in managing the multiple identities. Looking forward, I envision that this is the beginning of an ongoing investigation that examines the role of information technology in facilitating other sources of strategic tensions, such as other instances of ambidexterity, and other sources of intangible business value of IT.

Overall, I show that IT resources enable the management of seemingly paradoxical challenges that arise in the tolerance of the complexity inherent in effectively resolving strategic tensions. The results from this dissertation and complimentary studies contribute towards a theory of IT-enabled management of strategic tensions and inform our understanding of the complex relationships and theoretical pathways from IT to competitive advantage.

I validate the viability of IT-enabled organizational ambidexterity and IT-enabled management of multiple identities as competitive possibilities emergent in the 21^{st} century. Thus, through this dissertation, I show that in the 21^{st} century, IT enables firms to be like the two-headed Roman god of auspicious beginnings and transitions. Janus.

Begin at the beginning and go on till you come to the end; then stop. – Lewis Carroll

Appendix 1: Detailed Tables

Table A1. Respondent Statistics

Characteristic	***Category***	***Percent***
Industry	Air Conditioners & Refrigeration	3.7%
	Auto Ancillaries	76.4%
	Home Appliances	8.2%
	Hand Tools	7.1%
	Telecom Equipments	4.5%
Ownership Structure	Foreign Subsidiary	4.8%
	Joint Venture	6.8%
	Public Limited Indian Company	19.0%
	Privately held Indian Company	69.3%
Firm Size (Number of Employees)	< 100	35.2%
	100-200	18.3%
	201-500	18.6%
	501-1000	14.6%
	1000-2000	5.7%
	> 2000	7.4%
Geographical Region	North	54.0%
	South	32.3%
	East	0.6%
	West	13.1%
Firm Age (in Years)	1 – 10	15.4%

	11 – 20	27.9%
	21 – 30	23.5%
	31 – 40	16.9%
	> 41	16.3%

Table A2. Summary of Key Constructs and Their Measures		
Construct	**Role in Nomology**	**Measure**
IT Resources	Antecedent	Average investment in IT as percentage of sales revenue over past three years.
Hardware IT Resources	Antecedent	Average investment in IT hardware as percentage of sales revenue over past three years.
Software IT Resources	Antecedent	Average investment in software as percentage of sales revenue over past three years.
Technical IT Resources	Antecedent	Average investment in IT related training and internal IT services as percentage of sales revenue over past three years.
Automate IT Capability	Antecedent	Hierarchy indexed seven-point scale of number of IT applications used in the firm that automate existing business processes.
Informate IT Capability	Antecedent	Hierarchy indexed seven-point scale of number of IT applications used in the firm that enhance information access.
Transform IT Capability	Antecedent	Hierarchy indexed seven-point scale of number of IT applications used in the firm that redefine business practices.
Organizational Ambidexterity	Dependent Variable	Formulation (addition, multiplication and subtraction of exploration and exploitation) that provides least loss of explanatory power when regressed on competitive performance.
Exploration		Five-item measure of exploratory innovation adapted from He and Wong (2004) and Jansen et al. (2009).
Exploitation		Five-item measure of exploitative innovation adapted from He and Wong (2004) and Jansen et al. (2009).
Heterogeneity of Senior Team	Control	Number of executives responsible for strategy formulation and implementation.
Heterogeneity of Founding Team	Control	Number of executives responsible for strategy formulation and implementation at time of founding.
Firm Size	Control	Natural logarithm of number of full-time employees.
Firm Age	Control	Number of years since founding.

Environmental Dynamism	Control	Four item measure adapted from Jansen et al. (2009; 2006)
Environmental Competitiveness	Control	Five item measure adapted from Jansen et al. (2009; 2006)
Geographic Location	Control	Indian state in which organization has major facilities.
Ownership Structure	Control	Structure of ownership (privately or publically owned Indian firm, joint venture or foreign subsidiary)
Industry	Control	Industrial sector from which maximum revenues are generated
Competitive Performance	Validity Check	Five-item measure adapted from Rai and Tang (2010)

Table A3. List of IT Applications	
Enterprise resource planning system (ERP)	Electronic Markets
Inventory management system	E-commerce
Just-in-time inventory system	Financial analysis system
Production planning system	Budgeting system
Production scheduling system	Ledgers/statements system
Quality audit and measurement system	Billing system
Quality control system	Payroll system
Expert Research and Development system	Personnel and HR management system
Materials requirement planning II system (MRP)	Accounting System
Product data management system (PDM)	Project management system
Computer-aided design software (CAD)	Content / document management system
Computer-aided manufacturing software (CAM)	Information retrieval or search software
3D images (parts imaging for quality control)	Business intelligence
Robotics-automated system	Data analytics
Supervisory control and data acquisition system (SCADA)	Data mining tools
Optimization software	Simulation software
Supply chain management system (SCM)	Decision support system
Supplier account management system	Digital dashboard
Purchase management system	Online analytical processing
Supplier relationship management system (SRM)	Visualization tools
Customer relationship management system (CRM)	E-mail systems
Customer accounts management system	Internet access for communication
Market share monitoring system	Video conferencing
Forecasting system	Web conferencing

Cost-price analyzing system	Intra-company instant messaging
Sales management system	Web 2.0 for collaboration (wikis and other tools)
Order management system	Groupware
Delivery monitoring system	Cloud computing services
Distribution system for delivery	Other (Please state)

Table A4. Rotated Component Matrix

Item	Component				
	1	2	3	4	5
Competitive Performance 1	.763	-.082	-.006	-.083	.107
Competitive Performance 2	.834	.067	.019	.102	-.124
Competitive Performance 3	.820	.047	.030	-.005	-.235
Competitive Performance 4	.726	.024	.175	-.015	-.307
Competitive Performance 5	.805	-.015	.044	-.046	-.103
Exploitative Innovation 2	-.004	.731	-.069	-.057	.023
Exploitative Innovation 3	-.029	.769	-.032	-.069	-.162
Exploitative Innovation 4	.089	.682	-.057	-.030	.143
Exploitative Innovation 5	-.023	.752	.017	.096	.150
Environmental Dynamism 1	.033	.079	.596	.198	-.060
Environmental Dynamism 2	.155	-.200	.694	.065	-.194
Environmental Dynamism 3	.053	.015	.697	.147	-.274
Environmental Dynamism 4	.035	-.030	.692	-.023	.099
Environmental Dynamism 5	-.047	-.114	.502	.245	.092
Environmental Competitiveness 1	.101	.004	.226	.749	-.040
Environmental Competitiveness 2	-.052	.135	.096	.696	-.385
Environmental Competitiveness 3	-.117	.006	.132	.745	.030
Environmental Competitiveness 4	.014	-.108	.076	.595	.030
Explorative Innovation 3	-.191	.084	-.051	-.087	.758
Explorative Innovation 4	-.258	-.018	-.021	-.096	.770
Explorative Innovation 5	-.067	.418	-.186	.091	.554

Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.

Table A5. Regression Results for First Hypothesized Model

Variables	**Model 1**	**Model 2**	**Model 3**	**Model 4**
Senior Team Size	0.010	0.011	0.009	0.009
	(0.007)	(0.008)	(0.007)	(0.007)
Founding Team Size	-0.009	-0.011	-0.010	-0.011
	(0.008)	(0.009)	(0.008)	(0.008)
ln (Firm Age)	-0.047	-0.039	0.011	0.014
	(0.168)	(0.169)	(0.165)	(0.168)
ln (Firm Size)	0.136	0.153	0.153	0.167
	(0.102)	(0.105)	(0.104)	(0.104)
Home Appliances	0.281	0.122	0.138	0.111
	(0.522)	(0.550)	(0.545)	(0.542)
Hand Tools	0.217	0.318	0.326	0.323
	(0.665)	(0.666)	(0.675)	(0.670)
Telecom Equipments	-1.141	-1.136	-0.979	-1.057
	(0.731)	(0.745)	(0.749)	(0.746)
Air Conditioners & Refrigeration	0.075	0.053	0.152	0.150
	(0.536)	(0.532)	(0.517)	(0.510)
Haryana	2.947***	2.895***	2.803***	2.691***
	(0.389)	(0.388)	(0.385)	(0.399)
Punjab	1.243**	0.988	0.833	0.805
	(0.600)	(0.609)	(0.627)	(0.623)
Maharashtra	3.222***	3.312***	2.790***	2.686***
	(0.417)	(0.434)	(0.460)	(0.470)
Delhi	3.107***	2.996***	2.826***	2.751***
	(0.492)	(0.494)	(0.492)	(0.499)

Karnataka	0.886*	0.938*	0.987**	0.941*
	(0.500)	(0.495)	(0.480)	(0.487)
Uttar Pradesh	3.022***	3.035***	2.848***	2.780***
	(0.480)	(0.477)	(0.491)	(0.499)
Gujarat	3.521***	3.479***	3.279***	3.156***
	(0.526)	(0.618)	(0.748)	(0.792)
Madhya Pradesh	2.600***	2.464***	2.318***	2.296***
	(0.786)	(0.784)	(0.794)	(0.791)
Andhra Pradesh	3.310***	3.239***	3.198**	3.190**
	(1.156)	(1.198)	(1.329)	(1.277)
West Bengal	3.091*	3.118*	2.914**	2.740*
	(1.699)	(1.879)	(1.470)	(1.436)
Chandigarh	0.273	0.118	-0.123	-0.150
	(3.024)	(3.073)	(1.126)	(1.132)
Uttarakhand	-0.675	-0.767	-0.951	-0.936
	(1.699)	(3.591)	(3.256)	(2.587)
Public Limited Indian Company	0.038	0.021	-0.048	-0.067
	(0.350)	(0.352)	(0.350)	(0.353)
Joint Venture: Indian & Foreign Companies	0.011	0.034	0.157	0.093
	(0.490)	(0.482)	(0.467)	(0.476)
Foreign Subsidiary	0.069	0.223	0.214	0.272
	(0.665)	(0.666)	(0.610)	(0.617)
Joint Venture: Indian Companies	0.404	0.473	0.611	0.485
	(1.853)	(2.025)	(2.255)	(2.261)
Environmental Competitiveness	-0.010	-0.017	-0.010	-0.016
	(0.047)	(0.049)	(0.049)	(0.050)

Environmental Dynamism	0.042	0.044	0.056	0.059
	(0.049)	(0.050)	(0.050)	(0.051)
IT Resources		-0.099**		
		(0.044)		
Hardware IT Resources			-0.280^	-0.131
			(0.181)	(0.187)
Software IT Resources			-0.574***	-0.493**
			(0.179)	(0.216)
Technical IT Resources			0.698***	0.736**
			(0.249)	(0.327)
Software x Hardware IT Resources				-0.340**
				(0.155)
Technical x Hardware IT Resources				-0.049
				(0.203)
Hardware x Software x Technical IT				0.129*
				(0.074)
Constant	3.908***	4.032***	3.792***	3.801***
	(1.116)	(1.192)	(1.187)	(1.228)
Observations	323	318	313	313
R-squared	0.336	0.345	0.368	0.374
Adj. R-squared	0.277	0.284	0.303	0.303

Robust standard errors in parentheses

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$ for two-tailed test; ^ $p < 0.1$ for one-tailed test

Table A6. Regression Results for Second Hypothesized Model

Variables	**Model 1**	**Model 5**	**Model 6**	**Model 7**
Senior Team Size	0.010	0.012*	0.012*	0.011*
	(0.007)	(0.007)	(0.007)	(0.007)
Founding Team Size	-0.009	-0.012	-0.011	-0.009
	(0.008)	(0.009)	(0.008)	(0.008)
ln (Firm Age)	-0.047	-0.032	-0.044	-0.001
	(0.168)	(0.169)	(0.168)	(0.162)
ln (Firm Size)	0.136	0.128	0.135	0.107
	(0.102)	(0.109)	(0.102)	(0.104)
Home Appliances	0.281	0.018	-0.004	-0.044
	(0.522)	(0.517)	(0.509)	(0.499)
Hand Tools	0.217	0.078	0.015	-0.040
	(0.665)	(0.643)	(0.637)	(0.635)
Telecom Equipments	-1.141	-1.268*	-1.198	-1.219
	(0.731)	(0.743)	(0.727)	(0.765)
Air Conditioners & Refrigeration	0.075	0.077	0.163	0.065
	(0.536)	(0.531)	(0.538)	(0.551)
Haryana	2.947***	2.726***	2.619***	2.674***
	(0.389)	(0.392)	(0.408)	(0.394)
Punjab	1.243**	1.203**	1.124**	1.253**
	(0.600)	(0.565)	(0.564)	(0.552)
Maharashtra	3.222***	2.802***	2.736***	2.807***
	(0.417)	(0.443)	(0.435)	(0.430)
Delhi	3.107***	2.761***	2.666***	2.752***
	(0.492)	(0.507)	(0.509)	(0.517)

Karnataka	0.886*	1.068**	0.976*	1.124**
	(0.500)	(0.488)	(0.508)	(0.515)
Uttar Pradesh	3.022***	2.677***	2.625***	2.539***
	(0.480)	(0.484)	(0.489)	(0.494)
Gujarat	3.521***	2.936***	2.760***	2.875***
	(0.526)	(0.647)	(0.682)	(0.657)
Madhya Pradesh	2.600***	2.174**	2.017*	2.007*
	(0.786)	(1.047)	(1.044)	(1.023)
Andhra Pradesh	3.310***	3.016**	3.099***	3.112***
	(1.156)	(1.330)	(1.149)	(1.193)
West Bengal	3.091*	2.132	2.118	2.039
	(1.699)	(1.511)	(1.718)	(1.862)
Chandigarh	0.273	0.753	0.616	0.546
	(3.024)	(4.814)	(3.276)	(10.407)
Uttarakhand	-0.675	-1.412	-1.531**	-1.063
	(1.699)	(1.084)	(0.657)	(1.459)
Public Limited Indian Company	0.038	-0.112	-0.157	-0.225
	(0.350)	(0.345)	(0.350)	(0.354)
Joint Venture: Indian & Foreign Companies	0.011	0.143	0.141	0.048
	(0.490)	(0.490)	(0.485)	(0.490)
Foreign Subsidiary	0.069	-0.020	-0.149	-0.086
	(0.665)	(0.637)	(0.633)	(0.625)
Joint Venture: Indian Companies	0.404	0.441	0.366	0.406
	(1.853)	(1.754)	(2.057)	(2.047)
Environmental Competitiveness	-0.010	-0.035	-0.038	-0.037
	(0.047)	(0.048)	(0.047)	(0.048)

Environmental Dynamism	0.042	0.044	0.046	0.048
	(0.049)	(0.050)	(0.049)	(0.050)
IT Automate Capability		-0.283*		-0.348**
		(0.145)		(0.163)
IT Informate Capability		-0.395**		-0.353**
		(0.156)		(0.157)
IT Transform Capability		0.664***		0.816***
		(0.188)		(0.209)
Balance of IT Transform & Informate			0.512***	
			(0.165)	
Balance of IT Transform & Automate			0.224^	
			(0.154)	
Balance of IT Automate & Informate			0.269^	
			(0.189)	
IT Transform x IT Informate Capability				-0.192**
				(0.092)
IT Transform x IT Automate Capability				0.138
				(0.134)
Constant	3.908***	5.635***	-1.017	5.676***
	(1.116)	(1.195)	(1.823)	(1.209)
Observations	323	323	323	323
R-squared	0.336	0.373	0.380	0.385
Adj. R-squared	0.277	0.310	0.319	0.320

Robust standard errors in parentheses

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$ for two-tailed test; ^ $p < 0.1$ for one-tailed test

Table A7. Variance Inflation Factors

Construct	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
Senior Team Size	1.61	1.63	1.64	1.67	1.63	1.62	1.63
Founding Team Size	1.50	1.51	1.51	1.53	1.52	1.51	1.55
ln (Firm Age)	1.32	1.31	1.33	1.35	1.32	1.32	1.34
ln (Firm Size)	1.56	1.55	1.54	1.55	1.78	1.58	1.79
Env. Competitiveness	1.24	1.25	1.25	1.30	1.29	1.29	1.29
Environmental Dynamism	1.27	1.28	1.31	1.34	1.30	1.30	1.32
IT Resources		1.16					
IT Hardware Resources			1.80	2.43			
IT Software Resources			1.60	3.19			
IT Technical Resources			1.76	3.90			
Software x Hardware IT				5.44			
Technical x Hardware IT				3.43			
Hardware x Software x Technical				3.76			
Automate IT Capability					2.83		3.22
Informate IT Capability					5.79		5.85
Transform IT Capability					4.70		5.27
Balance of Transform & Informate						1.82	
Balance of Transform & Automate						1.90	
Balance of Automate & Informate						1.69	
IT Transform x IT Informate							3.72
IT Transform x IT Automate							3.28
Mean VIF of Model	**1.35**	**1.35**	**1.41**	**1.82**	**1.72**	**1.44**	**1.88**

Table A8. Abbreviated Results for Auto Sub-sample for First Hypothesized Model

Variables	Model 1	Model 2	Model 3	Model 4
IT Resources		-0.097**		
		(0.044)		
Hardware IT Resources			-0.207	-0.099
			(0.163)	(0.175)
Software IT Resources			-0.571***	-0.544***
			(0.170)	(0.207)
Technical IT Resources			0.519**	0.532*
			(0.232)	(0.275)
Software x Hardware IT Resources				-0.227^
				(0.150)
Technical x Hardware IT Resources				-0.033
				(0.216)
Hardware x Software x Technical IT				0.099^
				(0.076)
Constant	4.394***	4.618***	4.476***	4.458***
	(1.147)	(1.196)	(1.197)	(1.272)
Observations	244	241	237	237
R-squared	0.375	0.386	0.408	0.412
Adj. R-squared	0.313	0.321	0.338	0.333

Robust standard errors in parentheses

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$ for two-tailed test; ^ $p < 0.1$ for one-tailed test

Table A9. Abbreviated Results for Auto Sub-sample for Second Hypothesized Model

Variables	**Model 1**	**Model 5**	**Model 6**	**Model 7**
IT Automate Capability		-0.221		-0.269^
		(0.174)		(0.204)
IT Informate Capability		-0.488***		-0.457**
		(0.184)		(0.184)
IT Transform Capability		0.679***		0.759***
		(0.237)		(0.262)
Balance of IT Transform & Informate			0.588***	
			(0.192)	
Balance of IT Transform & Automate			0.181	
			(0.172)	
Balance of IT Automate & Informate			0.215	
			(0.203)	
IT Transform x IT Informate Capability				-0.111
				(0.102)
IT Transform x IT Automate Capability				0.077
				(0.162)
Constant	4.394***	6.062***	-0.393	6.131***
	(1.147)	(1.300)	(1.947)	(1.303)
Observations	244	244	244	244
R-squared	0.375	0.410	0.417	0.415
Adj. R-squared	0.313	0.343	0.350	0.341

Robust standard errors in parentheses

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$ for two-tailed test; ^ $p < 0.1$ for one-tailed test

Table A10. Examples of Research Using Computation Simulation
Cohen, March and Olsen (1972) used a simulation approach to develop a garbage can model of organizational decision making, consisting of independent and exogenous streams of problems, solutions, choices and participants.
Morecroft (1984) developed a systems dynamics simulation model to illustrate the ability of behavioral simulation to provide insight into consequences of proposed strategy changes and hence be used as a strategy support tool.
Masuch and LaPotin (1989) extended the garbage can model by combining it with organizational structure. Representing decision making as symbol-driven search, they analyzed the implications of their artificial intelligence based simulation model.
Lant and Mezias (1990) examined an organizational learning simulation model of entrepreneurship in organizations in the face of discontinuous change.
Carley (1992) studied the impact of personnel turnover and organizational structure on organizational learning using an organizational decision making Monte Carlo simulation.
Mezias and Glynn (1993) Conceptualized innovation process through the organizational learning perspective and used simulation to examine the theoretical implications of using different organizational innovation strategies.
Levy (1994) used a system dynamics simulation model to illustrate the application of chaos theory to strategy.
Bruderer and Singh (1996) developed a computational model of organizational evolution based on the genetic algorithm and investigated the role of organizational learning in guiding environmental selection.
Abrahamson and Rosenkopf (1997) used computer simulations of innovation diffusion models to develop theoretical propositions on how social network structure can influence the extent of diffusion of an innovation.
Brush and Bromiley (1997) used a Monte Carlo simulation to question earlier results, which showed that corporate effect explains little variability in business unit profitability.
Sastry (1997) extended the punctuated equilibrium theory of organizational change by analyzing a system dynamics simulation based formalization.
Rivkin (2001) extended the NK fitness landscape simulation model to explore the effect of complexity on imitation and replication by modeling these as 'competitive search via incremental improvement' and 'follow-the-leader long jumps' heuristics respectively.
Lee, Lee and Rho (2002) applied a genetic algorithm simulation to describe competition as a process and identified conditions under which strategic groups emerge.
Zott (2003) used a computational simulation to examine a multi-stage model of the evolution of dynamic capabilities through imitation and experimentation and attributed differential firm performance to differences in timing, cost and learning effects of dynamic capabilities.

Prietula and Watson (2008) replicated the oligopoly model from *A Behavioral Theory of the Firm* (Cyert and March 1963) and examined how the model component processes contributed to outcome product.
Aggarwal, Siggelkow, and Singh (2011) extended the NK framework to examine the performance impacts of governance modes used to make decisions in inter-organizational alliances.
Hu, Blettner, and Bettis (2011) extended prior simulations of adaptive aspirations by incorporating changes in risk preference at extremes of performance and alternative reference group strategies.
Markle (2011) used experimental data and setting from a prior published study to develop a computer simulation that examines the judgment of firms regarding employee reciprocity.
Miller, Fabian, and Lin (2009) used a simulation model to study the participation of online communities as a means to use social learning processes shape demand for their products.

Table A11. ANOVA Results for Full Model when Acquiring Explorative Innovation

Source	Type III Sum of Squares	Degrees of Freedom	Mean Square	F	Sig.
Corrected Model	7307890.5	252	28999.6	119.1	.000
Intercept	45675415.9	1	45675415.9	187632.5	.000
Culture	122365.3	3	40788.4	167.6	.000
Knowledge	5308843.7	3	1769614.6	7269.5	.000
Knowledge Repository	118485.2	3	39495.1	162.2	.000
Communication Technologies	86483.2	3	28827.7	118.4	.000
Culture * Knowledge	808216.1	9	89801.8	368.9	.000
Culture * Knowledge Repository	19259.4	9	2139.9	8.8	.000
Culture * Communication Technologies	4731.4	9	525.7	2.2	.022
Knowledge * Knowledge Repository	62262.6	9	6918.1	28.4	.000
Knowledge * Communication Technologies	25440.4	9	2826.7	11.6	.000
Knowledge Repository * Communication Technologies	88915.1	9	9879.5	40.6	.000
Culture * Knowledge * Knowledge Repository	15342.4	27	568.2	2.3	.000
Culture * Knowledge * Communication Technologies	6251.4	27	231.5	1.0	.536
Culture * Knowledge Repository * Communication Technologies	15895.9	27	588.7	2.4	.000
Knowledge * Knowledge Repository * Communication Technologies	44654.3	27	1653.9	6.8	.000
Culture * Knowledge * Knowledge Repository * Communication Tech.	24420.2	78	313.1	1.3	.045
Error	24573551.3	100947	243.4		
Total	79117529.2	101200			

Corrected Total	31881441.8	101199			
R Squared = .229 (Adjusted R Squared = .227) Dependent Variable: Knowledge Gain					

Table A12. ANOVA Results for Full Model when Acquiring Exploitative Innovation

Source	**Type III Sum of Squares**	**Degrees of Freedom**	**Mean Square**	**F**	**Sig.**
Corrected Model	20822840.4	255	81658.2	1771.3	.000
Intercept	6527921	1	6527921	141598.7	.000
Culture	88485.1	3	29495	639.8	.000
Knowledge	5039023.6	3	1679674.5	36434.2	.000
Knowledge Repository	9403893.4	3	3134631.1	67994.1	.000
Communication Technologies	924754.6	3	308251.5	6686.4	.000
Culture * Knowledge	122358.7	9	13595.4	294.9	.000
Culture * Knowledge Repository	27811.1	9	3090.1	67.0	.000
Culture * Communication Technologies	3809	9	423.2	9.2	.000
Knowledge * Knowledge Repository	3140458.1	9	348939.8	7568.9	.000
Knowledge * Communication Technologies	306701.6	9	34078	739.2	.000
Knowledge Repository * Communication Technologies	1305578.6	9	145064.3	3146.6	.000
Culture * Knowledge * Knowledge Repository	10777.8	27	399.2	8.7	.000
Culture * Knowledge * Communication Technologies	714.7	27	26.5	0.57	.962
Culture * Knowledge Repository * Communication Technologies	3982.1	27	147.5	3.2	.000
Knowledge * Knowledge Repository * Communication Technologies	441251.5	27	16342.6	354.492	.000
Culture * Knowledge * Knowledge Repository * Communication Tech.	3240.6	81	40	.868	.796
Error	4708996.3	102144	46.1		
Total	32059757.7	102400			

Corrected Total	25531836.7	102399			
R Squared = .816 (Adjusted R Squared = .815) Dependent Variable: Knowledge Gain					

Table A13. Detailed Construct Correlation Table (Part 1)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)	(25)	(26)	(27)	(28)	(29)	(30)	(31)	(32)	(33)	(34)	(35)
(1)	1.00																																		
(2)	0.86	1.00																																	
(3)	0.82	0.59	1.00																																
(4)	0.72	0.54	0.43	1.00																															
(5)	0.12	0.22	0.10	-0.07	1.00																														
(6)	0.29	0.35	0.26	0.04	0.72	1.00																													
(7)	0.27	0.32	0.22	0.08	0.64	0.85	1.00																												
(8)	0.10	0.06	0.08	0.10	0.15	0.13	0.15	1.00																											
(9)	0.03	0.02	0.01	0.01	0.17	0.13	0.16	0.53	1.00																										
(10)	-0.02	-0.05	-0.02	-0.02	0.05	0.09	0.10	0.10	0.01	1.00																									
(11)	0.12	0.09	0.11	0.08	0.31	0.38	0.44	0.38	0.23	0.28	1.00																								
(12)	-0.11	-0.13	-0.08	-0.11	-0.15	-0.17	-0.08	0.00	-0.07	-0.08	-0.06	1.00																							
(13)	-0.07	-0.03	-0.06	-0.11	0.02	0.10	0.13	0.13	-0.01	-0.03	0.16	0.36	1.00																						
(14)	-0.08	-0.11	-0.16	0.11	-0.24	-0.20	-0.03	0.08	-0.05	-0.01	0.10	0.11	0.11	1.00																					
(15)	0.02	0.06	0.02	0.01	-0.06	-0.06	0.02	0.06	-0.02	0.05	0.20	-0.00	0.15	0.36	1.00																				
(16)	-0.05	-0.05	-0.05	-0.02	-0.15	-0.02	0.05	0.04	-0.02	-0.01	0.09	0.15	0.18	0.14	-0.02	1.00																			
(17)	-0.14	-0.12	-0.12	-0.08	-0.08	-0.05	-0.09	-0.04	-0.02	0.11	-0.02	-0.03	-0.03	-0.04	-0.11	-0.08	1.00																		
(18)	0.01	0.01	0.03	-0.02	-0.01	0.03	0.07	0.02	-0.03	-0.05	0.04	-0.10	0.06	-0.00	0.04	-0.07	-0.06	1.00																	

(1)IT Resources, (2) IT Infrastructure, (3) IT Software, (4) IT Technical, (5) Automate IT Resources, (6) Informate IT Resources, (7) Transform IT Resources, (8) Senior Team Size, (9) Founding Team Size, (10) ln (Firm Age), (11) ln (Firm Size), (12) Environmental Competitiveness, (13) Environmental Dynamism, (14) Ambidexterity, (15) Competitive Performance, (16) Electronic Home Appliances, (17) Hand Tools, (18) Telecom Equipments, (19) Air Conditioners and Refrigeration, (20) Haryana, (21) Punjab, (22) Maharashtra, (23) Delhi, (24) Karnataka, (25) Uttar Pradesh, (26) Gujarat, (27) Madhya Pradesh, (28) Andhra Pradesh, (29) West Bengal, (30) Chandigarh, (31) Uttarakhand, (32) Public Limited Indian Company, (33) Joint Venture Between Indian and Foreign Company, (34) Foreign Subsidiary, (35) Joint Venture Between Indian Companies

Table A14. Detailed Construct Correlation Table (Part 2)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)	(25)	(26)	(27)	(28)	(29)	(30)	(31)	(32)	(33)	(34)	(35)
(19)	-0.04	-0.04	-0.00	-0.04	0.00	-0.09	-0.03	-0.05	-0.03	0.02	-0.04	0.04	0.07	0.10	0.09	-0.06	-0.05	-0.04	1.00																
(20)	-0.03	0.03	-0.02	-0.05	0.08	-0.04	0.00	0.05	-0.07	-0.20	0.01	0.10	0.07	0.23	0.27	-0.10	-0.14	-0.04	-0.02	1.00															
(21)	-0.16	-0.13	-0.15	-0.06	-0.09	-0.08	-0.15	-0.04	-0.05	0.14	0.01	-0.04	-0.05	-0.09	-0.09	-0.10	0.63	-0.09	-0.08	-0.21	1.00														
(22)	0.12	0.05	0.01	0.30	-0.25	-0.09	-0.06	0.03	-0.00	0.04	0.06	0.00	0.01	0.20	0.15	0.14	-0.09	0.02	-0.07	-0.17	-0.14	1.00													
(23)	-0.08	-0.08	-0.04	-0.05	-0.11	-0.15	-0.09	-0.04	-0.02	0.03	-0.04	0.06	0.08	0.16	0.03	0.12	-0.09	0.12	0.35	-0.16	-0.13	-0.11	1.00												
(24)	0.13	0.14	0.12	-0.05	0.26	0.29	0.21	0.02	0.15	-0.05	0.14	-0.07	-0.03	-0.14	-0.09	0.05	-0.09	0.07	-0.06	-0.16	-0.13	-0.11	-0.10	1.00											
(25)	0.02	-0.05	0.02	0.06	0.02	-0.07	0.03	-0.03	-0.06	-0.02	-0.04	0.05	0.01	0.14	0.06	0.14	-0.04	0.03	0.11	-0.15	-0.13	-0.10	-0.10	-0.10	1.00										
(26)	-0.01	0.00	-0.05	-0.02	-0.22	-0.14	-0.13	-0.05	-0.04	0.04	-0.18	0.06	-0.07	0.09	-0.02	-0.05	-0.05	0.04	-0.04	-0.09	-0.08	-0.06	-0.06	-0.06	-0.05	1.00									
(27)	-0.06	-0.05	-0.04	-0.03	-0.06	-0.06	-0.05	-0.04	-0.02	0.02	-0.05	-0.05	-0.06	0.02	-0.01	-0.03	-0.03	-0.02	-0.02	-0.05	-0.04	-0.04	-0.03	-0.03	-0.03	-0.02	1.00								
(28)	-0.03	-0.03	-0.02	-0.03	-0.06	-0.05	-0.04	0.05	-0.00	0.02	0.04	-0.05	-0.06	0.05	-0.07	0.08	-0.03	0.13	-0.02	-0.05	-0.04	-0.03	-0.03	-0.03	-0.03	-0.02	-0.01	1.00							
(29)	0.02	0.03	-0.00	0.01	-0.03	0.04	0.09	-0.02	-0.02	0.03	-0.03	0.00	-0.01	0.02	-0.03	-0.02	-0.02	0.16	-0.01	-0.04	-0.03	-0.03	-0.02	-0.02	-0.02	-0.01	-0.01	-0.01	1.00						
(30)	-0.03	-0.03	-0.02	-0.02	0.05	0.04	0.01	-0.02	-0.02	0.03	0.04	0.05	0.05	-0.03	-0.05	-0.02	-0.01	-0.01	-0.01	-0.03	-0.02	-0.02	-0.02	-0.02	-0.02	-0.01	-0.01	-0.00	-0.00	1.00					
(31)	-0.02	-0.03	-0.03	-0.02	-0.10	-0.09	-0.06	-0.02	-0.01	0.04	0.04	0.06	-0.06	-0.06	0.02	-0.02	-0.01	-0.01	-0.01	-0.03	-0.02	-0.02	-0.02	-0.02	-0.02	-0.01	-0.01	-0.00	-0.00	-0.00	1.00				
(32)	0.00	0.01	-0.04	0.09	0.04	0.06	0.15	0.10	0.10	0.16	0.29	-0.04	-0.02	0.01	0.05	0.09	-0.02	0.17	-0.06	-0.09	-0.04	0.16	-0.03	0.05	-0.07	-0.09	-0.05	0.19	-0.04	-0.03	0.11	1.00			
(33)	0.04	0.09	0.03	0.01	0.07	0.04	0.02	0.02	-0.01	-0.26	0.07	0.02	0.04	0.09	0.08	0.00	-0.08	-0.06	-0.05	0.21	-0.11	0.10	-0.05	0.11	-0.04	-0.05	-0.03	-0.03	-0.02	-0.01	-0.01	-0.13	1.00		
(34)	0.12	0.10	0.15	0.06	-0.03	0.09	0.09	0.02	0.01	-0.11	0.12	0.06	0.06	0.04	0.08	0.08	-0.06	0.01	0.17	0.06	-0.09	0.01	0.06	0.02	-0.02	-0.04	-0.02	-0.02	-0.02	-0.01	-0.01	-0.11	-0.06	1.00	
(35)	0.04	0.07	0.03	0.00	0.06	0.10	0.07	-0.02	0.00	-0.05	-0.00	-0.06	-0.05	-0.04	-0.07	-0.02	-0.02	-0.02	-0.01	-0.04	-0.03	-0.03	-0.02	0.11	-0.02	-0.01	-0.01	-0.01	-0.01	-0.00	-0.00	-0.04	-0.02	-0.02	1.00

(1)IT Resources, (2) IT Infrastructure, (3) IT Software, (4) IT Technical, (5) Automate IT Resources, (6) Informate IT Resources, (7) Transform IT Resources, (8) Senior Team Size, (9) Founding Team Size, (10) ln (Firm Age), (11) ln (Firm Size), (12) Environmental Competitiveness, (13) Environmental Dynamism, (14) Ambidexterity, (15) Competitive Performance, (16) Electronic Home Appliances, (17) Hand Tools, (18) Telecom Equipments, (19) Air Conditioners and Refrigeration, (20) Haryana, (21) Punjab, (22) Maharashtra, (23) Delhi, (24) Karnataka, (25) Uttar Pradesh, (26) Gujarat, (27) Madhya Pradesh, (28) Andhra Pradesh, (29) West Bengal, (30) Chandigarh, (31) Uttarakhand, (32) Public Limited Indian Company, (33) Joint Venture Between Indian and Foreign Company, (34) Foreign Subsidiary, (35) Joint Venture Between Indian Companies

Appendix 2: Measures

Respondents to the two questionnaires were instructed to restrict their answers to their organization's India based operations. They were also assured of the privacy and confidentiality of their responses.

Exploratory Innovation was assessed using five items, adapted from He and Wong (2004) and Jansen et al. (2009; 2006) that measured fundamental changes leading to new products, services and concepts. Scale anchors ranged from 1 for strongly agree to 7 for strongly disagree. Respondents were asked to indicate the extent to which they agree or disagree with the following statements about their organization's strategic outlook and intent.

1. We accept demands that go beyond existing products and services (extend existing product and service range). *
2. We frequently utilize new opportunities in new markets. *
3. We regularly use new sales / distribution channels.
4. We commercialize products and services that are completely new to our organization.
5. We innovate to enter new technology fields.

Exploitative Innovation was assessed using five items, adapted from He and Wong (2004) and Jansen et al. (2009; 2006) that measured minor changes to existing products, services and concepts. Scale anchors ranged from 1 for strongly agree to 7 for strongly disagree. Respondents were asked to indicate the extent to which they agree or disagree with the following statements about their organization's strategic outlook and intent.

1. We frequently make small adjustments to our existing products and services. *
2. We improve efficiency of our products and services.
3. We increase economies of scale in existing markets (improve yield, reduce material consumption or reduce production cost).
4. We expand services for our existing clients.
5. We improve production flexibility.

Firm Size was measured as the number of full time employees in the organization during the last full financial year. This measure was adapted from Jansen et al. (2009).

Firm Age was measured as the number of years lapsed since the organization founded its India operations. This measure was adapted from Jansen et al. (2009).

Senior Team Size was measured as the number of executives responsible for strategy formulation. This measure was adapted from Jansen et al. (2009).

Founding Team Size was measured as the number of executives responsible for strategy formulation at the company when it founded its India operations. This measure was adapted from Jansen et al. (2009).

Primary Industrial Sector was measured as the industry from which the organization generates its maximum revenues.

Ownership Structure was assessed by asking respondents to state or select the ownership structure of their organization from the below list.

1. Foreign Subsidiary
2. Joint Venture between Indian and Foreign Companies
3. Joint Venture between Indian Companies
4. Public Limited Indian Company
5. Privately Held Indian Company

Environmental Dynamism was assessed using five items, adapted from Jansen et al. (2009; 2006) that tapped into the rate of change and turbulence of the environment. Scale anchors ranged from 1 for strongly disagree to 7 for strongly agree. Respondents were asked to indicate the extent to which they agree or disagree with the following statements about their organization's competitive environment.

1. Environmental changes in our market are severe.
2. Our clients regularly ask for new products and services.
3. In our market, changes are taking place continuously.
4. In a year, nothing has changed in our market. ®
5. In our market, the volumes of products and services to be delivered change fast and often.

Environmental Competitiveness was assessed using four items, adapted from Jansen et al. (2009; 2006), that tapped into the rate of competition of the environment. Scale anchors ranged from 1 for strongly disagree to 7 for strongly agree. Respondents were asked to indicate the extent to which they agree or disagree with the following statements about their organization's competitive environment.

1. Competition in our market is intense.
2. Our organization has relatively strong competitors.
3. Number of competitors in our market is high.
4. Price competition is a hallmark of our market.

Relative Financial Performance was assessed using four items, adapted from Kim, Shin and Grover (2010), that measured the organization's general financial performance over the past three years. Scale anchors ranged from 1 for strongly disagree to 7 for strongly agree. Respondents were asked to indicate the extent to which they agree or disagree with the following statements about their organization's performance.

1. Over the past 3 years, our financial performance has been outstanding.
2. Over the past 3 years, our financial performance has exceeded our competitors'.
3. Over the past 3 years, our sales growth has been outstanding.
4. Over the past 3 years, we have been more profitable than our competitors.

Real Financial Performance was assessed using four items, adapted from He and Wong (2004), that measured the organization's financial performance over the past financial year. Respondents were asked to answer the following questions about their organization's performance.

1. Percentage growth in sales witnessed in financial year 2010 – 2011
2. Percentage returns on sales witnessed in financial year 2010 – 2011
3. Percentage returns on assets witnessed in financial year 2010 – 2011
4. Percentage growth in returns on assets witnessed in financial year 2010 – 2011

Competitive Performance was assessed using five items, adapted from Rai and Tang (2010), that measured the organization's ability to capture market share, remain profitable, keep growing, and be innovative and cost-efficient in comparison to its major competitors. An 11-point percentage scale was used with anchors at 0% to 100%. Respondents were asked to rate the performance of their organization compared with that of their competitors on the aspects listed below.

1. Market share

2. Profitability
3. Growth
4. Innovativeness
5. Cost leadership

IT Resources was measured as the percentage of the organization's annual sales revenue represented by its total IT budget, rounded to the nearest ½ %, for the financial years 2009-2010, 2010-2011 and 2011-2012 (projected).

Software Component of IT Resources was measured as the percentage of the organization's total IT budget, devoted to pre-packaged software purchases, internal IT services and external IT services, for the financial years 2009-2010, 2010-2011 and 2011-2012 (projected).

Technical Component of IT Resources was measured as the percentage of the organization's total IT budget, devoted to IT related training and internal IT services, for the financial years 2009-2010, 2010-2011 and 2011-2012 (projected).

Hardware Component of IT Resources was measured as the percentage of the organization's total IT budget, devoted to hardware technology purchases, for the financial years 2009-2010, 2010-2011 and 2011-2012 (projected).

IT Unit Size was measured as the number of full-time IT employees in the organization, including the number of full-time IT employees in the IT organization and the number of full-time IT employees not part of a formal decentralized or centralized IT structure but working wholly within business units.

Key: ***** = Dropped item; **®** = reversed item

Appendix 3: Excerpts of Representative Pilot Study Interviews

The pilot test was conducted in March and April 2011. I took several field notes during this process. At the end of each day, I summarized the major points and learning from each interview. Below are some excerpts from a representative sample of these notes. Similar notes were taken during the primary data collection process.

Meeting at medium sized (Rupees 150 crores) auto components firm

The organization is a joint venture between large Indian automotive group and major Asian manufacturer of brake drums and disks. A meeting was scheduled with the Plant Head (PH) for 12:00 noon at the manufacturing plant. The PH had been informed that we wished to meet with the CEO and CIO. After waiting for some time, the meeting commenced at 1 pm. The PH reports directly to the CEO and is in-charge of day to day operations at the plant.

There was a lot of initial hesitancy regarding research. The investigator was introduced as an associate of the university, visiting from the US. Presentation of credentials helped to ease the doubts regarding authenticity of the study.

Fifteen to twenty minutes were spent with the PH, answering questions such as what is research, where are results published, etc. The main question raised was "why are you doing this study and what is in it for you"? There were apprehensions regarding what we will do with the data that is collected – will we publish it in newspapers with identifying information or will we offer it for sale? We reiterated our request for meetings with the CEO and CIO.

After his queries were answered satisfactorily, the PH had a look at the questionnaires. Once he verified that it contained no questions that asked proprietary company information, he agreed to call the IT Manager. The IT Manager reports to the PH and overall, the IT function rolls up into the CFO. I spent nearly an hour conducting a test of the IT questionnaire with the IT Manager, in the presence of the PH. Several good points were raised, which lead to changes in language, presentation and format of the questions. An additional application was added to the IT Portfolio question. The IT manager estimated that it would take 20 to 30 minutes to complete the questionnaire. He stated that questions regarding IT budget as a percentage of sales revenue would take the most time as he would need to involve the Finance department - "We know our budget, but we don't know the sales revenue."

After completion of the test, we again asked to meet with the CEO. The PH was very hesitant to approach the CEO and offered to fill in the CEO questionnaire himself. We explained to him once again why we needed a CEO to fill in the responses. After several requests for a meeting, the PH agreed to check if the CEO was available for 10 minutes. However, the CEO was out for lunch and hence a meeting could not be arranged.

After this meeting, I decided to address all correspondence directly to the CEO during the data collection process and use a US based correspondence address. I also decided to add a description of academic research in the communication packet for the study.

Meeting at medium sized (Rupees 100 crores) auto components firm

The organization is a joint venture between large Indian Tier 1 automotive components group and a foreign manufacturer of auto components. The organization has multiple plants and the plant visited contributes 50+ crores of production and thus is the primary manufacturing site. A meeting was arranged with the Plant Head (PH) at the manufacturing plant. The PH reports directly to the CEO and is in-charge of all operations at the plant, with profit and loss responsibilities for the facility. The PH was not interested in listening to details of the research. He stated that "I have no concerns regarding the authenticity of the study. I also have no doubt that you will keep your word regarding privacy and confidentiality of the data."

The PH was very helpful and provided fifteen minutes of feedback on the CEO questionnaire. He suggested some changes in the language of the questions. Overall, he expressed satisfaction with the language, wording and understanding of the entire questionnaire. He estimated that it would take him twenty minutes to fill it completely. On examining the IT questionnaire, he expressed doubts if his plant's IT Executive would be able to be of any help. The PH felt that his highest ranked IT personnel would be unable to understand or answer most of the questionnaire and suggested that this would be the case across many firms. Hence the IT Executive was not called into the meeting. The PH stated that across the group, IT adoption was mainly due to pressures from international joint venture partners and hence level of IT adoption was different for each organization in the group. IT decisions were taken at a corporate level for the entire conglomerate. These decisions were taken by a Group IT Manager, who reported into the Group CFO. Due to the diversified nature of the group, the CEO of the focal firm was based at the corporate office and was mainly involved in interacting with the foreign partner and reporting to the Group CEO (who was Indian owner). All strategic and operational details regarding each plant were left to their respective PHs. After this meeting, I decided to address all correspondence at the corporate level and not to individual manufacturing sites.

Meeting at large sized heating, ventilation, and air conditioning firm

The organization is the subsidiary of a large international heating, ventilation, and air conditioning firm. It is one of the largest players in the Indian market. I contacted the Plant Head (PH) and requested meetings with the CEO and CIO. Our request was denied as the permissions are required from the parent company headquarters for an executive to answer any queries about the organization. The PH agreed to meet and help in a personal capacity, provided we did not discuss any details regarding the organization.

The Head of IT, who reports to the Group CIO, joined the meeting. As a career IT professional, he had extensive technology knowledge and was well aware of IT use in the Indian manufacturing sector. He provided detailed feedback on each question. He said that they used similar questionnaires within their organization to assess IT requirements and asked for our permission to use our items for their internal surveys.

During the meeting, several concerns regarding the identity of the University and the business school were raised. The PH and Head of IT wanted to know why academics from the US were taking an interest in conducting research in India. After being presented with a profile of the university and the motivation behind the study, they were convinced that this was not a market intelligence gathering operation. Both stated that they understood the importance of research in benefitting the industry and the country and hence were willing to help in their personal capacities.

After hearing our responses to their queries and a thorough inspection of the questionnaires, the PH and Head of IT said that they saw no reason why their company would not participate in the study. They advised that without verifying that the questionnaire did not ask any proprietary information, it was not possible for their organization to provide approval for participation in the study. Thus, they offered to supplement the official channel with an unofficial approach to the CEO and CIO to show them the questionnaires and solicit their agreement for participation.

After this meeting, I decided to create a profile page for the university and business school. This page was added to our communication packet. I also decided to include a copy of a published research paper for which data had been collected by the local partner.

Meeting at small sized (Rupees 50 crores) auto components firm

The organization is a small Indian Tier 2 automotive components company with a single plant located in the northern region. A meeting was arranged at the manufacturing plant with the CEO / owner of the organization. The meeting, scheduled for 10 am, started at 11:15 am. The CEO commenced the meeting with "Yes – please tell me what I can do for you". The CEO seemed initially very apprehensive at having to 'waste his time'. He had never heard of the university, the school, or of the local partner. However, he was aware of research and said that he understood that the Harvard Business Review could be an outlet for our work. During his interactions, he seemed to be evaluating the authenticity of the study. After presentation of the profile page and talking with the US based investigator, his attitude visibly changed.

After being explained the motivations behind the study, he said that he was willing to "do anything for the industry". He said that "Indian manufacturers need to adopt more IT - however there is a big gap in the understanding of its benefits." As the president of the regional trade association, he was very knowledgeable about his industry. The CEO provided feedback on several questions across both surveys. He also provided feedback on the state of the auto components industry with regards to IT and innovation practices. He was of the opinion that across the industry, IT use, particularly the use of ERPs, had grown significantly in the past 3 years. He stated that in his firm, they did not have a large IT budget due to resource constraints. Yet, they had recently implemented an ERP and also used optimization, finance / accounting and simulation software.

As a result of this meeting, I decided to include the potential benefits of the study to the industry and country into the communication packet for the study.

Meeting at large sized home appliance firms

The organization is the subsidiary of a large international home appliances firm. It is a leader in many segments of the Indian home appliances market. A meeting was arranged with the CIO of the organization. I was initially met by a couple of senior managers, who inquired about the purpose of the study, and verified the identity of the primary investigator. They then verified that the questionnaire did not ask for any proprietary or personal information. They advised the CIO of the nature of the study, who then agreed to meet with us.

The CIO provided detailed, in depth feedback on several questions across both surveys. He also provided feedback on the state of his industry with regards to IT and innovation practices. He expressed satisfaction with the language and clarity of the questionnaire and suggested several helpful changes in the accompanying communication packet that would help ease trust related concerns. He suggested that print outs of all relevant documentation and prior communications be presented whenever we solicit participation as this would help to verify the authenticity of the study and the identity of the agents.

Appendix 4: Features of the Extended EEA Model

The Extended EEA model consists of the following features (adapted from Kathuria et al. (2011a)):

1. A common directly unobservable external reality of *m* dimensions. This is implemented as a vector, R_v, of 60 values drawn randomly from the set (-1, +1).

2. Two firms, Org_1 and Org_2, with n_1 and n_2 employees respectively. I assume that the number of agents in Org_1 is greater than the number of agents in Org_2 (n_1 is greater than n_2) as I wish to model the acquisition of a small firm (Org_2) by a larger firm (Org_1). For my manipulations, I set $n_1 = 100$ and $n_2 = 50$.

3. Organizational code for each firm, indicating its beliefs of the values of the reality vector, R_v. This is implemented as a vector of 60 integers set initially to 0, capable of eventually taking on values from the set (-1, 0, +1).

4. Each agent's knowledge is represented by a vector of 60 integer values, initialized by random drawings from the set (-1, 0, +1), which represents an agent's beliefs of values of R_v. Expressed abstractly, a component of reality or belief might be "invest in cloud services", where the corresponding organizational code or agent knowledge would be +1 -1, or 0, which correspond to agree, disagree or undecided.

5. The level of exploitation in Org_1 is reflected by the parameter p_{11} and the level of exploitation in Org_2 is reflected by the parameter p_{21}. The level of exploration in Org_1 is reflected by the parameter p_{12} and the level of exploration in Org_2 is reflected by the parameter p_{22}.

6. p_c, defined as the *intent to appropriate organizational beliefs*. The acquiring firm alters a particular dimension of its code to match that of the target firm with probability p_c, given that the two firms differ in extant beliefs.

7. p_k, defined as the *intent to retain acquired employees*. The acquiring firm retains an employee from the target firm with probability p_k.

8. p_{kr}, defined as the *effectiveness of knowledge repository*. An employee alters a particular dimension of its knowledge to match that of the knowledge repository with probability p_{kr}.

9. P_{ct}, defined as the *effectiveness of communication technology*. An employee alters a particular dimension of its knowledge to match that held by the majority of employees who have relatively superior knowledge and are connected through communication technology with probability p_{kr}.

Other key technical details of the Extended EEA Model are as follows:

1. I constructed the Extended EEA model using Microsoft's VB.NET framework. For the primary experiment, the default values for each run of the model were set at $m = 50$, $n_1 = 200$, $n_2 = 100$, $t_1 = 100$ and $t_2 = 100$. I averaged the results over each replication set to perform the analysis.

2. In the extended EEA model, I assumed that like external reality, the knowledge of an individual is not directly observable and reputation mechanisms are vulnerable to gaming, therefore uncertain. Consequently, this introduced the possibility and consequences of retaining those employees who do not confirm to the organizational

code of the acquired firm. I also assumed that the intent to retain acquired employees, the intent to appropriate acquired organizational beliefs, the effectiveness of the knowledge repository, and the effectiveness of communication technologies are independent of one another.

3. Though in his original formulation, March states that p_1 and p_2 occur simultaneously, he does not explicitly mention the algorithmic order of p_1 and p_2. While this may seem a trivial detail, this specification has high implications on the results of the post-acquisition phase of the Extended EEA model. Specifically, in a state where a target firm with high exploration is acquired by an acquirer with high exploitation, if p_1 occurs before p_2, there is lesser opportunity for exploration to occur due to the high effectiveness of exploitation. Similarly, when a target firm with high exploitation is acquired by an acquiring firm with high exploration, if p_2 occurs before p_1, there is greater impact of exploration due to its high effectiveness. Thus, I kept with the spirit of March's original formulation and provided an algorithmic solution to this issue - a 'state buffer'. Under this implementation, at each time period, I first calculated the impact of p_1. However, I did not update the values of agent-based knowledge vectors. I then calculated the impact of p_2 on the organizational code is by using the original, non updated values of the knowledge vectors. I followed a similar 'state buffer' approach when implementing the impacts of knowledge repositories and electronic communication technologies. For this purpose, I then calculated the impact of the knowledge repository on individual knowledge vectors using the original value of the knowledge repository and the buffered values of the knowledge vectors. Similarly, I used the buffered values of individual knowledge vectors to calculate the effects of agent to agent learning. Finally, I

simultaneously updated the values of organizational code and the individual knowledge vectors.

4. March defined $(1 - p_2)^k$ as the probability that the organizational code would remain unchanged for a specific dimension, where k is the number of individuals within the superior group who differ from the organizational code minus the number of individuals who do not. Miller et al. (2006) model the exploration process as p_2^k being the probability that the organizational code will change for a specific dimension. I followed March's original specifications. Also, in the Extended EEA model, if there is no majority view, then the code changes to 0, with a probability of p_2.

Representative program code for the main functions of Extended Exploration Exploitation Acquisition Model for External Ambidexterity is provided below:

```
'Function to acquire the target firm
Private Sub Acquire_Org2()
Dim i, j, score1, score2, score3, KLScore As Integer
'
'Appropriate Org2 Code?
If AppropriateCodeProb > 0 Then
    AppropriateOrg2Code()
End If
'
'What ret% of Org2 employees?
If Val(cmbRetention.SelectedItem) > 0 Then
    Add_Org2_Agents()
End If
'
'Initialize Knowledge Repository
'Setting all dimensions to zero
For i = 0 To gOrgCodeSize
    KnowledgeRepository(i) = 0
Next

KLScore = 0
'loop through each dimension
For j = 1 To gOrgCodeSize
    score1 = 0
```

```
    score2 = 0
    score3 = 0
    For i = OrgSize1 + 1 To OrgSize3
      'loop through the acquired agents for this dimension j
      Select Case Agents_Org1(i, j)
          Case Is = -1
            score1 = score1 + 1
          Case Is = 0
            score2 = score2 + 1
          Case Is = +1
            score3 = score3 + 1
      End Select
      If score1 > score2 And score1 > score3 Then
          KnowledgeRepository(j) = -1
      End If
      If score3 > score2 And score3 > score1 Then
          KnowledgeRepository(j) = +1
      End If
    Next
    If KnowledgeRepository(j) = Reality(j) Then
      KLScore += 1
    End If
Next
KnowledgeRepository(0) = Int(KLScore)

'Initialize Social Network
'Set social group for each employee
j = GetRandomNumber(1, CommGroups)
For i = OrgSize3 To 1
    CommTechStructure(i) = j
    j += 1
    If j > CommGroups Then
      j = 1
    End If
Next
End Sub



'Function to appropriate org code
Private Sub AppropriateOrg2Code()
Dim i As Integer
'
For i = 1 To gOrgCodeSize
    If (OrgCode1(i) <> OrgCode2(i)) And (OrgCode2(i) <> 0) Then
      'possible acquistion of code(i) from Org2
      If GetRandomNumber(1, 100) <= AppropriateCodeProb Then
          OrgCode1(i) = OrgCode2(i)
      End If
    End If
Next
End Sub



'Function to retain employees
Private Sub Add_Org2_Agents()
```

```
'Add agents from Org2 to Org1 with some probRet
Dim newagents, i, j, k As Integer

k = 0
newagents = 0
'Calculate how many agents to retain based on RetentionProb
For i = 1 To OrgSize2
    If GetRandomNumber(1, 100) < RetentionProb Then
      newagents += 1
    End If
Next
'Add agent from firm 2 with prob RetentionProb
For i = 1 To OrgSize2
    k += 1
    For j = 0 To gOrgCodeSize
      Agents_Org1(OrgSize1 + k, j) = Agents_Org2(i, j)
    Next
Next
OrgSize3 = OrgSize1 + newagents
ReplicationData(gRep, 44) = OrgSize3
End Sub



'Main function to run the merged organization
Private Sub Run_Period_Org3()
Dim i, j, irandom As Integer
If TurnoverRateOrg1 > 0 Then
    'handle turnover
    For i = 1 To OrgSize3
      If GetRandomNumber(1, 1000) < TurnoverRateOrg1 Then
          'replace the agent with a new one
          For j = 1 To gOrgCodeSize
            irandom = GetRandomNumber(1, 3)
            Select Case irandom
                Case Is = 1
                  Agents_Org1(i, j) = -1
                Case Is = 2
                  Agents_Org1(i, j) = 0
                Case Is = 3
                  Agents_Org1(i, j) = +1
            End Select
          Next j
      End If
    Next
End If
'
Do_Exploitation_Org3()
Do_Exploration_Org3()
Do_IT_Mechanisms_Org3()
Do_Integration_Org3()
'
End Sub



'Function to implement exploitation
```

```
Private Sub Do_Exploitation_Org3()
'use redefined Org1, but different size (OrgSize3)
Dim i, j As Integer
'copy to buffer
For i = 1 To OrgSize1
    For j = 1 To gOrgCodeSize
      Agents_Org1_buffer_array(i, j) = Agents_Org1(i, j)
    Next
Next
'
For i = 1 To OrgSize3
      'handle Agent i
      For j = 1 To gOrgCodeSize
          If OrgCode1(j) <> 0 Then
            If GetRandomNumber(1, 100) < ExploitationOrg3 Then
                ' agent adopts org code for dimension j
                Agents_Org1_buffer_array(i, j) = OrgCode1(j)
            End If
          End If
      Next j
    Next i
End Sub



'Function to implement Exploration
Private Sub Do_Exploration_Org3()
'use redefined Org1, but different size (OrgSize3)
Dim i, j, isNegative, isPositive As Integer
Dim pchange As Single
'
For j = 1 To gOrgCodeSize
    OrgCode1_buffer_array(j) = OrgCode1(j)
Next
'
For j = 1 To gOrgCodeSize
    isNegative = 0
    isPositive = 0
    SizePhiGrp3 = 0
    For i = 1 To OrgSize3
      If Agents_Org1(i, 0) > OrgCode1(0) Then
          'found a superior agent
          SizePhiGrp3 = SizePhiGrp3 + 1
          Select Case Agents_Org1(i, j)
            Case Is = -1
                isNegative += 1
            Case Is = +1
                isPositive += 1
          End Select
      End If
    Next i
    'Is the majority +1?
    If isPositive > isNegative Then
      'does it differ?
      If OrgCode1(j) <> 1 Then
          'yes, majority (+1) differ from code (-1)
```

```
          pchange = (1 - (ExplorationOrg3 / 100)) ^ (isPositive -
isNegative)
          pchange = 1 - pchange     'prob of code changing to majority
view
          If GetRandomNumber(1, 100) < Int(pchange * 100) Then
            OrgCode1_buffer_array(j) = 1    'write to buffer array
          End If
      End If
    End If
    '
    'is the majority -1?
    If isNegative > isPositive Then
      'does it differ?
      If OrgCode1(j) <> -1 Then
          'yes
          pchange = (1 - (ExplorationOrg3 / 100)) ^ (isNegative -
isPositive)
          pchange = 1 - pchange       'prob of code changing to
majority view
          If GetRandomNumber(1, 100) < Int(pchange * 100) Then
            OrgCode1_buffer_array(j) = -1    'write to buffer array
          End If
      End If
    End If
Next j
End Sub



'Function to implement IT-enabled Learning Mechanisms
Private Sub Do_IT_Mechanisms_Org3()
Dim i, j, k, opinion As Integer
'Learn from Knowledge Repository
If KnowRepProb > 0 Then
    'For each agent
    For i = 1 To OrgSize3
      'for each dimension
      For j = 1 To gOrgCodeSize
          If KnowledgeRepository(j) <> 0 Then
            If GetRandomNumber(1, 100) < KnowRepProb Then
                Agents_Org1_buffer_array(i, j) = KnowledgeRepository(j)
            End If
          End If
      Next
    Next
End If

'Learn from Comm Tech
If CommTechProb > 0 Then
    'For each agent
    For i = 1 To OrgSize3
      'For each dimension, calculate the majority view of relatively
superior agents in the social group
      For j = 1 To gOrgCodeSize
          opinion = 0
          'If other agent is in same group and has higher knowledge,
then get opinion
```

```
          For k = 1 To OrgSize3
            If CommTechStructure(i) = CommTechStructure(k) And
Agents_Org1(i, 0) < Agents_Org1(k, 0) Then
                opinion += Agents_Org1(k, j)
            End If
          Next
          If opinion >= 1 Then
            opinion = 1
          ElseIf opinion <= -1 Then
            opinion = -1
          End If
          'If agent's belief does not match non-zero belief of
majority, then change with p(CT)
          If Agents_Org1(i, j) <> opinion And opinion <> 0 Then
            If GetRandomNumber(1, 100) < CommTechProb Then
                Agents_Org1_buffer_array(i, j) = opinion
            End If
          End If
      Next
    Next
End If
End Sub
```

Appendix 5: Main Program Code for the ITCOID Model

```
'Matrix of 100 orgs, each having 10 IDs of 50 dimensions
Dim IDMatrix(100, 10, 50) As Integer '(i,0,1-50) is the projected ID
for org i
'IT Capability for each org
Dim ITc(100) As Integer
'Plurality of the IDs for each Org
Dim Plurality(100) As Integer
'Synergy of the IDs for each Org
Dim Synergy(100) As Integer
'The current expected ID for each Org
Dim SelectedID(100) As Integer
'The cost for each org, in each period
Dim Cost(100, 100) As Single '(i,0) is the total cost for org i
'The Profit for each org, in each period
Dim Profit(100, 100) As Single '(i,0) is the total profit for org i
'The multiplicative factor for each Org
Dim History(100) As Single
'
' Replications for each setup
Dim Replications As Integer
'
Dim ID_Dimensions As Integer
Dim ID_Plurality As Integer
Dim ID_Synergy As Integer
Dim Org_IT As Integer
'
Dim Req_Periods As Integer



'Function to Initialize System
Private Sub Initialize_Org(ByVal OrgNumber As Integer)
      Dim i, j, sel As Integer
      Dim selection(ID_Dimensions) As Integer
      Dim flag As Boolean

      'Random projected and 1st identities
      For i = 0 To 1
            For j = 1 To ID_Dimensions
                  If GetRandomNumber(1, 2) = 1 Then
                        IDMatrix(OrgNumber, i, j) = 0
                  Else
                        IDMatrix(OrgNumber, i, j) = 1
                  End If
            Next
      Next
      'Copy 1st identity to others
      For i = 2 To Plurality(OrgNumber)
            For j = 1 To ID_Dimensions
                  IDMatrix(OrgNumber, i, j) = IDMatrix(OrgNumber, 1, j)
            Next
      Next
      'Flip bits in synergy number of dimensions
      For i = 1 To ID_Dimensions
```

```
            selection(i) = i
      Next
      For i = 1 To Synergy(OrgNumber)
            flag = False
            While Not flag
                  sel = GetRandomNumber(1, ID_Dimensions)
                  If sel = selection(sel) Then
                        flag = True
                        selection(sel) = 0
                  End If
            End While
            If IDMatrix(OrgNumber, Plurality(OrgNumber), sel) = 0 Then
                  IDMatrix(OrgNumber, Plurality(OrgNumber), sel) = 1
            Else
                  IDMatrix(OrgNumber, Plurality(OrgNumber), sel) = 0
            End If
            If Plurality(OrgNumber) > 2 Then
                  For j = 1 To Plurality(OrgNumber) - 2
                        If GetRandomNumber(1, 2) = 2 Then
                              If IDMatrix(OrgNumber, j, sel) = 0 Then
                                    IDMatrix(OrgNumber, j, sel) = 1
                              Else
                                    IDMatrix(OrgNumber, j, sel) = 0
                              End If
                        End If
                  Next
            End If
      Next
      History(OrgNumber) = 1.0
      Cost(OrgNumber, 0) = 0
      Profit(OrgNumber, 0) = 0
End Sub



'Function to Select an ID for an ID expectation
Private Sub Do_Select_ID(ByVal OrgNumber As Integer)
      SelectedID(OrgNumber) = GetRandomNumber(1,Plurality(OrgNumber))
End Sub

'Function to Project an ID to match the ID expectation
Private Sub Do_Project_ID(ByVal OrgNumber As Integer)
      Dim i, period_cost As Single
      i = 1
      period_cost = 0
      While (period_cost <= ITc(OrgNumber) And i <= ID_Dimensions)
            If IDMatrix(OrgNumber, 0, i) <> IDMatrix(OrgNumber,
            SelectedID(OrgNumber), i) Then
                  IDMatrix(OrgNumber, 0, i) = IDMatrix(OrgNumber,
                  SelectedID(OrgNumber), i)
                  period_cost += 1
            End If
            i = i + 1
      End While
      'Incremental Cost
      Cost(OrgNumber, Period) = (period_cost / 2) * (2 + ((period_cost
- 1) * 0.01))
```

```
        Cost(OrgNumber, 0) += Cost(OrgNumber, Period)
End Sub



' Function to Calculate Profit
Private Sub Do_Calculate_Profit(ByVal OrgNumber As Integer)
        Dim i As Integer
        Dim revenue, NewHistory As Single
        revenue = 0
        For i = 1 To ID_Dimensions
                If IDMatrix(OrgNumber, 0, i) = IDMatrix(OrgNumber,
                SelectedID(OrgNumber), i) Then
                        revenue = revenue + 1
                End If
        Next
        NewHistory = History(OrgNumber) * (1 - ((ID_Dimensions - revenue)
        * (ID_Dimensions - revenue) / (ID_Dimensions *
        Synergy(OrgNumber))))
        If NewHistory < 0.1 Then
                NewHistory = 0.1
        End If
        If NewHistory > 1 Then
                NewHistory = 1
        End If
        If revenue = ID_Dimensions Then
                NewHistory = 1
        End If
        'Incremental Revenues
        revenue = (revenue / 2) * (2 + ((revenue - 1) * 0.01))
        Profit(OrgNumber, Period) = History(OrgNumber) * revenue -
        Cost(OrgNumber, Period)
        Profit(OrgNumber, 0) += Profit(OrgNumber, Period)
        'Updating historical valuation
        If chk_History.Checked = True Then
                History(OrgNumber) = NewHistory
        End If
End Sub



'Function to Calculate Synergy
Private Sub Do_Calculate_Synergy(ByVal OrgNumber As Integer)
        Dim i, j As Integer
        Dim Match As Boolean
        Synergy(OrgNumber) = 0
        For i = 1 To ID_Dimensions
                Match = True
                For j = 2 To Plurality(OrgNumber)
                        If IDMatrix(OrgNumber, 1, i) <> IDMatrix(OrgNumber,
                        j, i) Then
                                Match = False
                        End If
                Next
                If Match = False Then
                        Synergy(OrgNumber) = Synergy(OrgNumber) + 1
                End If
```

```
      Next
End Sub



'Main Code
For j = 1 to Req_Periods
      For i = 1 To Replications
            Do_Select_ID(i)
            Do_Project_ID(i)
            Do_Calculate_Profit(i)
      Next
Next
```

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