European Journal of Information Systems (2014) 23, 326–342

www.palgrave-journals.com/ejis/

EMPIRICAL RESEARCH

IT capability and organizational performance: the roles of business process agility and environmental factors

Yang Chen[1],
Yi Wang[2],
Saggi Nevo[3],
Jiafei Jin[1],
Luning Wang[4] and
Wing S. Chow[5]

[1]School of Business Administration, Southwestern University of Finance and Economics, Sichuan, P. R. of China; [2]Business School, Shantou University, Guangdong, P. R. of China; [3]Information Technology Management, School of Business, University at Albany, Albany, NY, U.S.A; [4]Department of Management, Hong Kong University of Science and Technology, Hong Kong, P.R. China; [5]Department of Finance and Decision Sciences, School of Business, Hong Kong Baptist University, Hong Kong, P.R. China

Correspondence: Yi Wang, Business School, Shantou University, No. 243, Daxue Road, Shantou, Guangdong 515063, P. R. of China.
Tel: +86 754 865 03693;
Fax: +86 754 829 03442;
E-mail: ywang63@stu.edu.cn

Received: 16 January 2012
Revised: 28 July 2012
2nd Revision: 4 December 2012
3rd Revision: 3 February 2013
Accepted: 4 February 2013

Abstract

The business value of information technology (IT) has been one of the top concerns of both practitioners and scholars for decades. Numerous studies have documented the positive effects of IT capability on organizational performance but our knowledge of the processes through which such gains are achieved remains limited due to a lack of focus on the business environment. Such a linkage therefore remains the subject of debate in the information systems literature. In this study, we fill this gap by investigating the mediating role of business process agility and the moderating roles of environmental factors. On the basis of matched survey data obtained from 214 IT and business executives from manufacturing firms in China, our analyses show that even though firm-wide IT capability presents the characteristics of rarity, appropriability, non-reproducibility, and non-substitutability, its impact on organizational performance is fully mediated by business process agility. Our results also show that the impact of the environment is multifaceted and nuanced. In particular, environmental hostility weakens the effect of IT capability on business process agility, while environmental complexity strengthens it. The theoretical and practical implications of this study, and its limitations, are also discussed.
European Journal of Information Systems (2014) **23**(3), 326–342.
doi:10.1057/ejis.2013.4; published online 26 March 2013

Keywords: IT capability; organizational performance; business process agility; environmental factors

Introduction

Today's fast-moving and competitive business environment increases the pressure on firms to increase their market exposure and revenue-earning potential. Information technology (IT) is widely considered to be a critical underpinning for a firm's survival and growth (Bhatt & Grover, 2005). Recently, drawing on the resource-based view (RBV) theory, information systems (IS) scholars have argued that firms should develop their IT capability to achieve competitive advantage (e.g., Bharadwaj, 2000; Stoel & Muhanna, 2009). At its core, the notion of IT capability underscores the importance of mobilizing and deploying IT-based resources in combination with, and leveraging the value of, other resources and capabilities (Bharadwaj, 2000). Empirical evidence also indicates that it contributes to organizational performance (e.g., Melville *et al*, 2004; Stoel & Muhanna, 2009). Despite the strong appeal of the concept, there is lack of agreement in the IS literature about how IT capability contributes to superior performance (for useful reviews, see Melville *et al*, 2004 and Kohli & Grover, 2008). It appears that rather than tracing a direct link between IT

capability and organizational performance we should instead seek to identify the processes by which a firm uses its IT capability to achieve superior performance in an unpredictable business environment.

On the basis of RBV theory, some scholars propose that internal business processes could be important factors linking IT capability and organizational performance (e.g., Dehning & Richardson, 2002; Melville *et al*, 2004). An important aspect of internal business processes is that of *business process agility* (Sambamurthy *et al*, 2003). This term refers to the ease and speed with which firms can alter their business processes to respond to threats in their markets (Tallon, 2008). It is critical to internal business processes, since a firm's capability to achieve excellent performance depends on its reaction to market changes (Bharadwaj, 2000; Weill *et al*, 2002). Recognizing that business process agility is driven by technology, IS scholars have tended to conclude that a firm could strengthen it by leveraging its IT capability (e.g., Tallon, 2008). In this sense, a firm's IT capability may impact organizational performance through the mediating effect of business process agility (Sambamurthy *et al*, 2003; Tallon, 2008). Accordingly, the current study seeks to close a gap in the literature by investigating the role of business process agility in the relationship between IT capability and organizational performance.

Traditional RBV theory, which focuses on the internal mechanisms used by a firm to build competitive advantage, underemphasizes the importance of the external business environment (e.g., Burns & Stalker, 1994; Aragon-Correa & Sharma, 2003). Therefore, critics of the RBV have called for an integrated analysis of the influence of exogenous variables on the internal operational mechanism of a firm (Barney *et al*, 2001; Priem & Butler, 2001a, b). This paper extends previous studies by explicitly arguing for, and empirically examining, the influential role of exogenous variables (such as external environmental factors) in the IT capability-business process agility relationship. IT capability, while recognized as a strategic resource (Bharadwaj, 2000), cannot create value in a vacuum. Instead, its role in supporting business strategic processes is affected by exogenous influences (Aragon-Correa & Sharma, 2003; Wade & Hulland, 2004). Scholars also argue that such exogenous influences are critical to the value-creating process of IT capability by modifying the conditions through which it contributes to firms (e.g., Melville *et al*, 2004; Stoel & Muhanna, 2009). Accordingly, the present study aims to identify empirical support for the influential role of external environmental factors, namely environmental hostility, dynamism, and complexity, on the relationship between IT capability and business process agility.

IS scholars suggest that future research should link firm-wide IT capability to competitive advantage (e.g., Mata *et al*, 1995; Ross *et al*, 1996; Bharadwaj, 2000; Bhatt & Grover, 2005; Lu & Ramamurthy, 2011). Partly motivated by this call, the present study investigates the process by which firm-wide IT capability affects performance in an unpredictable business environment by answering the following two research questions:

RQ1. *Does business process agility play a mediating role in the relationship between IT capability and performance?*

And, if so:

RQ2. *What are the effects of environmental factors (that is, environmental hostility, dynamism, and complexity) on the relationship between IT capability and business process agility?*

In the following sections, we first provide a theoretical background on IT capability and business process agility. Drawing on RBV theory, we develop our hypotheses about the relationships between IT capability, business process agility, environmental factors, and organizational performance. We then describe our methodology and present our results, ending with a discussion of our findings and the limitations of this study.

Theoretical background

IT capability

Organizational capabilities play an important role in inter-organization competition. Grant (1991) defines organizational capabilities as a firm's overall competency to coordinate its complex human and other resources effectively to achieve corporate performance. According to RBV theory (Barney, 1991; Amit & Schoemaker, 1993), firms can obtain competitive advantage by acquiring or developing organizational capabilities that are valuable, rare, cannot be perfectly reproduced, and are non-substitutable in unique combinations. Since organizational capabilities usually exhibit path-dependency, causal ambiguity, and social complexity, a capability-generated competitive advantage can be sustained over longer time periods (Porter, 1985; Barney, 1991).

Long recognized as a key organizational capability (Wade & Hulland, 2004), IT capability has been defined as an ability to mobilize and deploy IT-based resources in combination with other organizational resources and capabilities (Bharadwaj, 2000). Consistent with the rationale of RBV, an IT capability that presents the characteristics of rarity, appropriability, non-reproducibility, and non-substitutability, may become a source of superior performance (Wade & Hulland, 2004). IS researchers have extensively examined the impact of IT capability on firm performance. For example, Bharadwaj (2000) indicates that firms with a high IT capability tend to outperform their rivals on a variety of profit- and cost-based performance measures. Furthermore, there is growing evidence that competitive advantage often depends on whether or not firms take full advantage of their IT capability (Bhatt & Grover, 2005).

Within this stream of research, some studies (e.g., Rai & Tang, 2010; Fink, 2011) focus their attention on the

competitive advantage linked to specific IT capabilities such as IT management. However, this might be too narrow a focus to reveal the scope of the business value of IT since (1) specific IT capabilities tend to generate only short-term competitive advantage (Bharadwaj *et al*, 1999; Bharadwaj, 2000), and (2) such a view risks overlooking the commonality shared by, and the correlation among, these specific IT capabilities (Lu & Ramamurthy, 2011). Therefore, in this study, we adopt a more holistic perspective of IT capability, which reflects the commonalities and potential synergies between firms' various IT assets and resources (e.g., Mata *et al*, 1995; Ross *et al*, 1996; Bharadwaj, 2000; Bhatt & Grover, 2005; Zhang & Sarker, 2008; Lu & Ramamurthy, 2011). Accordingly, we treat IT capability as a second-order construct with six dimensions: IT infrastructure, IT business partnerships, business IT strategic thinking, IT business process integration, IT management, and external IT linkage (Bharadwaj *et al*, 1999; Bharadwaj, 2000).

Research has tended to focus on the underlying mechanism of how IT capability contributes to excellent performance (e.g., Pavlou & El Sawy, 2010; Rai & Tang, 2010; Kim *et al*, 2011). For example, it has been proposed that IT capability may contribute indirectly by influencing other resources or capabilities within the firm (Kohli & Grover, 2008). Also, Ravichandran & Lertwongsatien (2005) conclude that variation in firm performance may be explained by the extent to which IT capability is used to support and enhance core competencies. Similarly, Radhakrishnan *et al* (2008) show that the business value of IT capability lies in leveraging the value of other resources and capabilities (such as management capabilities and operational capabilities) within a firm. It is widely recognized that IT does not create business value by itself and must interact and integrate with other IS and organizational factors, particularly business process capability, to influence performance (Dehning & Richardson, 2002; Melville *et al*, 2004; Wade & Hulland, 2004; Radhakrishnan *et al*, 2008; Nevo & Wade, 2010). However, few empirical studies have examined the possible relationships between IT capability, business process capability, and firm performance. Linking IT to specific business process capabilities is critical to developing a more complete understanding of the role of IT capability on firm performance and providing practitioners with actionable guidelines for making decisions about IT development, acquisition, and implementation. Therefore, further investigation on the mediating effect of business process capabilities on the IT capability-performance linkage is expected to provide important insights.

In examining the mechanisms underlying the contribution of IT capability to firm performance, the IS literature suggests that exogenous variables could play a moderating role (e.g., Weill, 1992; Ray *et al*, 2005; Stoel & Muhanna, 2009). As firm performance is dependent upon a proper match between internal organizational mechanisms and external variables (Lawrence & Lorsh, 1967; Miller, 1988; Thompson *et al*, 1992; Chandler, 1962; Burns & Stalker, 1994), firms should formulate different levels of strategies to match their organizational resources so as to simultaneously exploit business opportunities and reduce threats from the exogenous environment (Hofer & Schendel, 1978; Andrews, 1998). Consistent with this argument, Stoel & Muhanna (2009) find that the effect of IT capability on firm performance is contingent on its match to the demands of the industry in which the firm competes. Recent studies support the notion that the effect of IT capability on firm performance depends on external environmental factors such as turbulence (Pavlou & El Sawy, 2006), dynamism (Sila, 2010), and unpredictability (Davis-Sramek *et al*, 2010). Specifically, a close match between a firm's IT capability and the demands of the external environment is expected to improve performance, while a mismatch is unfavorable to its competitive position.

To address the gaps in extant knowledge on the business value of IT capability, this paper examines the possible mediating effects of business process capabilities and the moderating effects of environmental factors in an integrated manner. We set out to provide a wider perspective on how IT creates value in a firm operating in an uncertain environment.

Business process agility

Recently, agility has received much attention from both academics and practitioners. According to a recent survey conducted by the Economist Intelligence Unit (Glenn, 2009), an overwhelming majority of executives (88%) identify agility as the key to global success. A possible explanation for this surge in interest is that agility may provide a firm with the ability to refine businesses and business processes swiftly and easily in order to effectively manage unpredictable external and internal changes (Dove, 2001; Van Oosterhout *et al*, 2006).

A form of organizational agility that is of particular relevance to IS research is business process agility, or the extent to which firms can easily and quickly retool their business processes to adapt to the market environment (Tallon, 2008). It highlights the need for a firm to detect changes, opportunities, and threats in the environment and to provide swift and focused responses to customers and stakeholders by reconfiguring resources and processes (Mathiyakalan *et al*, 2005). Business process agility is an important mechanism through which firms interact with the market environment, and can explain inter-firm performance variance over time (Van Oosterhout *et al*, 2006; Raschke, 2010). By prioritizing the speed and ease of firms' reaction to changes in the market environment, agile business processes are expected to help firms achieve cost economies. In addition, they also enable firms to exploit opportunities for innovation and competitive action (Sambamurthy *et al*, 2003; Seethamraju, 2006).

However, even though firms are paying increasing attention to the role of process agility, not enough is known about how to actually become more agile

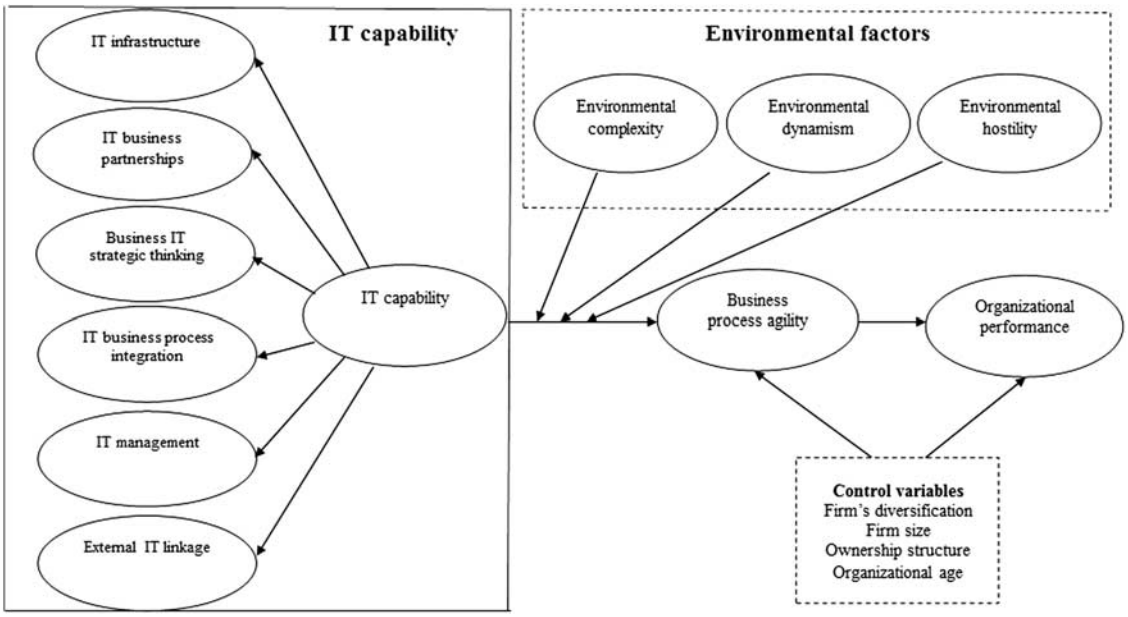

Figure 1 Research model.

(Sambamurthy *et al*, 2003). In this sense, business process agility is a rare capability. Further, it allows firms to redesign existing processes and to create new processes rapidly in order to be able to take advantage of uncertain market conditions (Raschke, 2010). This procedure is rooted in organizational routines, thus making it harder for firm's competitors to discern which parts or processes are valuable. Therefore, business process agility is difficult to imitate and non-substitutable. To conclude, business process agility has the characteristics of a strategic organizational capability that can help firms to better acquire and deploy resources to match a firm's market environment.

Such a definition of business process agility implies the capabilities of speed, flexibility, and innovation. It provides firms with the ability to respond quickly to customer demands, market dynamics, and emerging technology options (Mathiassen & Pries-Heje, 2006). This kind of agility can be demonstrated by swiftness in sensing relevant events, interpreting what is happening and assessing the consequences for the organization, exploring options and making decisions, and implementing appropriate responses (Haeckel, 1999). With business process agility, firms can rapidly and flexibly redesign existing processes or create new ones to cope with dynamic market conditions (Sambamurthy *et al*, 2003).

Research model and hypotheses

In this study, we propose that IT capability has an indirect impact on firm performance and that business process agility serves as a mediator of this relationship. Furthermore, environmental factors (that is, hostility, dynamism, and complexity) moderate the effect of IT capability on business process agility. Figure 1 illustrates our research model.

IT capability and business process agility

Considering the definition of business process agility discussed above, the main ways through which IT capability can help organizations achieve this are: (1) enabling rapid business process operations, (2) facilitating flexible business processes, and (3) enabling business process innovation (Tallon, 2008).

First, agility is an important aspect of a firm making rapid business decisions. The presence of a solid IT infrastructure allows a firm to easily reach the relevant data it holds (Duncan, 1995). Various IT applications provide access to a vast amount of real-time managerial information (for example, the status of resources such as inventory, product development status, and product delivery times). An effective IT capability is critical in organizing and efficiently managing these applications. Moreover, external IT linkages help companies to exchange information and communicate with outside partners in a timely manner. IT capability that permeates and infuses ordinary business activities and processes helps to shorten the time for responding to change, processing information, and implementing strategies (Melville *et al*, 2004).

The flexibility enabled by IT capability can be demonstrated by the following aspects. First, a firm with a solid IT infrastructure and IT management ability can deploy new applications efficiently and effectively and solve maintenance hurdles associated with old systems (Van Oosterhout *et al*, 2006). This implies that a firm with a low level of IT capability, due, say, to the presence of legacy systems, would fail to respond effectively and

quickly to market changes. Second, external IT linkages and a strong IT infrastructure help to build an efficient communication and information exchange environment within and across firm boundaries, thereby improving market responsiveness (Shang & Seddon, 2002). Third, IT business partnerships, IT business process integration, and business IT strategic thinking are all useful in enabling coordination and knowledge sharing between IT and business staff (Qu *et al*, 2010). These IT-enabled advantages are fundamental if a firm is to leverage IT to support its activities and maintain operational flexibility in business processes. For example, Fichman (2004) and Weill *et al* (2002) indicate that a superior IT capability strengthens a firm's capacities in terms of hardware compatibility, software modularity, network connectivity, and IT skill adaptability. These abilities, in turn, improve responsiveness to change and the flexibility of mechanisms.

In terms of its role as an enabler of business process innovation, IT capability could be 'driving the modularization and atomization of business processes and enabling their combination and recombination to create new business processes' (Sambamurthy *et al*, 2003, p. 265). Tallon (2008) notes that managerial aspects of IT capability, such as strategic foresight and relationship building, can promote ongoing learning, greater use of best practices, strategic flexibility, and trust among business partners. By facilitating organizational learning and distributing best practices and knowledge, IT capability enables a firm to continuously transform its business processes.

In summary, given the increasing embeddedness of IT applications in business processes, the extent to which a firm can rapidly modify or alter the latter appears to be heavily dependent upon its ability to leverage and implement IT, which is reflected in its IT capability. Hence, we hypothesize as follows:

H1: *IT capability will have a positive impact on business process agility.*

Business process agility and organizational performance

Business process agility is generally believed to be beneficial for firms since it allows them to adapt and align their activities in a manner that helps to achieve superior financial performance (Sambamurthy *et al*, 2003). Firms with strong process agility can proactively address aspects such as partnership choice and responsiveness to customer needs, improve operational flexibility and customer retention, and generally increase revenues while reducing costs (Tallon, 2008). Furthermore, a firm's level of business process agility also reflects the strength of the interface between the firm and its market (Katayama & Bennett, 1999). A high level of agility reflects the swiftness with which a firm can adapt to market changes. It can be manifested in increasing product customization, improved delivery performance, and reduced reaction time. According to RBV theory, business process agility represents a valuable capability (Swafford *et al*, 2008) and can contribute to a firm's superior performance (Prahalad & Hamel, 1990; Teece *et al*, 1997). On the basis of these arguments, we hypothesize that:

H2: *Business process agility will have a positive impact on organizational performance.*

The mediating role of business process agility

IT capability can affect firm performance through the mediating role of other resources or capabilities. Business process agility, as a strategic capability, depends on a firm's ability to implement and leverage IT resources (Bharadwaj, 2000; Weill *et al*, 2002). Combining these arguments suggests that business process agility mediates the relationship between a firm's IT capability and organizational performance. High levels of IT capability could enable firms to strengthen business processes in a manner that infuses their operational processes with swiftness, robustness, and flexibility. Improved business process agility provides an opportunity for firms to achieve high profitability, return on investment, sales growth, and market share growth. In contrast, without it, the firm is less likely to achieve superior performance. Thus, we expect that business process agility will serve as a mediator of the relationship between IT capability and performance. Accordingly, we hypothesize as follows:

H3: *Business process agility will mediate the relationship between IT capability and organizational performance.*

The moderating effects of environmental factors

Recent critiques of RBV theory have called for an empirical examination of the effect of exogenous variables on corporate strategy, which are under-studied in the traditional RBV (e.g., Wade & Hulland, 2004; Rueda-Manzanares *et al*, 2008). A proper match between internal mechanisms and exogenous variables can help firms achieve superior performance (Thompson *et al*, 1992; Burns & Stalker, 1994). The extent of such a match can moderate internal processes and influence firm performance (Venkatraman, 1989). Research suggests that external environmental factors are important exogenous variables. For instance, event studies on the effect on shareholders wealth of IT-related announcements suggest that the nature and significance of this impact varies depending on different environmental factors (Im *et al*, 2001). Aragon-Correa & Sharma's (2003) theoretical framework proposes that environmental factors moderate the deployment of organizational capabilities for environmental strategy. Stoel & Muhanna (2009) empirically examine the moderating role of environmental conditions in the linkage between IT capability and firm performance. We draw on this literature to study how environmental factors, in terms of hostility, dynamism, and complexity (Newkirk & Lederer, 2006), moderate the

relationship between IT capability and business process agility.

Environmental hostility Environmental hostility refers to the existence of unfavorable external forces in a firm's business environment (Zahra & Garvis, 2000). It reflects the extent to which a firm's environment can diminish or prevent a continuous rate of organizational or sales growth (Dess & Beard, 1984). Environmental hostility may result from various economic, societal, and political factors, such as radical changes in the industry, the imposition of more intense regulatory burdens, or fierce rivalry among competitors (Dess & Beard, 1984; Werner *et al*, 1996). Firms operating in a hostile business environment may encounter high tax burdens, governmental deterrence, inaccessible technical knowledge provided by educational institutions, fragile infrastructure, slow market growth, general economic downturn, or a lack of suitably qualified staff (Rueda-Manzanares *et al*, 2008).

These obstacles may prevent firms from accessing or improving the resources required to develop IT capability (McArthur & Nystrom, 1991). In turn, underdeveloped IT capability may further slow firms' progress toward innovation, investment in processes, and the changes in operational structures required to achieve flexibility and effectiveness via exploration and exploitation (Aragon-Correa & Sharma, 2003). Therefore, a firm that devotes time, money, and effort to create an IT capability may receive little return on its investment in a hostile environment (Rueda-Manzanares *et al*, 2008; Stoel & Muhanna, 2009). Furthermore, a hostile environment often leads to greater restrictions on communication, over-formalization of procedures, and centralization of strategic decision making, all of which can hinder firms in their efforts to achieve process agility (Stoel & Muhanna, 2009). Therefore, in a very hostile business environment, a firm may not be able to make better decisions, such as choosing products that satisfy consumer demand, even though it has developed a superior IT capability. This will reduce its ability to develop agility. This does not mean that firms in unstable sectors such as manufacturing should overlook investing in the IT capability that will facilitate agility; rather, firms in highly hostile markets are less likely to use their IT capability to improve agility compared with those in less hostile environments. Building on this rationale, we formulate the following hypothesis for empirical testing:

H4a: *Environmental hostility will negatively moderate the impact of IT capability on business process agility.*

Environmental dynamism Environmental dynamism denotes the rate and unpredictability of environmental changes such as product/service obsolescence, technology change, competitors' moves, and shifts in customer demand (Newkirk & Lederer, 2006). In a dynamic or rapidly changing environment, top managers experience high degrees of uncertainty and have a greater need for both information and the capacity to process it (McArthur & Nystrom, 1991; Flynn & Flynn, 1999; Li & Ye, 1999). Accordingly, in dynamic environments IT capability becomes more valuable because it enables firms to effectively mobilize various types of IT assets and resources in more dynamic environments compared with those that are relatively stable. Consistent with these arguments, Li & Ye (1999) find that IT investment appears to have a stronger positive impact on financial performance when the environmental changes are greater, and Nevo & Wade (2011) find that IT-enabled resources become more valuable under more dynamic environmental conditions.

In a more dynamic environment, it may be difficult to create a competitive advantage because of many changes occurring simultaneously. Furthermore, it may be particularly difficult to sustain whatever competitive edge may have been created, because the speed of change can neutralize or render obsolete any benefits generated. In such volatile and dynamic environments, in order to operate efficiently and effectively firms may be required to frequently reconfigure their various IT resources, generate new knowledge, and constantly look out for new opportunities. Such activities may include capturing market information, analyzing and transferring data from customers and competitors, and sharing up-to-date information quickly among internal departments and partners in turbulent environments (e.g., Zhang & Sarker, 2008; Chen, 2010). Putting this another way, greater environmental dynamism is expected to impose greater and more variable requirements on information processing, thus demanding superior IT capability to enable efficient market operation. On the basis of this logic, we formulate the following hypothesis for empirical testing:

H4b: *Environmental dynamism will positively moderate the relationship between IT capability and business process agility.*

Environmental complexity Environmental complexity refers to 'the heterogeneity and range of an industry and/or an organization's activities' (Wade & Hulland, 2004, p. 127). In a complex environment, a firm needs to address important business issues such as simplifying operational processes by applying complex and sophisticated knowledge, and coping with varied external stakeholders (such as suppliers, customers, and competitors) (Wade & Hulland, 2004). The more complex the business environment becomes, the more factors managers need to be concerned with, often simultaneously (Aragon-Correa & Sharma, 2003).

The complexity of a firm's operational environment has a direct and negative effect on its engagement with business processes (Aragon-Correa & Sharma, 2003). Since in complex settings managers find it difficult to make fundamental changes, they often opt for small-scale alterations instead. However, the reverse may be

true of decisions about IT applications. Specifically, before making a decision to address process agility, managers faced with task uncertainty need to collect and process more information (Galbraith, 1974). Kearns & Sabherwal (2007) report that top managers are forced to recognize the importance of IT and integrate the firm's IT capability development into business planning in highly complex environments. Similarly, Wade & Hulland (2004) argue that 'a robust and flexible IS infrastructure coupled with strong IS technical skills may help a firm manage its operations more efficiently in the face of environmental complexity' (p. 127). As a result, firms are more likely to apply or develop their IT capability to improve agility in terms of operational efficiency and effectiveness (Stoel & Muhanna, 2009). In such environments, having superior IT capability can help firms to cope better with the complexity induced by the processes and to coordinate such complex operations more effectively (Stoel & Muhanna, 2009). To conclude, in a complex environment, firms with superior IT capability are better able to collect, analyze, and disseminate market information in a coordinated and effective manner, and are thus more likely to achieve business process agility. On the basis of this rationale, we formulate the following hypothesis for empirical testing:

H4c: *Environmental complexity will positively moderate the impact of IT capability on business process agility.*

Research methodology and data analysis

Data collection

To test these hypotheses, we collected data from manufacturing firms in Northern China. We focused on this sector for two reasons: (1) to minimize potential confounding effects due to industry variation, and (2) because IT continues to contribute significantly to greater effectiveness across a wide range of manufacturing industries (Karim *et al*, 2007). Data were gathered in a field survey that recorded responses from (1) senior IS executives, such as the chief information officer (CIO), IT director, and IT manager and (2) senior business executives such as the CEO or other members of the top management team (TMT). Separate questionnaires were developed for each group. Since senior IT and business executives are well versed in their firm's organizational capabilities and its strategic management approaches, they can be considered appropriately informed respondents.

With the permission of the TMT of each firm, we invited one IT and one business executive to respond to two sets of questionnaires measuring firms' IT applications and business processes. Respondents were informed of the goals of the survey and assured of the confidentiality of their answers. Participants completed the questionnaires during the working day and returned the completed forms to research assistants, who then matched up the responses of the IT and business executives in each of the firms. We received completed responses from 232 IT and 240 business executives. After deleting unmatched and/or missing cases, the final sample consisted of 214 matched questionnaires, giving a response rate of 92.2% for IT and 89.2% for business executives. Table 1 summarizes the demographic data of our respondents. Of the 214 sets of questionnaires from the IT executives, 68.2% of respondents were CIOs, 8.4% IT directors, and 13.6% are IT managers, with an average organizational tenure of 9 years (SD = 6). For the business executives, 47.7% of respondents were operational managers, 25.7% CEOs/directors or general managers, and 12.6% chief financial managers or strategic planners, with an average organizational tenure of 11 years (SD = 7). Thus, it appears that the sample is appropriate for testing our theoretical model.

Table 1 Sample characteristics ($N = 214$)

	Frequency	*Percentage*
Firm size (number of employees)		
Fewer than 100	128	59.8
100–1000	59	27.6
More than 1000	27	12.6
Ownership structure		
State-owned	144	67.3
Nonstate-owned	70	32.7
Organizational age (in years)		
Less than or equal to 1	2	0.9
2–20	196	91.6
More than 20	16	7.5
Respondents (matched surveys)		
IT executive survey		
IT director	18	8.4
CIO	146	68.2
IT manager	29	13.6
Other IT executives	21	9.8
Business executive survey		
CEO/Director	4	1.9
General manager	51	23.8
Operational manager	102	47.7
Chief financial officer	21	9.8
Strategic planner	6	2.8
Other managers	30	14.0

Measurement items

We developed multi-item reflective measures by adopting scales previously validated in other studies and modifying them slightly to fit the context. Appendix lists the measurement items used. Responses to all the multi-item measures were captured using seven-point Likert-type scales.

While the questionnaire had been originally developed in English, it was subsequently translated into Chinese to facilitate respondents' understanding. We followed the approach of Bhalla & Lin (1987) by adopting the

back-translation technique to ensure the linguistic equivalence of the two versions. Several faculty members and doctoral students reviewed the initial version of the questionnaire and provided feedback on content validity and on the clarity of instructions. Their feedback led to several changes in the item wording in the final version.

IT capability Consistent with our theoretical conceptualization, we followed Bharadwaj *et al* (1999) by treating IT capability as a second-order construct reflected in six interrelated first-order dimensions; IT infrastructure, IT business partnerships, business IT strategic thinking, IT business process integration, IT management, and external IT linkage. This measurement model specification is suitable for capturing the common variances or covariances shared by the first-order factors (Lu & Ramamurthy, 2011). The reflective second-order factor of IT capability represents a covariation model (Venkatraman, 1989) and captures the commonality shared across these six dimensions (Bharadwaj, 2000). We asked senior IT executives to evaluate the significance of the measurement items compared with other firms in the same industry. A seven-point Likert-type scale was used to capture responses, ranging from 1 = poorer than most to 7 = exceptionally well.

Business process agility Previous research has studied this variable at the process level by focusing on specific business processes (e.g., Raschke & David, 2005; Raschke, 2010). For example, Raschke (2010) defines business process agility as 'the ability to add and/or reconfigure a business process by quickly adding new capabilities to the set of business process capabilities to accommodate the potential needs of the firm' (p. 299). However, other scholars (e.g., Goldman *et al*, 1995; Seethamraju, 2006; Ganguly *et al*, 2009) argue that it is more appropriate to study agility from a firm-level perspective because the process-level approach potentially overlooks the synergies that may be created by unanticipated interrelationships among the different processes. Furthermore, a firm-wide IT capability may impact the agility of different business processes. Therefore, we follow Tallon (2008) by studying this construct at the firm level. We adopted the reflective measurements of business process agility in Tallon (2008). A seven-point Likert-type scale was used to capture responses, ranging from 1 = strongly disagree through to 7 = strongly agree.

Organizational performance Wade & Hulland (2004) suggest that dependent variables in RBV theory should exhibit three key attributes. Specifically, they should (1) provide an assessment of performance, (2) incorporate a competitive assessment element, and (3) address the notion of performance over time. In this study, we used relative assessments of a number of financial performance indicators with respect to competition over a period of 2–3 years. The reflective scales used by Judge & Douglas (1998) were adopted. A seven-point Likert-type scale was used to capture responses, ranging from 1 = far below average through to 7 = far above average.

Environmental factors To measure the three constructs of environmental factors (hostility, dynamism, and complexity), we adopted the reflective measurements of Newkirk & Lederer (2006) and Teo & King (1997). We asked senior business executives to evaluate the environmental factors facing their industries. A seven-point Likert-type scale was used to capture responses, ranging from 1 = strongly disagree through to 7 = strongly agree.

Control variables We identified the following control variables as relevant. First, a firm's level of diversification was included, on the grounds that IT-enabled performance might depend upon the diversity of business operations (Tallon, 2007). We used the number of sub-industries to control for the possible effect of the extent of diversification. Second, organizational age was included since this could be linked to sales growth – that is, older firms might enjoy an experience-based advantage that enables them to sustain growth better than younger ones (Autio *et al*, 2000). Third was ownership structure, since firms with different ownership structures may consistently demonstrate different levels of performance (Darnall & Edwards, 2006). We coded this variable as 0 for state-owned, 1 for nonstate-owned. In China, state-owned enterprises are generally less willing to take risks and less proactive than nonstate-owned ones (Zhou *et al*, 2008). Fourth, we included firm size as a control variable on the grounds that larger firms may have more resources than smaller ones, which may affect the relationship between firm strategy and the dependent variables (Rueda-Manzanares *et al*, 2008). We used a categorical description of firm size based on Judge & Elenkov (2005), defining firms with fewer than 100 employees as small (coded 1), with more than 100 but fewer than 1000 medium-sized (2), and firms with more than 1000 employees as large (3).

Data analysis and results

Convergent validity Convergent validity was assessed by examining the significant factor loadings on each construct. Following Anderson & Gerbing (1988), convergent validity is established when items load significantly on their designated latent variables. A second-order confirmatory factor analysis (CFA) (Bentler, 1989) was carried out to investigate the convergent validity of each construct. We examined a six-construct CFA model in which IT capability (formulated as a reflective second-order factor), business process agility, environmental hostility, complexity, dynamism, and organizational performance were all included (using SmartPLS 2.0). The standardized CFA loadings in Table 2 present evidence of convergent validity. The results also demonstrate that the path coefficients from IT capability as a second-order factor to all six first-order factors are significant and of high

Table 2 Finalized confirmatory factor analysis results for the constructs (six first- and one second-order factors)

Model construct	*Measurement item*	*Standardized loading*	*t-value*	*Cronbach's α*	*AVE*	*Second-order factor loading*[a]
IT capability						
IT infrastructure	ITF 1	0.93	51.25*	0.93	0.83	0.91
	ITF 2	0.90	38.11*			
	ITF 3	0.91	47.92*			
IT business partnerships	IBP 1	0.89	41.26*	0.91	0.73	0.94
	IBP 2	0.87	34.28*			
	IBP 3	0.79	19.83*			
	IBP 4	0.86	30.10*			
	IBP 5	0.86	36.26*			
IT business process integration	BPI 1	0.80	16.90*	0.86	0.78	0.73
	BPI 2	0.93	30.32*			
	BPI 3	0.91	29.89*			
Business IT strategic thinking	BIT 1	0.88	13.61*	0.91	0.83	0.91
	BIT 2	0.93	28.34*			
	BIT 3	0.93	60.15*			
IT management	ITM 1	0.89	43.21*	0.95	0.79	0.94
	ITM 2	0.92	50.63*			
	ITM 3	0.88	49.81*			
	ITM 4	0.87	35.30*			
	ITM 5	0.89	49.94*			
	ITM 6	0.87	36.47*			
External IT linkage	EIT 1	0.96	74.68*	0.91	0.84	0.87
	EIT 2	0.91	41.35*			
	EIT 3	0.88	29.98*			
Business process agility	BPA1	0.77	11.67*	0.91	0.60	—
	BPA2	0.64	6.41*			
	BPA3	0.70	8.93*			
	BPA4	0.69	8.66*			
	BPA5	0.80	12.27*			
	BPA6	0.86	14.96*			
	BPA7	0.88	18.68*			
	BPA8	0.80	13.27*			
Organizational performance	OP 1	0.87	14.95*	0.89	0.70	—
	OP 2	0.72	9.03*			
	OP 3	0.89	18.58*			
	OP 4	0.86	17.19*			
Environmental hostility	EH1	0.83	19.58*	0.92	0.75	—
	EH2	0.88	38.15*			
	EH3	0.86	25.77*			
	EH4	0.90	41.50*			
	EH5	0.85	25.06*			
Environmental dynamism	ED1	0.85	11.03*	0.85	0.68	—
	ED2	0.82	8.88*			
	ED3	0.87	9.04*			
	ED4	0.76	4.92*			
Environmental complexity	EC1	0.86	35.58*	0.86	0.78	—
	EC2	0.88	35.49*			
	EC3	0.90	60.85*			

[a]Second-order factor loading from second-order factor (that is, IT capability) to first-order factors (that is, IT infrastructure, IT business partnerships, IT business process integration, business IT strategic thinking, IT management, and external IT linkages).
*Estimated standardized factor loading significant at $P \leqslant 0.05$.

magnitude, surpassing the suggested cutoff of 0.70 (Chin *et al*, 1997). This confirms IT capability should be treated as a reflective second-order factor with good convergent validity.

Reliability testing Cronbach's α was used to assess the internal consistency of the proposed constructs. Table 2 summarizes the loading ranges and the values of Cronbach's α for each construct identified and used. All the alpha values ranged from 0.85 to 0.95; above the 0.70 level suggested by Nunally (1978) and thus the constructs can be considered reliable.

Discriminant validity Discriminant validity can be inferred when the measures of each construct converge on their respective true scores, which are uniquely distinct from those of the others (Churchill, 1979). Discriminant validity was assessed by examining factor correlations (Kling, 2001) and whether the square root of the average variance extracted (AVE) for each construct was larger than its correlation with the other factors (Gefen *et al*, 2000). As shown in Table 3, all construct correlations were less than 0.80 and the square root of the AVE for each construct is significantly higher than the correlation between any pair of factors, confirming the discriminant validity of the scale.

Common method variance (CMV) Because the data on business process agility, environmental factors, and organizational performance came from the same source, CMV was a concern. Several procedural and statistical remedies suggested by Podsakoff *et al* (2003) were used to minimize this potential. First, participants were assured of the anonymity and confidentiality of responses so as to limit concerns about evaluation apprehension and social desirability. Second, a psychometric separation was constructed in the survey with the aim of reducing the participants' perception of any direct connection between these constructs. This was achieved by using different sets of instructions, putting a number of filler items in between constructs, and placing these items in different parts of the survey.

Finally, we tested the potential influence of CMV statistically using Harman's one-factor test. Principal factor analysis with Varimax rotation was performed to determine whether a single method factor explained a majority of the variance. More than one factor with an eigenvalue of greater than 1 was reported, with the first factor accounting for 19.56% of the total variance explained. Thus, CMV did not appear to be a serious problem in this study.

Test of hypotheses Hierarchical linear regression (HLR) is often used to test models involving interaction effects, such as the ones developed here (e.g., Goodhue *et al*, 2007; Mishra & Agarwal, 2010; Lu & Ramamurthy, 2011; Chatterjee & Ravichandran, 2012; Zhou & Li, 2012). Using HLR to test moderating relationships is expected to produce accurate estimates of the strength of the linkages between the interaction products without loss of power (Majchrzak *et al*, 2005; Goodhue *et al*, 2007; Rai & Tang, 2010). Models 1 and 2 specify the effects of the control variables and IT capability, respectively, on business process agility. Three additional models are then developed to test the mediating hypothesis. Model 3 shows a regression equation on organizational performance with control variables. In model 4, we added IT capability based on the control variables. In model 5, we added business process agility. Next, four further models were developed to test the moderating hypotheses. Model 6 shows a regression equation on business process agility with control variables. In model 7, we added IT capability. We added environmental factors in model 8, and the multiplied moderating variables into model 9.

Table 4 shows the results of these regressions. The data in model 1 indicate that the effects of firm size and age are positive and significant (standardized $\beta = 0.16$, $P < 0.05$ and 0.14, $P < 0.05$, respectively). The explanatory power of the equation is also significant ($R^2 = 0.06$, $F = 3.19$, $P < 0.01$). In model 2, IT capability has a significant and positive effect on business process agility (standardized $\beta = 0.49$, $P < 0.01$). The explanatory power of this equation is significant at the 0.05 level (with $\Delta F = 63.92$) thereby supporting H1.

Table 3 Descriptive statistics

Variables	*Mean*	*SD*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*
1. IT capability	5.13	1.16	**0.89**								
2. Environmental hostility	4.39	1.55	0.23**	**0.87**							
3. Environmental dynamism	4.12	1.31	0.22**	0.64**	**0.82**						
4. Environmental complexity	4.66	1.46	0.43**	0.58**	0.56**	**0.88**					
5. Business process agility	5.45	1.08	0.51**	0.26**	0.21**	0.47**	**0.77**				
6. Organizational performance	5.38	1.09	0.43**	0.15*	0.11	0.32**	0.63**	**0.84**			
7. Firm's diversification	3.49	1.05	−0.04	−0.10	−0.02	−0.09	0.06	−0.01			
8. Firm size	1.53	0.71	0.22**	−0.01	−0.05	−0.03	0.20**	0.19**	−0.20**		
9. Ownership structure	0.33	0.47	−0.03	−0.05	−0.18**	−0.22**	0.08	0.01	0.01	0.30**	
10. Organizational age	9.54	5.99	0.21**	0.10	0.07	0.15*	0.14*	0.21**	−0.06	0.10	−0.17*

Notes: Diagonal elements are the square roots of average variance extracted; **$P \leqslant 0.01$, *$P \leqslant 0.05$ (two-tailed).

Table 4 Results of the regression analyses[a]

	Business process agility		*Organizational performance*			*Business process agility*			
	M1	*M2*	*M3*	*M4*	*M5*	*M6*	*M7*	*M8*	*M9*
Control variables									
Firm diversification	−0.02	−0.02	0.04	0.03	0.04	−0.02	−0.02	0.01	0.01
Firm size	0.16**	0.06	0.18**	0.10	0.07	0.16**	0.06	0.09	0.10
Ownership structure	0.06	0.09	−0.01	0.01	−0.03	0.06	0.09	0.15**	0.12*
Organizational age	0.14**	0.05	0.19**	0.12	0.10	0.14**	0.05	0.04	0.02
Independent variables									
IT capability		0.49**		0.38**	0.11		0.49**	0.34**	0.38**
Environmental hostility								0.00	0.02
Environmental dynamism								−0.05	−0.05
Environmental complexity								0.38**	0.39**
Business process agility					0.55**				
Interaction									
IT capability × Environmental hostility									−0.20**
IT capability × Environmental dynamism									−0.04
IT capability × Environmental complexity									0.25**
R^2	0.06	0.28	0.07	0.21	0.42	0.06	0.28	0.37	0.40
ΔR^2	0.06	0.22	0.07	0.13	0.22	0.06	0.22	0.10	0.03
F	3.19**	16.10**	4.16**	10.82**	25.30**	3.19**	16.10**	15.30**	12.47**
ΔF	3.19**	63.92**	4.16**	34.74**	77.75**	3.19**	63.92**	10.35**	3.46**

[a]Tabled values are standardized regression weights.
**$P<0.01$; *$P<0.05$ (two-tailed).

Following the recommendations of Zhao *et al* (2010) and MacKinnon *et al* (2002), we use regression analyses (Baron & Kenny, 1986), Sobel tests (Sobel, 1982), and the bootstrapping mediation test (Preacher & Hayes, 2008) to test the mediating effect. As shown by the regression results in Table 4, model 3 indicates that the effects of firm size and age are positive and significant (standardized $\beta=0.18$, $P<0.01$ and 0.19, $P<0.01$). The explanatory power of the equation is also significant ($R^2=0.07$, $F=4.16$, $P<0.01$). In model 4, IT capability has a significant and positive effect on organizational performance (standardized $\beta=0.38$, $P<0.01$). However, in model 5, its effect is positive but not significant (standardized $\beta=0.11$, $P>0.05$), while the effect of business process agility is both positive and significant (standardized $\beta=0.55$, $P<0.01$). The explanatory power of our model is significant ($F=25.30$, $P<0.01$), and can explain 42% of the variance in organizational performance. Using the approach suggested by Baron & Kenny (1986), we show that business process agility mediates the relationship between IT capability and organizational performance. The explanatory powers of these equations are both significant at the 0.05 level (with $\Delta F=34.74$ and $\Delta F=77.75$, respectively). In addition, the Sobel test results indicate a significant indirect effect of IT capability on organizational performance through business process agility ($Z=6.19$, $P<0.01$). Recent work (e.g., Preacher & Hayes, 2008; Zhao *et al*, 2010) questions the use of the mediation tests of Baron & Kenny (1986) while emphasizing the superiority of bootstrapping procedures for statistical tests (for a useful review see Zhao *et al*, 2010). To test our full mediation relationship more thoroughly, we drew on Preacher & Hayes (2008) and applied bootstrapping. Preacher and Hayes's (2008) SPSS macro with 5000 bootstrapped samples revealed an indirect-only mediation effect (Zhao *et al*, 2010; Spiller, 2011). Controlling for business process agility, the direct effect of IT capability on firm performance was not significant ($\beta=0.10$; t-value $=1.55$, $P>0.05$). The indirect path ($\beta=0.27$) had a 95% confidence interval that did not include zero (0.17, 0.38). Hence H2 and H3 are both supported.

The data in model 6 indicate that the effects of the control variables firm size and organizational age are both positive and significant (standardized $\beta=0.16$, $P<0.01$ and 0.14, $P<0.01$). The explanatory power of the equation is also significant ($R^2=0.06$, F = 3.19, $P<0.01$). In model 7, the variable IT capability has a significant and positive effect on business process agility (standardized $\beta=0.49$, $P<0.01$). Moreover, model 8 indicates that among the three environmental factors, only environmental complexity has a positive and significant effect on business process agility (standardized $\beta=0.38$, $P<0.01$). As mentioned above, the explanatory power of these equations is significant at the 0.05 level (with $\Delta F=63.92$ and $\Delta F=10.35$, respectively).

Finally, in model 9, the interaction term between environmental hostility and IT capability is both negative

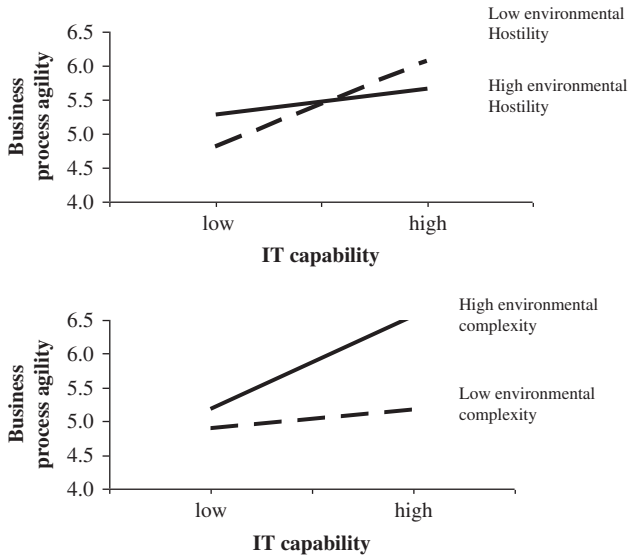

Figure 2 Interactions between IT capability and business process agility.

and significant (standardized $\beta = -0.20$, $P < 0.01$), which supports H4a, indicating environmental hostility has a negative moderating effect on the relationship between IT capability and business process agility. This suggests that the positive interaction between these two characteristics is more likely to be observed in firms facing lower levels of environmental hostility. We plotted the interaction using Aiken & West's (1991) procedure of computing slopes one standard deviation above and below the mean of environmental hostility. Figure 2 shows the interaction pattern. Consistent with H4a, IT capability has a weaker positive relationship with business process agility when environmental hostility is high rather than low. Furthermore, the interaction term between environmental complexity and IT capability is positive and significant (standardized $\beta = 0.25$, $P < 0.01$), which supports H4c, indicating environmental complexity has a positive moderating effect on the relationship between IT capability and business process agility. This suggests that this positive interaction is more likely to be observed in firms confronting higher levels of environmental complexity. This equation has an explanatory power similar to the previous one ($\Delta F = 3.46$, $P < 0.01$). Again, we plotted the interaction by computing the slopes one standard deviation above and below the mean of environmental complexity. Figure 2 indicates that the interaction pattern is consistent with H4c; that is, IT capability is more strongly related to business process agility when environmental complexity is high rather than low.

Post-hoc analyses

Agility enables business processes to be rapidly and easily designed and redesigned in order to respond effectively to unanticipated changes in the business environment (Meade & Sarkis, 1999). This viewpoint suggests that process agility already reflects responsiveness to the outside world. Thus, the payoff from process agility is likely to have already incorporated the influence of environmental factors. In other words, its impact on performance may not vary according to characteristics of the external environment. Therefore, we have not considered the moderating effects of the environmental factors in the link between agility and performance. Nevertheless, to confirm our rationale for this exclusion, we examined whether the effect of business process agility on organizational performance is increased by the presence of environmental factors (as moderating variables). The results indicate that the interaction terms of business process agility and environmental factors are not significantly related to organizational performance (specifically, for complexity, standardized $\beta = 0.04$, ns; for dynamism, standardized $\beta = -0.01$, ns; for hostility, standardized $\beta = 0.10$, ns). Therefore, we conclude that environmental factors do not play a moderating role in the relationship between business process agility and organizational performance.

Limitations

Inevitably, our study has some limitations. First, we examined IT capability at the firm level. We recognized that some specific initiatives that involve this capacity will occur at the level of individual business processes, units, or departments, so our firm-level measure might be a relatively coarse representation of the nature and impact of IT capability. Nevertheless, our respondents were drawn from top management, suggesting that our results captured valid truths about the firms' use of IT. Despite this mitigating factor, future research should also study IT applications at the level of individual business processes, units, or departments. Second, when businesses become globalized, their decisions about IT acquisition and deployment may also depend on the policies of trading partners. This is especially true for supply chain applications. We therefore believe that it would be valuable to examine how firms are influenced by their trading partners (and vice versa) (Huber & Power, 1985) and to explore the impact of this on the variables included in our model. Third, given the perceptual nature of the study's data, it is important to recognize the issues associated with cross-sectional research design (Chow *et al*, 2008). In particular, even though our use of the term 'effects' implies causal relationships, we acknowledge the need for more evidence to be obtained from longitudinal or experimental research before our suggested pattern of causation can be defended. Fourth, our sample was drawn from manufacturing organizations. Though the role of business processes is more salient in such firms, the impact of IT capability on process agility in other industries remains to be studied, to allow for more confidence in the generalizability of these results beyond the manufacturing context. By conducting future studies in other industries, which may have different perceptions of IT and different external environments, we are likely to further enhance our understanding of the important

issue of the business value of IT. Finally, we employed subjective measures of firm performance in this study. Even though previous work has concluded that subjective measures of firms' performance relative to competitors correlate with objective measures with a high degree of reliability (e.g., Dess & Robinson, 1984; Venkatraman & Ramanujam, 1986), there may be gaps between these subjective measures and the financial information released by firms. Future research could augment this aspect of our work by using objective measures of firm performance.

Discussion

Implications for research

Despite the important influence of business process agility on firm performance, empirical evidence for its role as a mediator is scarce. To address this gap this study has explored the role of business process agility in the relationship between firms' IT capability and performance, thus contributing to our understanding of how the presence of superior IT capability within a firm can improve outcomes. Our results show that business process agility fully mediates this capability – performance relationship, and that environmental factors (hostility, dynamism, and complexity) moderate the link between IT capability and business process agility.

The contributions of this study are threefold. First, it provides robust empirical support for the impact of IT capability on firm performance by focusing on the mediating effect of business process agility. This finding helps to explain why even superior IT capability cannot alone determine firm performance, an issue raised in prior research (e.g., Barua *et al*, 1995). Second, the study contributes to the research on the business value of IT by empirically illustrating how an IT-based capability enables the creation of flexible and responsive operations and processes, which consequently have a positive impact on performance. With an enhanced IT capability, a firm is more capable of adapting its business processes to meet the demands of customers and suppliers. This view is consistent with the value chain perspective (Porter, 1985) where IT-related activities assist primary processes such as product development, manufacturing, sales, and marketing. Business process agility ensures that inputs are transformed efficiently into outputs, a process that is expected to be enhanced if data flow more smoothly and systems are more stable. Third, we shed further light on the business value of IT by demonstrating the importance of environmental factors. While the majority of studies focusing on IT capability examine its impact on firm performance, few have taken exogenous factors into consideration (Rueda-Manzanares *et al*, 2008). Yet logic suggests that external environmental factors will be critical in inferring the overall effect of IT capability. Our study fills this gap by examining the moderating role of three environmental factors (hostility, dynamism, and complexity) and identifies how superior IT capability translates into business process agility across varying external environments. The results identify hostility and complexity as two significant moderators, suggesting that it is vital to examine a firm's multifaceted and nuanced external environment before committing to any IT investment. The negative moderating effect of environmental hostility shows that IT performs better in less hostile environments. This is consistent with other recent studies (e.g., Aragon-Correa & Sharma, 2003), which take external actors into consideration. These results also support the notion that IT capability leads to greater process agility in more complex environments. A more diverse business environment requires a firm to respond faster and more precisely to changes in areas such as product design and customer requirements. Therefore, higher levels of process agility are needed to defend against a more complex business environment. Our results can be interpreted as evidence that IT provides a feasible route to increasing process agility in a highly complex environment. For example, technologies such as Enterprise Resource Planning and Customer Relationship Management enable a firm to plan its production processes more efficiently, maintain better relationships with customers, and come to a better understanding of their needs.

Implications for practice

This study also has a number of implications for management. First, our results indicate that firm-wide IT capability plays a fundamental, albeit indirect, role in generating real economic payoffs. This highlights the importance of investing in the development of a superior firm-wide IT capability. For example, companies should hire and retain skilled and experienced IT managers who should simultaneously develop an adequate level of competency across the six key dimensions (that is, IT infrastructure, IT business partnerships, business IT strategic thinking, IT business process integration, IT management, and external IT linkage) in order to achieve superior performance. Second, these results indicate that the business value of IT largely depends on how agile a firm is in terms of managing and operating its business processes. Clearly, firms need to do more than pursue the latest technologies or hire top IT professionals. Rather, the economic benefits they can gain depend critically on how IT capability is leveraged to improve or enable process agility. In particular, managers should strive to guarantee that IT capability is channeled toward important areas of the firm (such as process agility). To achieve this, IT managers should interact closely with business executives who are making IT investment and deployment decisions. Third, our findings demonstrate the important role played by environmental factors. While firms might not be able to control or influence these, a better understanding of them should be expected to inform managers' decisions. In particular, the results suggest that firms operating in environments characterized by high complexity and low hostility should focus their efforts on the development and maintenance of their IT capability to maximize the return on IT

investment. For instance, when tax rates are low and government support is high, superior IT capability is expected to lead to improved process agility, which in turn enhances firm performance. Therefore, managers should carefully assess the hostility and complexity of the external environment in order to manage their IT-related activities more effectively.

Conclusion

The present study contributes to a better understanding of how firm-wide IT capability helps achieve superior performance. Specifically, we find that the influence of IT capability on firm performance is fully mediated by business process agility. The present study has not only established the theoretical rationale for the important, yet indirect, influence of IT capability on organizational performance, but also provided supporting empirical evidence, thereby advancing our understanding of IT capability and its implications for performance. Moreover, we have investigated the moderating effect of environmental factors on the ability of firms' IT capability to generate and influence business process agility. This further informs the debate on the relationship between IT capability and business process agility, contributing to the literature on IT business value.

Acknowledgements

The authors are grateful for financial support from Humanities and Social Sciences Foundation of the Ministry of Education of China (No. 10YJC630258, No. 10YJC630102), National Natural Science Foundation of China (No. 71273160) and Social Science Research of China (No. 12CGL053) for this project.

About the Authors

Dr. Yang Chen is an associate professor in School of Business Administration, Southwestern University of Finance and Economics in China. He has published research papers in *Journal of Business Ethics, Human Resource Management, International Journal of Human Resource Management*, and *Journal of Computer Information Systems*. His current research interests include corporate sustainable development, IT business values, human resource management, and so on.

Dr. Yi Wang is an associate professor in Business School, Shantou University in China. She has published research papers in *International Journal of Electronic Business*, *Journal of Shantou University* (Humanities Edition), *Journal of Systems and Information Technology*. Her current research interests include IT diffusion and adoption and IT business value.

Dr. Saggi Nevo is an assistant professor in the Information Technology Management Department at the University at Albany. His work has been accepted or published in journals such as *MIS Quarterly, The DATA BASE for Advances in IS*, *Communications of the AIS*, *International Journal of Electronic Commerce*, and *Journal of Strategic Information Systems*. His current research interests include open source software, social computing, and virtual worlds.

Dr. Jiafei Jin an associate professor in School of Business Administration, Southwestern University of Finance and Economics in China. He has published research papers in *Journal of Business Ethics, Human Resource Management,* and *International Journal of Human Resource Management*. His current research interests include work-family-conflict, human resource management, and so on.

Mr. Luning Wang is a Ph.D. student in Department of Management, Hong Kong University of Science and Technology. His current research interests include strategic human resource management, strategic management, and so on.

Dr. Wing S. Chow is an associate professor of MIS in the School of Business, Hong Kong Baptist University. Dr. Chow published more than 70 papers in the journals and conference proceedings. He has published research papers in journals such as *Journal of Business Ethics, OMEGA, European Journal of Operational Research,* and *Journal of Computer Information Systems*. His current research interests include corporate information systems, e-commerce, and so on.

References

AIKEN L and WEST S (1991) *Multiple Regression: Testing and Interpreting Interactions*. Sage, Newburg Park, CA.

AMIT R and SCHOEMAKER P (1993) Strategic assets and organizational rent. *Strategic Management Journal* **14(1),** 33–46.

ANDERSON JC and GERBING DW (1988) Structural equation modeling in practice: a review and recommended two-step approach. *Psychological Bulletin* **103(3),** 411–423.

ANDREWS C (1998) Environmental business strategy: corporate leaders' perceptions. *Society & Natural Resources* **11(5),** 531–540.

ARAGON-CORREA J and SHARMA S (2003) A contingent resource-based view of proactive corporate environmental strategy. *Academy of Management Review* **28(1),** 71–88.

AUTIO E, SAPIENZA H and ALMEIDA J (2000) Effects of age at entry, knowledge intensity, and imitability on international growth. *Academy of Management Journal* **43(5),** 909–924.

BARNEY J (1991) Firm resources and sustained competitive advantage. *Journal of Management* **17(1),** 99–120.

BARNEY J, WRIGHT M and KETCHEN DJ (2001) The resource-based view of the firm: ten years after 1991. *Journal of Management* **27(6),** 625–641.

BARON R and KENNY D (1986) The moderator-mediator variable distinction in social psychological research: conceptual, strategic, and statistical considerations. *Journal of Personality and Social Psychology* **51(6),** 1173–1182.

BARUA A, KRIEBEL C and MUKHOPADHYAY T (1995) Information technologies and business value: an analytic and empirical investigation. *Information Systems Research* **6(1)**, 3–23.
BENTLER P (1989) *EQS: Structural Equations Program Manual*. BMDP Statistical Software, Los Angeles, CA.
BHALLA G and LIN L (1987) Cross-cultural marketing research: a discussion of equivalence issues and measurement strategies. *Psychology and Marketing* **4(4)**, 275–285.
BHARADWAJ A (2000) A resource-based perspective on information technology capability and firm performance: an empirical investigation. *MIS Quarterly* **24(1)**, 169–196.
BHARADWAJ A, SAMBAMURTHY V and ZMUD R (1999) IT capabilities: theoretical perspectives and empirical operationalization. In *Proceedings of the 19th International Conference on Information Systems* (HIRSCHHEIM R, NEWMAN M and DEGROSS J, Eds), pp 378–385, Helsinki, Finland.
BHATT G and GROVER V (2005) Types of information technology capabilities and their role in competitive advantage: an empirical study. *Journal of Management Information Systems* **22(2)**, 253–277.
BURNS T and STALKER GM (1994) *The Management of Innovation*. Oxford University Press, USA.
CHANDLER AD (1962) *Strategy and Structure*. MIT Press, Cambridge, MA.
CHATTERJEE D and RAVICHANDRAN T (2012) Governance of interorganizational information systems: a resource dependence perspective. *Information Systems Research*, advance online publication, 24 August, 2012; doi: 10.1287/isre.1120.0432.
CHEN L (2010) Business-IT alignment maturity of companies in China. *Information & Management* **47(1)**, 9–16.
CHIN W, GOPAL A and SALISBURY W (1997) Advancing the theory of adaptive structuration: the development of a scale to measure faithfulness of appropriation. *Information Systems Research* **8(4)**, 342–367.
CHOW W, MADU C, KUEI C, LU M, LIN C and TSENG H (2008) Supply chain management in the US and Taiwan: an empirical study. *Omega* **36(5)**, 665–679.
CHURCHILL G (1979) A paradigm for developing better measures of marketing constructs. *Journal of Marketing Research* **16(1)**, 64–73.
DARNALL N and EDWARDS D (2006) Predicting the cost of environmental management system adoption: the role of capabilities, resources and ownership structure. *Strategic Management Journal* **27(4)**, 301–320.
DAVIS-SRAMEK B, GERMAIN R and IYER K (2010) Supply chain technology: the role of environment in predicting performance. *Journal of the Academy of Marketing Science* **38(1)**, 42–55.
DEHNING B and RICHARDSON VJ (2002) Returns on investments in information technology: a research synthesis. *Journal of Information Systems* **16(1)**, 7–30.
DESS G and ROBINSON R (1984) Measuring organizational performance in the absence of objective measures: the case of the privately-held firm and conglomerate business unit. *Strategic Management Journal* **5(3)**, 265–273.
DESS GG and BEARD DW (1984) Dimensions of organizational task environments. *Administrative Science Quarterly* **29(1)**, 52–73.
DOVE R (2001) *Response Ability: The Language, Structure, and Culture of the Agile Enterprise*. Wiley, New York, NY.
DUNCAN NB (1995) Capturing flexibility of information technology infrastructure: a study of resource characteristics and their measure. *Journal of Management Information Systems* **12(2)**, 37–57.
FICHMAN RG (2004) Real options and IT platform adoption: implications for theory and practice. *Information Systems Research* **15(2)**, 132–154.
FINK L (2011) How do IT capabilities create strategic value? Toward greater integration of insights from reductionistic and holistic approaches. *European Journal of Information Systems* **20(1)**, 16–33.
FLYNN BB and FLYNN EJ (1999) Information-processing alternatives for coping with manufacturing environment complexity. *Decision Sciences* **30(4)**, 1021–1052.
GALBRAITH JR (1974) Organization design: an information processing view. *Interfaces* **4(3)**, 28–36.
GANGULY A, NILCHIANI R and FARR JV (2009) Evaluating agility in corporate enterprises. *International Journal of Production Economics* **118(2)**, 410–423.
GEFEN D, STRAUB D and BOUDREAU M (2000) Structural equation modelling and regression: guidelines for research practice. *Communications of the Association for Information Systems* **4(7)**, 1–77.
GLENN M (2009) Organisational agility: how business can survive and thrive in turbulent times. A report from the Economist Intelligence Unit, *The Economist*, March, retrieved from website http://www.emc.com/collateral/leadership/organisational-agility-230309.pdf (accessed 3 March 2013).
GOLDMAN S, NAGEL R and PREISS K (1995) *Agile Competitors and Virtual Organizations: Strategies for Enriching the Customer*. Van Nostrand Reinhold, New York.
GOODHUE D, LEWIS W and THOMPSON R (2007) Statistical power in analyzing interaction effects: questioning the advantage of PLS with product indicators. *Information Systems Research* **18(2)**, 211–227.
GRANT R (1991) The resource-based theory of competitive advantage. *California Management Review* **33(3)**, 114–135.
HAECKEL SH (1999) *Adaptive Enterprise: Creating and Leading Sense-and-respond Organizations*. Harvard Business Press, Boston, MA.
HOFER CW and SCHENDEL D (1978) *Strategy Formulation: Analytical Concepts*. West Publishing Company, St Paul, MN.
HUBER G and POWER D (1985) Retrospective reports of strategic-level managers: guidelines for increasing their accuracy. *Strategic Management Journal* **6(2)**, 171–180.
IM KS, DOW KE and GROVER V (2001) Research report: a reexamination of IT investment and the market value of the firm-An event study methodology. *Information Systems Research* **12(1)**, 103–117.
JUDGE W and DOUGLAS T (1998) Performance implications of incorporating natural environmental issues into the strategic planning process: an empirical assessment. *Journal of Management Studies* **35(2)**, 241–262.
JUDGE WQ and ELENKOV D (2005) Organizational capacity for change and environmental performance: an empirical assessment of Bulgarian firms. *Journal of Business Research* **58(7)**, 893–901.
KARIM J, SOMERS TM and BHATTACHERJEE A (2007) The impact of ERP implementation on business process outcomes: a factor-based study. *Journal of Management Information Systems* **24(1)**, 101–134.
KATAYAMA H and BENNETT D (1999) Agility, adaptability and leanness: a comparison of concepts and a study of practice. *International Journal of Production Economics* **60–61**, 43–51.
KEARNS GS and SABHERWAL R (2007) Strategic alignment between business and information technology: a knowledge-based view of behaviors, outcome, and consequences. *Journal of Management Information Systems* **23(3)**, 129–162.
KIM G, SHIN B, KIM KK and LEE HG (2011) IT capabilities, process-oriented dynamic capabilities, and firm financial performance. *Journal of the Association for Information Systems* **12(7)**, 491–492.
KLING R (2001) *Principles and Practices of Structural Equation Modelling*. Guilford Press, New York.
KOHLI R and GROVER V (2008) Business value of IT: an essay on expanding research directions to keep up with the times. *Journal of the Association for Information Systems* **9(1)**, 23–39.
LAWRENCE P and LORSH J (1967) *Organization and Environment*. Harvard University Press, Cambridge.
LI M and YE RL (1999) Information technology and firm performance: linking with environmental, strategic and managerial contexts. *Information & Management* **35(1)**, 43–51.
LU Y and RAMAMURTHY K (2011) Understanding the link between information technology capability and organizational agility: an empirical examination. *MIS Quarterly* **35(4)**, 931–954.
MACKINNON D, LOCKWOOD C, HOFFMAN J, WEST S and SHEETS V (2002) A comparison of methods to test mediation and other intervening variable effects. *Psychological Methods* **7(1)**, 83–104.
MAJCHRZAK A, MALHOTRA A and JOHN R (2005) Perceived individual collaboration know-how development through information technology-enabled contextualization: Evidence from distributed teams. *Information Systems Research* **16(1)**, 9–27.
MATA FJ, FUERST WL and BARNEY JB (1995) Information technology and sustained competitive advantage: a resource-based analysis. *MIS Quarterly* **19(4)**, 487–505.
MATHIASSEN L and PRIES-HEJE J (2006) Business agility and diffusion of information technology. *European Journal of Information Systems* **15(2)**, 116–119.
MATHIYAKALAN S, ASHRAFI N, ZHANG W, WAAGE F, KUILBOER J and HEIMANN D (2005) Defining business agility: an exploratory study. In *The 16th Information Resources Management Conference*, San Diego, CA.

McArthur AW and Nystrom PC (1991) Environmental dynamism, complexity, and munificence as moderators of strategy-performance relationships. *Journal of Business Research* **23(4)**, 349–361.
Meade L and Sarkis J (1999) Analyzing organizational project alternatives for agile manufacturing processes: an analytical network approach. *International Journal of Production Research* **37(2)**, 241–261.
Melville N, Kraemer K and Gurbaxani V (2004) Review: information technology and organizational performance: an integrative model of IT business value. *MIS Quarterly* **28(2)**, 283–322.
Miller D (1988) Relating Porter's business strategies to environment and structure: analysis and performance implications. *Academy of Management Journal* **31(2)**, 280–308.
Mishra AN and Agarwal R (2010) Technological frames, organizational capabilities, and IT use: an empirical investigation of electronic procurement. *Information Systems Research* **21(2)**, 249–270.
Nevo S and Wade MR (2010) The formation and value of IT-enabled resources: antecedents and consequences of synergistic relationships. *MIS Quarterly* **34(1)**, 163–183.
Nevo S and Wade M (2011) Firm-level benefits of IT-enabled resources: A conceptual extension and an empirical assessment. *Journal of Strategic Information Systems* **20(4)**, 403–418.
Newkirk HE and Lederer AL (2006) The effectiveness of strategic information systems planning under environmental uncertainty. *Information & Management* **43(4)**, 481–501.
Nunally J (1978) *Psychometric Theory*. McGraw-Hill, New York.
Pavlou PA and El Sawy OA (2006) From IT leveraging competence to competitive advantage in turbulent environments: the case of new product development. *Information Systems Research* **17(3)**, 198–227.
Pavlou PA and El Sawy OA (2010) The 'third hand': IT-enabled competitive advantage in turbulence through improvisational capabilities. *Information Systems Research* **21(3)**, 443–471.
Podsakoff PM, MacKenzie SB, Lee JY and Podsakoff NP (2003) Common method biases in behavioral research: a critical review of the literature and recommended remedies. *Journal of Applied Psychology* **88(5)**, 879–903.
Porter M (1985) *Competitive Advantage*. Free Press, New York.
Prahalad C and Hamel G (1990) The core compentency of a corporation. *Harvard Business Review* **68(3)**, 79–91.
Preacher K and Hayes A (2008) Asymptotic and resampling strategies for assessing and comparing indirect effects in multiple mediator models. *Behavior Research Methods* **40(3)**, 879–891.
Priem RL and Butler JE (2001a) Is the resource-based 'view' a useful perspective for strategic management research? *Academy of Management Review* **26(1)**, 22–40.
Priem RL and Butler JE (2001b) Tautology in the resource-based view and the implications of externally determined resource value: further comments. *Academy of Management Review* **26(1)**, 57–66.
Qu WG, Oh W and Pinsonneault A (2010) The strategic value of IT insourcing: an IT-enabled business process perspective. *Journal of Strategic Information Systems* **19(2)**, 96–108.
Radhakrishnan A, Zu X and Grover V (2008) A process-oriented perspective on differential business value creation by information technology: an empirical investigation. *Omega* **36(6)**, 1105–1125.
Rai A and Tang X (2010) Leveraging IT capabilities and competitive process capabilities for the management of interorganizational relationship portfolios. *Information Systems Research* **21(3)**, 516–542.
Raschke RL (2010) Process-based view of agility: the value contribution of IT and the effects on process outcomes. *International Journal of Accounting Information Systems* **11(4)**, 297–313.
Raschke RL and David JS (2005) Business process agility. In *The 11th Americas Conference on Information Systems*, pp 355–360, Omaha, NE.
Ravichandran T and Lertwongsatien C (2005) Effect of information systems resources and capabilities on firm performance: a resource-based perspective. *Journal of Management Information Systems* **21(4)**, 237–276.
Ray G, Muhanna WA and Barney JB (2005) Information technology and the performance of the customer service process: a resource-based analysis. *MIS Quarterly* **29(4)**, 625–652.
Ross JW, Beath CM and Goodhue DL (1996) Develop long-term competitiveness through IT assets. *Sloan Management Review* **38(1)**, 31–42.
Rueda-Manzanares A, Aragon Correa J and Sharma S (2008) The influence of stakeholders on the environmental strategy of service firms: the moderating effects of complexity, uncertainty and munificence. *British Journal of Management* **19(2)**, 185–203.
Sambamurthy V, Bharadwaj A and Grover V (2003) Shaping agility through digital options: reconceptualizing the role of information technology in contemporary firms. *MIS Quarterly* **27(2)**, 237–263.
Seethamraju R (2006) Influence of enterprise systems on business process agility. *Global conference on emergent business phenomena in the digital economy (ICEB+eBRF)*, Tampere, Finland.
Shang S and Seddon PB (2002) Assessing and managing the benefits of enterprise systems: the business manager's perspective. *Information Systems Journal* **12(4)**, 271–299.
Sila I (2010) Do organisational and environmental factors moderate the effects of Internet-based interorganisational systems on firm performance? *European Journal of Information Systems* **19(5)**, 581–600.
Sobel ME (1982) Asymptotic confidence intervals for indirect effects in structural equation models. In *Sociological Methodology* (Leinhart S, Ed), pp 290–312, Jossey-Bass, San Francisco, CA.
Spiller SA (2011) Opportunity cost consideration. *Journal of Consumer Research* **38(4)**, 595–610.
Stoel D and Muhanna W (2009) IT capabilities and firm performance: a contingency analysis of the role of industry and IT capability type. *Information & Management* **46(3)**, 181–189.
Swafford PM, Ghosh S and Murthy N (2008) Achieving supply chain agility through IT integration and flexibility. *International Journal of Production Economics* **116(2)**, 288–297.
Tallon PP (2007) A process-oriented perspective on the alignment of information technology and business strategy. *Journal of Management Information Systems* **24(3)**, 227–268.
Tallon PP (2008) Inside the adaptive enterprise: an information technology capabilities perspective on business process agility. *Information Technology and Management* **9(1)**, 21–36.
Teece DJ, Pisano G and Shuen A (1997) Dynamic capabilities and strategic management. *Strategic Management Journal* **18(7)**, 509–533.
Teo TSH and King WR (1997) Integration between business planning and information systems planning: an evolutionary-contingency perspective. *Journal of Management Information Systems* **14(1)**, 185–214.
Thompson CA, Kopelman RE and Schriesheim CA (1992) Putting all one's eggs in the same basket: a comparison of commitment and satisfaction among self-and organizationally employed men. *Journal of Applied Psychology* **77(5)**, 738–743.
Van Oosterhout M, Waarts E and Van Hillegersberg J (2006) Change factors requiring agility and implications for IT. *European Journal of Information Systems* **15(2)**, 132–145.
Venkatraman N (1989) The concept of fit in strategy research: toward verbal and statistical correspondence. *Academy of Management Review* **14(3)**, 423–444.
Venkatraman N and Ramanujam V (1986) Measurement of business performance in strategy research: a comparison of approaches. *Academy of Management Review* **11(4)**, 801–814.
Wade M and Hulland J (2004) Review: The resource-based view and information systems research: review, extension, and suggestions for future research. *MIS Quarterly* **28(1)**, 107–142.
Weill P (1992) The relationship between investment in information technology and firm performance: a study of valve manufacturing sector. *Information Systems Research* **3(4)**, 307–333.
Weill P, Subramani M and Broadbent M (2002) Building IT infrastructure for strategic agility. *Sloan Management Review* **44(1)**, 57–65.
Werner S, Brouthers LE and Brouthers KD (1996) International risk and perceived environmental uncertainty: the dimensionality and internal consistency of Miller's measure. *Journal of International Business Studies* **27(3)**, 571–587.
Zahra SA and Garvis DM (2000) International corporate entrepreneurship and firm performance: the moderating effect of international environmental hostility. *Journal of Business Venturing* **15(5–6)**, 469–492.
Zhang M and Sarker S (2008) Unpacking the effect of IT capability on the performance of export-focused SMEs: a report from China. *Information Systems Journal* **18(4)**, 357–380.
Zhao X, Lynch JG and Chen Q (2010) Reconsidering Baron and Kenny: myths and truths about mediation analysis. *Journal of Consumer Research* **37(2)**, 197–206.

ZHOU KZ and LI CB (2012) How knowledge affects radical innovation: knowledge base, market knowledge acquisition, and internal knowledge sharing. *Strategic Management Journal* **33(9),** 1090–1102.

ZHOU KZ, LI JJ, ZHOU N and SU C (2008) Market orientation, job satisfaction, product quality, and firm performance: evidence from China. *Strategic Management Journal* **29(9),** 985–1000.

Appendix

Table A1 CIO and TMT questionnaires

CIO questionnaire	
	Rate your firm's performance on each item, relative to other firms in your industry (1 = 'poorer than most' to 7 = 'exceptionally well')
IT capability Bharadwaj *et al* (1999)	
IT infrastructure	ITF 1: Appropriateness of the data architectures ITF 2: Appropriateness of network architectures ITF 3: Adequacy of architectural flexibility
IT business partnerships	IBP 1: Multi-disciplinary teams to blend business and technology expertise IBP 2: Relationship between line management and IT service providers IBP 3: Line management sponsorship of IT initiatives IBP 4: Climate that encouraging risk taking and experimentation with IT IBP 5: Climate nurturing IT project championship
IT business process integration	BPI 1: Consistency of IT application portfolios with business processes BPI 2: Restructuring of business work processes to leverage opportunities BPI 3: Restructuring of IT work processes to leverage opportunities
Business IT strategic thinking	BIT 1: Clarity of vision regarding how IT contributes to business value BIT 2: Integration of business strategic planning and IT planning BIT 3: Management's ability to understand value of IT investments
IT management	ITM 1: Effectiveness of IT planning ITM 2: IT project management practices ITM 3: Planning for security control, standard compliance, and disaster recovery ITM 4: System development practices ITM 5: Consistency of IT policies throughout the enterprise ITM 6: IT evaluation and control systems
External IT linkage	EIT 1: Technology-based links with customers EIT 2: Technology-based links with suppliers EIT 3: We use IT-based entrepreneurial collaborations with external partners
TMT questionnaire	
Business process agility Tallon (2008)	To what extent do you agree that your firm can easily and quickly perform the following business actions (1 = 'Strongly disagree' to 7 = 'Strongly agree') BPA1: Respond to changes in aggregate consumer demand. BPA2: Customize a product or service to suit an individual customer. BPA3: React to new product or service launches by competitors. BPA4: Introduce new pricing schedules in response to changes in competitors' prices. BPA5: Expand into new regional or international markets. BPA6: Change the variety of products/services available for sale. BPA7: Adopt new technologies to produce better, faster and cheaper products and services. BPA8: Switch suppliers to avail of lower costs, better quality, or improved delivery times.
Organizational performance Judge & Douglas (1998)	The extent to which your firm's performance during the last 2 or 3 years, relative to all other competitors (1 = 'Much below the average' to 7 = 'Much above the average') OP1: Our profitability has been substantially better. OP2: Our return on investment has been substantially better. OP3: Our growth in market share has been substantially better. OP4: Our sales growth has been substantially better.
Environmental factors Newkirk & Lederer (2006); Teo & King (1997)	What extent do you agree the following statements (1 = 'Strongly disagree' to 7 = 'Strongly agree')
Environmental hostility	EH1: The survival of our firm is currently threatened by scarce supply of labor EH2: The survival of our firm is currently threatened by scarce supply of materials EH3: The survival of our firm is currently threatened by tough price competition EH4: The survival of our firm is currently threatened by tough competition in product/service quality EH5: The survival of our firm is currently threatened by tough competition in product/service differentiation
Environmental dynamism	ED1: Products and services in our industry become obsolete quickly ED2: The product/services technologies in our industry change quickly ED3: We can predict what our competitors are going to do next ED4: We can predict when our products/services demand changes
Environmental complexity	EC1: In our industry, there is considerable diversity in customer buying habits EC2: In our industry, there is considerable diversity in nature of competition EC3: In our industry, there is considerable diversity in product lines