Asia Pacific J Manage (2008) 25:489–507
DOI 10.1007/s10490-008-9087-2

Does knowledge management matter for information technology applications in China?

Danming Lin · Qiang Liang · Zongling Xu · Runtian Li · Weimin Xie

Published online: 22 April 2008

Abstract This study explores the role of knowledge management (KM) in mediating and moderating the relationship between information technology (IT) and firm performance based upon the data collected from 236 firms in China. Through a structural equation model and hierarchical regression analysis, we found that KM capability partially mediated the performance impact of IT resources. Furthermore, KM capability affected the strength of the IT-performance relationship. The theoretical contributions and managerial implications are discussed and limitations of the study are highlighted accordingly.

Keywords Information technology · Knowledge management · Performance · Mediating effect · Moderating effect

In today's competitive landscape, information technology (IT) has become substantially more important in achieving firm strategic objectives. In recent years, the study of IT related issues by strategic management scholars has been increasing (Rivard, Raymond, & Verreault, 2006). In particular, research interests have been drawn to the relationship between IT and specific components of firm strategy (Tippins & Sohi, 2003). While some studies have found a significant link between

D. Lin (✉) · Q. Liang · Z. Xu · R. Li
Shantou University Business School, Guangdong 515063, China
e-mail: dmlin@stu.edu.cn

Q. Liang
e-mail: g_qiangliang@stu.edu.cn

Z. Xu
e-mail: zlxu@stu.edu.cn

R. Li
e-mail: rdli@stu.edu.cn

W. Xie
School of Business, Sun Yat-sen University, Guangdong 510275, China
e-mail: xieweimin@tom.com

IT and firm performance, others have failed to do so (Devaraj & Kohli, 2003). One explanation for the inconsistent findings is that IT resources are necessary, but insufficient, for superior competitive advantages (Clemons & Row, 1991). IT exerts its influence on organizations through complementary relationships with other organizational assets and capabilities (Wade & Hulland, 2004). Therefore, important organizational capabilities that mediate and/or moderate the relationship between IT and firm performance must be taken into account.

Recent studies have indicated that among key organizational capabilities, knowledge management (KM) capability has become crucial in facilitating IT application in order to achieve firm competitive advantages and performance excellence (Sher & Lee, 2004). IT enhances organizational KM capability by improving and enabling new opportunities for key KM activities (Walsham, 2001), while KM's proliferation has generated new domains for IT applications (Sher & Lee, 2004). Further, from a strategic management point of view, KM capability could provide competitive advantages and bring about superior firm performance (Eisenhardt & Santos, 2002). Consequently, the relationships among IT, KM, and firm performance have become an emerging topic in extant IT-related studies.

To date, studies conducted in developed countries such as the USA, suggest that key organizational capabilities, notably KM capability, could leverage the relationship between IT and firm performance (Tanriverdi, 2006; Tippins & Sohi, 2003). However, there has been scant research conducted in the relationship between IT, KM capabilities, and firm performance in emerging economies such as China, where institutional arrangements and market conditions are uniquely distinct from developed countries. In order to fill in the gap in the extant literature, this paper explores the role of KM's effect on the impacts of IT on firm performance through investigating firms operating in China, where IT applications are widely promoted but receive scarce research attention.

KM is a strategic management factor, and strategic management factors in IT applications could be examined either as a mediator (Tanriverdi, 2005) or a moderator (Li & Ye, 1999). Accordingly, the paper aims to answer the following research questions: (1) Does KM have a mediating effect on the IT-performance relationship for firms operating in China? i.e., Does KM act in an intermediate way to account for the performance impact of IT? and (2) Does KM have a moderating effect on the IT-performance relationship for firms operating in China? i.e., Does KM also play a role in affecting the strength of the above relationship?

The major contribution of this paper lies in extending previous studies. First, as a context-blind component of real life problems, IT can only affirm itself in a specific institutional and cultural context (Crowston & Myers, 2004; Demeester, 1999; Montealegre, 1999). The success of IT applications will critically depend on how well they are adapted (Martinsons & Davidson, 2007). This study shall conduct an empirical analysis within China, to test whether research findings generated from a Western context are applicable to an emerging economy. As a result, the study will contribute to a global understanding on IT applications as well as KM, given the significant east-west cultural and institutional differences that influence the context-specific firm strategies (Peng, 2002) and competence (Van de Ven, 2004).

Second, this paper also contributes to theory development by simultaneously investigating KM as a mediator and a moderator for the IT-performance relationship.

Previous studies have focused on the mediating effect of KM, identifying KM as a necessary condition for successful IT applications. Largely unexplored, however, is the potential of the moderating effect of KM on the same relationship, as suggested by the intensive interactions between KM and IT (Spiegler, 2003), as well as the performance impact of both IT and KM (Tanriverdi, 2005). Accordingly, this study goes a further step to examine whether KM plays a moderating role to affect the strength of the IT-performance relationship. In other words, the paper proposes that superior KM capability is not only necessary for realizing the business value of IT, but also critical for maximizing such value. More important, the paper examines this proposition empirically. In doing so the paper focuses on providing insights on strategic management in terms of building key organizational capabilities to sustain competitive advantages in the process of IT applications.

The literature review section of this paper introduces key constructs of the study and develops hypotheses concerning the mediating and moderating roles of KM capability in explaining the performance impact of IT applications. The methodology section presents the procedures used for data collection and validation of the measurement properties of the constructs. The major research findings are presented in the results section with the paper concluding in a discussion of the findings and suggestions for future research.

Literature review and hypotheses

The resource-based view of information technology

The relationship between IT and firm performance should be studied within a strategic management framework (Li & Ye, 1999), since IT investment is inherently related to company strategy (Palvia, 1997). To the strategic management scholars, the contribution of IT to business performance has been increasingly studied from a resource-based view (RBV), which conceptualizes the firm as a bundle of unique resources and indicates a positive relationship between IT and firm performance (Rivard et al., 2006). The RBV sees IT resources capabilities as a source of competitive advantage (Bharadwaj, 2000). It is recognized as the "primary theoretical foundation" in IT research due to its firm roots in microeconomics, its focus on resource attributes, and its usefulness in examining IT resources (Melville, Kraemer, & Gurbaxani, 2004).

Resources that are valuable, rare, difficult to imitate, and difficult to substitute can generate sustained competitive advantages (Barney, 1991). In practice, competitive advantages are mainly obtained from firms' intangible capabilities and assets (Christensen & Overdorf, 2000). In her seminal work, Bharadwaj (2000) classified key IT-based resources as (1) The tangible resource comprising the physical IT infrastructure components, (2) The human IT resources comprising the technical and managerial IT skills, and (3) The intangible IT-enabled resources such as knowledge assts, customer orientation, and synergy. This categorization was thereafter refined and restructured. From a practical view, Wade and Hulland (2004) divided IT-related resources into IT infrastructure (tangible resources) and IT implementation skills (intangible resources). Tanriverdi (2006) added the IT strategy-making process,

which refers to the degree to which IT investment strategy adheres to the objectives and strategy of firm as another key component of IT resources.

The IT infrastructure is physical IT assets comprised of both computer and communication technologies as well as the shareable technical platforms and databases. It gives support to a firm's competitive position by enabling initiatives such as cycle time improvement, cross-functional processes, and cross-selling opportunities (Sambamurthy & Zmud, 1992). At the same time, because of the accumulation of experience, adaptability, and path-dependent process, human IT resources are difficult to acquire and complex to imitate, representing a source of competitive advantage (Wade & Hulland, 2004). Further, as Powell and Dent-Micallef (1997) stated, IT-strategy integration is a "potential advantage-producing complementarity". The IT decisions of a business unit within a firm require a general strategic direction to guarantee the IT implementation (Tanriverdi, 2006), whereas the real links between IT and strategic planning support the firm's strategic objectives (Clemons, 1986). In sum, the IT resources, as categorized above, are embedded in the process of strategy-making and its implementation which, in turn, entails profound implications to firm performance.

Information technology and knowledge management

Organizational knowledge has become a crucial source of competitive advantage (Nonaka & Takeuchi, 1995). Managing knowledge is an effective way to organize and share the whole of organizational intelligence and creativity and systematically helps to make use of the intellectual assets (Daft, 2001). KM can be identified as both systematic and organized approaches that enable organizations to create and manipulate knowledge for securing advantageous, competitive positions (Serban & Luan, 2001). Developing a KM capability that creates, exploits, and renews the organizational intelligence can lead the firm to achieve superior performance (Tanriverdi, 2005).

IT has become the primary driving force for effective KM (Choi, 2000). The application of IT facilitates collection, search, storage and transmission of knowledge within and beyond an organization (Nonaka, Toyama, & Nagata, 2000). For example, the Internet and E-commerce technologies enable firms to overcome geographic and time limitations, which lead to effective KM mechanisms linking outsiders, for instance, customers (Barua, Konana, Whinston, & Yin, 2004). IT also provides a platform for individuals and working units, enabling them to solve problems jointly within an organization, at the same time benefiting the sharing of internal knowledge and creativity by providing enriching knowledge resources (Sambamurthy, Bharadwaj, & Grover, 2003). In sum, IT enhances organizational KM capability through promoting employees' communication, participation in problem solving, decision making and other activities (Alavi & Leidner, 2001).

Conversely, organizational KM activities significantly impacts IT applications. For example, to enable extensive and intensive knowledge flows in KM, IT applications have been initiated toward the following issues: comprehensiveness of IT construction within a firm; knowledge construction and maintenance; facilitation of knowledge creation, search, and diffusion; and congruence with corporate strategy (Sher & Lee, 2004). In short, while IT facilitates KM in terms of processing data into

valuable knowledge (Spiegler, 2000), KM also acts on IT because knowledge is needed before data are collected and indeed, it determines which of these data to store (Tuomi, 1999).

Knowledge management and firm performance

To a large extent, managing knowledge effectively determines the competitiveness of firms (Almashari, Zarri, & Alathari, 2002). Organizational knowledge is generally classified into explicit knowledge and tacit knowledge. Explicit knowledge refers to the type of knowledge that can be easily documented and shaped (Choi & Lee, 2003), while tacit knowledge can be defined as un-codified and un-embodied knowledge (know-how) that is obtained from learned behaviors and procedures through various sharing mechanisms (Howells, 1996). Firms managing explicit knowledge effectively can achieve scale economies and organizational efficiency through reusing codified knowledge (Markus, 2001). Effective management of tacit knowledge, which is hard to imitate, benefits firms to develop core processes, obtain new understandings, rapidly combine their ability and experiences, thus allowing them to achieve competitive advantages in dynamic environments (Nonaka & Takeuchi, 1995).

In recent years, empirical studies have been conducted to explicate the impact of KM on firm performance. Using a sample of 217 Finnish firms from seven different industry sectors, Jantunen (2005) showed that knowledge-utilization capabilities were reflected in firms' innovative performance. Sabherwal and Sabherwal (2005) drew secondary data from 89 IT-based KM announcements from 1995 to 2002 and employed an event study methodology to illustrate empirical support of the benefits delivered by KM to firm performance in terms of short-term market value. A recent survey by Darroch (2005) examined the relationships between KM, innovation, and firm performance by analyzing data collected from 443 firms. Empirical evidence supports the view that a firm with a KM capability will use resources more efficiently and therefore will be more innovative and exhibit better performance. In a more sophisticated study, Tanriverdi (2005) used a sample of 303 multi-business firms to investigate the relationship between knowledge relatedness and firm performance, and found that the synergies, arising from the complementarity of the product, customer, and managerial knowledge, significantly improve both market-based and accounting-based firm performance. To sum up, current studies indicate that superior KM capabilities exert significant influence on firm performance.

The role of knowledge management in IT applications

While resources alone can serve as the basic units of analyses, firms create competitive advantage by assembling these resources to create organizational capabilities (Grant, 1991). Firm-specific capabilities provide economic returns because the firm is more effective than its rivals in deploying resources (Makadok, 2001). In IT-related studies, researchers have adopted this capability notion of resources by arguing that competitors may easily duplicate investments in IT resources by purchasing identical hardware and software, and hence resources per se do not provide sustained competitive advantages (Santhanam & Hartono, 2003).

Bharadwaj (2000) went further to define a firm's IT capability as its ability to mobilize and deploy IT resources in combination or co-present with other resources and capabilities, and showed that firms with superior IT capabilities can attain superior performance. It is the manner in which firms leverage their IT investments with unique capabilities that impacts a firm's overall effectiveness (Clemons & Row, 1991).

Accordingly, important organizational capabilities that affect the relationship between IT and firm performance must be taken into account (Sambamurthy et al., 2003). Unless incorporated into the firm strategic management process and combined with other organizational capabilities, IT resources themselves cannot automatically produce positive effects on firm performance (Tippins & Sohi, 2003). Further, among the organizational capabilities, KM capability could affect IT applications to achieve competitive advantages and business excellence (Sher & Lee, 2004). With increasingly faster, cheaper, and broader sources of data plus advanced means of communication, IT enhances the KM capability of organizations by improving and enabling new opportunities for key KM activities which include knowledge creation and knowledge sharing (Walsham, 2001), resulting in enhanced organizational KM capability (Alavi & Leidner, 2001). At the same time, the proliferation of KM activities has generated new directions and domains for IT applications (Sher & Lee, 2004). Further, strategic management scholars also suggest that KM capability could provide competitive advantages and bring about superior firm performance (Eisenhardt & Santos, 2002; Tanriverdi, 2005).

Since IT serves as a critical enabler to KM and KM is a fundamental source of competitive advantage, KM capability could be investigated as a critical mediator between IT and firm performance (Tanriverdi, 2006). Using data collected from 250 *Fortune 100* firms, Tanriverdi (2005) empirically investigated the mediating effect of KM in IT application in a multi-business context. Results showed that IT does have significant indirect effects on firm performance through the mediation of KM capability. Similarly, Tippins and Sohi (2003) proposed that organizational learning capability, which is closely related to KM capability, plays a mediating role in determining the outcome of IT. The authors collected data from 271 manufacturing firms to conduct analysis, showing empirical support for their research hypothesis.

In short, the extant literature shows some support to the mediating role of KM in IT applications. However, it should be noted that most of the relevant studies were conducted in the developed countries, notably the USA. As discussed before, the extent to which current research findings can be internationally generalized remains to be studied, given the vast cross-national differences in institutions and cultures.

Therefore the following hypothesis is set forth in a China context:

Hypothesis 1 KM capability has a mediating effect on the IT-performance relationship.

It is worth noting that a variable may be a hybrid in which it acts as both a mediator and a moderator (Sauer & Dick, 1993). While IT advances organizational KM capability, KM largely influences the domains of IT applications (Tuomi, 1999). In addition to mediating the business value of IT applications, KM can also be complementary with IT in an interactive and harmonious manner to achieve firm performance (Mohamed, Stankosky, & Murray, 2006), mainly by generating

synergies between IT and managerial procedures (Carayannis, 1999). In IT applications, such synergies are related to overall integration, leveraging of IT resources, and competence building (Li & Ye, 1999). To this regard, how IT is integrated into a firm's KM capabilities will affect the multitude of the synergy benefit that can be generated from the IT resources.

Thus, given the potential synergies resulted from the interactive integration of IT and KM, as well as the positive impact of both IT and KM on firm performance, a moderating effect of KM on the IT-performance relationship is expected. To date, there are few, if any, studies conducted in this area. Accordingly, the following hypothesis is set forth:

Hypothesis 2 KM capability has a moderating effect on the IT-performance relationship.

Research methodology

Research design, sample, and data collection

A questionnaire survey was adopted for conducting an empirical analysis. Twenty-six (26) items were included in the questionnaire. These items were extracted from previous studies related to IT applications and KM. They were translated into Chinese and rearranged in line with the analytic framework of this study. To ensure compatibility and consistency of the survey questionnaire, reverse translation and further modifications were also performed. The items were grouped to segment key variables of this study, i.e., IT resources, KM capability, and firm performance. Using the initial draft of the questionnaire, a small-scale pilot test was conducted on ten firms, and wording was refined to ensure the respondents' clear understanding and precise answers in a China context.

The questionnaire survey was conducted during November, 2005 to April, 2006. Four hundred questionnaires were distributed to firms operating in Guangdong Province, one of the most developed regions in China. Typical respondents were middle and senior managers or IT executives who have knowledge and experience in IT management. Of the 400 questionnaires, 256 were returned, representing a response rate of 64%. Furthermore, 20 responses were eliminated according to the following criteria: (a) Respondents worked in current firms less than one year; and (b) missing values. The remaining 236 respondents were middle/senior managers and executives with an average of more than five years work experience and sound knowledge about IT applications in their firms. The sample firms reflected a wide range of ownership structures, which included state-owned, private, joint venture, and foreign-invested firms. One hundred twenty-eight firms were operated in the manufacturing sector while 108 firms were in the service sector. Small and medium-sized firms accounted for a majority of the sample firms, with 184 firms having recorded less than 2,000 employees. Major IT applications included MIS, Intranet, e-business, and the Internet, etc.

It should be noted that responses to the questionnaire survey were obtained from single-source, and data on firm performance and other variables were self-reported.

Therefore, the common method variance problem should be dealt with, although Doty and Glick (1998) suggested that this problem may not invalidate research findings. Following the comments of Podsakoff and Organ (1986), Harman's (1967) single-factor testing was undertaken as a reasonably post hoc remedial approach. Specifically, a principal components factor analysis was conducted on all of the 26 questionnaire measurement items. The unrotated factor solution output showed five factors with eigenvalues greater than one that together accounted for 62.98% of the total variance, ruling out the emergence of a single factor. Further, the first factor only accounted for 27.54% of the total variance. In other words, there was no one 'general' factor which accounted for the majority of variance. Therefore, the problem of common method variance could be considered as not severe in this research.

In this study, non-response bias was also examined. Respondents and non-respondents were compared based on key research variables and firm characteristics in terms of size and industry category. These comparisons did not indicate any significant differences. Therefore, non-response bias could be considered as neutral.

Measures

Measures used in this study were adopted from the literature and previous studies. They are shown in the Appendix, including the sources of measures. All the research constructs were designed by using a seven-point Likert scale, from one, which stands for 'strongly disagree', to seven, which stands for 'strongly agree'.

Adopting the concepts proposed in previous studies (Byrd & Turner, 2000; Daft, 2001; Powell & Dent-Micallef, 1997; Tanriverdi, 2006), this study specified IT resource (ITR) as a second-order construct, measured by the three first-order constructs of IT infrastructure (ITINF), IT human resources (ITHR), and IT strategy-making process (ITSM). IT infrastructure refers to the level of IT configuration and flexibility in firms. IT human resources refers to the level of personal, technical, and managerial IT skills in firms. The IT strategy-making process refers to the degree to which IT investment strategy adheres to the objectives and strategy of firms. KM capability (KMC) was specified as a first-order construct, referring to the extent to which a firm can acquire, create, transfer, integrate, and share information or knowledge within and beyond organization.

Since the disclosure of performance information was sensitive, many firms were reluctant to report financial data such as profitability and return on investment (ROI; Tippins & Sohi, 2003). The research therefore used an indirect and subjective approach, which could be a reasonable substitute for the objective measure of organizational performance (Dess & Robinson, 1984). Previous studies suggested that subjective measures have a significant correlation with objective measures of financial performance (Hansen & Wernefelt, 1989). In our study, the respondents had sufficient perspective and information to assess their firms' performance relative to the key competitors; the subjective measures were therefore valid to indicate firm performance, as commented by Powell and Dent-Micallef (1997). Specifically, firm performance (FPER) was defined as a subjective measure on improvement in overall firm performance over the past three years.

Data analysis

As shown in Table 1, the Cronbach alphas range from 0.760 to 0.856, indicating a high internal consistency and good scale reliability (Cronbach, 1951). The construct validity was tested in terms of discriminant and convergent validity. The discriminant validity was tested by comparing the variance extracted (VE) from each construct to the square of correlations between this construct and others (Barua et al., 2004; Fornell & Larcker, 1981; Thong, Yap, & Raman, 1996). Results are also presented in Table 1. The comparison of VE and corresponding squared correlations shows that there is indeed discriminant validity for each construct.

The convergent validity was assessed by reviewing the T tests for the factor loading (Thong et al., 1996). The estimated results shown in Table 2 confirmed convergent validity of the scales. Further, confirmatory factor analysis (CFA) was performed to check the reliability and validity of the measurement models. The properties of the measurement models are also summarized in Table 2. All composite reliability measures of constructs exceed the recommended level of 0.70 (Bagozzi & Yi, 1988), and the fit indexes, including goodness of fit index (GFI), comparative fit index (CFI), and normed fit index (NFI), are all above the cut-off level of 0.90 (Bagozzi & Yi, 1988). These results confirm that the measurement models have sound reliability and validity.

Research findings

Table 3 summarizes the descriptive statistics and correlations among the variables of IT resources, KM capability, and firm performance. As the table shows, significant correlations among these variables were found ($p<0.01$).

The mediating effect of KM capability

Table 4 shows nested SEM results, which compare goodness of fit of the rival models. In model 1 (M1) and model 2 (M2) KM capability was specified as a mediator between IT resources and firm performance. M1 was designed for testing partial mediation, while M2 represented a full mediation model. In model 3 (M3) IT

Table 1 Instrument reliability and discriminant validity.[a]

Constructs	Cronbach alpha	Comparison of VE and squared correlations				
		ITINF	ITHR	ITSM	KMC	FPER
ITINF	0.856	(0.550)				
ITHR	0.760	0.051	(0.524)			
ITSM	0.851	0.148	0.256	(0.583)		
KMC	0.849	0.115	0.179	0.557	(0.594)	
FPER	0.849	0.211	0.243	0.444	0.537	(0.543)

ITINF IT infrastructure, *ITHR* IT human resources, *ITSM* IT strategy making process, *KMC* knowledge management capability, *FPER* firm performance

[a] $N=236$; VEs are on the diagonal; Squared correlations are off-diagonal.

Table 2 Confirmatory factor analysis and convergent validity.

Constructs		Composite reliability [a]	GFI	CFI	NFI	Items	Standard loadings (*T* value)
Information technology resources (ITR)	IT infrastructure	0.856	0.95	0.96	0.97	ITINF1	0.64 (–)
						ITINF2	0.73 (8.65)
						ITINF3	0.77 (9.02)
						ITINF4	0.73 (8.73)
						ITINF5	0.75 (8.91)
	IT human resources	0.784	0.94	0.95	0.92	ITHR1	0.71 (–)
						ITHR2	0.62 (7.95)
						ITHR3	0.66 (8.31)
						ITHR4	0.68 (8.54)
	IT strategy making process	0.851	0.93	0.95	0.94	ITSM1	0.77 (–)
						ITSM 2	0.70 (10.73)
						ITSM 3	0.75 (11.64)
						ITSM 4	0.65 (9.88)
						ITSM 5	0.73 (11.39)
Knowledge management capability (KMC)		0.849	0.95	0.98	0.96	KMC1	0.54 (–)
						KMC2	0.56 (6.78)
						KMC3	0.72 (7.89)
						KMC4	0.58 (6.92)
						KMC5	0.78 (8.27)
						KMC6	0.76 (8.16)
						KMC7	0.75 (8.10)
Firm performance (FPER)		0.851	0.97	0.98	0.95	FPER1	0.71 (–)
						FPER2	0.75 (10.66)
						FPER3	0.77 (10.92)
						FPER4	0.65 (9.27)
						FPER5	0.78 (11.04)

[a] Composite reliabilities are approximations of, but not identical to, Cronbach Alphas. The former were estimated using the formula recommended by Fornell and Larcker (1981), while the latter were computed directly through SPSS software.
ITINF, ITHR, ITSM, KMC, and FPER stand for IT infrastructure, IT human resources, IT strategy making process, Knowledge management capability, and Firm performance, respectively.

resources and KM capability were treated as independent variables impacting firm performance. Model 4 (M4) was taken as the reference model without taking KM capability into account.

The χ^2 values and degrees of freedom (*df*) increase with models move from M1 to M4. The χ^2/df statistics of all models are below three, i.e., within the acceptable limit (Byrne, 1989). Other goodness of fit indices are also presented in Table 4. The non-normed fit index (NNFI), also known as the Tucker–Lewis index (Bentler &

Table 3 Descriptive statistics and correlations.*

Constructs	Means	Standard error	IT resource	KM capability	Firm performance
IT resource	4.736	0.795	1.00		
KM capability	5.298	0.854	0.663*	1.000	
Firm performance	5.057	1.039	0.705*	0.733*	1.00

*$p<0.01$

Table 4 The comparison of nested SEMs.

Structural equation model	χ^2	*df*	$\Delta\chi^2$	χ^2/df	RMSEA	CFI	NNFI
M1: ITR → KMC → FPER and ITR → FPER	773.50	291		2.658	0.084	0.95	0.94
M2: ITR → KMC → FPER	779.82	292	6.320*	2.671	0.084	0.95	0.94
M3: ITR → FPER and KMC → FPER	871.32	292	97.820**	2.984	0.092	0.93	0.92
M4: ITR → FPER	878.70	293	105.20**	2.999	0.092	0.93	0.92

*$p<0.05$, **$p<0.01$
ITR IT resource, *KMC* knowledge management capability, *FPER* firm performance

Bonett, 1980), and the comparative fit index (CFI; Bentler, 1990) are all above 0.90, indicating that the structural models fit the data well. The RMSEAs are slightly above the critical value of 0.08, as suggested by Browne and Cudeck (1992), but still below 1.00, an acceptable limit proposed by Kelloway (1998). In short, all fit indices are within the acceptable limit, suggesting that the structural models provide good fit with the data.

As shown in Table 4, the mediation models of M1 and M2 are superior to M3 and M4 in terms of smaller changes of χ^2 values ($\Delta\chi^2$) and better results shown in goodness of fit indices. In other words, M1 and M2 are more acceptable. Further comparisons also suggest that the partial mediation model (M1) is superior to the full mediation model M2 in terms of all the indices of goodness of fit, especially the changes of χ^2 values ($\Delta\chi^2$). Thus, the SEM analysis indicates that KM capability should be considered as a partial mediator between IT and firm performance.

Path analysis is adopted to explicate in detail whether the mediating effect of KM capability between IT resource and firm performance is full (M2) or partial (M1). Applying Baron and Kenny's (1986) analytic logic, KM capability can be regarded as a full mediator when it meets all of the following conditions in path analysis: (a) IT resource significantly associates with firm performance, (b) IT resource significantly associates with KM capability, (c) KM capability significantly associates with firm performance, and (d) in the SEMs, when KM capability is added in M2, the path linking IT resource to firm performance becomes not significant. Otherwise, KM capability should be considered as a partial mediator.

Results of path analysis are presented in Figures 1 and 2.

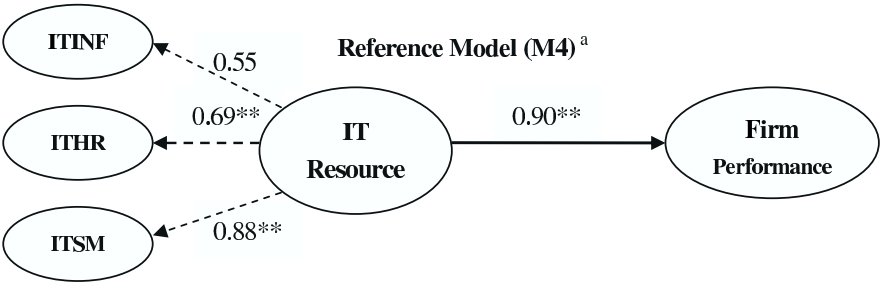
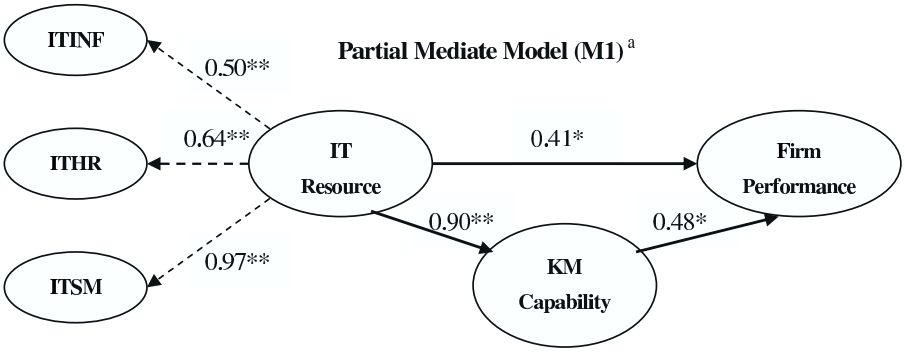


Figure 1 Reference model (M4). *$p<0.01$



a *p<0.05, ** p<0.01.

Figure 2 Partial mediate model (M1). *p<0.05, **p<0.01

Significant associations were found in the paths linking IT resource to firm performance, IT resource to KM capability, and KM capability to firm performance. Therefore, the positive impact of IT resources on both firm performance and KM capability and that of KM capability on firm performance are validated. More importantly, Figure 2 indicates significant association for the path linking IT resource to firm performance after taking the mediator of KM capability into account, and the value of structural link (0.41) is smaller than that shown in the reference model of M4 (0.90). These results not only support the first research hypothesis of this study but also confirm KM capability as a partial, rather than full, mediator. This is reasonable and understandable given the possibility of other organizational capabilities in mediating the relationship between IT and firm performance.

The moderating effect of KM capability

Hierarchical regression analysis was performed to estimate the moderating effect of KM capability on the relationship between IT resources and firm performance. Adopting the comments of Aiken and West (1991), the variables included in regression were generated through a factor analysis procedure. These mean-centered variables can minimize collinearity and distortion resulted from high correlations

Table 5 Results of hierarchical regression analysis.

Variables	Dependent variable: Firm performance		
	Model 1	Model 2	Model 3
IT resource	0.64**	0.39**	0.39**
KM capability		0.46**	0.43**
IT resource × KM capability			0.11*
ΔF		70.37**	10.25**
R^2	0.508	0.621	0.656
ΔR^2		0.113	0.035

*p<0.05, **p<0.01

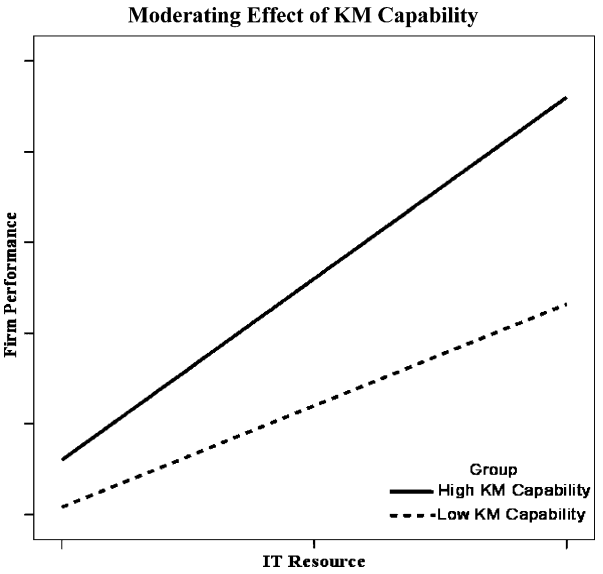


Figure 3 Moderating effect of KM capability

between the interaction variable (ITR × KMC) and its component variables. Table 5 shows the results which indicate that the incremental changes of F and R^2 value are significant and the coefficient of the interaction variable is positive and significant. Therefore, the moderating effect of KM capability is validated and the second research hypothesis is supported. The performance effect of IT resources is dependent on KM capability.

Figure 3 provides a graphic demonstration of the moderating effect using one standard deviation above and below the mean to capture high and low KM capability. The figure shows that the line for high KM capability (high KMC) has steeper positive slope than that for low KM capability (low KMC). Accordingly, firms with higher KM capability would be expected to realize greater business value from IT applications.

Discussion and conclusion

The issue of IT applications has received a great deal of attention, and previous studies show different results. In recent years, research suggests that the effects of IT may be indirect as leveraged by intermediate organizational capabilities (Tanriverdi, 2006; Tippins & Sohi, 2003). In this study, we simultaneously examine the mediating and moderating roles of KM capability in a China context: The results of empirical analysis largely support the research hypotheses.

Theoretical contributions

Overall, this study contributes to the literature on IT business value and KM by adopting the strategic management perspectives of "resource-based" to empirically

examine the mediating and moderating effect of KM in IT applications. Through empirical analysis, this study uncovers that KM matters for IT applications. Consistent with previous research and with the first hypothesis of the study, IT resources have significant, indirect effects on firm performance through the mediation of KM capability. Therefore, KM capability should be considered as a necessary condition for realizing business value from IT applications. It should be noted that there could be other intermediate organizational capabilities that mediate the relationship between IT resources and firm performance because KM capability was found to be a partial, rather than full, mediator of the IT–performance relationship.

Further, this study confirms that KM capability moderates the relationship between IT and firm performance. Thus, superior KM capability is associated with stronger performance impact of IT applications and inferior KM capability is associated with weaker, even trivial, performance impact. Therefore, superior KM capability is necessary for not only realizing, but also maximizing the business value of IT applications. In this way, the study extends the extant literature and suggests that for firms to successfully implement IT applications, KM capability should be better developed. This is true because such intangible organizational capabilities are the main source of sustainable competitive advantages. Thus, this study contributes to the literature on strategic management.

Finally, previous studies conducted in developed countries, for example the USA have shown the effect of organizational capabilities, for instance, KM capability regarding the IT–performance relationship. As revealed by this study, these research findings are largely applicable in China. Thus, the study provides additional insights toward a global understanding on issues related to IT applications and KM.

Managerial implications

This study has significant managerial implications, especially for firms operating in China by displaying insights for understanding how firms would better realize benefits from their IT applications. As the research findings have revealed, KM capability should play an important role in the dynamic process of IT applications and simply investing in IT resources in isolation is unlikely to achieve the desired results. Thus, firms are better off implementing IT applications by developing KM capability. In justifying investments in various dimensions of IT resources, such as IT infrastructures and IT management processes, practicing managers may want to consider not only the direct effects of IT resources on firm performance but also the indirect and interactive effects resulting from key organizational capabilities. This study demonstrates that when critical organizational capabilities are considered, the true business value of IT resources and the mechanism through which this value is generated become better delineated.

This study also promotes the understanding of current IT applications in China. The research findings of this study are consistent with results of previous studies conducted in developed countries including the USA. Research findings of this study indicate the possibility of Chinese firms, as latecomers to the IT arena, in catching up their counterparts in the developed world in terms of adopting and applying IT through innovative means such as KM.

Limitations

Though this study offers some insights to the extant literature and managerial understandings, there are a number of limitations and issues to be dealt with in the future. In our study, KM capability is defined as a partial, rather than a full, mediator. Accordingly, future studies must be refined to include other organizational capabilities which have the potential of mediating the IT–performance relationship. The moderating effect of other key organizational capabilities should also be investigated; the mechanism of IT applications can then be described more precisely. Furthermore, IT resources may have more effect on the management of explicit knowledge than on the management of tacit knowledge (Alavi & Leidner, 2001). In the future, research design must be refined to distinguish the mediating and moderating effects of explicit and tacit KM in IT applications.

In this study, data were collected from firms operating in the single province of Guangdong in south China. Therefore, the extent to which the findings of this study may be generalized, even for firms operating in China, remains to be discussed. Given the significant geographic and cultural differences in the huge China market, it is necessary to conduct further studies with wider coverage, thus reflecting the current situation of IT applications in China more comprehensively.

Conclusion

Researchers have called for the study of key organizational variables that can influence the performance of IT applications. This study addresses current research concerns by conducting empirical investigation. We take KM capability as the focal organizational variable of inquiry, indicating the increasing importance of KM in IT applications and suggesting the implications of KM that impact key strategic issues, for example, competitive advantage and firm performance. Research findings confirm the mediating and moderating effects of KM capability in IT applications as well as reveal the importance of realizing the benefits of IT applications through the development of KM capability. In conclusion, these findings have future implications for KM and IT business value studies in particular and strategic management research in general.

Appendix: Measurement items in questionnaire

Respondents were asked to indicate the extent to which they agree or disagree with the following statements, using the seven-point Likert scale (with 7 = strongly agree, to 1 = strongly disagree):
Information technology resources (ITR)
IT infrastructure (ITINF)

1. IT infrastructure assists in our organization's technological innovation (Byrd & Turner, 2000).
2. Compared to the competitors, the expenditure about IT investment in our organization is more (Byrd & Turner, 2000).
3. The IT infrastructure in the organization would be difficult and expensive for rivals to duplicate (Byrd & Turner, 2000).

4. The IT infrastructure in our organization can be upgraded and reusable (e.g. hardware, software; Byrd & Turner, 2000).
5. Our organization equips a wide variety of types of information equipments (Byrd & Turner, 2000).

IT human resources (ITHR)

1. The personnel in our organization are well trained in the use of various information technology (Powell & Dent-Micallef, 1997).
2. IT personnel in our organization are skilled in IT development, management and maintenance (Byrd & Turner, 2000).
3. IT personnel are able to interpret business problems and develop appropriate technical solutions (Byrd & Turner, 2000).
4. Our IT personnel have the ability to plan, organize, and lead projects (Byrd & Turner, 2000).

IT strategy making (ITSM)

1. The strategies of our IT group are well aligned with organization's marketing policies and practices (Byrd & Turner, 2000).
2. Our IT personnel understand our organization's polices and plans (Byrd & Turner, 2000).
3. Our top management is involved in and supports the IT system and applications (Byrd & Turner, 2000).
4. The employees in our organization accept the application of new information technology (Powell & Dent-Micallef, 1997).
5. The strategies of the IT group and our organization's strategies are well aligned (Powell & Dent-Micallef, 1997).

Knowledge management capability (KMC)

1. In our organization, information flow is free (Daft, 2001).
2. We frequently use cross-departmental teams to solve key problems (Powell & Dent-Micallef, 1997).
3. When the personnel encountered the technical problems, they can seek help within organization (Byrd & Turner, 2000).
4. When the personnel encountered the technical problems, they can seek help beyond organization (Byrd & Turner, 2000).
5. In our organization, the customer information is managed well (e.g. with the help of IT; Byrd & Turner, 2000).
6. The personnel in our organization can acquire needed knowledge (e.g. with the help of IT; Byrd & Turner, 2000).
7. In our organization, sharing the information and resource among various departments is promoted (e.g. with the help of IT; Byrd & Turner, 2000).

Firm performance (FPER)

1. Over the past 3 years, our financial performance has been outstanding (Powell & Dent-Micallef, 1997).
2. Over the past 3 years, our financial performance has exceeded our competitors (Powell & Dent-Micallef, 1997).
3. Over the past 3 years, our sales growth has been outstanding (Powell & Dent-Micallef, 1997).
4. Over the past 3 years, we have been more profitable than our competitors (Powell & Dent-Micallef, 1997).
5. Over the past 3 years, our sales growth has exceeded our competitors (Powell & Dent-Micallef, 1997).

References

Aiken, L. S., & West, S. C. 1991. *Multiple regression: Testing and interpreting interactions*. Newbury Park, CA: Sage.

Alavi, M., & Leidner, D. E. 2001. Review: Knowledge management and knowledge management systems: Conceptual foundations and research issues. *MIS Quarterly*, 25(1): 107–136.

Almashari, M., Zarri, M., & Alathari, A. 2002. An empirical study of the impact of knowledge management on organization performance. *Journal of Computer Information Systems*, 42(5): 74–82.

Bagozzi, R. P., & Yi, Y. 1988. On the evaluation of structural equation model. *Journal of Academy of Marketing Science*, 16(1): 1–19.

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

Baron, R. M., & Kenny, D. A. 1986. The moderator–mediator variable distinction in social psychological research: Conceptual, strategic, and statistical consideration. *Journal of Personality and Social Psychology*, 51(6): 1173–1182.

Barua, A., Konana, P., Whinston, A., & Yin, F. 2004. An empirical investigation of net-enabled business value. *MIS Quarterly*, 28(4): 585–620.

Bentler, P. M. 1990. Comparative fit indexes in structural models. *Psychological Bulletin*, 107(2): 238–246.

Bentler, P. M., & Bonett, D. G. 1980. Significance tests and goodness of fit in the analysis of covariance structures. *Psychological Bulletin*, 88(3): 588–606.

Bharadwaj, A. S. 2000. A resource-based perspective on information technology capability and firm performance: An empirical investigation. *MIS Quarterly*, 24(1): 169–196.

Browne, M. W., & Cudeck, R. 1992. Alternative ways of assessing model fit. *Sociological Methods & Research*, 21(2): 230–258.

Byrd, T. A., & Turner, D. E. 2000. Measuring the flexibility of information technology infrastructure: Exploratory analysis of a construct. *Journal of Management Information Systems*, 17(1): 167–208.

Byrne, B. M. 1989. *A Primer of LISREL: Basic applications and programming for confirmatory factor analytic models*. New York: Springer.

Carayannis, E. G. 1999. Fostering synergies between information technology and managerial and organizational cognition: The role of knowledge management. *Technovation*, 19: 219–231.

Choi, Y. S. 2000. *An empirical study of factors affecting successful implementation of knowledge management*. Doctoral Dissertation, University of Nebraska.

Choi, B., & Lee, H. 2003. An empirical investigation of KM styles and their effect on corporation performance. *Information and Management*, 40(5): 403–417.

Christensen, C. M., & Overdorf, M. 2000. Meeting the challenge of disruptive change. *Harvard Business Review*, 78(2): 67–75.

Clemons, E. 1986. Information systems for sustainable competitive advantage. *Information and Management*, 11: 131–136.

Clemons, E. K., & Row, M. C. 1991. Sustaining IT advantage: The role of structural differences. *MIS Quaterly*, 15(3): 275–292.

Cronbach, L. J. 1951. Coefficient alpha and the internal structure of tests. *Psychometrika*, 16: 297–334.

Crowston, K., & Myers, M. D. 2004. Information technology and the transformation of industries: three research perspectives. *Journal of Strategic Management Information Systems*, 13: 5–28.

Daft, R. L. 2001. *Organization theory and design*. New York: South-Western College Publishing.

Darroch, J. 2005. Knowledge management, innovation and firm performance. *Journal of Knowledge Management*, 9(3): 101–115.

Demeester, M. 1999. Cultural aspects of information technology implementation. *International Journal of Medical Informatics*, 56: 25–41.

Dess, G., & 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.

Devaraj, S., & Kohli, R. 2003. Performance impacts of information technology: Is actual usage the missing link? *Management Science*, 49(3): 273–289.

Doty, D. H., & Glick, W. H. 1998. Common methods bias: Does common methods variance really bias results? *Organizational Research Methods*, 1(4): 374–406.

Eisenhardt, K. M., & Santos, F. M. 2002. Knowledge-based view: A new theory of strategy? In Pettigrew, A., Howard, T. & Whittington, R. (Eds.). *Handbook of strategy and management*: 139–164. London: Sage.

Fornell, C., & Larcker, D. F. 1981. Evaluating structural equation models with unobservable variables and measurement error. *Journal of Marketing Research*, 18(1): 39–50.

Grant, R. M. 1991. The resource-based theory of competitive advantage. *California Management Review*, 33(3): 114–135.

Hansen, G., & Wernefelt, B. 1989. Determinants of firm performance in relative importance of economic and organizational factors. *Strategic Management Journal*, 10(5): 399–411.

Harman, H. H. 1967. *Modern factor analysis*. Chicago: University Press.

Howells, J. 1996. Tacit knowledge, innovation and technology transfer. *Technology Analysis and Strategic Management*, 8(2): 91–105.

Jantunen, A. 2005. Knowledge processing capabilities and innovative performance: An empirical study. *European Journal of Innovation Management*, 8(3): 336–349.

Kelloway, K. 1998. *LISREL for structural equation modeling: A researcher's guide*. Thousand Oaks: Sage.
Li, M., & Ye, R. L. 1999. Information technology and firm performance: Linking with environmental, strategic and managerial contexts. *Information & Management*, 35: 43–51.
Makadok, R. 2001. Toward a synthesis of the resource-based and dynamic-capability views of rent creation. *Strategic Management Journal*, 22(5): 387–401.
Markus, M. L. 2001. Toward a theory of knowledge reuse: Types of knowledge reuse situations and factors in reuse success. *Journal of Management Information Systems*, 18(1): 57–93.
Martinsons, M. G., & Davidson, R. M. 2007. Strategic decision making and support systems: Comparing American, Japanese and Chinese management. *Decision Support Systems*, 43: 284–300.
Melville, N., Kraemer, K., & Gurbaxani, V. 2004. Information technology and organizational performance: An integrative model of IT business Value. *MIS Quarterly*, 28(2): 283–322.
Mohamed, M., Stankosky, M., & Murray, A. 2006. Knowledge management and information technology: Can they work in perfect harmony? *Journal of Knowledge Management*, 10(3): 103–116.
Montealegre, R. 1999. A temporal model of institutional interventions for information technology adoption in less-developed countries. *Journal of Management Information Systems*, 16(1): 207–232.
Nonaka, I., & Takeuchi, H. 1995. *The knowledge-creating company*. Oxford: Oxford University Press.
Nonaka, I., Toyama, R., & Nagata, A. 2000. A firm as a knowledge-creating entity: A new perspective on the theory of the firm. *Industry and Corporate Change*, 9: 1–20.
Palvia, P. C. 1997. Developing a model of the global and strategic impact of information technology. *Information and Management*, 32(5): 229–244.
Peng, M. W. 2002. Towards an institutional-based view of business strategy. *Asia Pacific Journal of Management*, 19: 251–267.
Podsakoff, P. M., & Organ, D. W. 1986. Self-reports in organizational research: Problems and prospects. *Journal of Management*, 12(4): 531–544.
Powell, T. C., & Dent-Micallef, A. D. 1997. Information technology as competitive advantage: The role of human, business, and technology resources. *Strategic Management Journal*, 18(5): 375–405.
Rivard, S., Raymond, L., & Verreault, D. 2006. Resource-based view and competitive strategy: An integrated model of the contribution of information technology to firm performance. *Journal of Strategic Information Systems*, 15: 29–50.
Sabherwal, R., & Sabherwal, S. 2005. Knowledge management using information technology: Determinants of short-term impact on firm value. *Decision Sciences*, 36(4): 531–567.
Sambamurthy, V., Bharadwaj, A., & Grover, V. 2003. Shaping agility through digital options: Reconceptualizing the role of information technology in contemporary firms. *MIS Quarterly*, 27(2): 237–263.
Sambamurthy, V., & Zmud, R. W. 1992. Managing IT for success: The empowering business partnership. Working Paper, Financial Executives Research Foundation.
Santhanam, R., & Hartono, E. 2003. Issues in linking information technology capability to firm performance. *MIS Quarterly*, 27(1): 125–153.
Sauer, P. L., & Dick, A. 1993. Using moderator variables in structural equation models. *Advances in Consumer Research*, 20: 637–640.
Serban, A. M., & Luan, J. 2001. Overview of KM. *New Direction for Institutional Research*, 113: 5–10.
Sher, P. J., & Lee, V. C. 2004. Information technology as a facilitator for enhancing dynamic capabilities through knowledge management. *Information & Management*, 41: 933–945.
Spiegler, I. 2000. Knowledge management: A new idea or a recycled concept. *Communications of the AIS*, 14(3): 1–24.
Spiegler, I. 2003. Technology and knowledge: Bridging a "generating" gap. *Information and Management*, 40: 533–539.
Tanriverdi, H. 2005. Information technology relatedness, knowledge management capability, and performance of multibusiness firms. *MIS Quarterly*, 29(2): 311–334.
Tanriverdi, H. 2006. Performance effects of information technology synergies in multi-business firms. *MIS Quarterly*, 30(1): 57–77.
Thong, J. Y. L., Yap, C. S., & Raman, K. S. 1996. Top management support, external expertise and information systems implementation in small businesses. *Information Systems Research*, 7(2): 248–267.
Tippins, M. J., & Sohi, R. S. 2003. IT competency and firm performance: Is organizational learning a missing link? *Strategy Management Journal*, 24: 745–761.

Tuomi, I. 1999. Data is more than knowledge: Implications of the reversed knowledge hierarchy for knowledge management and organizational memory. *Journal of Management Information Systems*, 16 (3): 103–117.

Van de Ven, A. H. 2004. The context-specific nature of competence and corporate development. *Asia Pacific Journal of Management*, 21: 123–147.

Wade, M., & 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.

Walsham, G. 2001. Knowledge management: The benefits and limitations of computer systems. *European Management Journal*, 19(6): 599–608.

Danming Lin (PhD, University of Hong Kong) is a professor at the Shantou University Business School, China. His current research focuses on strategic issues related to applications of information technology (IT), particularly the mechanisms through which the business value of IT is generated in China.

Qiang Liang (BSc, Shantou University) is a graduate student at the Shantou University Business School, China. His current research focuses on performance implications of information technology investment.

Zongling Xu (PhD, University of Hong Kong) is a professor at the Shantou University Business School, China. Her current research focuses on economic analysis of high-tech investment, particularly the economic organizations and policy implications of high-tech investment in China.

Runtian Li (MEcon, Shantou University) is a teaching assistant at the Shantou University Business School, China. His current research focuses on economic analysis on information technology investment.

Weimin Xie (MEcon, Shantou University) is a PhD candidate at the School of Business, Sun Yat-sen University, Guangdong, China. His current research focuses on financial analysis of information technology investment in China.