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How valuable is information and communication technology? A study of emerging economy enterprises

Yadong Luo[a,b,*], Juan Bu[a]

[a] Department of Management, School of Business Administration, University of Miami, Coral Gables, FL 33124-9145, United States
[b] Sun Yat-Sen Business School, Sun Yat-Sen University, Guangzhou, China

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ABSTRACT

Anchored at the knowledge management perspective, we address how information and communication technology (ICT) improves the productivity of emerging economy enterprises. We present the logic that ICT enhances firm performance because it is an important channel or facilitator of effective knowledge sharing and knowledge integration. We further argue that the conditions characterizing an emerging economy (i.e., a country's economic development) and emerging economy businesses (i.e., internationalization and quality assurance) would affect the extent to which ICT contributes to knowledge management, and thus to firm performance. Our hierarchical linear modeling analysis of 6236 firms from 27 emerging economies lends support to our arguments and predictions, suggesting that ICT is a critical investment that generates satisfactory returns for emerging economy enterprises, yet this investment–return relationship is further contingent upon the macro- and micro-level conditions facing these enterprises. ICT actually adds more value to productivity when a focal emerging economy is less economically developed, and when a focal firm reaches foreign markets or its quality control and assurance is superior.

1. Introduction

Information and communication technology (hereafter, ICT) has improved rapidly and drastically in recent years, affecting business development in most countries of the world, including emerging economies. According to the International Telecommunication Union (ITU, 2013), the past decade has seen fast growth in ICT uptake worldwide, with an increase in all indicators (mobile-cellular telephone subscriptions, Internet access, mobile and fixed broadband subscriptions, etc.). Mobile-cellular subscriptions reached 6.8 billion by 2013—almost as many as the total global population. The fast move from using mobile to broadband has also enabled the rapid development of numerous new information and communication channels, such as social media, portable cloud computing, big data, and smart terminals. Undoubtedly, such development is shaping human life and creating new ways of operating and managing businesses.

Parallel to the above trend, research on ICT has begun to forge ahead in recent years. Prior studies looked at ICT conceptually, often through a resource-based view, contending that firms can and do differentiate on the basis of their ICT resources, which then create firm-specific capabilities and contribute to sustained competitive advantage (Bharadwaj, 2000; Melville, Kraemer, & Gurbaxani, 2004; Mithas, Ramasubbu, & Sambamurthy, 2011; Ray, Muhanna, & Barney, 2005). Empirical efforts, though limited, have shown that ICT improves a firm's Tobin's q (Bharadwaj, Bharadwaj, & Konsynski, 1999) or profit ratio (Santhanam & Hartono, 2003) and can leverage firm-specific assets in the process of international diversification (Chari, Devaraj, & David, 2007). Most extant empirical studies emphasized U.S. firms and relied heavily on data collected from U.S. sources. For example, a widely used source is Information Week' (IW) 500 annual survey of chief information executives of U.S. firms.

We know generally little on how valuable or how important ICT is for emerging economy enterprises (hereafter, EEEs), a gap requiring a significant attention for not only theoretical advancement but also practical implications. EEEs are competing in an increasingly knowledge-intensive and interconnected global marketplace, and at the same time are coping with the overflow of data and information which serves as one of the most important

* Corresponding author at: Department of Management, School of Business Administration, University of Miami, Coral Gables, FL 33124-9145, United States.
E-mail addresses: yadong@miami.edu (Y. Luo), j.bu@umiami.edu (J. Bu).

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issues influencing strategic business decisions, according to the 2012 IBM Global CEO study based on a survey of more than 1700 CEOs in 64 countries.[1] EEEs, while generally lack proprietary or core technologies, are taking advantages of ICT-enabled connectivity to gain access to knowledge, narrow the gap with market leaders in global competition, and exploit opportunities to leapfrog, both technologically and operationally (The Economist, 2007). Moreover, the information explosion era places a premium on an appropriate ICT strategy, which enables a firm to astutely manage knowledge and information database, make effective managerial decisions, and enhance its competitiveness. This ICT strategy is particularly important for EEEs as they are undergoing tremendous transformations and pursuing fast catch-up on the global stage. A properly designed and implemented ICT strategy fosters effective information and knowledge flows, and therefore is central to organizational learning, knowledge development, knowledge sharing and integration (Kogut & Zander, 1992). We thus use the knowledge-based view to explain how ICT helps EEEs to catch up and improve their competitiveness. Our research advances the theoretical development of both ICT and emerging economy firms and sheds light on the role of ICT in fostering knowledge integration and utilization and in compensating EEEs' weaknesses.

This study makes several theoretical contributions. We demonstrate that ICT facilitates effective knowledge sharing and knowledge integration, a mechanism through which ICT enhances efficiency and competitiveness of EEEs. While past literature has acknowledged the importance of ICT, the underlying mechanisms through which superior firm performance is achieved are not clear (Bharadwaj, 2000). Our research enriches the ICT literature by addressing how ICT fosters organizational learning, knowledge sharing, and knowledge integration for latecomers in international competition, such as EEEs. These firms can benefit from the learning advantage of newness (LAN) because they possess fewer deeply embedded routines and face less cognitive complexity (Autio, Sapienza, & Almeida, 2000). ICT bolsters such advantages by allowing EEEs to quickly learn lessons from more experienced and resourceful competitors and gain access to up-to-date information and knowledge worldwide. ICT can perform as a strategic enabler that helps close the gap in competitiveness (i.e., productivity in this study) between EEEs and their benchmark targets such as competent firms in developed countries. Also, we present the logic of fit, suggesting that the positive effect of ICT on firm competitiveness is further determined by the alignment between the firm's ICT and its specific needs and capability for ICT-enabled knowledge sharing and integration. The macro-level (country development) and micro-level contingencies (the firm's quality control and internationalization) moderate the extent to which ICT contributes to competitiveness.

Our research also bears some significant practical implications, particularly for firms from emerging economies. Between 2010 and 2025, emerging economies are likely to contribute more than 70% of global GDP growth (McKinsey, 2012). Some large emerging economies such as BRIC countries have been able to leapfrog some developmental phases for their ICT industries that most developed countries had undergone. They treat ICT as an important propellant for both country- and firm-level competitiveness. EEE managers also view ICT as a pivotal means by which to better connect global resources, partners, and other outside stakeholders, and use these outside resources and partnerships to compensate for their competitive disadvantages and resource constraints. The advancement of ICT – networking and telecommunication services, Internet and intranet access, e-mail, instant messaging, smartphones, VoIP, and Web conferencing – are forging closer and more interactive links between internal processes of EEEs and external connections with a wide array of global partners in international market (World Bank, 2007). To pave the way for rapid growth, EEEs managers need to recognize the importance of ICT as a catalyst for faster growth and higher productivity and a viable way to catch up with foreign competitors. Moreover, infrastructure availability and regulatory requirements vary across different emerging economies, the fact that is often corroborated with a country's development (Hoskisson, Eden, Lau, & Wright, 2000). Executives should be aware that firms across emerging economies, and within the same country and even the same industry, are highly heterogeneous in the breadth, intensity, domain and focus of ICT utilization. It is thus important not to pursue a one-size-fits-all solution when designing ICT strategies for firms in emerging economies.

Using data from the World Bank's Enterprise Surveys, we examined our hypotheses based on 6236 emerging economy enterprises across 27 emerging economies in 2007. Our hypotheses are generally supported. Overall, the present study extends extant ICT literature by exploring ICT's main effect and contingency effect in emerging economies and advances research on knowledge management for EEEs by diagnosing ICT's role in knowledge sharing and integration. This effort has been thus far largely overlooked. We theoretically construct a full path that links ICT, knowledge management, and performance together based upon knowledge-based view (Grant, 1996), but empirically acknowledge a limitation that we cannot directly quantify the mediating effect of knowledge sharing or knowledge integration per se due to the limitation of the World Bank's dataset. Instead, we offer an extensive discussion and conceptualization of how ICT nurtures knowledge sharing, integration and management in the context of emerging economies, which may serve as a foundation on which future empirical studies may build and follow up.

2. Theoretical development

2.1. ICT in emerging economies

A major characteristic of emerging economies is their recent transitions toward market-friendly institutions, which are accompanied by relatively fast economic growth rate (Hoskisson et al., 2000; Wright, Filatotchev, Hoskisson, & Peng, 2005). The institutions, commonly known as the "rules of the game" (North, 1990), are changing as a result of such transitions, and not fully known (Peng, Wang, & Jiang, 2008). Moreover, the rapid development of economies, the explosion in consumer demand, and the surging foreign direct investment all contribute to the dynamism of emerging markets. As argued by Duncan (1972), environmental dynamism is a critical contributor to the uncertainty facing the firm. Thus, compared with developed country firms, EEEs are expected to face greater uncertainty due to higher dynamism in both market and institutional environments. On the other hand, the relatively weak institutions of emerging economies, including, for example, underdeveloped factor markets, inefficient legal framework and its enforcement, weak intellectual property rights system, and information asymmetry (Khanna & Palepu, 1997), fail to ensure effective markets and may even undermine markets (Meyer, Estrin, Bhaumik, & Peng, 2009). To compensate for weak institutional support, EEEs are forced to rely more heavily on embeddedness in an inter-organizational or interpersonal network that facilitates collaboration and

[1] The 2012 IBM Global CEO Study, "Leading through Connections", can be retrieved from http://www-935.ibm.com/services/us/en/c-suite/ceostudy2012/#.

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reciprocity, and that serves as an important substitute for the insufficient formal institutions.[2] Inevitably, such network-based strategies increase interdependence between network members.

According to information processing logic (Tushman & Nadler, 1978), both environmental uncertainty and interdependence give rise to the greater extent of uncertainty that organizations face, thus leading to greater information processing requirements. More importantly, as organizational effectiveness is associated with the fit or match between information processing requirements and information processing capacity, EEEs are required to enhance their information processing capacities through building up organismic structures that are very well coordinated. Specifically, either highly connected (organismic) communication networks or effective coordinating and control mechanisms cannot be realized without properly implemented information systems and communication tools (Tushman & Nadler, 1978).

From a knowledge-based view, ICT-enabled organismic structure and coordination mechanisms do, indeed, facilitate effective knowledge sharing and knowledge integration within or across firms, given the premise that firms can be conceptualized as institutions for integrating knowledge (Grant, 1996). Knowledge, as a specific important intangible resource, has been identified as a critical value driver and a source of competitive advantage for a firm (Spender & Grant, 1996). However, it is less the knowledge per se than the firm's ability to effectively integrate and apply such knowledge that forms the basis for producing long-term sustainable competitive advantage from knowledge-based assets (Alavi & Leidner, 2001). The ability to manipulate knowledge resources is, moreover, especially crucial in turbulent markets (Kogut & Zander, 1996)—a condition of emerging economies that are characterized by rapid and unpredictable changes in their competitive environment. As such, an understanding of ICT and ICT-enabled knowledge sharing and integration is indispensable to understand the ultimate success of EEEs.

2.2. The role of ICT in knowledge sharing and knowledge integration

As noted above, ICT enables the establishment of organismic structure, which facilitates effective knowledge sharing internally and externally, as well as formally and informally. Building on knowledge management literature, we argue that knowledge sharing within and outside firms requires effectively connected (organismic) networks, and generally involves three distinct yet interrelated elements: *codification, search,* and *access.* ICT plays a significant role in implementing and facilitating each of these three elements. First, ICT increases the degree of codification of knowledge, be it explicit or tacit. "Codifiability" has been identified as an important characteristic of knowledge, and refers to the degree to which firm knowledge can be encoded into a set of identifiable rules and relationships that can be easily communicated and understood (Kogut & Zander, 1992). It has been demonstrated empirically, moreover, that the degree of codification has a significant influence on the speed of knowledge transfer (Zander & Kogut, 1995). However, some knowledge remains very difficult to articulate, such as knowledge that is hard to fully document, is insufficiently explained in writing, or is mainly personal know-how (Hansen, 1999). For the difficult-to-codify knowledge, ICT provides a number of new ways to realize effective codification. For example, computer- or cloud-based blueprints could identify and code infinite relevant information, and when accompanied by powerful searching functions, stored information can be easily retrieved as needed. For tacit knowledge such as know-how, procedural knowledge, and personal experience, ICT-enabled video and simulation integrated with rich textual narratives can help to approximate knowledge codification (Chari et al., 2007). Moreover, intranets and the Internet allow the ICT-based code to be adopted uniformly by the source and any recipient involved, thus reducing the cost of communication and knowledge transfer.

Second, ICT effectuates knowledge sharing by searching and locating knowledge effectively. Regarding searching from outside firms, Internet-based technologies enable firms to build unprecedented connectivity with the world. For example, some EEEs now compete on the world stage, in part by significantly copying the products of a market leader or pioneer (Luo, Sun, & Wang, 2011). Using ICT-enabled support, they can mimic products of their Western equivalents even without seeing those products in reality. Such imitation dramatically reduces R&D costs and shortens the product development cycle, resulting in unique competitive advantages in cost and speed for these imitators. With regard to searching within firms, ICT extends an individual's search channels beyond formal means into informal interactions. Examples of formal means include phones, e-mail, corporate directories, electronic bulletin boards, and groupware (e.g., IBM Lotus Notes or Microsoft Outlook). Emerging social software technologies also complement traditional formal communication lines by enhancing informal group interactions and allowing for flexibility and adaptability (von Krogh, 2012). Specifically, publishing and checking content in social media increases employee interactions, and makes it easier to find answers to important questions and to stay informed about the latest news (Paroutis & Al Saleh, 2009). Hansen (1999) points out that the distant and infrequent inter-unit relationships (i.e., weak ties) are more valuable in a knowledge search process than are strong inter-unit ties, because their contacts avoid redundant knowledge. We further argue that ICT has become a necessary tool in building and maintaining a loose coupling system (Orton & Weick, 1990), which is fraught with such weak ties among units. A simple example is that two units, while working separately, could be loosely coupled by using social media platforms to follow each other's recent moves.

Third, ICT enables individuals, units, and organizations to easily access shared knowledge. The word "access" is used rather than "transfer", because "transfer" is usually seen as a dyadic exchange of organizational knowledge between a source and a recipient (Szulanski, 1996). Instead, by using "access", we want to emphasize a new pattern of open sharing that has been significantly shaped by ICT. In fact, the utmost distinction between open sharing and dyadic exchange is that the former is characterized by simultaneous multi-party involvement in knowledge sharing. For example, a firm's online courses and online best practices database can be accessed by employees anytime and anywhere. As cloud computing techniques mature and become more popular, various applications such as Google Docs and its alternatives in emerging markets can be used to manage office documents and files in a cloud computing environment that allows registered users to upload and share documents, and to make changes from any location with Internet access (Yates & Paquette, 2011). More recently, IBM[3] helped its client – a global knowledge process

[2] For example, prior research has identified a micro-macro link that translates managers' micro interpersonal ties with managers at other firms and with governmental officials into macro organizational performance improvement (Peng & Luo, 2000). Also, a number of empirical studies have focused on the prevalence of business groups that aim to fill the institutional void in emerging markets. According to Carney, Gedajlovic, Heugens, Van Essen, & Van Osterhout meta-analysis of 141 studies covering 28 countries, business group's affiliates are comparatively better off in contexts with underdeveloped financial and labor market institutions.

[3] This news was released by IBM on May 8th 2014 and can be retrieved from the link below: http://www.ibm.com/press/us/en/pressrelease/43879.wss.

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outsourcing (KPO) company based in emerging markets – to build a private cloud environment that supports a virtual desktop infrastructure (VDI) for nearly 2000 employees, providing them with faster access to client analytics and thereby increasing productivity. Overall, a trend toward more effective open sharing of knowledge has emerged.

On the other hand, as ICT helps to establish mechanisms for coordination and control (Tushman & Nadler, 1978), we argue that ICT also facilitates knowledge integration, since knowledge-based theory views the fundamental task of organization as coordination through which knowledge can be integrated (Grant, 1996). Grant (1996) identifies four primary elements in coordination mechanisms: *rules, routines, group problem solving,* and *common knowledge*. We will further demonstrate how ICT supports knowledge integration by enhancing these four elements. First, ICT facilitates knowledge integration by enhancing the implementation and updating of rules. Because rules generally refer to standards that regulate the integration of knowledge, a standardized information and communication system can ensure the execution of these rules and make timely updates as the rules change. Also, because ICT allows transparent processing and long-term tracking of performance, agency theory literature (Jensen & Meckling, 1976) leads us to suggest that the diminished information asymmetry of ICT can help create incentives to mitigate moral hazards for organizational members. In this way, the effect of rules is enforced, and the quality and value of integrated knowledge are better guaranteed.

Second, ICT serves as a basis for organizational routines which, in turn, creates integrative knowledge. An example is an Enterprise Resource Planning (ERP) system that is built on advanced ICT. The ERP system not only collects data and information from various business activities, such as manufacturing, marketing, sales, inventory, and shipping, but also provides and shares an integrated view of knowledge across the various departments that are the sources of information. In doing so, ERP is considered to be an effective organizational routine that significantly improves the level of management and decision making. Moreover, prior research has emphasized the automatic nature of routines (Nelson & Winter, 1982; Gersick & Hackman, 1990), and ICT applications are capable of automating organizational routines. For example, workflow automation systems enable timely and automatic routing of work-related documents and activities, thus increasing the speed of knowledge integration (Alavi & Leidner, 2001).

Third, ICT makes group problem solving and decision making easier and less costly. As Galbraith (1973) has pointed out, "impersonal" coordination through rules and routines needs to be supplemented by group problem solving, which involves high-interaction and non-standardized coordination mechanisms. Because uncertainty increases for EEEs faced with radical and discontinuous changes, reliance on "group" and "personal" coordination modes is greater. In facilitating group coordination, ICT can aid cost-effective interactions between group members. For example, through remote video conferencing systems, meetings can be arranged for people from geographically dispersed locations. In the Web 2.0 environment, online communities provide a virtual organizational form in which knowledge can be dispersed among members who are not necessarily known or identifiable but who share common interests, allowing individuals to add to, and to integrate, knowledge that others have contributed (Faraj, Jarvenpaa, & Majchrzak, 2011; Levy, 2009; Sproull & Arriaga, 2007). Furthermore, advances in ICT will bring a shift toward decentralized decision making, because centralization is not optimal when communication becomes cheaper (Rangan & Sengul, 2009). Such decentralization can relieve organizations from the burden of making complex corporate-level decisions under conditions of uncertainty (Mintzberg, 1979), and can enable organizations to better exploit knowledge from the frontlines.

Last, ICT is capable of enhancing common knowledge which, in turn, increases the efficiency of knowledge integration. At its most simple, common knowledge refers to the intersection of the knowledge sets of organizational members (Grant, 1996). By codifying and sharing knowledge (as we discussed earlier), ICT helps build the common part of the knowledge base of organizational members. Such commonality contributes to a shared language that permits effective communication (Cohen & Levinthal, 1990) and significantly reduces the cost of a coordination mechanism, namely, knowledge integration through rules, routines, and group problem solving. Supportive evidence comes from Argyres (1999) study, which demonstrates that a highly standardized and shared information system (also called "technical grammar") can facilitate complex coordination of a complex corporation operating in a highly uncertain and complex environment.

Taken together, we argue that ICT significantly facilitates effective knowledge sharing and knowledge integration, which further bolster value chain integration and synergy development among primary and support activities of a value-chain system. These synergized and synchronized value-chain activities are conductive to the improvement of firm productivity (Rai, Patnayakuni, & Seth, 2006). Also, ICT provides a digital platform for integration and cooperation not only within a firm, but also with multiple external stakeholders such as suppliers, customers, partners, etc. For instance, a higher level of customer- and supplier-side digitization enables a firm to better understand and respond to customer demands, coordinate procurement processes and material movement, and significantly improve the financial and operational performance of a firm (Barua, Konana, Whinston, & Yin, 2004). On the other hand, the effective ICT-driven sharing and integration mechanisms reduce the costs associated with knowledge flows, transactions and governance and can lead to cost-effective operations of a firm (Grant, 1996). For example, product and customer knowledge management systems enable a firm to more effectively and profitably leverage and exploit related R&D and customer knowledge across multiple units and across multiple product domains. To sum up, we argue that ICT-enabled knowledge sharing and knowledge integration will increase firm productivity by enhancing the efficiency and effectiveness of firm's operating activities.

Hypothesis 1. In the context of emerging economies, the higher the firm's ICT level, the higher the firm productivity, ceteris paribus.

2.3. ICT's contingencies

Drawing from the premise of the contingency theory – that organizational effectiveness results from fitting characteristics of the organization to contingencies reflecting the situation of the organization (Donaldson, 2001) – we expect to see a contingent effect of ICT on firm performance. As discussed earlier, effective knowledge sharing and knowledge integration are mechanisms through which ICT improves firm performance, therefore we argue that the positive effect of ICT is primarily determined by the fit between a firm's ICT and the firm's particular needs for ICT-enabled knowledge sharing and integration. Given the reality that the business value of ICT may vary depending on the environmental and organizational context (Melville et al., 2004), we emphasize the three macro- and micro-level moderating conditions – country-level economic development, firm-level quality assurance, and firm-level internationalization – that affect the main effect of ICT on firm productivity. We realize the possibility of other

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conditions working as such contingent or moderating forces, as we detail later, yet we specifically emphasize these three because they determine a firm's needs or capability for information-processing and knowledge transfer, sharing and integration. A country's economic development is arguably the best indicator for this country's overall economic condition, thus reflecting the common availability and country-level capability of ICT to firms in this country. Quality assurance may best indicate a firm's overall management level and the extent to which information and knowledge are needed to be transferred and aggregated in order to meet the unified quality standards. It also mirrors a firm's ability of information processing and managing. Finally, internationalization points to a firm's market boundaries within which ICT and ICT-enabled knowledge management play their roles, and ICT may become more important in supporting information flows and integrating knowledge across geographically disparate locations when such boundaries expand increasingly.

2.3.1. Country development

Although studies that incorporate macro characteristics are needed in order to examine how macro characteristics shape the ability of firms to apply ICT for organizational improvement, the development of such research has been inhibited due to the emphasis on U.S. firms (Melville et al., 2004). Emerging economies themselves vary according to their extent of development, demonstrated by the variation of their macroeconomic data. Firms from relatively more developed countries may already have established knowledge management systems, even in the absence of ICT. For example, based on access to convenient transportation and accommodations, these firms are able to more easily convene for annual or quarterly meetings of sales staff as a way to facilitate the dissemination of knowledge. Benefits drawn from ICT by means of enhancing knowledge sharing and knowledge integration may be alleviated for these firms. In contrast, firms of less developed countries initially suffer from a lack of alternative ways to deal with knowledge and, hence, have a stronger urge to improve knowledge management through use of newly emerged ICT. Compared to more developed countries, in less developed countries the extent to which ICT is widely available to all firms is relatively lower, which determines its rareness and heterogeneity, two attributes required for a sustained competitive advantages (Barney, 1991). As a result, we regard ICT as essential to enable firms in less developed countries to catch up with their counterparts in more developed countries in improving efficiency and competitiveness. We are aware that an alternate hypothesis is possible—that is, predicting a positive moderating effect of country development on the ICT-competitiveness link. This is logical especially if country development is emphasized with regard to the institutional, regulatory, legal, or even social environment. As this study focuses on the economic (gross national income per capita) aspect of country development, we subscribe to the fact that a firm's ICT level compared with the country's average economic development level is a stronger indicator for the firm's competitive strength in ICT investment, which lends us to posit the following:

Hypothesis 2. In the context of emerging economies, the less economically developed the country is, the stronger the positive impact of the firm's ICT on its productivity, ceteris paribus.

2.3.2. Quality assurance

Quality assurance refers to the assured and consistent quality of a firm's products and services. Although many EEEs have long been perceived as manufacturers of low-quality and cheap products, they are struggling to change this image by providing superior price-value ratios, that is, higher value provided to customers per unit of price or cost. Therefore, the ability to ensure product and services quality is critical in building a competitive advantage for an EEE. In fact, establishing and maintaining a quality assurance system for manufacturing and service industries requires implementation of a series of standards. For example, the ISO 9000 (the International Organization for Standardization) family of quality management standards provides guidance and tools to ensure that firms' products and services consistently meet customers' requirements, and that quality is consistently improved (ISO, 2009). The implementation of these standards requires effective and efficient dissemination, synchronization, and continual updating of information and data, which places a heavy demand on knowledge sharing and knowledge integration. Therefore, for EEEs that adopt a higher level of quality assurance, the increase in its ICT level will more effectively fit or match its enhanced requirement for knowledge sharing and integration. In other words, a positive moderating effect of firm's quality assurance is expected. Thus:

Hypothesis 3. In the context of emerging economies, the higher the firm's quality assurance is, the stronger the positive impact of the firm's ICT on its productivity, ceteris paribus.

2.3.3. Internationalization

A wealth of literature underlines the importance of learning and knowledge management for a firm's international expansion. For example, conventional internationalization process theory (Johanson & Vahlne, 1977) focuses on the gradual acquisition, integration, and use of knowledge about foreign markets and operations that is followed by increased commitment to international markets. According to Kogut and Zander (1993), the notion that the firm specializes in the creation, internal transfer, and recombination of knowledge is foundational to an evolutionary theory of a firm that transforms from its national origins to spanning across borders. Unlike the traditional path of internationalization for multinational corporations from advanced countries, the international expansion for EEEs is often not path dependent or evolutionary, but functions as a springboard for acquiring strategic resources and reducing their institutional and market constraints at home (Luo & Tung, 2007). However, significant differences between home and host countries imply that the established knowledge and capabilities in one market may not work in another (Lu & Beamish, 2001). Therefore, we argue that the requirement of knowledge sharing and knowledge integration will increase when EEEs pursue higher levels of internationalization. As EEEs internationalize more deeply, they not only need to accumulate knowledge of advanced technological and managerial skills through knowledge spillover from observing and cooperating with local or global players but also need to internalize such knowledge into their core competence, a process called capabilities upgrading, which has become increasingly fundamental to international expansion (Meyer, 2004). Again, following our logic that the effect of ICT on firm performance will become stronger in an environment that places higher demands on knowledge sharing and integration, we propose that the extent of internationalization is anther contingent variable that positively fortifies the main effect of a firm's ICT. Specifically, we postulate:

Hypothesis 4. In the context of emerging economies, the higher the firm's internationalization level, the stronger the positive impact of the firm's ICT on its productivity, ceteris paribus.

3. Research methods

3.1. Data collection

We obtained data from the World Bank's Enterprise Surveys (WBES), and benefit from the large number of firms in a wide range

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Table 1
Final sample distribution across 27 emerging countries in fiscal year 2007.

Regions	Sub-regions	Countries	Frequency	Percent	Cumulative%
Africa	Eastern Africa	Mauritius	168	2.69	2.69
America	South America	Brazil	886	14.21	16.90
Asia	Central Asia	Kazakhstan	282	4.52	21.42
		Kyrgyz Republic	120	1.92	23.35
		Tajikistan	146	2.34	25.69
		Uzbekistan	256	4.11	29.79
	South-Eastern Asia	Indonesia	88	1.41	31.21
		Philippines	122	1.96	33.16
	Western Asia	Armenia	171	2.74	35.90
		Azerbaijan	215	3.45	39.35
		Georgia	141	2.26	41.61
		Turkey	699	11.21	52.82
Europe	Eastern Europe	Belarus	150	2.41	55.23
		Bulgaria	162	2.60	57.83
		Czech Republic	117	1.88	59.70
		Hungary	189	3.03	62.73
		Moldova	232	3.72	66.45
		Poland	142	2.28	68.73
		Romania	188	3.01	71.74
		Russia	457	7.33	79.07
		Slovak Republic	110	1.76	80.84
		Ukraine	380	6.09	86.93
	Northern Europe	Estonia	172	2.76	89.69
		Latvia	163	2.61	92.30
		Lithuania	163	2.61	94.92
	Southern Europe	Bosnia and Herzegovina	140	2.25	97.16
		Slovenia	177	2.84	100.00
		Total number	6236		

of emerging economies that are represented. The WBES were conducted through face-to-face interviews with senior managers or owners of randomly selected firms and followed standardized questionnaires and rigorous interview protocols to maximize the consistency and comparability of the data collected from firms in different countries. The WBES and earlier versions, such as Business Environment and Enterprise Performance survey, have been widely used in recent studies (e.g., Angelini & Generale, 2008; Choi, Jia, & Lu, 2015; Martin, Cullen, Johnson, & Parboteeah, 2007; Spencer & Gomez, 2011).

For our study, we adopted Hoskisson et al. (2000) identification of 64 emerging economies,[4] and WBES has surveyed 14,802 firms from 27 emerging economies, capturing the firms' information and responses for fiscal year 2007. Two major advantages of the WBES are its standardized survey instruments and a uniform sampling methodology, which minimize measurement error and yield data that are comparable across the world's economies. First, the use of properly designed survey instruments enhances the reliability of variables measured. The survey questionnaire was designed to be administered in face-to-face interviews with managing directors, accountants, human resource managers, and other relevant senior managers. Prior to the launch of the surveys, WBES piloted the questionnaire with 20–25 interviews to determine whether questions were properly translated, worded, and understood in the context of the particular country's business environment. Piloting results were also used to check consistency and quality of responses, and to detect and correct early in the process any problems that appear to stem from enumerator mistakes. Further, the WBES operates with varying formats of question design and scales, and with a combination of both subjective and objective question items. Almost all variables used in this study were related to factual information and were not issues that focused on response bias. In addition, since all the variables studied are part of a large survey (WBES) and were structurally placed in very different sections, the threat of common method variance was alleviated (Podsakoff & Organ, 1986). Second, the use of a strict and systematic sampling methodology increases the validity of research that uses WBES data. The WBES collected data from key manufacturing and service sectors in every region of the world, generating a sample that is representative of the overall economy. In particular, WBES's sampling methodology generated sample sizes that was large enough for selected industries to conduct statistically robust analyses with precision levels of, at a minimum, 7.5% precision for 90% confidence intervals about estimates of population proportions and the mean of log of sales at the industry level. Not only stratified by industries, WBES also includes additional levels of stratification, such as location and firm size, which further enhance the representativeness and credibility of its sampling. Survey non-response is addressed by maximizing efforts to contact establishments that were initially selected for interview. In addition, substitutions are made in order to potentially achieve strata-specific goals.

While the WBES provides data for firm- and industry-level variables, we used various additional sources to search for and collect data related to country-level variables. For example, data regarding annual gross domestic product (GDP) growth rate and

[4] According to Hoskisson et al. (2000) identification, the 64 emerging markets include 11 countries from Asia: Bangladesh, China, India, Indonesia, Korea, Malaysia, Pakistan, Philippines, Sri Lanka, Taiwan, Thailand; 29 countries from Europe: Albania, Armenia, Azerbaijan, Belarus, Bosnia and Herzegovina, Bulgaria, Croatia, Czech Republic, Estonia, Georgia, Greece, Hungary, Kazakhstan, Kyrgyzstan, Latvia, Lithuania, Macedonia, Moldova, Poland, Portugal, Romania, Russia, Slovakia, Slovenia, Tajikistan, Turkey, Turkmenistan, Ukraine, Uzbekistan; 10 countries from Latin America: Argentina, Brazil, Chile, Colombia, Ecuador, Jamaica, Mexico, Peru, Trinidad and Tobago, Venezuela; and 14 countries from Middle East/Africa: Botswana, Cote d'Ivoire, Egypt, Ghana, Israel, Jordan, Kenya, Mauritius, Morocco, Nigeria, Saudi Arabia, Tunisia, Zimbabwe.

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gross national income (GNI) per capita were obtained from World Bank's online database.[5] Currency exchange rates were drawn from the online XE Currency Converter. After deleting observations with missing data, 6236 firms with complete information remained as the final sample. To check the representativeness of our final sample, we compared the mean differences between final sample and deleted observations in major firm attributes, including number of employees and total sales of firms. Results of the *t* values were not significant, indicating no significant bias in this respect for our final sample from the WBES full sample. Table 1 describes in detail the final sample distribution across 27 emerging economies.

3.2. Variable measurement

We developed the ICT index to measure a firm's ICT level. As a composite index, ICT index was calculated based on the following formula:

$$\text{ICTindex} = \left(\log\frac{CO_i}{N_i}\right)e^{CA_i}.$$

Specifically, CO_i refers to the total annual costs of information and communications services for firm *i*, which includes annual cost of telephone, data transmission, telegraph, telex, teletype, and all other communication services purchased in the complete fiscal year 2007. CO_i has been uniformly converted into U.S. dollars based on currency exchange rates in the last day (i.e., December 31) of 2007, the year that the survey concerns. Therefore, the values of CO_i can be compared across countries. Additionally, CA_i denotes ICT capabilities of firm *i*, which mainly examines two aspects: whether the firm uses e-mail for communication, and whether the firm has its own website. In particular, e-mail has been regarded as one of the most extensively used information technologies, and a firm's website is an important gateway through which both internal and external stakeholders gain access to relevant information and data for the firm. CA_i was coded 2 if the firm uses both e-mail and its own website, was coded 1 if the firm uses only e-mail or only its website, and was coded 0 if the firm uses neither. Moreover, N_i is the number of permanent, full-time employees[6] of firm *i*, and *e* is the base of the natural logarithm.

The above way of measuring ICT makes several contributions. First, prior empirical analyses mainly focused on either ICT expenditure (i.e., the exact amount or proportion of money spent on ICT) or ICT capability (i.e., a firm's ability to possess and fully utilize ICT, a construct measured by multi-item survey questions). We combined the advantages of these two and developed a new composite that incorporates both the total annual costs of ICT per employee and the ICT capability in terms of email and website use. Second, ICT expenditure (i.e., amount in $) and ICT capability (i.e., 0–2 scale) are significantly inconsistent and asymmetric in scale, and therefore to combine them properly we used a logarithm function to transform ICT expenditure and used an exponential function to transform ICT capability. As a result, $\log CO_i/N_i$ normalizes the variability of ICT costs and reduces its scale into a proper level that is comparable to the scale of exponentially transformed ICT capability.[7] Furthermore, ICT capability generally carries a higher weight than ICT expenditure in measuring the actual description of ICT. Accordingly, the use of an exponential function reflects this higher weight, which, with a one unit increase, will lead to an exponential increase in ICT power.

The dependent variable, *firm productivity,* was measured as the logarithm of the firm's total sales per employee. The transformation by log helps to avoid kurtosis and skewness problems. Similarly to CO_i, the values of a firm's total sales have been converted into U.S. dollars to allow cross-country comparison. Three moderators were studied in this study. First, we adopted GNI per capita[8] (the unit is ten thousand U.S. dollars) as a proxy for a *country's economic development*. Because the WBES concerns firm information in fiscal year 2007, data for GNI per capita in 2007 was collected. Second, *quality assurance* was defined as a dummy variable, coded 1 if the firm has an internationally recognized quality certification, such as ISO 9000, 9002, or 14,000, and coded 0 otherwise. Third, *internationalization* was also defined as a dummy variable, coded 1 if the firm simultaneously has both export sales and national sales, and was coded 0 if the firm did not engage in exports.

Six control variables (including country-level, industry-level, and firm-specific) that could potentially impact firm efficiency have been included in the model. Specifically, *GDP growth* refers to annual percentage growth rate of GDP at market prices based on constant local currency of each country in 2007. *Industry* is a dummy variable, using 1 for manufacturing industry and 0 for service industry. *Firm size* was measured as the logarithm of the number of permanent, full-time employees. *Firm age* was measured as the number of years that the firm has been in operation. *Foreign Ownership* was measured as the percent of the focal firm owned by private foreign individuals, companies, or organizations. *Firm location* was also measured as a dummy variable, coded 1 for firms located in a capital city and 0 for firms not located in a capital city. Table 2 presents the descriptive statistics and Pearson correlation between all related variables included in this study.

3.3. Statistical analysis

To test our hypotheses, we used hierarchical linear modeling (Raudenbush & Bryk, 2002) as implemented in STATA 13.0. We chose this technique because our observations are embedded in two hierarchically nested levels of analysis, namely, country and industry. Specifically, we tested the intra-class correlation coefficient (ICC) at both country and industry levels. The ICC is 0.29 at country level and 0.002 at industry level, suggesting that the most important source of non-independence is the country level. Therefore, to account for this interdependence, we specified our model as a two-level hierarchical model with firm observations (level 1) nested in countries (level 2) and controlled for industry-level variables.

Because our conceptual framework includes both cross-level interaction and within-level interaction, we adopted two different techniques for mean centering of these interactions. For cross-level interaction, group mean centering – centering a level 1 variable around the mean of all cases within the same Level 2 group – is recommended (Raudenbush & Bryk, 2002), and therefore was used in this study. For within-level interactions, we employed grand mean centering by way of standardization of the predictors within their respective levels.

[5] The data of World Bank online database can be accessed through the link: http://data.worldbank.org/indicator.

[6] According to the World Bank's definition, permanent full time employees are defined as all paid employees who are contracted for a term of one or more fiscal years or who work a full shift and are guaranteed renewal of their employment contract.

[7] After transformation, the mean and standard deviation (SD) of $\log CO_i/N_i$ are 5.09 and 2.03, and the mean and SD of e^{CA_i} are 4.85 and 2.78, which are generally comparable in terms of scale.

[8] GNI per capita is the gross national income, converted to U.S. dollars using the World Bank Atlas method, divided by the midyear population.

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Table 2
Descriptive statistics and Pearson correlation matrix ($N = 6236$).

	Variables	Mean	S.D.	1	2	3	4	5	6	7	8	9	10
1	Firm productivity	10.22	1.66										
2	GDP growth (%)	7.61	4.20	−0.17***									
3	Industry	0.59	0.49	−0.05***	−0.10***								
4	Firm size	3.50	1.45	0.09***	−0.06***	0.25***							
5	Firm age	16.86	16.30	0.03**	−0.06***	0.13***	0.29***						
6	Foreign ownership	6.71	23.04	0.11***	0.03*	0.03**	0.22***	−0.01					
7	Firm location	0.28	0.45	−0.04***	0.10***	−0.05***	−0.01	−0.02†	0.08***				
8	ICT index	26.54	19.92	0.42***	−0.23***	0.17***	0.22***	0.09***	0.10***	0.10***			
9	Country development	0.64	0.45	0.43***	−0.23***	0.06***	0.07***	0.04**	0.06***	−0.12***	0.40***		
10	Quality assurance	0.24	0.43	0.20***	−0.08***	0.19***	0.36***	0.13***	0.19***	−0.02†	0.26***	0.16***	
11	Internationalization	0.27	0.44	0.24***	−0.14***	0.31***	0.37***	0.16***	0.18***	−0.09***	0.31***	0.29***	0.34***

Notes: † Significant at $p < 0.10$; * significant at $p < 0.05$; ** significant at $p < 0.01$; *** significant at $p < 0.001$

4. Results

The results of our two-level hierarchical linear modeling regression are presented in Table 3. Model 1 is the baseline model with only control variables included. In model 2, we added an ICT index, to examine its impact on firm efficiency. Corroborating Hypothesis 1, the effect of the ICT index on firm efficiency is found to be significantly positive ($\beta = 0.03$, $p < 0.001$). All indicators of model fit improve significantly. We further checked the quadratic effect of the ICT index in relation to firm efficiency. However, as shown in model 3, we found that this curvilinear effect is not significant, while the linear effect of the ICT index remains positive and significant ($\beta = 0.03$, $p < 0.001$). This finding further confirms that for emerging economy businesses there is, indeed, a positive impact of a firm's ICT on its productivity, and this positive effect does not drop or decline when the level of ICT continues to increase. Therefore, Hypothesis 1 (main effect) is strongly supported.

Hypothesis 2 proposes that when operating in a less developed emerging market, a firm's ICT level will have a stronger positive impact on firm productivity. In model 4, we regressed our control variables, main effect, and interaction effect of the ICT index and

Table 3
Results of hierarchical linear modeling (dependent variable: firm productivity).

Variables	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Constant	10.58***	10.10***	10.07***	9.21***	10.16***	10.15***
	[0.35]	[0.24]	[0.24]	[0.22]	[0.24]	[0.24]
Controls						
GDP growth (%)	−0.06†	−0.05*	−0.05*	−0.03	−0.05*	−0.05*
	[0.04]	[0.02]	[0.02]	[0.02]	[0.02]	[0.02]
Industry	−0.42***	−0.41***	−0.41***	−0.41***	−0.42***	−0.46***
	[0.04]	[0.04]	[0.04]	[0.04]	[0.04]	[0.04]
Firm size	0.06***	0.00	0.00	0.00	−0.01	−0.01
	[0.01]	[0.01]	[0.01]	[0.01]	[0.01]	[0.01]
Firm age	0.00†	0.00†	0.00†	0.00†	0.00	0.00
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
Foreign ownership	0.01***	0.01***	0.01***	0.01***	0.00***	0.00***
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
Firm location	0.16***	0.03	0.03	0.03	0.04	0.05
	[0.04]	[0.04]	[0.04]	[0.04]	[0.04]	[0.04]
Main effect						
ICT index (X)		0.03***	0.03***	0.04***	0.03***	0.03***
		[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
ICT index squared (X^2)			0.02			
			[0.02]			
Interaction effects						
Country development (M_1)				0.76***		
				[0.14]		
$X \times M_1$				−0.01**		
				[0.00]		
Quality assurance (M_2)					0.15**	
					[0.05]	
$X \times M_2$					0.15**	
					[0.04]	
Internationalization (M_3)						0.21*** [0.05]
$X \times M_3$						0.11*
						[0.04]
Pseudo R^2	0.298	0.364	0.364	0.364	0.367	0.368
Wald Chi-square	231.04	319.55	310.19	452.72	344.02	348.24
$p \geq$ Chi-squared change	0.000	0.000	0.000	0.000	0.000	0.000
Sample size	6236	6236	6236	6236	6236	6236

Notes: The entries are unstandardized βs with standard errors in brackets. † Significant at $p < 0.10$; * significant at $p < 0.05$; ** significant at $p < 0.01$; *** significant at $p < 0.001$. Pseudo R^2 was calculated as: 1 − (residual variance)/(variance of firm productivity).

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Table 4
Comparative results of emerging markets in Africa and America.

Variables	Model 1		Model 2		Model 3		Model 4		Model 5	
	Africa	America	Africa	America	Africa	America	Africa	America	Africa	America
Constant	9.68***	9.93***	9.50***	9.05***	9.45***	9.15***	9.53***	9.17***	9.39***	9.22***
Controls										
Industry	−0.76**	−0.11	−0.68**	0.11	−0.68**	0.13	−0.72**	0.11	−0.66**	0.06
Firm size	0.23*	−0.04	0.11	−0.15**	0.11	−0.13*	0.06	−0.14*	0.12	−0.18**
Firm age	0.00	0.02***	0.01	0.02***	0.01	0.02***	0.01	0.02***	0.01	0.02***
Foreign ownership	0.00	0.01***	0.00	0.01***	0.00	0.01**	0.00	0.01***	0.00	0.01**
Firm location	−0.13	−0.52***	−0.04	−0.43**	−0.03	−0.43**	−0.09	−0.42**	−0.08	−0.38**
Main effect										
ICT index (X)			0.02**	0.02***	0.02**	0.02**	0.03**	0.02***	0.03**	0.02***
ICT index squared (X^2)					0.05	0.06				
Interaction effects										
Quality assurance (M_1)							0.72*	−0.34		
$X \times M_1$							−0.46	0.34*		
Internationalization (M_2)									−0.27	0.33
$X \times M_2$									−0.42	0.09
Model F	3.42**	10.55***	4.74***	22.65***	4.05***	19.69***	4.43***	17.79***	3.82***	17.82***
R^2	0.095	0.057	0.150	0.134	0.151	0.136	0.182	0.140	0.161	0.140
ΔR^2			0.055	0.077	0.001	0.002	0.032	0.006	0.011	0.006
Hierarchical F			10.35**	78.54***	0.11	1.78	3.13*	2.89†	1.07	3.02*
Sample size	168	886	168	886	168	886	168	886	168	886

Notes: The entries are unstandardized βs, with firm productivity as a dependent variable; † significant at $p < 0.10$; * significant at $p < 0.05$; ** significant at $p < 0.01$; *** significant at $p < 0.001$.

country development. Indicators of fit improve modestly. The interaction term between the ICT index and country development is negatively and significantly related to firm productivity ($\beta = -0.01$, $p < 0.01$). Hence, Hypothesis 2 is also supported. When interpreting this finding, we caution that a country's economic development was measured by GNI per capita.

Hypothesis 3 states that with a higher extent to which a firm's products and services quality can be assured, the effect of a firm's ICT level on firm productivity will increase. In model 5, we included an interaction term between the ICT index and quality assurance, and found that all indicators of model fit improve moderately. The interaction term between the ICT index and quality assurance is positive and statistically significant ($\beta = 0.15$, $p < 0.01$), validating the positive moderating effect of a firm's quality assurance, and thereby lending acceptance to Hypothesis 3. This finding confirms that ICT investment and usage is important to the firm's competitiveness but alone is not sufficient; instead, it is interdependent with the firm's quality control or improvement in jointly stimulating productivity or competitiveness.

Hypothesis 4 predicts that for EEEs with a higher extent of internationalization, the impact of ICT level on firm productivity will become stronger. Model 6 contains the interaction term between the ICT index and internationalization of a firm. This interaction term has a positive and significant influence on firm productivity ($\beta = 0.11$, $p < 0.05$). All indicators of model fit improve appropriately. As such, the positive moderating effect of a firm's internationalization has been proved, lending support to Hypothesis 4. Although the measurement of internationalization is limited in this study (export as a proxy), this result does suggest that ICT's value-adding effect on competitiveness fortifies when the firm is internationalized. It implies that ICT can contribute even more to firm performance when the firm has cross-border market reach.

This study revealed a number of interesting results associated with control variables. In sales or in revenue per employee, firms in service industries in emerging economies tend to outperform those in manufacturing industries. While service industries are certainly less developed in emerging economies than in advanced economies, firm efficiency in service industries may be actually higher than expected in this context. As well, foreign-owned enterprises (partially or fully) in emerging economies clearly show better productivity than indigenous counterparts, which is consistent with results reported by earlier studies (Luo, 2001). Finally, before including ICT and its interaction effects with conditioning contingencies, we observed that the larger the firm (concerning employment size), the higher the productivity. Similarly, those located in capital cities of emerging economies appear to outperform those in non-capital cities with respect to productivity, indicating a performance gap along firm locations.

As a robustness check, we split our observations into two groups in order to address the issue that countries with more observations may dominate the results. Specifically, firms of countries that account for more than 5% of the sample were included in group 1, while the rest of the firms were included in group 2. We compared the model results of group 1 with the results of group 2 and obtained similar results, which ruled out concerns of country domination. We further tested our hypotheses with a totally new sample that was also obtained from the WBES. The new sample concerns information in fiscal year 2006 and includes 2262 firms from five emerging countries: Albania (95),[9] Bulgaria (665), Croatia (304), Ghana (378), and South Africa (820). The results of this new sample were almost identical with our prior results. Therefore, we are confident that our findings are generally robust and reliable.

Finally, we performed several comparative analyses, further examining our hypotheses among emerging economies in different regions (see Table 4). Specifically, we used United Nation's classification of regions (see Table 1). Since there is only one country in Africa and America in the World Bank's database used for this study, multi-level modeling was not appropriate due to non-existence of level 2 (country level), we thus used hierarchical moderated regression to test our hypotheses in these two regions (assumptions for hierarchical moderated regression have been

[9] The number in the brackets denotes the number of firms surveyed in that country.

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Table 5
Comparative results of emerging markets in Asia and Europe.

Variables	Model 1		Model 2		Model 3		Model 4		Model 5		Model 6	
	Asia	Europe	Asia	Europe	Asia	Europe	Asia	Europe	Asia	Europe	Asia	Europe
Constant	9.64***	10.75***	9.88***	10.46***	9.84***	10.47***	8.25***	9.78***	9.92***	10.45***	9.19***	10.54***
Controls												
GDP growth (%)	−0.03	−0.03	−0.08***	−0.04	−0.08**	−0.04	0.01	−0.05**	−0.08***	−0.03	−0.01	−0.04
Industry	−0.49***	−0.41***	−0.47***	−0.45***	−0.47***	−0.45***	−0.48***	−0.44***	−0.48***	−0.47***	−0.50***	−0.50***
Firm size	0.06**	0.06***	0.02	0.03†	0.02	0.03	0.02	0.03†	0.01	0.02	−0.01	0.02
Firm age	0.00	−0.00*	0.00	−0.00*	0.00	−0.00*	0.00	−0.00*	0.00	−0.00**	0.00	−0.00**
Foreign ownership	0.01***	0.00***	0.00**	0.00***	0.00**	0.00***	0.00**	0.00***	0.00**	0.00***	0.00**	0.00***
Firm location	0.28***	0.41***	0.11	0.21***	0.11	0.21***	0.10	0.20***	0.11	0.21***	0.15*	0.21***
Main effect												
ICT index (X)			0.04***	0.02***	0.04***	0.02***	0.04***	0.03***	0.03***	0.02***	0.03***	0.02***
ICT squared ((X^2)					−0.02	−0.02						
Interaction effects												
Country development (M_1)							2.06***	0.64***				
$X \times M_1$							−0.03**	−0.01				
Quality assurance (M_2)									0.20**	0.15*		
$X \times M_2$									0.05	0.23***		
Internationalization (M_3)											0.28**	0.17**
$X \times M_3$											−0.05	0.12*
Pseudo R^2	0.424	0.306	0.480	0.371	0.480	0.371	0.480	0.371	0.482	0.377	0.482	0.375
Wald Chi-square	103.05	221.35	186.80	257.17	184.13	260.42	258.14	334.11	192.57	280.54	169.02	274.45
$p \geq$ Chi-squared change	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Sample size	2240	2942	2240	2942	2240	2942	2240	2942	2240	2942	2240	2942

Notes: The entries are unstandardized βs with firm productivity as a dependent variable. Pseudo R^2 was calculated as: 1 − (residual variance)/(variance of firm productivity). † Significant at $p < 0.10$; * significant at $p < 0.05$; ** significant at $p < 0.01$; *** significant at $p < 0.001$.

tested and validated). For Asia and Europe, we employed multilevel modeling, the same way as we tested the main predictions, with the results being reported in Table 5. These comparative analyses display that most effects we hypothesized (main effect and contingency effects) are identical among firms operating in different regions of emerging economies except some contingency effects. Quality assurance remains significant and positive in helping firm productivity in all regions except in South America (Brazil). Internationalization significantly and positively contributes to performance for firms in Asian and European emerging economies but not for firms in East Africa (Mauritius) and South America (Brazil). While ICT's joint effect with quality assurance on productivity remains positive and significant for European and South American emerging economy firms, this joint effect weakens for firms in Asia and East Africa. Comparing with the combined total sample (Table 3), regionalized sample results (Tables 4 and 5) show a declining and non-significant effect of ICT's interaction with internationalization on productivity. This reminds us that the joint effect of ICT and export orientation may be smaller in a smaller sample setting. It also infers that ICT's role in internationalization is limited for medium and small enterprises (sample firms in this study) than for larger firms in emerging economies.

5. Discussion and conclusion

Our study reveals several interesting findings that bear some important implications to research and practice pertaining to information-related knowledge management in general and ICT strategies in emerging economies in particular. We live in an information era today, so do businesses whose routine operations and management increasingly rely upon ICT investment and whose growth and success necessitates a well-functioned ICT system to foster knowledge flow, sharing and integration. Surprisingly, we did not find that research on ICT strategies was parallel to what has been happening in the real business world. In this study we document and validate that ICT is a necessary investment that has generated satisfactory returns for EEEs, and yet this investment–return link is further contingent on country- and firm-level conditions. A firm's ICT actually adds more value to its performance or productivity when its residing economy is less economically developed or when this firm reaches foreign markets and its quality assurance is superior.

Although our data (the World Bank's Enterprise Survey database) did not allow us to directly measure the knowledge management variables and hence to show a full path or loop of the ICT-knowledge management–performance relationship, which is, as we acknowledged, an empirical limitation, we did develop a logic that ICT is important to EEEs' productivity, competitiveness or performance because ICT's repercussions extend far beyond the information system itself—it is a central "infrastructure" for organizing, integrating, orchestrating and upgrading knowledge and its utilization. Without ICT system in place, firms cannot flawlessly streamline information, knowledge and all other resource sharing system in real time both inter-organizationally (with suppliers, distributors and other partners) and intra-organizationally (with all members and units inside the firm). Although the global management community has seen a growing attention to ICT and its organizational effect, prior research on ICT has mostly focused on its effect on promoting information processing and coordination capabilities (e.g., Chari et al., 2007; Rangan & Sengul, 2009). Our study takes a further step by incorporating knowledge management to explain the impact of ICT. Specifically, we conceptualized how ICT fosters the core elements contained in effective knowledge sharing (i.e., codification, search, and access) and knowledge integration (i.e., rules, routines, group problem solving, and common knowledge). Since

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the efficiency in organizations is associated with the effective utilization of knowledge integration mechanisms as well as knowledge sharing (Grant, 1996), it is logically consistent to derive our main argument that ICT improves firm productivity or competitiveness. As such, our study enriches existing research by offering a new perspective as well as the quantitative evidence toward the understanding of the role of ICT.

Moreover, we presented a contingency perspective—that is, under what circumstances EEEs' ICT would become even more important in enhancing competitiveness or productivity. In this study we identified and explained that firms in less economically developed countries, those with a higher level of quality assurance and control or those with a higher extent of internationalization tended to enjoy a stronger positive relationship between ICT and performance, measured by sales per employees in the present study. The contingency results we reported suggest that ICT's contribution to knowledge management and ultimately to competitiveness or performance varies across firms in different countries and in the same country. ICT's value "rareness", thus value contribution to firm performance, becomes stronger in less economically developed countries. Important too, there are other important drivers for firm performance that complement ICT in stimulating performance. Within the boundary of this study, we exhibit that a firm's internationalization and quality are two important building blocks that jointly promote firm performance with ICT. From the knowledge management lens, it implies that as firms extend their geographic boundary (internationalization) and improve their internal management (quality control and assurance), an improved and enlarged communication and information sharing system would be needed to orchestrate and nourish knowledge development, integration and utilization. The value chain system perspective clearly suggests that the necessity and development of ICT is an increasing function of the firm's geographic extension and management solidification because of the growing needs for inter-unit, inter-function and inter-region sharing of information, knowledge and resources (Bharadwaj, 2000).

Also, to our best knowledge, this paper might be the first effort of this kind that conducts cross-country study centered on EEEs. While numerous researchers have focused on U.S. firms, their results are conditional on the characteristics of the U.S. business environment (Melville et al., 2004). Instead, using a large cross-country sample, our research contributes to extant literature by demonstrating the role of ICT in the context of emerging economies characterized by structural transitions toward market-friendly institutions, changing and uncertain competitive markets, and less developed economic and institutional infrastructures. In particular, the stronger effect of ICT in less economically developed countries infers an existence of a competitive advantage, rather than disadvantage, of ICT investment in these countries. This is also consistent with the ITU (2013) which reports that in the countries with low levels of ICT development, ICT can become key enablers for achieving international and national development goals for their nations and for achieving catch-up competitiveness for their businesses.

This study has several limitations which should be addressed by future research. As stated above, our database (the World Bank's Enterprise Survey) is short in providing knowledge-related information. We would otherwise wish to investigate a full path of ICT-knowledge management–performance links. It is conceivable that knowledge management could serve as a mediating or at least a path variable connecting ICT and firm performance. Hence, future research may incorporate knowledge management (e.g., knowledge sharing, integration and utilization) in the complete model of analyzing not only the effect/role but also the full path/loop of the ICT-competitiveness relationship. Additionally, the database we used cannot provide us with a causal relationship between ICT and performance. Constrained by our cross-sectional data, we cannot address the change or causality of ICT's effect. Given such an inherent weakness, it is strongly encouraged to adopt longitudinal data referring to ICT in future studies.

We also acknowledge that there may be more internal contingency variables that complementarily affect firm performance with ICT. Although we have argued the importance of ICT in improving performance, we recognize that there are many other strategic, organizational and operational forces, some of which may jointly promote firm performance with ICT and some may not. Successful applications of ICT are often accompanied by complementary organizational resources, such as human capital (Dewan and Kraemer, 2000). Future studies should pay more attention to identify most relevant complementary organizational resources and understand how synergies can be generated to enhance the effect of ICT. Similarly, although our research serves as the first try to probe into the impact of macro-environment on ICT's effect in emerging economies, we investigated merely one country-level characteristic, namely, the extent of country development, as exerting moderating effect on ICT level. Future research should examine more country- and industry-level variables that potentially shape a firm's ICT strategies, investment and contributions (e.g., ICT infrastructure, governmental policies and regulations toward ICT, industry competition, maturity of an industry's upstream and downstream value chain activities) and explicate how they may interact with one another in shaping the process and outcome of ICT.

Moreover, we measured firm productivity or performance only by sales per employees, and we are fully aware the necessity to look at other important measurements of performance or competitiveness. ICT represents a new "general purpose technology" because it has an extremely wide range of potential uses and is complementary to a large variety of other inputs (World Bank, 2007). Therefore, the utilization of ICT may contribute to various outcomes that match various goals and objectives underlying firms' utilization of ICT. Future research can verify the diversity of these outcomes. Finally, our understanding of ICT strategies that may work differently across nations, industries, and firms remains limited. This encourages comparative studies of ICT effects and processes in different economic (e.g., developing and developed countries), industrial (e.g., start-up vs. mature industries; e-business vs. traditional business), and organizational (e.g., network-based vs. independently run) settings.

To conclude, this study has explored the link connecting a firm's ICT and its performance in the setting of EEEs. Building on the knowledge management perspective, we have explained that in the information era and open resource era we now live, firm-level ICT investment and strategy plays a bigger role than we expect for emerging economy companies over the course of their knowledge catch-up, competence catch-up and performance catch-up in global competition. ICT is a critical infrastructural foundation inside an emerging economy organization, and it helps identify needed open resources, fosters knowledge sharing and resource integration within the firm and between the firm and external partners, and expedites information flows and resource flows across various units within the organization and between the focal firm and its external business stakeholders, which altogether heighten competitiveness at the firm-level. ICT is an important architecture for effectuating knowledge sharing, integration and exploitation. In short, ICT is a springboard that helps spur EEEs' competence building and catch up, and its contribution to competitiveness or performance is greater when the firm's other efforts such as quality assurance and internationalization come to jointly play.

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