The moderating role of information technology capability in the relationship between supply chain collaboration and organizational responsiveness

Evidence from China

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Zhao Cai, Qian Huang, Hefu Liu and Liang Liang
School of Management,
University of Science and Technology of China, Hefei, China

Abstract

Purpose – The purpose of this paper is to propose a model to test the relationship between supply chain collaboration (SCC) and organizational responsiveness. Three types of information technology (IT) capability are considered as moderators in this relationship.

Design/methodology/approach – The study conducted a questionnaire survey of 208 firms from various industries in China. Hierarchical regression analysis was used to test the hypotheses.

Findings – SCC positively affects organizational responsiveness. Both outside-in and spanning IT capability positively moderates this relationship, whereas inside-out IT capability has a negative moderating effect on this relationship.

Originality/value – This research extends the knowledge regarding the value creation process of SCC from an organizational learning perspective. The study explores the moderating roles of three types of IT capability in this process and further clarifies the relationship between SCC and organizational responsiveness.

Keywords IT capability, Supply chain collaboration, Organizational learning perspective, Organizational responsiveness

Paper type Research paper

1. Introduction

Collaborations with supply chain partners in the process of planning and executing supply chain operations are increasingly important in ensuring the responsiveness of a firm to market changes (Wei and Wang, 2011; Blome *et al.*, 2014). Supply chain collaboration (SCC) refers to a mechanism that combines and deploys external and internal resources across a supply chain to help firms achieve goals that cannot be easily attained alone (Hoyt *et al.*, 2007; Zacharia *et al.*, 2011). A number of scholars have explored how SCC can be developed with the prevalence of collaborative relationships in supply chain (e.g. De Leeuw and Fransoo, 2009; Wiengarten *et al.*, 2013). Given that valuable findings have been generated from this stream of research, an important question emerges: "Does SCC always come with benefits?" A few studies that explored the value creation of SCC claimed that its benefits cannot be assumed

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(Vereecke and Muylle, 2006; Cao and Zhang, 2011; Blome *et al.*, 2014). For example, Cao and Zhang (2011) empirically proved the positive effect of SCC on firm performance in accordance with a paradigm of collaborative advantage, whereas Ha *et al.* (2011) discovered an insignificant link between a dimension of SCC (i.e. benefit/risk sharing) and logistics efficiency. Squire *et al.* (2009) reported an inverted U-shaped curvilinear relationship between SCC and organizational responsiveness. Although an increasing number of firms have acknowledged the value of SCC, "few firms have truly capitalized on the potential of supply chain collaboration" (Cao and Zhang, 2011, p. 163). Therefore, the value creation of SCC should be investigated further to determine how its potential benefits can be acquired and its drawbacks minimized.

A previous study indicated that the inconsistent findings regarding the SCC-responsiveness relationship "may be due to these practices being context dependent" (Sousa and Voss, 2008, p. 698). SCC generates benefits because coordinating with partners with considerable experience related to market responsiveness provides a firm with a mechanism for the systematic learning of the managerial and organizational skills needed to launch competitive actions with speed and efficiency (Narasimhan and Kim, 2002). However, the SCC alone is insufficient because the firm needs to utilize particular techniques to leverage the learning effects from its coordinators to solve problems. Information technology (IT) capability is widely defined as the essential capabilities that facilitate the learning effects from the coordination of supply chain (Rai *et al.*, 2006). IT capability reflects the ability of a firm to deploy IT-based resources in support of business strategies and work processes. This capability is primarily considered a critical factor that enables firms to acquire and apply knowledge as well as information during collaboration (Wade and Hulland, 2004). Inter-firm collaboration focuses on the interchange of resources; therefore, IT capability plays a necessary facilitating role in generating benefits for both parties (Liu *et al.*, 2015). Despite the acknowledged importance of IT capability, however, its effect on the value creation process of SCC is rarely studied. Therefore, investigating how the SCC-responsiveness relationship is contingent on IT capability can help us understand the underlying influencing mechanism of this collaboration.

The current study aims to investigate the relationship between SCC and organizational responsiveness as well as how IT capability moderates such a relationship based on organizational learning theory. According to this theory, knowledge is an important strategic resource that facilitates the development of a firm's competitive advantage (Grant, 1996). As a fundamental competitive advantage, organizational responsiveness requires the support of relevant knowledge (Hoyt *et al.*, 2007; Hult *et al.*, 2005). Firms must learn from others to leverage new external knowledge that can in turn improve responsiveness because no firm is self-sufficient in terms of intellectual capital (Zacharia *et al.*, 2011). Given that SCC provides opportunities to learn from partners (Squire *et al.*, 2009) this collaboration should be important in developing organizational responsiveness.

Furthermore, we propose that IT capability moderates the relationship between SCC and organizational responsiveness. Literature suggests that IT capability not only helps firms acquire external knowledge from partners but also helps firms assimilate and apply external knowledge to meet business needs (Tippins and Sohi, 2003). Accordingly, the current study intends to explore the various moderating roles of outside-in, spanning, and inside-out IT capability (Wade and Hulland, 2004; Roberts *et al.*, 2012). Outside-in IT capability reflects the partner relationships based on IT, spanning IT capability concentrates on the integration and coordination of IT, and

inside-out IT capability focuses on internal IT architectures for enterprise applications and services. These three IT capabilities provide support mechanisms that enable firms to meet business needs based on external knowledge with lesser obstacles of time and spatial distance. Incorporating IT capability into the current study is consistent with the themes that are observed in operations management and information systems literature; this integration also helps enhance understanding of the relationship between SCC and organizational responsiveness.

In the remainder of this paper, we review literature concerning organizational learning theory, SCC, IT capability, and organizational responsiveness, and then propose hypotheses to explain the research model. The research method and results are then given, and the paper concludes with a discussion of the findings, limitations, and implications of this research.

2. Literature review

2.1 Organizational learning theory

Organizational learning theory is a prevalent perspective arguing that prior learning facilitates the learning and application of new, related knowledge. This theory defines organizational learning as "the process of improving actions through better knowledge and understanding" (Fiol and Lyles, 1985, p. 803). In this view, knowledge acquisition, assimilation, and application are widely treated as the key learning processes through which firms acquire external knowledge and obtain new opportunities by interacting with their partners (Lane *et al.*, 2006; Lichtenthaler, 2009). Specifically, knowledge acquisition reflects the learning process through which a firm acquires new knowledge from its partners. Knowledge assimilation is the learning process through which acquired knowledge is analyzed, interpreted, and understood across a firm. Meanwhile, knowledge application is the learning process of applying newly assimilated knowledge to the context of firms (Lane *et al.*, 2006).

According to organizational learning theory, firms seek to establish and maintain competitive advantage by acquiring tacit and articulated knowledge (Fiol and Lyles, 1985). Firms need to learn how to understand, evaluate, and respond to environmental demands. As per Flores *et al.* (2012), "organizational learning is key to an organization's capability for continuous change and renewal" (p. 641). In this view, inter-organizational activities, including SCC, are defined as learning mechanisms used by firms. Thus, organizational learning theory is treated as an effective perspective through which the value creation process of supply chain partnership can be clarified (Yu *et al.*, 2013). Establishing a collaborative relationship can help firms exploit opportunities for learning from partners, thereby strengthening competitive advantage (Powell *et al.*, 1996; Ireland *et al.*, 2002; Yu *et al.*, 2013). For instance, Powell *et al.* (1996) claimed that a collaborative relationship can provide "timely access to knowledge and resources that are otherwise unavailable, while also testing internal expertise and learning capabilities" (p. 119). Ireland *et al.* (2002) argued that effective collaboration can facilitate learning by providing firms with access to new knowledge and combinations that contribute to the successful adjustment of a firm to a competitive environment. Yu *et al.* (2013) reported that a cooperative relationship with supply chain members can facilitate knowledge transmission and organizational learning, both of which are important in improving financial performance.

From organizational learning perspective, scholars also consider IT capability a specific firm-level capability that enables firms to manage knowledge and to leverage the value of the learning processes that connect these firms to external networks

(Tippins and Sohi, 2003). For example, Tang *et al.* (2011) suggested that firms can combine IT with business strategy to realize a strategic alignment in managing inter-organizational relationships and leveraging the knowledge embedded within. Yao and Zhu (2012) proposed that the IT use of a firm complements its internet-enabled integration with supply chain partners, thus allowing this firm to gain high performance benefits from such an alignment. Hence, IT capability necessarily facilitates a firm's embedding of IT-enabled resources to support learning from partners, although a collaborative relationship allows a firm to reap learning values from its partners.

2.2 SCC

SCC is "a partnership process where two or more autonomous firms work closely to plan and execute supply chain operations toward common goals and mutual benefits" (Cao and Zhang, 2011, p. 166). This collaboration normally involves integrated processes among supply chain members; this incorporation requires members to learn collectively to meet customer needs effectively (Cao *et al.*, 2010). SCC is akin to the formation of a close long-term partnership and can capitalize on learning effects to accomplish the mutual objectives of collaborating partners (Cao and Zhang, 2011). Scholars proposed that "collaboration is becoming more of a necessity than an option" (Matopoulos *et al.*, 2007, p. 177), thereby indicating that SCC can serve the critical predictor of a firm's competitive advantage (Vereecke and Muylle, 2006; Whipple and Russell, 2007). Moreover, empirical evidence demonstrates that SCC helps firms gain a competitive advantage in various ways, such as in terms of improving productivity, reducing inventory levels, and minimizing errors in execution (Vereecke and Muylle, 2006; Zacharia *et al.*, 2011; Ramanathan, 2012).

Although SCC is duly recognized as a factor in enhancing competitive advantage, the findings of empirical studies on such relationships have been mixed and even controversial (Flynn *et al.*, 2010; Cao and Zhang, 2011). A few researchers provided empirical support for a positive significant association (e.g. Rai *et al.*, 2006), whereas others reported an insignificant or even negative relationship (e.g. Flynn *et al.*, 2010). According to clues provided in previous research, these inconsistent findings can be attributed to the lack of contingencies. For example, Wong *et al.* (2012) posited that the value of information exchange activities in collaborative relationships is contingent on external environment conditions and operating characteristics. Yao and Zhu (2012) further argued that the use of IT mitigates the side effects of electronic linkages with partners in a given supply chain. Nonetheless, the contingencies in the value creation of SCC remain unexplored; given this knowledge gap, the factors that enable firms to reap the expected benefits of SCC must be identified and tested (Wong *et al.*, 2011).

2.3 IT capability

IT capability reflects "a firm's ability to acquire, deploy, combine, and reconfigure IT resources in support and enhancement of business strategies and work processes" (Lu and Ramamurthy, 2011, p. 932). This ability is an important catalyst that helps achieve business value by embedding IT-enabled resources to support the processes and strategies of a firm (Yao and Zhu, 2012). However, previous studies indicated that different objectives foster various types of IT capability, which generate diverse outcomes (Sanders, 2008). As mentioned previously, scholars have categorized IT capability into three types: outside-in, spanning, and inside-out (Wade and Hulland, 2004). Outside-in IT capability is externally oriented and represents the ability of a firm to develop IT-based linkages with key business partners (Bharadwaj *et al.*, 1999;

Wade and Hulland, 2004). Inside-out IT capability is developed within a firm, is internally focused, and reflects the ability of a firm to deploy data, network, and processing architectures for enterprise applications and services (Bharadwaj *et al.*, 1999). Spanning IT capability involves both internal and external factors; it focuses on the ability of a firm to integrate inside-out and outside-in IT capability (Wade and Hulland, 2004).

The importance of IT capability in supply chain management is widely recognized in literature. For example, Rai *et al.* (2006) considered supply chain management to be digitally enabled and generates significant research opportunities in the interdisciplinary field of IT and supply chain management. Fawcett *et al.* (2007) determined that both operational and competitive performance are enhanced by the use of IT in a collaborative supply chain. Liu *et al.* (2015) argued that "most successful collaborative relationships are developed when firms and their partners both equip with IT capability" (p. 173); however, practical evidence indicates that incorporating IT capability into supply chain management to gain benefits is difficult and expensive (Rai *et al.*, 2006). Empirical research also indicates that IT capability does not always enable a firm to benefit from managing a supply chain (Devaraj *et al.*, 2007). Kim *et al.* (2006) argued that innovations in IT cannot significantly improve information exchange and coordination between supply chain partners, and Kumar and Banerjee (2014) suggested that the connecting role of IT exerts an insignificant effect on operational performance. These controversial findings indicate the multifaceted nature of IT capability in supply chain management.

As Table I shows, an increasing number of scholars have recently explored the moderating role of IT capability. The embedding of IT capability in organizational processes comprises information processing capability, which enables firms to interpret and utilize information and knowledge in ways that enhance firm performance. For example, De Búrca *et al.* (2006) determined that IT helps firms listen to customer demands, thus strengthening the positive effect of service practice on performance. Paulraj and Chen (2007) claimed that IT capability can improve the efficiency of supply chain communication by facilitating joint routines and eliminating non-value activities. Furthermore, Chi *et al.* (2010) argued that the benefits derived from the network structure are contingent upon the use of IT, and Chakravarty *et al.* (2013) indicated that the business value of organizational agility is enhanced by IT competencies. These studies suggested that IT capability is conducive to harnessing information and generating business value.

2.4 Organizational responsiveness

Organizational responsiveness refers to the extent to which firms react rapidly to changes in a business environment to seize potential opportunities (Bernardes and Hanna, 2009). This responsiveness reflects "the efficiency and effectiveness with which firms sense, interpret, and act on market stimuli" (Garrett *et al.*, 2009, p. 783), and has been treated as a competitive advantage. For example, Wei and Wang (2011) proposed that this responsiveness represents a competitive marketing advantage by deploying resources to satisfy customer needs. Inman *et al.* (2011) noted that a firm with a high level of responsiveness outperforms its competitors in terms of operations.

Scholars have conducted numerous studies to explore how organizational responsiveness can be enhanced (Hoyt *et al.*, 2007; Wei and Wang, 2011). According to Bernardes and Hanna (2009), "central to this concept [organizational responsiveness] seems to be the capability to learn fast in an environment where changes are fast-paced and difficult to foresee" (p. 45). Accordingly, scholars have increasingly realized that to

Table I. Illustrative literature review of research considering IT as moderators

Study	Purpose	Independent variables	Dependent variables	Moderator
Chakravarty *et al.* (2013)	To propose two distinct roles to understand how information technology competencies shape organizational agility and firm performance	Organizational agility	Firm performance	IT competencies
Kmieciak *et al.*	To explore two basic research questions: what are the effects of information technology (IT) capability and employee empowerment on the innovativeness of small to medium-sized enterprises (SMEs), and what are the effects of innovativeness and IT capability on firm performance in SMEs?	Innovativeness	Firm performance	IT capability
Chi *et al.* (2010)	To focus on the sparse-vs-dense network structure of inter-organizational networks and aim to theoretically and empirically investigate how these contrasting types of network structure interact with IT to influence firm competitive behavior	Structural holes, network density	Competitive action	IT-enabled capability
Ravichandran *et al.*	To fill this gap in the literature by arguing that examining the performance effects of diversification is incomplete without taking into consideration the firm's information technology (IT) spending	Related diversification, unrelated diversification, geographic diversification	Firm profitability, firm valuation	IT spending
Paulraj *et al.*	To explore the impact of strategic buyer-supplier relationships and information technology on a firm's external logistics integration and agility performance	Strategic buyer-supplier relationships	External logistics integration	Information technology
De Búrca *et al.* (2006)	To investigate the relationship between service practices, service performance, business performance and information technology (IT) sophistication	Service practices	Service performance	IT sophistication
Sher *et al.*	To answer the research question: does knowledge management (KM) contribute to the enhancement of dynamic capabilities and thus to the enhancement of business excellence and competitive advantage?	Management of endogenous knowledge, management of exogenous knowledge	Enhancement of dynamic capabilities	IT applications

develop and maintain responsiveness, a firm must constantly learn from partners with rich experiences in terms of responding to market changes (Powell *et al.*, 1996; Ireland *et al.*, 2002; Yu *et al.*, 2013). SCC provides a platform that enables communication among partners; therefore, firms may learn from others. SCC can thus serve as an important factor in improving organizational responsiveness.

Nonetheless, research findings indicate that SCC does not ensure a high level of responsiveness for all firms. Existing research has proposed that the internal factors of a firm play an important role in boosting the learning process between SCC and responsiveness. For example, capabilities such as acquiring, disseminating, analyzing, and storing knowledge have been tested and reported to exert positive effects on organizational responsiveness (Homburg *et al.*, 2007; Wei and Wang, 2011). IT capability has been widely regarded as the effective capability on which a firm can rely to leverage the learning effects of SCC on responsiveness (Chakravarty *et al.*, 2013). In this view, firms may constantly learn the most current knowledge from their partners through SCC to make adjustments and improve organizational responsiveness (Hoyt *et al.*, 2007; Wei and Wang, 2011; Powell *et al.*, 1996; Cao and Zhang, 2011). In this influencing process, IT capability may leverage the effectiveness and efficiency of learning processes to help firms reap the benefit offered by SCC.

3. Conceptual model and hypotheses

3.1 SCC and organizational responsiveness

Lee and Whang (2004) contended that "the capability for all supply chain partners to have access to shared information on a timely basis is therefore key to improving supply chain performance" (p. 126). According to the organizational learning perspective, firms normally establish competitive advantages by acquiring external knowledge (Lichtenthaler, 2009). Thus, SCC helps firms improve organizational responsiveness through effective organizational learning processes. Such responsiveness requires firms to have extensive access to knowledge, and acquiring various types of knowledge enables a firm to sense market changes effectively. SCC also aids firms in learning how to respond to market changes by acquiring rich content and privacy knowledge from partners with whom these firms have developed a close coordinative relationship (Cao and Zhang, 2011). Given access to a broad range of knowledge, firms can easily understand market trends and respond appropriately based on this new insight. For example, firms facing marketplace changes can learn from the experiences of others that have handled a similar situation. Apart from providing a source of knowledge, SCC helps firms generate a common cognitive value with their partners when they learn collectively. This assistance simplifies the process of understanding and assimilating external knowledge from the latter for the former, thereby increasing the former's knowledge base to ensure organizational responsiveness (Cao *et al.*, 2010; Lane *et al.*, 2006). A series of closely coordinated activities, such as joint planning and operating, are also initiated in SCC (De Leeuw and Fransoo, 2009). Through these activities, firms acquire partner assistance in applying the external knowledge on the basis of which they can direct their market response:

H1. SCC is positively associated with organizational responsiveness.

3.2 Moderating effect of IT capability

From organizational learning perspective, IT capability supports the learning process through which a firm absorbs external intelligence by enhancing knowledge acquisition,

assimilation, and application (Chakravarty *et al.*, 2013). Hence, this capability ensures that the learning process in SCC can actually be transformed into intellectual capital for a firm; this occurrence is the base of organizational responsiveness.

Outside-in IT capability strengthens the SCC-responsiveness relationship by facilitating knowledge acquisition in the learning process. This capability reflects the ability of a firm to apply inter-organizational IT tools, such as electronic data interchange (EDI), virtual community, supply chain management systems (SCMS), and standard electronic business interfaces, for linkage with external partners. The outside-in IT capability is externally oriented; moreover, it focuses on leveraging and managing external relationships and resources. Partners that engage in SCC must learn the rich knowledge shared about customers, technologies, and markets from the focal firm; meanwhile, the focal firm should establish an externally oriented IT capability to obtain significant value from SCC; this capability facilitates the learning process by smoothing the flow of valuable knowledge into its boundary (Roberts *et al.*, 2012). For example, the focal firm can link to the inventory systems of collaborating suppliers to access real-time inventory knowledge based on effective SCMS application; hence, the latter can replenish needed parts and components for production or sales in a timely manner. The focal firm can also utilize link to its customers via virtual communities, thereby promoting two-way dialogues that enhance the intensity and richness of interaction. In addition, the EDI or standard electronic business interfaces can provide standardized technological support to the knowledge exchange process when collaborating with external partners; such support facilitates this exchange based on priority or open standardization (Liu *et al.*, 2010):

H2a. Outside-in IT capability positively moderates the influence of SCC on organizational responsiveness.

Spanning IT capability can strengthen the SCC-responsiveness relationship because this capability facilitates knowledge assimilation in the learning process. This type of IT capability reflects the ability of a firm to apply cross-functional IT applications, such as knowledge management systems and inter-organizational interpretation systems, to infuse external knowledge into its internal processes. This ability comprises both internal and external focuses, with emphasis on facilitating the knowledge assimilation within a firm (Wade and Hulland, 2004). Although a firm can acquire new external knowledge from its partners based on SCC, such knowledge remains in its "raw" form, that is, the firm cannot understand it immediately because the newly acquired knowledge is hardly incorporated into existing cognitive structures (Roberts *et al.*, 2012). Thus, to reap the value of SCC, the firm should employ spanning IT capability to assimilate raw knowledge. In certain knowledge management systems, for example, specialists who can interpret the acquired external knowledge can be identified so that the knowledge is converted into a form that fits the cognitive structure of the firm. Employees from different functional units can in turn gain access to and make sense of the interpreted knowledge as needed. Thus, spanning IT capability serves as a channel through which a firm assimilates the acquired external knowledge into its internal intellectual capital; this assimilation constitutes the basis of organizational responsiveness:

H2b. Spanning IT capability positively moderates the influence of SCC on organizational responsiveness.

Inside-out IT capability may help strengthen the influence of SCC on responsiveness by facilitating knowledge application in the learning process. This type of IT capability

reflects the ability of a firm to focus on IT infrastructure and skills and is internally oriented, thus emphasizing the integration of internal business processes based on IT resources (Roberts *et al.*, 2012; Ismail and Yee-Yen, 2015). Although SCC enables a firm to learn from its partners by acquiring external knowledge, the acquired knowledge can be difficult to apply to innovative activities across functional boundaries. With inside-out IT capability, firms can provide integrated access to data across organizational units (Lu and Ramamurthy, 2011). Moreover, such capability ensures that the data, network, and processing architectures are organized and secure across organizational functions (Bharadwaj *et al.*, 1999). Therefore, business functionalities can reach a wide range of knowledge across the entire firm. This combination of various types of knowledge helps optimize operations and facilitates the creation of new products or services. In this sense, the external knowledge provided by SCC can be applied to develop organizational responsiveness with the aid of inside-out IT capability:

H2c. Inside-out IT capability positively moderates the influence of SCC on organizational responsiveness.

4. Research method

4.1 Sample and data collection

A questionnaire survey was distributed in China to test our hypotheses. China has one of the largest economies in the world and has become an indispensable part of the global supply chain. Thus, an increasing number of multinational firms have expanded their operations in China (Liu *et al.*, 2013a). Meanwhile, Chinese firms are increasingly dependent on the use of IT to coordinate with their international supply chain partners, which enables such companies to compete domestically and internationally. Therefore, China is considered an ideal setting in which to conduct research on supply chains. We collaborated with a training institution to improve the feasibility of our survey; this institution is well known for its executive training programs and provides a series of high-quality training on information systems management, supply chain management, and other managerial fields. With the assistance of this institution, a sampling pool that included 300 firms from various industries was obtained. We then contacted the senior executives of these companies and invited them to participate in the survey; these sample companies represented a wide range of manufacturing and service industries, including machinery and equipment manufacturing, construction, electronic and optical product manufacturing, financial and insurance services, and wholesale and retail trade. The senior executives are considered the ideal respondents because they are knowledgeable about the relevant concepts in this research. They can provide accurate information on strategic issues and have the authority to influence the operations and strategies of their respective firms.

After distributing the questionnaires, we followed up with the participants through phone calls and e-mails to encourage responses. A total of 228 questionnaires were returned, including 20 incomplete questionnaires that were discarded. Thus, a total of 208 useful questionnaires were obtained, thus representing a response rate of 69.33 percent. Following the method suggested by Armstrong and Overton (1977), we tested the potential non-response bias. Upon comparing the χ^2 of the key measurement items of the responses derived from the first 25 percent of the respondents and from the final 25 percent, we detected no difference between the two groups in terms of firm size, firm history, and ownership. The results present that non-response bias is unlikely to be a problem for this study. Table II shows the demographic information of these respondents.

	n	%
Industry		
Machinery and equipment manufacturing industry	39	18.75
Construction industry	22	10.58
Electronic and optical product manufacturing industry	15	7.21
Textile mill industry	12	5.77
Chemical industry	14	6.73
Automotive industry	11	5.29
Food industry	7	3.37
Financial and insurance services industry	41	19.71
Wholesale and retail trade industry	14	6.73
Real estate industry	15	7.21
Information services industry	18	8.65
Ownership		
State-owned	99	47.60
Privately owned	92	44.23
Foreign-controlled	17	8.17
Number of employees		
Less than 100	52	25.00
100-299	54	25.96
300-999	37	17.79
1,000-1,999	19	9.13
More than 1,999	46	22.12
Firm history (years)		
1-5	36	17.31
6-10	47	22.60
11-25	78	37.50
26-50	24	11.54
More than 50	23	11.05

Table II.
Sample demographic information

4.2 Measures

The survey instrument was developed according to previously validated measures. We first developed an English questionnaire based on the scales presented in previous research. This questionnaire was then translated into Chinese; subsequently, a professional translator with no prior knowledge of this research was hired to translate the Chinese questionnaire back to English. We compared the translated English questionnaire with the original English version and did not detect semantic discrepancies. To ensure that all the respondents shared our understanding of the relevant concepts, a brief description of these concepts was provided in the questionnaire. All items were measured through five-point Likert scales that ranged from "strongly disagree" to "strongly agree."

SCC was measured by adapting four items from Zacharia *et al.* (2011) and Sanders and Premus (2005). The items assessed the extent to which a respondent firm conducts joint problem-solving activity and product design, as well as the extent to which this firm shares cross-functional processes and information with key partners. Organizational responsiveness was measured via a four-item scale adapted from Homburg *et al.* (2007) and Hult *et al.* (2005). The respondents were asked to indicate the degree to which their firms can respond to market demand by providing a wide range of products or by leveraging the competencies of partners. The satisfaction and

responsiveness of these companies to the expectations of their end customers in the supply chain were measured as well.

We assessed the three types of IT capability by adopting the scale developed by Zhang *et al.* (2008). Outside-in IT capability was evaluated according to the extent to which a firm has technology-based links with customers and suppliers, and establishes IT-based entrepreneurial collaborations with external partners. The five items that quantify spanning IT capability tested the degree to which the firm has assigned multidisciplinary teams to blend business and technology expertise, facilitated a good relationship between line management and IT service providers, a climate that nurtures IT project championship, restructures business work processes to leverage opportunities, and restructures IT work processes to leverage opportunities. The three items of inside-out IT capability tested the extent to which the firm has appropriate data architectures, suitable network architectures, and adequate architecture flexibility.

We included industry type (IND), ownership type, and firm size as control variables. A dummy variable was used for industry type; IND = 1 was assigned for the manufacturing industries and IND = 0 for service industries. On the basis of whether a firm manufactures physical products or provides services (Liu *et al.*, 2010), we placed machinery and equipment manufacturing, construction, electronic and optical product manufacturing, textile mill, chemical, and automotive industries in the manufacturing industry category. We also incorporated financial and insurance services, wholesale and retail trade, real estate, and information services in the service industry category. We utilized dummy variables for three ownership types, namely, state-owned, privately owned, and foreign-controlled. Firm size was measured by the number of full-time employees in the focal firm.

5. Analysis and results

Given that all the data were perceptual and were collected from a single source at one point in time, common method bias were tested by two methods. Following Harman's one-factor test, all the items we applied to measure constructs can be categorized into seven constructs with eigenvalues > 1.00, thereby accounting for 68.36 percent of the variance; nonetheless, the first construct did not account for the majority of the variance (21.80 percent). We further employed the technique suggested by Liang *et al.* (2007). We adopted a common method factor whose indicators included all the indicators of the principal constructs and calculated each indicator variance substantively as explained by the principal construct and by the method. The results shown in Appendix 1 manifest that the average substantively explained that the variance (0.718) of the indicators is greater than the average method-based variance (0.004). All method factor loadings are insignificant as well. The results of the two tests ensure that common method bias is unlikely to be an issue in the study.

5.1 Measure validation

We assessed the reliability via Cronbach's α. As Table III shows, all Cronbach's α values were higher than the suggested threshold of 0.70. We then tested the convergent validity through loading and average variance extracted (AVE). The loadings varied from 0.67 to 0.92 at a significance level of 0.001, whereas the AVE ranged from 0.53 to 0.85; all of these values were above the recommended benchmark for loadings (0.60) and AVEs (0.50). The favorable convergent validity implies that most variances in the constructs were captured by the indicators and do not denote measurement errors. We further tested a structural equation model and found that the fit was acceptable ($\chi^2 = 320.232$ on 139 df, RMSEA = 0.079, CFI = 0.967, IFI = 0.967, NFI = 0.949, NNFI = 0.960).

Discriminant validity was tested by comparing the inter-construct correlations and the square roots of AVEs (Liu *et al.*, 2013b). Table IV shows that all the correlations among constructs were lower than the square roots of corresponding AVEs. This finding suggests that the discriminant validity of our measures is acceptable. Several correlations in Table IV were higher than 0.60; thus, a multicollinearity test was conducted. The highest variance inflation factor (VIF) was 2.50 and the lowest tolerance value was 0.40. Multicollinearity occurs when the VIF is higher than 10 and the tolerance value is lower than 0.10; therefore, multicollinearity was not a serious issue in our research according to these criteria.

5.2 Endogeneity and robustness check

Prior to hypothesis testing, we evaluated the presence of endogeneity bias. Although we theoretically propose the moderating role of IT capability based on organizational learning theory, there exists the concern that IT capability may be improved by SCC. It indicates that endogeneity bias is a potential problem for this research. We performed the Durbin-Wu-Hausman test to evaluate this bias (Tang and Rai, 2012). To obtain the residuals for each moderator, the first regressed SCC on outside-in, spanning, and inside-out IT capability; subsequently, we conducted another regression on organizational responsiveness that includes the control variables, SCC, and the residuals of three moderators. As Table V indicates, the coefficients of three residuals were insignificant, thus suggesting that endogeneity bias is not an issue in this study.

To check the robustness of the statistical analysis, we followed the steps recommended by Tang and Rai (2012). First, the error terms must follow a normal distribution to accord with the assumption of regression analysis. Figure 1 shows the

Table III.
Results of confirmatory factor analysis

Items	Loading	Cronbach's α	Composite reliability	AVE
Supply chain collaboration	0.83-0.90	0.89	0.92	0.75
Organizational responsiveness	0.81-0.84	0.84	0.89	0.68
Outside-in IT capability	0.87-0.92	0.87	0.92	0.79
Spanning IT capability	0.67-0.86	0.83	0.88	0.53
Inside-out IT capability	0.91-0.92	0.91	0.94	0.85
Industry	Single item			
Ownership	Single item			
Firm size	Single item			

Table IV.
Assessment of discriminant validity

	Mean	SD	1	2	3	4	5	6	7	8	9
1. SCC	3.49	0.89	*0.86*								
2. Responsiveness	3.62	0.77	0.54	*0.82*							
3. Outside-in IT capability	3.21	1.05	0.37	0.37	*0.89*						
4. Spanning IT capability	3.02	0.92	0.45	0.38	0.64	*0.73*					
5. Inside-out IT capability	3.07	1.11	0.46	0.38	0.52	0.70	*0.92*				
6. Industry_Dum	na	na	0.07	−0.02	−0.11	−0.16	−0.21	na			
7. Ownership_Dum1	na	na	−0.07	−0.11	0.13	−0.01	0.06	−0.08	na		
8. Ownership _Dum2	na	na	0.04	0.11	−0.19	−0.02	−0.11	−0.03	−0.85	na	
9. Firm size	na	na	0.07	0.09	0.21	0.10	0.09	0.17	−0.86	−0.35	na

Note: The diagonal elements are the square roots of AVEs

	Organizational responsiveness
Industry (Dummy)	−0.02
Ownership (Dummy 1): state-owned	0.01
Ownership (Dummy 2): privately owned	0.14
Firm size	0.07
Supply chain collaboration (SCC)	*0.53***
Residual of outside-in IT capability	0.09
Residual of spanning IT capability	0.11
Residual of inside-out IT capability	0.04

Notes: *$p < 0.05$; **$p < 0.01$

Table V.
Results for endogeneity test

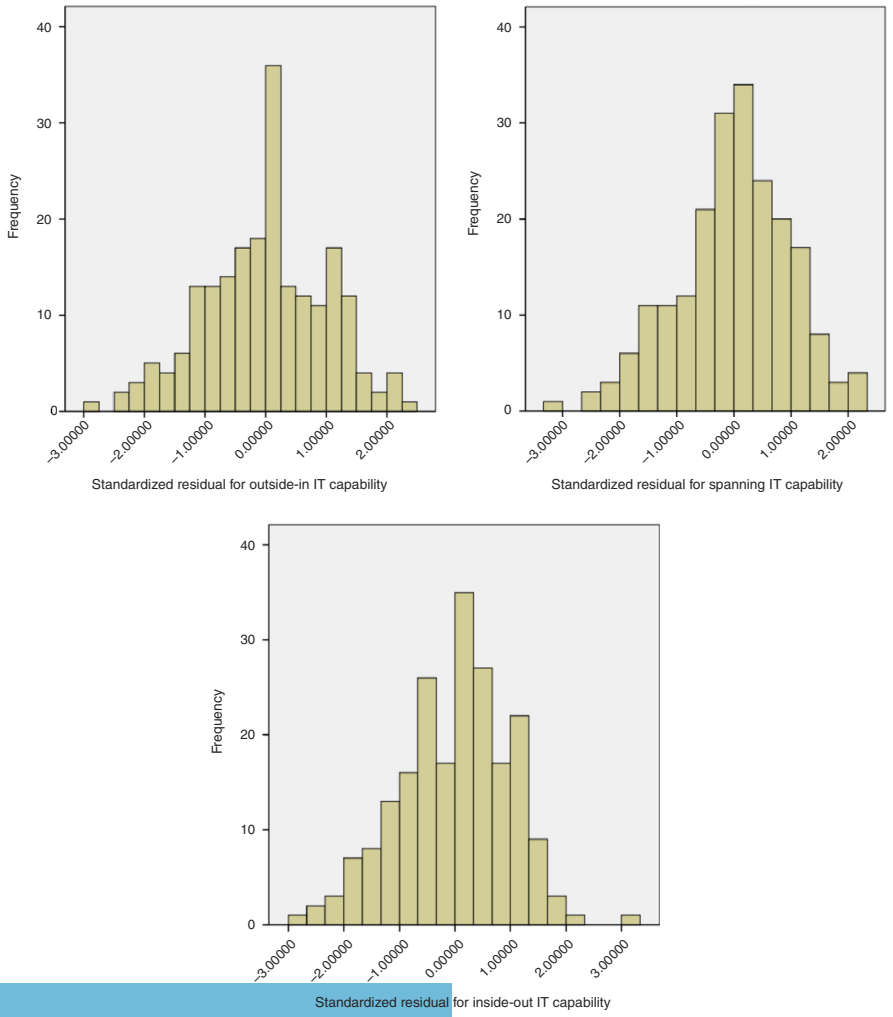

Figure 1.
Histograms of the standardized residuals of outside-in, spanning, inside-out IT capabilities

histograms of three standardized residuals that generate a roughly normal curve. Aside from the graphic approach, Shapiro-Wilk's W test generated insignificant results for the residuals of outside-in ($W = 0.993$, $p = 0.492$), spanning ($W = 0.990$, $p = 0.176$), and inside-out IT capability ($W = 0.992$, $p = 0.294$), thereby confirming the normal distribution of all the standardized residuals. Second, we performed a *post hoc* statistical power analysis using the software package G*Power to test whether or not the sample size of 208 explained this research model with sufficient power. The α level used for this analysis was $p < 0.05$. A total of 11 predictor variables were included in the regression. We also calculated the effect size f^2 of both the direct effect model ($f^2 = 0.285$) and the moderating effect model ($f^2 = 0.131$). This test showed that the statistical power on the effect sizes of both models exceeded 0.999 and were above the benchmark of 0.800. Thus, the sample size adequately explained the research model.

5.3 Hypothesis testing

Hierarchical regression analysis was conducted to test the hypotheses. We standardized the variables to minimize the possibility of multicollinearity (Aiken and Stephen, 1991). As shown in Model 1 of Table VI, no control variable significantly affected organizational responsiveness, whereas the effect of SCC was significant ($\beta = 0.53$, $p < 0.01$). Model 2 was a full model that contained all the variables, and the hypothesized interaction effects acted as independent variables. The results supported *H1* by manifesting the positive effect of SCC on organizational responsiveness ($\beta = 0.43$, $p < 0.01$). Outside-in IT capability positively moderated the relationship between SCC and organizational responsiveness ($\beta = 0.15$, $p < 0.05$), thus supporting *H2a*. Similarly, the positive moderating effect of spanning IT capability as proposed by *H2b* was confirmed by the results ($\beta = 0.19$, $p < 0.05$). However, inside-out IT capability exerted a significantly negative moderating effect ($\beta = -0.20$, $p < 0.01$), in contrast to *H2c*.

We followed the graphical procedure suggested by Aiken and Stephen (1991) to analyze the moderating effects further. Values that were one standard deviation above and below the means were assigned to the outside-in, spanning, and inside-out IT capability to plot their moderating effects. Figure 2(a) indicates that the sloped regression

	Organizational responsiveness	
	Model 1	Model 2
Industry (Dummy)	−0.07	−0.01
Ownership (Dummy 1): state-owned	−0.04	−0.05
Ownership (Dummy 2): privately owned	0.09	0.12
Firm size	0.10	0.09
Supply chain collaboration (SCC)	*0.53***	*0.43***
Outside-in IT capability (OutITC)		0.13
Spanning IT capability (SpanITC)		0.05
Inside-out IT capability (InITC)		0.05
SCC × OutITC		*0.15**
SCC × SpanITC		*0.19**
SCC × InITC		*−0.20***
R^2	0.31	0.40
Adjusted R^2	0.29	0.37
F change	18.20**	4.91**

Notes: *$p < 0.05$; **$p < 0.01$

Table VI. Results for hierarchical regression analysis

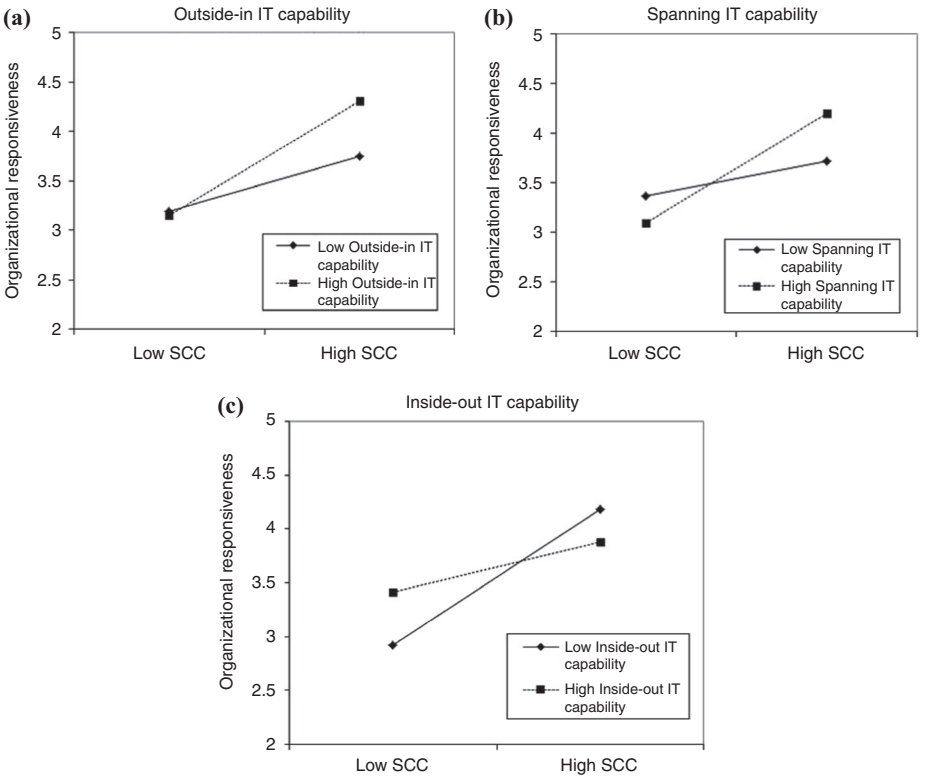

Figure 2.
Moderating effects of IT capability on the relationship between supply chain collaboration and organizational responsiveness

line for the relationship between SCC and organizational responsiveness is positive and significant for both low ($\beta = 0.28$, $p < 0.01$) and high outside-in IT capability ($\beta = 0.59$, $p < 0.01$). Similarly, Figure 2(b) suggests that the sloped regression line is positive and significant for low ($\beta = 0.24$, $p < 0.05$) and high spanning IT capability ($\beta = 0.63$, $p < 0.01$). The sloped regression line in Figure 2(c) indicates a positive and significant relationship between SCC and organizational responsiveness when inside-out IT capability is both low ($\beta = 0.63$, $p < 0.01$) and high ($\beta = 0.24$, $p < 0.05$).

5.4 Post hoc analysis

The literature suggested that firms in different industries reap value from SCC in various ways (Liu *et al.*, 2015). In line with this view, we performed a *post hoc* analysis to check whether or not our findings were consistent in both the manufacturing and service industries. Although these two subsamples are small, their statistical power exceeded the benchmark of 0.80. As per Table VII, SCC is positively related to organizational responsiveness in both manufacturing and service industries, although the moderating roles of IT capability vary in these industries. Moderating effect was significant only in the manufacturing industry for outside-in ($\beta = 0.26$, $p < 0.05$) and spanning capability ($\beta = 0.35$, $p < 0.01$). By contrast, inside-out IT capability ($\beta = -0.26$, $p < 0.01$) was significant in the service industry. These findings indicated the various moderating effects of the three IT capabilities on the SCC-responsiveness relationship in the manufacturing and service industries.

Table VII. Hierarchical regression analysis for manufacturing and service industries

	Organizational responsiveness			
	Manufacturing industry ($n = 82$)		Service industry ($n = 126$)	
	Model 1	Model 2	Model 1	Model 2
Ownership (Dummy 1): state-owned	−0.05	−0.11	−0.05	−0.07
Ownership (Dummy 2): privately owned	0.10	0.09	0.08	0.11
Firm size	0.17	*0.21***	0.07	0.04
Supply chain collaboration (SCC)	*0.52***	*0.32**	*0.54***	*0.57***
Outside-in IT capability (OutITC)		0.15		0.15
Spanning IT capability (SpanITC)		0.15		−0.04
Inside-out IT capability (InITC)		0.01		0.06
SCC × OutITC		*0.26**		0.07
SCC × SpanITC		0.03		*0.35***
SCC × InITC		−0.13		*−0.26***
R^2	0.30	0.40	0.32	0.44
Adjusted R^2	0.27	0.32	0.30	0.39
F change	8.30**	1.99***	14.35**	4.03**

Notes: *$p < 0.05$; **$p < 0.01$; ***$p = 0.10$

6. Discussion, limitations, and implications

6.1 Discussion

This research investigates the relationship between SCC and organizational responsiveness as well as its boundary condition based on the organizational learning perspective. Our findings empirically demonstrate the theoretical positive relationship between SCC and organizational responsiveness and are consistent with those of previous literature; thus, SCC provides firms with a platform through which they can access external knowledge by learning from others (Cao and Zhang, 2011; Whipple and Russell, 2007). Our results further reinforce the notion that "being opposed to collaboration these days is a bit like being against quality, or maybe even profitability" (Prahalad and Ramaswamy, 2001, p. 2).

The current study reports that IT capability serves as a significant boundary factor that moderates the relationship between SCC and organizational responsiveness. In addition, the moderating effects of the three IT capability types vary; both outside-in and spanning IT capability enhance the positive relationship between SCC and organizational responsiveness. This finding is consistent with the prevailing arguments regarding the appropriate configuration of IT capability and business processes (Zhu, 2004). Previous studies have suggested that information flows quickly and transparently within and across organizational boundaries in this configuration and that this procedure can be combined with business processes to improve the outcome. For example, Kampstra *et al.* (2006) argued that the success of collaboration largely depends on IT capability when the level of collaboration is sufficiently high to share knowledge. Meanwhile, Whipple and Russell (2007) suggested that the technological issue should match the evolving collaborative relationship; otherwise, the technology becomes the primary barrier.

Surprisingly, inside-out IT capability weakens the relationship between SCC and organizational responsiveness; therefore, although SCC can significantly improve organizational responsiveness, its influence is stronger on firms with low inside-out IT capability than on those with high inside-out IT capability. Hence, this finding should be interpreted with caution and should not be treated as evidence to suggest that IT

capability is dispensable in SCC value creation (Yao and Zhu, 2012). The possible explanation is that focusing on inside-out IT capability to support internal knowledge exchange may restrict a firm's capability to identify external knowledge from the SCC. Inside-out IT capability addresses the existing well-organized data, network, and processing architectures within a firm, which facilitates efficient communication among employees (Wade and Hulland, 2004). However, Bhatt and Grover (2005) argued that a firm's "standardized enterprise packages suggest that this capability might not be heterogeneously distributed across firms—or, even if it is, that access to infrastructure is not restrictive" (p. 260). In this view, inside-out IT capability may fail to generate new "cognitive maps" to accommodate new interpretations of shared knowledge among channel partners. Thus, such capability may depreciate the value of the external knowledge shared by channel partners. Under this condition, the acquired external knowledge would not be applied efficiently, thereby limiting the role of SCC in improving organizational responsiveness.

The *post hoc* analysis findings presented that the positive effect of SCC on organizational responsiveness is validated in both manufacturing and service industries; however, the moderating effects differ across these two industries. Manufacturing firms do not rely on both spanning and inside-out IT capability to reap the benefits of SCC in responding to market changes; by contrast, service firms are not dependent on outside-in IT capability to leverage the relationship between SCC and responsiveness. These findings are inconsistent with our general hypotheses but are consistent with "the existing literature which indicates that manufacturing and service does differ in terms of the level of IT use" (Liu *et al.*, 2015, p. 186). These findings help us understand that the moderating influence of different IT capabilities on the SCC-responsiveness relationship varies given that manufacturing and service firms have different business objectives, interests, models, and environments.

Finally, our results show that the three types of IT capability cannot directly influence organizational responsiveness in the context of supply chains. These findings are inconsistent with the existing view that IT directly improves responsiveness by facilitating real-time transmission and information flow processing (Sanders and Premus, 2005). Instead, our finding reflects an emerging insight that IT capability is valuable but not rare (Drnevich and Croson, 2013). IT has been standardized and homogenized; therefore, most firms can afford IT artifacts and acquire such capability. As the IT barrier decreases, the strategic role of IT capability changes from a leading one to a supporting one. Our findings echo the claim of Drnevich and Croson (2013), which postulates that "IT is thus often best suited to play the role of are source multiplier, an enhancer of existing capabilities, or an enabler of new capabilities in conjunction with the existing resource portfolio rather than a stand-alone resource" (p. 494).

6.2 Limitations and implications

We declare the limitations of the current research before evaluating its contributions. First, our study treats only IT capability as the boundary factor influencing the relationship between SCC and organizational responsiveness. Although the literature presented the importance of IT capability for supply chain management, organizational or managerial factors such as trust, risk management capability, and contract mechanism may also act as the alternative factors to leverage the role of SCC (Wong *et al.*, 2011). Second, the questionnaire was distributed to one group of key informants; although this approach is feasible for the existing research (e.g. Zhou *et al.*, 2014), it may generate bias. Hence, we urge future researchers to collect data from multiple

informants. Third, the measures are subjective rather than objective, thus potentially generating informant bias and random errors. Collecting data from different sources can increase the robustness of results; therefore, we recommend that future researchers should obtain both subjective and objective data to validate our conclusions. Fourth, we tested our hypotheses using data collected in China, which may limit the generalizability of the results. Given that China has specific cultural, economic, and institutional mechanisms, extending the findings of the current study to other contexts should be done with caution.

This research offers new insights into the relationship among SCC, organizational responsiveness, and IT capability by providing an integrated view from the perspectives of both information systems and operations management. First, the findings answer the question, "Does SCC always come with benefits?" based on the organizational learning perspective. Knowledge is widely acknowledged as an important element in the supply chain (Bessant *et al.*, 2003). According to Myers and Cheung (2008) "the flow of knowledge is what enables a supply chain to come together in a way that creates a true value chain for all stakeholders" (p. 68). Accordingly, scholars have adopted an organizational learning perspective in investigating the process through which a firm improves its performance at the supply chain level (Hult *et al.*, 2007). Our research aims to apply this perspective by exploring how a firm can benefit from a collaboration with supply chain members. Our findings echo the suggestion of Bessant *et al.* (2003) to further investigate supply chain learning by addressing the enabling role of collaboration and the facilitating role of supportive capability. In addition, we adopt the organizational learning perspective to obtain insights on how to improve the capabilities of firms, especially those faced with a changing environment. Our research provides empirical evidence on the benefits of organizational learning and supports the statement that "organizational learning is key to an organization's capability for continuous change and renewal" (Flores *et al.*, 2012, p. 641).

Second, our results indicate that SCC needs the support of IT capability to eliminate possible barriers in the process of generating benefits. For example, supply chain members cannot benefit from a collaboration because of a cognitive gap (Ha *et al.*, 2011). By cultivating a specific IT capability, especially the outside-in and spanning IT capability, firms can leverage inter-organizational IT tools to improve communication with their respective partners. By reaching a consensus and acting synchronously, firms can also benefit from collaboration. Our findings suggest a possible approach to solve the value creation paradox of SCC, that is, the development of supportive organizational capabilities to help firms seize opportunities and exclude inhibitors.

Third, our findings challenge the prevailing view on the complementary role of IT capability in improving organizational responsiveness through SCC. Specifically, we investigate the moderating role of the three types of IT capability (i.e. outside-in, spanning, and inside-out IT capability) and address the multifaceted nature of this role. Outside-in and spanning IT capability support SCC value creation, whereas inside-out IT capability actually inhibits this process. Thus, we should consider IT capability to be a multifaceted construct when discussing its effects. The results also highlight the fact that examining the three types of IT capability simultaneously facilitates a new understanding of the conditions under which such capability can be detrimental to the SCC value creation process. In accordance with this view, our study not only highlights the advantage of the "fit" between IT capability and SCC but also acknowledges the danger of their "misfit." In this sense, inside-out IT capability is worthy of further research because of its unexpected negative moderating effect; in previous research,

this capability was merely treated as a basic capability and attracted little attention because it was lower in value and rarity than the outside-in and spanning IT capability (Wade and Hulland, 2004). Our study reveals the potential deviation of inside-out IT capability from the other two types and requires additional research to determine its attributes and effects.

Finally, our findings contribute to SCC literature by demonstrating the importance of the interactive relationships between SCC and IT capability in terms of improving organizational responsiveness across industries in China. The findings may verify the applicability of the results of prior studies that were conducted in mature markets in the Chinese context. Given that China shares many characteristics with other emerging economies, the outcomes derived based on this context can help scholars understand the relationship among SCC, IT capability, and organizational responsiveness in other emerging economies (Yina *et al.*, 2014).

Our research also has several practical implications. As a necessity in supply chain management, SCC has increased the participation of many firms in this practice. However, only a few of these firms have prospered after engaging in collaborative activities (Kampstra *et al.*, 2006). Our findings suggest that firms should concentrate on learning processes during SCC to develop responsiveness. Moreover, managers should pay attention to the role of IT capability so that they can help their respective firms maximize the benefits from SCC value. Further, managers are encouraged to develop the IT capability of firms in particular to magnify the positive effects of SCC on the organizational responsiveness of each firm; nonetheless, they should invest in different types of IT capability through various approaches. Specifically, investing in outside-in and spanning IT capability enables a firm to reap the value of SCC, whereas controlling investments in inside-out IT capability can enhance responsiveness.

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(The Appendix follows overleaf.)

Appendix 1

Table AI. Common method bias analysis

Construct	Indicator	Substantive factor loading ($R1$)	$R1^2$	Method factor loading ($R2$)	$R2^2$
Supply chain collaboration	SCC1	0.842	0.709	−0.020	0.000
	SCC2	0.902	0.814	−0.014	0.000
	SCC3	0.879	0.773	0.030	0.001
	SCC4	0.833	0.694	0.004	0.000
Responsiveness	Res1	0.798	0.637	0.037	0.001
	Res2	0.766	0.587	0.067	0.004
	Res3	0.838	0.702	−0.034	0.001
	Res4	0.885	0.783	−0.071	0.005
Outside-in IT capability	OutITC1	0.960	0.922	−0.114	0.013
	OutITC2	0.872	0.760	0.061	0.004
	OutITC3	0.828	0.686	0.058	0.003
Spanning IT capability	SpanITC1	0.849	0.721	−0.044	0.002
	SpanITC2	0.540	0.292	0.168	0.028
	SpanITC3	0.772	0.596	−0.059	0.003
	SpanITC4	0.814	0.663	−0.011	0.000
	SpanITC5	0.870	0.757	−0.035	0.001
Inside-out IT capability	InITC1	0.920	0.846	0.007	0.000
	InITC2	0.964	0.929	−0.057	0.003
	InITC3	0.878	0.771	0.052	0.003
Average		0.843	0.718	0.001	0.004

Appendix 2. Constructs, item measures, and related literature

(A) Supply chain collaboration (adapted from Zacharia *et al.*, 2011 and Sanders and Premus, 2005:
SCC1. We have joint decision-making activity with our key partners.
SCC2. We engage in joint product design.
SCC3. We share cross-functional processes with our key partners to make improvement.
SCC4. We effectively share information with our key partners.

(B) Organizational responsiveness (adapted from Homburg *et al.*, 2007 and Hult *et al.*, 2005):
OR1. We are capable to provide a wide range of product to quickly respond to market demand.
OR2. We are capable to leverage competencies to quickly respond to market demand.
OR3. We have good satisfaction of our customers.
OR4. We have good responsiveness to expectations of our customers.

(C) IT capability (adapted from Zhang *et al.*, 2008):

C. 1. Outside-in IT capability:
OutITC1. We have technology-based links with customers.
OutITC2. We have technology-based links with suppliers.
OutITC3. We use IT-based entrepreneurial collaborations with external partners.

C. 2. Spanning IT capability:
SpanITC1. We have multidisciplinary teams to blend business and technology expertise.
SpanITC2. We have a good relationship between line management and IT service providers.
SpanITC3. There is a climate that nurtures IT project championship.
SpanITC4. We restructure business work processes to leverage opportunities.
SpanITC5. We restructure IT work processes to leverage opportunities.

C. 3. Inside-out IT capability:
InITC1. We have good appropriateness of the data architectures.
InITC2. We have good appropriateness of network architectures.
InITC3. We have good adequacy of architecture flexibility.

About the authors

Zhao Cai is a PhD Candidate in the School of Management at the University of Science and Technology of China. His interest covers operations management and information systems. He has published papers in the academic conference ICIS, PACIS, and HICSS.

Qian Huang is an Associate Professor in the School of Management at the University of Science and Technology of China. She obtained her PhD from the USTC and City University of Hong Kong. Her research focuses on knowledge management and e-commerce. She has published papers in the *Information Systems Journal*, *Asia Pacific Journal of Management*, and *Journal of Global Information Management*. Qian Huang is the corresponding author and can be contacted at: huangq@ustc.edu.cn

Hefu Liu is an Associate Professor in the School of Management at the University of Science and Technology of China. He earned his PhD Degree with the University of Science and Technology of China and City University of Hong Kong. He has published in *Journal of Operations Management*, *Decision Support Systems*, *International Journal of Productions Research*, *International Journal of Operations and Production Management*, *Information Technology and People*, and in the academic conference ICIS, PACIS and AMCIS.

Liang Liang is a Professor in the School of Management at the University of Science and Technology of China. He earned his PhD Degree from Southeast University. His research focuses on decision analysis and supply chain management. He has published in *Operations Research*, *Journal of Operations Management*, *IEEE Transaction on SMC, OMEGA*, *IIE Transactions*, *Naval Research Logistics*.