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THE INTERACTION EFFECTS BETWEEN SUPPLY CHAIN INTEGRATION AND IT CAPABILITIES ON FIRM PERFORMANCE

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Abstract

It is well touted that embedding information technology (IT) capabilities in supply chain processes would allow firms to derive competitive advantage. Yet the outcomes of such embeddedness vary greatly across companies. Investigating how a firm configures appropriate IT capabilities with supply chain integration (SCI) to achieve superior performance is of significance. Drawing upon the dynamic capabilities theory, we examine how SCI and IT capabilities jointly affect firm performance. We test the hypotheses of interest with data collected from 252 firms in China. The results of hierarchical regression analysis reveal that the interactive effects of SCI and IT capabilities on firm performance vary across different combinations of dimensions of SCI (i.e., information sharing and collaborative planning) and IT capabilities(i.e., IT infrastructure flexibility, IT assimilation capability, and top management's IT knowledge). In addition, the dimensions of SCI and IT capabilities have differential effects on firm performance. Theoretical contributions and managerial implications of the current research are discussed.

Keywords: Supply chain integration, IT capabilities, Dynamic capabilities, Firm performance.

1 INTRODUCTION

Fostering Supply Chain Integration (SCI) via the Internet has generated much excitement among researchers and practitioners (Hartnell et al. 2011; Liu et al. 2010; Lyer et al. 2009; Wu & Chuang 2010). With the characteristics of global connectivity, broad interactivity, and open-standard network integration, the Internet enables firms to achieve open, worldwide, and real-time supply chain management (SCM), thereby resolving the tradeoffs between low cost, rich content, real-time data, and broad channel deployment (Frohlich 2002; Frohlich & Westbrook 2001). As such, SCI, referring to the degree to which a firm manages intra- and inter-organizational processes collaboratively with channel partners through the Internet, has become a crucial element of operational and IS strategies (Rai et al. 2006; Rosenzweig 2009; Zhao et al. 2008).

Although it is well touted that SCI would lead to superior performance, the findings of previous empirical studies on SCI-performance relationships have been mixed, and even controversial (e.g.,Cao & Zhang 2011; Fabbe-Costes & Jahre 2007; Flynn et al. 2010; Terjesen et al. 2012; Vaart & Donk 2008). Some researchers provide empirical support for a positively significant linkage (e.g.,Rai et al. 2006; Vaart & Donk 2008), while others show an insignificant relationship (e.g.,Flynn et al. 2010; Vickery et al. 2003). Given the significance of SCI for the industry, it is imperative to conduct research to identify and test which factors that would facilitate firms to reap the expected benefits of SCI (Rosenzweig 2009; Saeed et al. 2011; Terjesen et al. 2012; Wong et al. 2011).

The existing IS and OM literature has treated IT capabilities as the important catalyst for value realization of SCI (e.g.,Devaraj et al. 2007; Johnson & Whang 2002; Lee & Whang 2005; Li et al. 2009; Lyer et al. 2009; Saeed et al. 2011; Wu et al. 2006). IT capabilities reflect a firm's ability to collect, integrate, and transform IT-related resources into higher value in supporting firm's strategies and processes (Luo et al. 2010). It enables the firm to establish a requisite set of technological resources, providing the foundation for diffusing and routinizing IT applications to better benefit from the new business model, such as SCI (Pavlou & El Sawy 2006; Tu 2010). Some scholars thus argue that appropriate configuration of IT resources makes information flow more quickly and transparently across organizational boundaries, which would ultimately improve the performance of business relationships (Marchildon & Hadaya 2011). For example, Zhu (2004) explores the complementarity of IT infrastructure and e-commerce capability and find a strong interaction effect on firm performance. Yet, few scholars have unpacked the nature of SCI and IT capabilities and empirically investigate the interactive effects of different combinations of dimensions of SCI (i.e., information integration and collaborative planning) and IT capabilities (i.e., IT infrastructure flexibility, IT assimilation capability, and IT knowledge of top management) on firm performance. Hence, investigating how SCI impacts firm performance contingent upon the firm's IT capabilities would shed new light on the understanding of the underlying influential mechanisms of SCI and IT capabilities.

To this end, we draw on dynamic capabilities theory to address the joint effects of SCI and IT capabilities on firm performance. Different from previous studies conceptualizing SCI and IT capabilities as unidimensional constructs or measuring them at an aggregate level (e.g.,Kristal et al. 2010; Prajogo & Olhager 2012; Wu et al. 2006), we try to explore the multidimensional relationships among SCI, IT capabilities, and firm performance. Specifically, we propose that two degrees of SCI and three types of IT capabilities are complementary capabilities and they would interact with each other in affecting firm performance.

2 THEORETICAL FRAMEWORK AND HYPOTHESES

Resource based view (RBV) indicates that variations of performance among firms can be attributed to the heterogeneity in their possession of value, rare, inimitable, and non-substitutable resources (Barney 1991; Goldsmith & Amir 2010). However, this view has been criticized for its oversight of dynamism, environmental contingencies, and managers' role (Priem & Butler 2001; Sirmon et al.

2007). Scholars thus increasingly adopt the dynamic capabilities theory to address the limitations of the traditional RBV. This theory highlights firms' abilities to integrate, build, and reconfigure internal and external competencies to achieve competitive advantage in the rapidly-changing business environment (Eisenhardt & Martin 2000; Teece et al. 1997). Meanwhile, organizational capabilities are always embedded with other resources or capabilities which process is path-dependent and complex, preventing imitation by competitors (Lavie 2006). As such, a firm will be able to attain and sustain a competitive advantage by combining and configuring its resources in unique and inimitable ways (Marchildon & Hadaya 2011).

Building on dynamic capabilities theory, as shown in Figure 1, we develop a model to examine the interactive effects of different combinations of dimensions of SCI and IT capabilities as well as their individual effects on firm performance. As IT is becoming increasingly embedded in the SCI process including information sharing, coordination, and cooperation among partners (Narasimhan et al. 2010), configuring proper IT capabilities with a specific degree of SCI to develop casual ambiguity and then create a sustained competitive advantage is a challenge for most managers (Saeed et al. 2011). In this view, we aim to explore the different combinations of the interactive relationships between two degrees of SCI and three types of IT capabilities and examine how these interactions affect the firm performance.

To explore the potential multi-dimensional relationships between SCI-IT capabilities interactions and firm performance, we follow Flynn et al. (2010) and focus on two aspects of firm performance, namely financial performance and operational performance. Specifically, financial performance refers to a firm's performance as regards investment return, profitability, and net income relative to its key competitors (Zahra & George 2002), whereas operational performance refers to a firm's improvement in the response to the market and its customer service relative to its key competitors (Fisher 1997; Flynn et al. 2010). Differentiating these two dimensions of performance could help us holistically understand the influence of the IT capabilities-SCI interactions, which differs from previous studies that focused either on a specific aspect of performance or mixed different aspects of performance at an aggregate level (e.g., Liu et al. 2013; Vaart & Donk 2008).
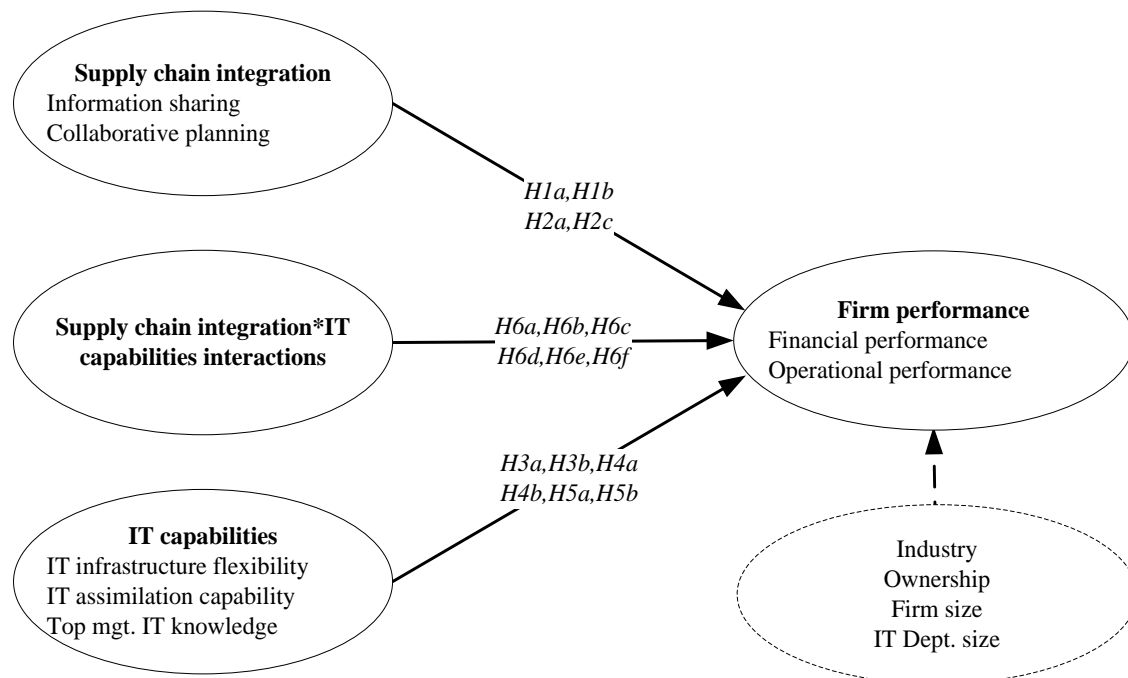

Figure 1.   Research model

2.1 Supply Chain Integration

SCI refers to the degree to which a firm collaborates with its business partners through the application of Internet-based technologies (Frohlich 2002; Kulp et al. 2004; Lee & Whang 2004; Rai et al. 2006). Although traditional modes of communication, such as phone and fax, are still used by firms to exchange information and knowledge, we focus on Internet technologies since Internet-enabled SCI has become the core component of SCM (Frohlich 2002; Frohlich & Westbrook 2002; Hartnell et al. 2011; Liu et al. 2010; Lyer et al. 2009; Rosenzweig 2009; Wu & Chuang 2010). It is widely advocated that Internet-based technologies make SCI more flexible and economically feasible than traditional modes of communication, such as electronic data interchange systems, which are based on proprietary value-added networks (Devaraj et al. 2007; Frohlich 2002; Zhu et al. 2006). Specifically, SCI allows firms to conduct integration within a new platform featuring open standards, a broad partner base, ease of access, rich content, high interoperability, low complexity, and low communication costs (Ross 2003; Zhu et al. 2006).

Deriving from the work of Cai et al. (2010) and Kulp et al. (2004), we identify information sharing and collaborative planning as the two fundamental dimensions of SCI. Information sharing refers to the extent to which information is shared among members along the supply chain via the Internet (Kulp et al. 2004; Lee & Whang 2004; Rai et al. 2006). It allows chain partners to share direct and real-time information on sales, inventory holding, production, and delivery schedules across the supply chain (Singh 2005), leading to lower inventory levels and less stock outs, thereby giving rise to reduced costs (Kulp et al. 2004). In addition, the information sharing about sales and market changes would facilitate the firms to develop their abilities to make production plans, offer products or services on time, and thus improve their delivery performance (Flynn et al. 2010). Furthermore, sharing information related to consumer research can help firms more proactively sense and respond to customers' demands or demands changes, and consequently improve operational performance (Lee & Whang 2000).

H1a: A firm's information sharing is positively associated with its financial performance.

H1b: A firm's information sharing is positively associated with its operational performance.

Collaborative planning refers to the extent to which a firm works with business partners in designing synchronized plans (e.g., production planning and scheduling, new product development, inventory replenishment, and promotions and advertisement) via the Internet (Cai et al. 2010; Lee & Whang 2004). It allows firms to specify future joint supply chain activities and determine the necessity for continued joint efforts, which can be updated on a real-time basis (Kulp et al. 2004; Lee & Whang 2004). The processes of collaborative planning are specific to firms, which involve shared process development, joint strategic planning, and relationships building (Narasimhan et al. 2010). Therefore, collaborative planning can affect the firm's performance in several ways. First, collaborative planning could allow firms to respond to uncertainties proactively, such as proactively pooling and deploying necessary resources to increase their responsiveness (Kulp et al. 2004). Second, collaborative planning indicates that firms have reached mutual agreement with their customers on specific actions, such as demand management, new product introduction and service plan that can improve customer service (Lee & Whang 2000). Finally, collaborative planning allows firms to improve financial performance through reconciling differences and decreasing "bullwhip effect", enabling firms to decrease unnecessary resources deployment such as extra inventory (Kulp et al. 2004; Lee & Whang 2004).

H2a: A firm's collaborative planning is positively associated with its financial performance.

H2b: A firm's collaborative planning is positively associated with its operational performance.

2.2 IT Capabilities

IT capabilities refer to a firm's ability to assemble, integrate, and deploy IT resources to meet business needs and capitalize on business opportunities (Bharadwaj 2000; Karimi et al. 2007; Saraf et

al. 2007; Wade & Hulland 2004). According to Tippins and Sohi (2003), IT capabilities include the dimensions of IT objects, IT operations, and IT knowledge. In particular, IT objects refer to tangible artifacts, such as a firm's physical IT infrastructure that assists in business processes; IT operations reflect the extent to which a firm applies IT to market and customer management; and IT knowledge refers to the extent to which a firm possesses a body of knowledge on IT. In this view, we specify IT capabilities as a construct including three dimensions, i.e., IT infrastructure flexibility (IT objects), IT assimilation capability (IT operations), and top management's IT knowledge (IT knowledge).

IT infrastructure flexibility refers to a set of technological resources providing the foundation for rapid development and implementation of present and future IT applications (Bharadwaj 2000; Byrd & Turner 2000; Ray et al. 2005). It reflects the readiness of a firm's platform to update its current infrastructure, integrate disparate data sources, resist system failure, and add new applications (Kumar 2004). For example, IT infrastructure flexibility reduces the technological constraints of Internet implementation and makes organizational resources more easily access and share (Bharadwaj 2000; Rai et al. 2006). Furthermore, firms can realize the synergies between supply and demand with little added costs through flexible IT systems (Bharadwaj 2000). From dynamic capability perspective, IT infrastructure flexibility would evolve over time, which makes it difficult for competitors to imitate and thus allow the firm to achieve superior performance (Bharadwaj 2000).

H3a: A firm's flexible IT infrastructure is positively associated with its financial performance.

H3b: A firm's flexible IT infrastructure is positively associated with its operational performance.

IT assimilation capability refers to the ability of a firm to effectively apply IT in supporting, shaping, and enabling its business strategies and value-chain activities (Armstrong & Sambamurthy 1999). It reflects the extent to which IT applications have been diffused into organizational processes, as well as how these applications have been used effectively in different functions. IT assimilation capability facilitates the execution of related business strategies and value-chain activities, which would enable firms to realize the business value of IT (Armstrong & Sambamurthy 1999). Further, when IT assimilation capability is embedded appropriately in the organizational processes, it will help firms effectively leverage its existing resources and capabilities to create value for customers (Morgan et al. 2009; Sirmon et al. 2007; Teece et al. 1997). For example, high IT assimilation capability would make firms' employees familiar with the IT systems such as customer relationships management systems more quickly, and thus improve firms' efficiencies and effectiveness.

H4a: A firm's IT assimilation capability is positively associated with its financial performance.

H4b: A firm's IT assimilation capability is positively associated with its operational performance.

Top management's IT knowledge refers to the top management's knowledge of the strategic potential of IT (Armstrong & Sambamurthy 1999; Kearns & Sabherwal 2006; Ranganathan et al. 2004). It reflects the extent to which top managers recognize the importance, value, and tendency of IT, and their willingness to support IT-related initiatives (Ranganathan et al. 2004). Top management's knowledge of the strategic potential of IT will affect their beliefs and participation in these projects (Kearns & Sabherwal 2006; Wu et al. 2003). In particular, with a high understanding of the strategic potential of IT, the managers would develop appropriate strategies to facilitate the creation of a clear vision for IT, and ensure the strategic use of IT (Bassellier et al. 2001). While top management's knowledge about IT-related initiatives is firm-specific and difficult to be imitated by its rivals (Tippins & Sohi 2003), it would help the firm achieve competitive advantage.

H5a: Top management's IT knowledge is positively associated with financial performance.

H5b: Top management's IT knowledge is positively associated with operational performance.

2.3 The Interaction Effects between SCI and IT Capabilities

The dynamic capability theory indicates the importance of the interaction between SCI and IT capabilities for a firm's performance (Grant 1996; Marchildon & Hadaya 2011; Saeed et al. 2011). Specifically, this theory suggests that firms' capabilities can interact with each other (Marchildon &

Hadaya 2011; Narasimhan et al. 2010; Voola et al. 2012). That is, capabilities that complement with each other can jointly enhance firm performance more than the sum of contributions made by each capability individually (Moorman & Slotegraaf 1999). Voola et al. (2012) further argue that because of the resource uniqueness deriving from the reconfiguration of existing capabilities, the value of a capability should depend on other capabilities. This would develop a complex and imperfectly imitable process that may lead to sustained competitive advantage.

In this view, SCI and IT capabilities have been defined as complementary capabilities. SCI focuses on how and to what extent firms should collaborate with supply chain partners. It reflects an outward-looking view of match between internal business process and external supply chain partners. In contrast, IT capabilities are focusing on how to reconfigure and bundle IT resources into higher-order competencies (Zhou & Li 2010). As such, a firm's SCI, representing the capability of resource deployment in pursuit of strategic collaboration with partners, and IT capabilities should be reinforcing and synergistic. Thus, we argue that they should interact with each other and be combined to more quickly respond to environment changes and better create value for customers (Sirmon et al. 2007)

Specifically, as part of a firm's resource portfolio, IT capabilities enable the resources reconfiguration within and across organizational boundaries (Sambamurthy et al. 2003), which could be blended with inter-organizational processes to help firms better exchange information, sense market conditions, and coordinate operations (Devaraj et al. 2007; Li et al. 2009; Rai et al. 2006). While when a firm tries to benefit from SCI, it is required to work with chain partners in developing new business processes. Under this condition, IT capabilities facilitate the accurate and timely knowledge sharing between partners by spanning knowledge boundaries, which enhance the performance outcomes of information sharing (Im & Rai 2008).

In addition, SCI enables firms within the supply chain to jointly make synchronized decisions, such as production planning, inventory replenishment, and promotions (Cai et al. 2010), which requires close and comprehensive communication, coordination, and collaboration among supply chain partners. In this view, IT capabilities can cultivate firms' social capital and support direct human interactions and communications by seamlessly linking partners within supply chain, which make it more likely for supply chain members to negotiate new agreements (Joshi et al. 2010). Following this logic, IT capabilities help firms better know what they want and their partners have and thus strengthen the relationship between collaborative planning and firm performance (Billington & Davidson 2012).

Furthermore, the process of integrating IT capabilities with SCI is of great complexity and casual ambiguity (Barney 1991; Saeed et al. 2011), which makes it difficult for competitors to imitate, thereby yielding sustained competitive advantage. Besides, a lot of theoretical literatures also indicate that there exists interdependencies between individual capabilities, which can provide a source of sustained competitive advantage (e.g.,Teece et al. 1997; Voola et al. 2012; Vorhies & Morgan 2005). Therefore, we propose that the interactions between SCI and IT capabilities should be positively associated with firm performance.

H6a: The interaction between a firm's information sharing and flexible IT infrastructure is positively associated with the firm's performance (financial and operational performance).

H6b: The interaction between a firm's information sharing and IT assimilation capability is positively associated with the firm's performance (financial and operational performance).

H6c: The interaction between a firm's information sharing and top management's IT knowledge is positively associated with the firm's performance (financial and operational performance).

H6d: The interaction between a firm's collaborative planning and flexible IT infrastructure is positively associated with the firm's performance (financial and operational performance).

H6e: The interaction between a firm's collaborative planning and IT assimilation capability is positively associated with the firm's performance (financial and operational performance).

H6f: The interaction between a firm's collaborative planning and top management's IT knowledge is positively associated with the firm's performance (financial and operational performance).

3   RESEARCH METHOD

3.1   Research Design

To test our hypotheses, we collected data using a questionnaire survey. This survey was conducted in China. With a list provided by government agencies administering major industrial parks, we randomly selected 1,000 firms that had run their supply chains by Internet-enabled applications. We further identified a senior executive from each firm based on the standard practice of using senior executives or ''key informants'' as data sources (Flynn et al. 2010; Liu et al. 2010; Paulraj et al. 2008), These senior executives were chosen as appropriate informants for three reasons: i) they have significant responsibility in overseeing their firms' partners and information systems; ii) as active executives, they have a good understanding of their firms' SCM and Internet technologies; and iii) as their posts are at the top of the organizational structure, they have the power and opportunities to make or affect their firms' strategic decisions, such as those regarding supply chain relationships and IT configuration.

After the questionnaires had been sent out for two weeks, we made follow-up phone calls and sent reminder emails to encourage response. Finally, we received 252 useful questionnaires, with a response rate of approximately 25%. To test for possible non-response bias, we compared the Chi-squares from the first 25% of the respondents to that of the final 25%, and found no significant difference between these two groups on any of the constructs. This result suggested that non-response bias was not a serious issue in this study (Armstrong & Overton 1977). Table 1 shows the demographic information of the sample.

	N	Percentage
Respondent titles		
President, Managing Director, CEO	29	11.5%
Senior VP of Operations , COO	119	47.2%
CIO/CTO	104	41.3%
Industry		
Manufacturing	147	58.3%
Service	105	41.7%
Ownership		
State owned	86	34.1%
Privately owned	75	29.8%
Foreign controlled	70	27.8%
Joint venture	21	8.3%
Number of employees		
≤ 100	44	17.5%
100–500	59	23.4%
500–1000	34	13.5%
1000–2000	21	8.3%
More than 2000	94	37.3%
Number of IT employees		
≤ 5	101	40.1%
6–10	41	16.3%
11–15	19	7.5%
More than 15	91	36.1%

Table 1.   Sample Demographic (N=252)

3.2 Measures

The current study developed an English questionnaire through adopting or adapting the previously validated measures from the existing literature first. In the questionnaire, we used 5-point Likert scales, with options ranging from 1 ("strongly disagree") to 5 ("strongly agree") to measure the items. Given that the current research was conducted in China, the English questionnaire was then translated into Chinese by a team consisting of four researchers from different majors. Further, a professional translator, who was unfamiliar with this study, was hired to translate the Chinese questionnaire back to English. No semantic discrepancies were found when the translated questionnaire was compared with the original English version.

Specifically, the items used to measure information sharing were adapted from Devaraj et al. (2007), such as respondents were asked to indicate the extent to which they agreed with "We have shared the demand forecasts with channel partners via Internet" and on, whereas the items of collaborative planning were developed based on the work of Cai et al. (2010). Meanwhile, IT infrastructure flexibility was measured by four items adapted from the work of Saraf et al. (2007) and items used to measure IT assimilation capability were adapted from Liang et al. (2007). Moreover, items used to measure the top management' IT knowledge were adapted from Ranganahan et al. (2004). Finally, the items used to measure financial performance were adapted from Carr and Pearson (1999), while operational performance items were adapted from Rai et al. (2006) and Ravichandran and Lertwongsatiem (2005).

Additionally, several control variables that might affect firm performance were included: industry, ownership type, firm size, and the size of IT department. Specifically, we used a dummy variable for the industry, with values of 1 and 0 for the manufacturing and service industries, respectively. Dummy variables were also used for ownership types, namely state-owned, private-owned, foreign-controlled, and joint venture. The size of the firm was measured by the number of full-time employees, while the size of the focal firm's IT department was measured by the number of employees in the department.

4 ANALYSIS AND RESULTS

4.1 Common Method Bias

All the data this study collected were perceptual and from a single source at the same time. This may incur the issue of common method bias, which would threat the validity of the study. To analyse common method bias, we applied the Harmon's single-factor test. The results finally revealed that all the items in the dataset could develop five distinct factors with eigenvalues above 1.0, and explain 63.23% of total variance. Meanwhile, the first factor did not account for the majority of the variance (only 16.37%). These results indicated that common method bias was unlikely to be a major issue in the dataset.

4.2 Reliability and Validity

Exploratory Factor Analysis (EFA) and Confirmatory Factor Analysis (CFA) were used to assess the construct reliability and validity of the measurement. The CFA results indicated that the fit between the measurement model and the dataset was acceptable ($\chi2$=593.45 on 303 d.f., RMSEA=0.062, CFI=0.97, IFI=0.97, NFI=0.95, NNFI=0.97). We also assessed Cronbach's alpha and composite reliability, values ranging from 0.801 to 0.877 and from 0.870 to 0.925 respectively, indicating the good reliability of the measurements (Table 2). We further tested construct validity by convergent and discriminant validity. The convergent validity was tested based on the value of loading and average variance extracted (AVE). As Table 2 showed, loadings of all items were higher than 0.60, and the t-values were significant at the p< 0.001 level. Further, the average variance extracted (AVE) values

ranged from 0.586 to 0.803, which were above the 0.50 recommended level. These results confirmed the convergent validity of the measures.

Constructs	Loadings range	Composite reliability	Cronbach's alpha	AVE
IT capabilities				
Flexible IT infrastructure	0.775–0.887	0.909	0.865	0.715
IT assimilation capability	0.752–0.889	0.897	0.847	0.687
Top management's knowledge	0.884–0.903	0.925	0.877	0.803
Supply chain integration				
Information sharing	0.678–0.859	0.874	0.801	0.636
Collaborative planning	0.672–0.859	0.870	0.802	0.628
Firm performance				
Financial performance	0. 873–0.893	0.912	0.854	0.775
Operational performance	0.693–0.795	0.876	0.822	0.586

Table 2.   Descriptive Statistics (N=252)

To assess the discriminant validity, the square roots of the AVE of each construct were calculated and compared with the correlations among constructs. As shown in Table 3, the square roots of AVEs for all constructs were greater than the correlations between constructs, thus confirming the discriminant validity. Further, three inter-construct correlations values were over the 0.60 criteria, which indicated that multicollinearity may be a potential problem. Generally, multicollinearity is indicated by a variance inflation factor (VIF) value that is higher than 10 or a tolerance value that is less than 0.1 (Mason & Perreault 1991). We tested these values, and found that the highest VIF and the lowest tolerance values were 2.36 and 0.42, respectively. This finding indicated that multicollinearity was not a significant issue in this study.

Variable	Mean (SD)	1	2	3	4	5	6	7	8	9	10	11
1. Flexible IT infrastructure	3.47 (0.90)	**0.85**										
2. IT Assimilation capability	3.90 (0.86)	0.66	**0.83**									
3. Top management's knowledge	3.56 (0.85)	0.51	0.56	**0.90**								
4. Information sharing	3.58 (0.88)	0.46	0.54	0.50	**0.80**							
5. Collaborative planning	3.36 (0.82)	0.48	0.52	0.47	0.64	**0.79**						
6. Financial performance	3.62 (0.72)	0.31	0.42	0.44	0.38	0.46	**0.88**					
7. Operational performance	3.82 (0.67)	0.36	0.52	0.39	0.49	0.53	0.52	**0.77**				
8. Industry	NA	-0.11	-0.09	-0.17	0.03	-0.05	0.03	-0.02	**NA**			
9. Ownership	NA	0.06	0.00	0.06	0.15	0.12	0.06	0.14	0.17	**NA**		
10. Firm Size	NA	0.31	0.28	0.16	0.03	0.13	0.19	0.18	0.02	-0.04	**NA**	
11. IT Dept. Size	NA	0.40	0.40	0.33	0.14	0.20	0.23	0.23	-0.23	-0.02	0.69	**NA**
Note: The diagonal elements are the square root of the AVE.												

Table 3.   Correlations (N=252)

4.3   Hypothesis Testing

We used hierarchical regression analysis to test our hypotheses. To minimize the possibility of multicollinearity, all the independent variables and moderator variables were mean-centered (Aiken & West 1991). As shown in Table 4, for each dependent variable, financial and operational performance, we estimated three hierarchical regressions: (i) including just control variables; (ii) adding SCI and IT capabilities; and (iii) adding the interaction of SCI and IT capabilities.

Dependent variables	**Financial performance**			**Operational performance**		
	M 1a	M 2a	M 3a	M 1b	M 2b	M 3b
Control variables						
Industry	0.07	0.09	0.07	0.00	0.00	0.00
Ownership	0.06	0.01	0.01	**0.14***	0.09	0.07

Firm size	0.03	0.06	0.07	0.06	0.09	0.12
IT Dep. Size	**0.23***	0.05	0.04	**0.19***	0.00	0.00
Main effects						
Information sharing (IS)		0.02	0.04		**0.16***	**0.16***
Collaborative planning(CP)		**0.29***	**0.30***		**0.27***	**0.27***
Flexible IT infrastructure (FITI)		-0.10	-0.13		-0.09	-0.06
IT assimilation capability(ITAC)		**0.16***	**0.18***		**0.31***	**0.23****
Top management's IT knowledge(KMIT)		**0.25***	**0.23****		0.04	0.06
Interaction effects						
IS*FITI			**0.41***			**0.21***
IS*ITAC			**-0.34****			**-0.27***
IS*KMIT			-0.04			-0.04
CP*FITI			**-0.37***			-0.06
CP*ITAC			**0.31****			0.05
CP*KMIT			**0.21***			**0.19***
R^2	0.06	0.31	0.38	0.07	0.39	0.43
ΔR^2		0.25	0.07		0.32	0.04
F for		17.39***	4.71***		29.94***	2.77*
Overall F	4.16**	12.12***	9.82***	4.90***	17.09***	11.81***
*Note: *p<0.05 **p<0.01 ***P<0.001*						

Table 4.   Hierarchical regression results (N=252)

The results showed that (M3a and M3b) information sharing positively impacted operational performance (β=0.16, p<0.05), which supported H1b. Yet, the results showed that information sharing did not influence financial performance significantly (β=0.04), thereby H1a was not supported. Further, we found that collaborative planning was positively associated with both financial (β=0.30, p<0.001) and operational performance (β=0.27, p<0.001), thus both H2a and H2b were supported. For IT capabilities, the results presented that IT infrastructure flexibility did not impact either financial (β=-0.13) or operational performance (β=-0.06) significantly, which did not support H3a and H3b. Meanwhile, the results showed that IT assimilation capability was positively associated with both financial (β=0.18, p<0.05) and operational performance (β=0.23, p<0.01), which supported H4a and H4b. Further, top management's IT knowledge was positively associated with the financial performance (β=0.23, p<0.01), supporting H5a. Yet, it did not influence operational performance significantly, which did not support H5b.

On the other hand, the results showed significant changes in R2 between each of the three models for both financial and operational performance, with a significant ΔR2 of 0.07 in the financial performance model andΔR2 of 0.04 in the operational performance model. This finding provided a calibration of the relative impact of the interaction between SCI and IT capabilities. Specifically, as expected, the interaction between information sharing and IT infrastructure flexibility was positively associated with both financial (β=0.41, p<0.001) and operational performance (β=0.21, p<0.05), and interaction between collaborative planning and top management's IT knowledge was positively related to both financial (β=0.21, p<0.05) and operational performance (β=0.19, p<0.05), which support H6a and H6f. The interaction between collaborative planning and IT assimilation capability was only positively related to financial performance (β=0.31, p<0.01), partly supporting H6e. However, the interaction between information sharing and top management's IT knowledge has no significant influence on either financial or operational performance, thus H6c was not supported. More surprisingly, the interaction between information sharing and IT assimilation capability was negatively related to both financial (β=-0.34, p<0.01) and operational performance (β=-0.27, p<0.05) and the interaction between collaborative planning and IT infrastructure flexibility has a negative effect on financial performance (β=-0.37, p<0.001), which were contrary to our H6b and H6d.

5　　DISCUSSION AND IMPLICATIONS

5.1　　The Direct Impacts of SCI and IT Capabilities on Firm Performance

Overall, our study provides the empirical evidence for the theoretical relationships between SCI and firm performance. The results suggested that information sharing influences financial and operational performance differently, while collaborative planning could affect the two aspects of firm performance positively. Specifically, information sharing can affect operational performance positively, which is consistent with previous research (e.g., Liu et al. 2013; Rai et al. 2006). That is, information sharing is an effective way to help firms acquire relevant historical and current information timely, thereby responding market quickly. Yet, we found that information sharing do not improve financial performance significantly. The possible explanation for this finding may be that, the diffusion of Internet technologies has made online information sharing more convenient and prevalent, which makes it difficult for a firm to directly achieve superior financial performance than competitors (Kulp et al. 2004). Indeed, scholars have suggested that to earn above-industry average margins, the firm should shift from information sharing to collaboration and cooperation (Kulp et al. 2004; Liu et al. 2013). The significant relationships between collaborative planning and firm performance in our study also support such arguments.

While the results presented that the three types of IT capabilities have various impacts on firm performance. Specifically, we found that IT infrastructure flexibility does not significantly impact either of firm performance. One possible explanation is that IT infrastructure can be purchased or duplicated fairly easily by rivals, which would make it difficult for a firm to generate better performance than competitors (Bharadwaj 2000). This finding is also consistent with Morgan et al.'s (2009) argument that it is the capabilities by which firms' resources are deployed, rather than the resources firms possess that explain variations of firm performance. Further, the results indicated that top management's IT knowledge did not influence operational performance significantly. A possible explanation may be that operational performance is normally affected by a firm's daily operations and general management. Indeed, top manager's IT knowledge could help firm deploy IT applications strategically. As Tippins and Sohi (2003) argued, only when the firm's top management share their IT knowledge with the employees and then transform such knowledge into its internal base, could the knowledge improve the firm's sensing and responding capability in marketplace. Thus, this ability may help the firm achieve superior financial performance, but difficult to help the firm get superior operational performance directly.

5.2　　The Interaction Effects between SCI and IT Capabilities on Firm Performance

The findings of the effects of SCI -IT capabilities interactions on firm performance support the dynamic capabilities theory propositions concerning the role of "asset interconnectedness". Specifically, our results indicated that the multidimensional interactions of SCI and IT capabilities have different effects on firm performance. For example, we found that IT infrastructure flexibility can strengthen the relationship between information sharing and firm performance, and top management's IT knowledge can enhance the impact of collaborative planning on firm performance, respectively. Meanwhile, IT assimilation capability can strengthen the influence of collaborative planning on financial performance. These findings are consistent with the dynamic capabilities theory, which indicate that organizational capabilities, such as SCI and IT capabilities, can complement one another in important ways and then jointly contribute to superior firm performance (Morgan et al. 2009).

However, we found that the effect of the interaction between collaborative planning and IT assimilation capability on operational performance is insignificant. A possible explanation may be that collaborative planning normally involves intensive human intervention, which may limit the role of IT applications in enhancing the influence of collaborative planning on customer responsiveness (Ba & Johansson 2008; Miller et al. 2000). As such, the joint effects of collaborative planning and IT

assimilation capability may not add more value for operational performance improvement. Further, this reason could also explain the findings about the interaction between collaborative planning and IT infrastructure flexibility, which is negatively related to financial performance, but insignificantly associated with operational performance.

The results further showed that neither financial performance nor operational performance can be affected by the interaction of information sharing and top management's IT knowledge. A potential explanation for such inconsistence may be that firms normally share more information about daily operations and general management, which has the formal and regular routines. Yet, top management's IT knowledge normally focus the strategic potential and value of IT, which may withhold it to gain strategic advantages (Chen 2003). The different focus of information sharing and top management's IT knowledge make firms difficult to achieve joint value from their interaction.

Contrary to our hypotheses, we found that the interaction between information sharing and IT assimilation capability is negatively associated with both financial and operational performance. A possible explanation for these unexpected results is that IT assimilation capability enables the automation of basic business activities such as information sharing (Armstrong & Sambamurthy 1999). However, to achieve superior firm performance, information sharing should include the sharing of important, proprietary information through some informal ways, such as through their guanxi with government officers and important personnel at partner firms. This indicates that the diffusion of IT applications would prevent the firm to benefit from those informal sharing ways, and then weaken the role of information sharing in improving both financial and operational performance. As such, IT assimilation capability may weaken the impact of information sharing on both financial and operational performance.

5.3   Theoretical and Practical Implications

The current research aims to explore how SCI and IT capabilities impact firm performance independently and interdependently. Our findings support the dynamic capabilities theoretical propositions on the independent impact of SCI and IT capabilities on firm performance, and explain how SCI and IT capabilities interactively affect firm performance. The findings have the following theoretical implications for IS and OM researchers. First, SCI and IS research is enriched by distinguishing different dimensions of SCI and IT capabilities. In the existing literature, the measurement of SCI and IT capabilities have been done either at an aggregate level, or inconsistently (Boon-itt 2009; Flynn et al. 2010; Marchildon & Hadaya 2011; Tippins & Sohi 2003), few studies have unpacked the composition of SCI and IT capabilities simultaneously. To complement these studies, we identify two degrees of SCI and three types of IT capabilities and investigate the specific effects of these dimensions on firm performance. Given that firms always make important trade-off decisions in emphasizing effectiveness or efficiency, we further assessed the two important aspects of firm performance, i.e., financial and operational performance. The results indicate that different types of IT capabilities and degrees of SCI would differentially affect the two aspects of firm performance.

Further, this study provides a more fine-grained insight into the nature of the interactive relationship between IT capabilities and SCI, which enriches our understanding of the contingent effects of different dimensions of SCI on performance outcomes. This finding is consistent with the dynamic capabilities theory, which indicates that firm capabilities can interact with each other. That is, the value of a capability depends on other capabilities, which partly because of resource uniqueness attained from the reconfiguration of existing capabilities (Voola et al. 2012). As such, the capabilities complement with each other can enhance the casual ambiguity of firm capabilities, thus generate sustained competitive advantage. Our study therefore provides some support for dynamic capabilities theory concerning "asset interconnectedness" effects (Teece et al. 1997).

In addition, our findings could offer some guidelines and directions for mangers who strive to improve the performance of value chain activities through configuring appropriate IT capabilities. Specifically, this study provides the guidelines for managers on SCI implementation. The different roles of information sharing and collaborative planning in improving financial and operational performance provide managers with support for making decision on the right integration strategy.

Further, our findings help managers realize that investing IT based on the immediate impacts of general IT capabilities on firm performance is not appropriate. That is, only developing IT infrastructure is not an effective way to improve firm performance. To enhance performance through IT investment, managers should extend their IT knowledge, and push the firm to diffuse IT applications in their business processes and supply chain activities. Finally, this study suggests that it is critical for managers to apply their firms' IT capabilities to leverage the value of SCI. For example, firms could provide some IT knowledge training to the top management, which would help realize the value of collaborative planning. In contrast, managers should notice that developing IT infrastructure flexibility may prevent the firm benefiting from information sharing. That means, when the firm deploys IT capabilities, it is critical to notice the various match between specific type of IT capabilities and specific degree of SCI.

6 LIMITATIONS AND FURTURE RESEACH

Evaluating the contributions of the study along with its limitations is of primary importance. This study has the following limitations, which can be addressed by future research. First, we tested our hypotheses using data collected in China, which may limit the generalization of the findings. Indeed, China has specific cultural, economic, and institutional mechanisms. For example, Chinese government is still playing a critical role in the business environment. In this view, it should be cautious when extending the findings of the current research to other contexts. Regarding this issue, as an anonymous referee pointed out, we conducted a comparison between the state-owned samples (86 samples) and non-state-owned samples (166 samples) and no significant difference was found. Second, the hypotheses were tested with cross-sectional data. Given that the IT capabilities configuration and SCI implementation are gradual processes, a longitudinal study may help extend our understanding about these issues. The longitudinal study could explore the interrelationships between IT capabilities and SCI at different stages considering the time issue. It also help reduce common method bias (Podsakoff & Organ 1986Podsakoff & Organ 1986). Finally, this study applied the single respondent as the source of survey data. However, a firm's strategic decisions, such as SCI or configuring IT capabilities, usually involve a group of related executives. In this view, collecting data from multiple informants in the top management team would be helpful to enhance the robustness of the research results. As the same anonymous referee above pointed out, an additional comparison between the technology (CIO/CTO, 104 samples) and business executive data sets (CEO/COO, 148 samples) was also conducted, no significant difference was found.

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