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Risk management and firm performance: the moderating role of supplier integration

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Abstract

Purpose – The purpose of this paper is to scrutinize the performance effects of supply chain risk management (SCRM). Besides financial performance, two aspects of operational performance are examined: operational efficiency and flexibility. Moreover, the authors explore the moderating role of supplier integration in the relationship between SCRM and operational performance.

Design/methodology/approach – A survey-based methodology was adopted. Based on the data from an international survey, this study applied the structural equation modeling and latent moderated structural equations approach to test the hypotheses.

Findings – The results indicate that SCRM positively influences both operational efficiency and flexibility, and has an indirect effect on financial performance. In addition, supplier integration enhances the impact of SCRM on operational flexibility, but does not moderate the relationship between SCRM and operational efficiency.

Originality/value – This study extends the existing literature by providing a comprehensive analysis of the performance effects of SCRM. It also provides managerial insights on both risk management and supplier integration.

Keywords Financial performance, Supply chain risk management, Supplier integration, Operational flexibility, Operational efficiency, Information processing theory

Paper type Research paper

1. Introduction

Modern supply chains operate in the complex and rapidly changing environment (Chen *et al.*, 2013; Wiengarten *et al.*, 2017). Meanwhile, firms apply increasingly sophisticated operations practices (e.g. lean manufacturing, rapid responsiveness and global outsourcing) to gain competitive advantage (Blome and Schoenherr, 2011; Kauppi *et al.*, 2016). The fast-changing environment and firms' complicated operational strategies together contribute to a higher level of supply chain risks. As a result, supply chain risk management (SCRM), which is defined as the identification and management of risks in the supply chain through coordinated approaches (Kauppi *et al.*, 2016; Jüttner *et al.*, 2003), is widely adopted by firms to cope with increasing risks (Lavastre *et al.*, 2014; Manuj *et al.*, 2014; Kauppi *et al.*, 2016). Prior theoretical studies have suggested that firms can gain performance benefit through the implementation of SCRM (Narasimhan and Talluri, 2009; Thun and Hoenig, 2011; Manuj *et al.*, 2014). The main

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arguments in the extant literature are that SCRM is beneficial to firms' financial performance by lowering operations accidents and preventing supply chain disruptions (Ritchie and Brindley, 2007; Narasimhan and Talluri, 2009; Thun and Hoenig, 2011; Manuj *et al.*, 2014). However, the implementation of SCRM generally requires up-front investment and additional costs for excess inventories, extra capabilities, back-up suppliers and alternative transportation modes (Premkumar *et al.*, 2005; Tang, 2006; Colicchia and Strozzi, 2012; Bode and Wagner, 2015; Kauppi *et al.*, 2016), which may weaken financial performance. To our best knowledge, there is a dearth of empirical evidence on how SCRM practices actually influence financial performance. Therefore, this paper aims to explore the links between SCRM and financial performance.

In the extant literature, most scholars focus on the effect of SCRM on operational performance. Previous studies have widely recognized operational performance as a multi-dimensional construct. For example, Kauppi *et al.* (2016) show that risk management along the supply chain is positively related to five aspects of operational performance including quality, delivery, flexibility, cost and customer service. Operational efficiency and operational flexibility, which may compete for firm's limited resources (e.g. labor, capital, etc.) and require different organizational configurations (e.g. operating processes, organizational structure, etc.) (Ebben and Johnson, 2005), are regarded as contradictory aspects of operational performance and have attracted great attention (Adler *et al.*, 1999; Ebben and Johnson, 2005; Kortmann *et al.*, 2014). On the one hand, firms attempt to profit from a lower cost by maintaining high efficiency (Ebben and Johnson, 2005; Eisenhardt *et al.*, 2010). On the other hand, flexibility is critical for firms to adapt to the ever-changing environment and to satisfy diverse customer needs (Nadkarni and Narayanan, 2007; Eisenhardt *et al.*, 2010). While previous studies have evidenced the positive effects of SCRM on different aspects of operational performance (e.g. cost, delivery, flexibility, quality, etc.) (Thun and Hoenig, 2011; Lavastre *et al.*, 2014; Kauppi *et al.*, 2016), the influence of SCRM on both operational efficiency and flexibility has not been investigated simultaneously. Thus, this paper intends to establish the relationship between SCRM and the two aspects of operational performance. Overall, the first research question of this study is:

RQ1. What are the effects of SCRM on firm performance, including both financial performance and operational performance?

The implementation of SCRM relies on coordination and collaboration between the focal firm and its suppliers to gain rich real-time upstream information. Prior studies have indicated the significant role of supplier relationship in the implementation of SCRM (Chen *et al.*, 2013; Kauppi *et al.*, 2016; Lavastre *et al.*, 2014; Li *et al.*, 2015; Zeng and Yen, 2017; Zsidisin and Smith, 2005). For example, Wiengarten *et al.* (2016) suggest that SCRM complements with supply chain integration in the weak rule of law environments to enhance firm performance. Li *et al.* (2015) highlight that joint risk management practices with suppliers contribute to the improvement of performance. This paper focuses on supplier integration, which indicates the coordination and collaboration practices with suppliers (Das *et al.*, 2006; Flynn *et al.*, 2010; Shou *et al.*, 2017). Supplier integration provides external linkages for the focal firm to access supply chain information and improves the firm's information processing capability through joint information sharing actions (Flynn *et al.*, 2010; Wong *et al.*, 2011). Since SCRM is an information intensive process (Manuj and Mentzer, 2008), supplier integration is supposed to improve the effectiveness of SCRM. Therefore, this study attempts to analyze the moderating effect of supplier integration on the relationship between SCRM and operational performance. The second research question is:

RQ2. How does supplier integration influence the performance effect of SCRM?

This study applies information processing theory (IPT) to crystallize the relationship between SCRM and performance outcomes, and the moderating effect of supplier

integration. IPT indicates that an organization can cope with uncertainty and achieve superior performance through reducing information processing requirements or increasing information processing capability (Galbraith, 1973; Premkumar *et al.*, 2005). We argue that SCRM is an information intensive process which contributes to the improvement of performance outcomes, and should complement with supplier integration to access accurate and timely supply chain information and enhance information processing capabilities. An international survey was utilized to measure the relevant constructs and structural equation modeling (SEM) was used to test the hypothesized relationships. We find that SCRM has direct effects on operational performance and indirectly influence on financial performance. In addition, supplier integration shows different moderating effects on the relationship between SCRM and operational flexibility/efficiency. The contributions of this study are three-fold. First, it clarifies the performance effects of SCRM based on empirical evidence. Second, it provides an in-depth understanding on the relationship between SCRM and the two dimensions of operational performance (i.e. efficiency and flexibility). Last but not least, this study confirms the role of supplier integration in the effectiveness of SCRM and further supports the standpoints of IPT.

The rest of this paper is organized as follows. Section 2 introduces the theoretical background and hypotheses development. The research method, data analysis and results are presented in Sections 3 and 4. In Section 5, both theoretical and managerial implications are discussed. The last section concludes this study.

2. Theoretical background and hypotheses development

2.1 SCRM and firm performance

SCRM refers to focal firm's activities to identify and manage risks associated with the supply chain through a coordinated approach (Jüttner *et al.*, 2003). It includes "the integrated processes of identification, analysis and either acceptance or mitigation of uncertainty and risk in the supply chain" (Wiengarten *et al.*, 2016, p. 364). We speculate that SCRM promotes financial performance. Financial performance indicates how well a firm can utilize its assets in generating profits (Wagner *et al.*, 2012). Companies' financial performance may be threatened by various supply chain risks, which "disrupt the information, material or product flow from original suppliers to the delivery of the final product to the ultimate end-user" (Peck, 2006). Kleindorfer and Saad (2005) mention two categories of risks affecting supply chain management: risks associated with supply and demand coordination, and disruption risks such as natural disasters, strikes and economic disruptions. Particularly, the increasing environmental uncertainty and supply chain complexity make companies vulnerable to risks (Bode and Wagner, 2015). Once the risk events occur, the firm will suffer damage to businesses while the remediation afterwards results in additional costs. In this case, financial performance cannot be ensured. SCRM practices can help reduce the loss through risk prevention and control, thereby leading to superior financial performance (Papadakis, 2006; Ritchie and Brindley, 2007). Hence, we propose the following hypothesis:

H1. SCRM is positively associated with financial performance.

Some studies have argued that SCRM contributes to operational performance such as lower operational loss or faster response (Thun and Hoenig, 2011; Manuj *et al.*, 2014). This study scrutinizes two aspects of operational performance, i.e. operational efficiency and flexibility. From the perspective of IPT, uncertainty indicates the "difference between the amount of information required to perform a task and the amount of information already possessed by the organization" (Galbraith, 1973, p. 5), and therefore, the firm needs to gather and process information to cope with environmental uncertainty and achieve high levels of performance. In the context of supply chain, the information is concerned with inventory, logistics,

quality, quantity, technology, market, politics, monetary issues and the like (Fan *et al.*, 2017). The information about demand, supply and production is highly complex, ambiguous and uncertain. Fan *et al.* (2017) point out that supply chain risk events always happen randomly, discretely, inevitably and continuously, which deteriorate firm performance. We argue that SCRM practices including risk preventing, detecting, responding and recovering can act as routines for companies to gather and process supply chain information. SCRM practices as information processing systems, and confirm that SCRM practices help mitigate uncertainty and ambiguity (Fan *et al.*, 2017). The efficient information processing capability is beneficial to the improvement of operational efficiency and flexibility (Kauppi *et al.*, 2016).

Operational efficiency is more easily achieved in a highly stable and controlled environment with prescribed quality and predictable demand (Maffei *et al.*, 1993). Internal and external uncertainties are identified as key obstacles, which impede the realization of operational efficiency (Ebben and Johnson, 2005). The lack of information and faulty decisions will result in time and cost losses. Through mechanisms such as buffering strategies, contingency planning and referable procedures, companies can establish a reliable environment in which production activities operate with lower operational costs and shorter lead time (Ebben and Johnson, 2005). Meanwhile, a firm's operational efficiency highly relies on its routines and capabilities (Lam *et al.*, 2016). SCRM practices equip the firm with the ability to figure out and control potential risk factors in manufacturing processes and in the supply channel (Narasimhan and Talluri, 2009). The improved information processing capability through SCRM practices also helps reduce errors, avoid rework and thus leads to better delivery speed and higher efficiency (Fan *et al.*, 2017). In turn, the inefficient SCRM practices may lead to resource waste and time losses. Once risk events such as demand fluctuations, supply shortage or production interruption occur, companies have to put extra time and cost into coordination and operation. In such cases, neither time-based nor cost-based efficiency can be guaranteed.

Operational flexibility (a.k.a. manufacturing flexibility) (Koste *et al.*, 2004; Patel *et al.*, 2012) is "a measure of a firm's ability to respond to market demands by switching from one product to another through coordinated policies and actions" (Nemetz and Fry, 1988, p. 629). SCRM practices can improve operational flexibility by solving information-related problems. Due to the changing and competitive environment, companies are required to keep operational flexibility to adapt to customized requirements (Patel, 2011). Kauppi *et al.* (2016) indicate that one main method for risk management practices is buffering strategy. The companies adopt flexible production processes, alternative transportation modes, and multiple and back-up suppliers to reduce information needs in the competitive environment (Maffei *et al.*, 1993; Bode *et al.*, 2012). Manufacturers producing a variety of products and volumes rely on these buffers to deal with supply and demand uncertainty, so that they can respond to customers' requirements in a flexible way. Moreover, strict risk management planning, specialized task forces, clear responsibilities and other risk management practices can enhance companies' information processing capability and problem-solving capability. Quick decision making based on existing information helps the companies respond to contingencies rapidly and timely. The excellent information processing capability is always linked to increased responsiveness (Williams *et al.*, 2013) and improved flexibility (Lummus *et al.*, 2005). Therefore, we propose the hypothesis as follows:

H2. SCRM is positively associated with (a) operational efficiency and (b) operational flexibility.

Operational efficiency and flexibility are conjectured to promote financial performance. Prior studies have discussed that volume flexibility, delivery speed and delivery dependability contribute to the growth in sales, return on sales (ROS) and return on investment (Vickerya and Marklandb, 1997). Droge *et al.* (2004) have confirmed the positive

effects of speed and efficiency on market share and financial performance. In addition, Elgazzar *et al.* (2012) analyze how supply chain performance like responsiveness, agility and cost links with financial performance like sales and return on assets. Yu *et al.* (2012) find in their survey that operational performance yields greater customer satisfaction and financial performance by providing quality products to satisfy customer needs and reducing delivery costs and serving costs. Indeed, operational efficiency and flexibility exhibit firms' competitive capabilities in offering diversified products with lower cost and shorter lead time (Ebben and Johnson, 2005; Kortmann *et al.*, 2014). Firms can fetch more orders by quickly responding to changing customer demand and satisfying customer needs (Yeung, 2008; Shrikant and Ravi, 2017). In other words, operational flexibility leads to increasing market share growth, sales and revenues. Moreover, operational efficiency enables the firm to deliver the orders in cost-saving and time-saving way, which ensures the orders to be profitable (Liu and Lai, 2016). Therefore, the firms with high levels of efficiency and flexibility are more likely to gain sales, accumulate earnings and attain high profit. Hence, we propose the following hypothesis:

H3. The firm's (a) operational efficiency and (b) operational flexibility are positively associated with financial performance.

2.2 The moderating role of supplier integration

As proposed by prior studies, the implementation of SCRM relies on the integrative relationship between focal firm and its suppliers (Chen *et al.*, 2013; Li *et al.*, 2015; Kauppi *et al.*, 2016; Wiengarten *et al.*, 2016). Supplier integration indicates the coordination and collaboration practices with suppliers (Das *et al.*, 2006; Flynn *et al.*, 2010). The term integration "essentially represents a structural and relational characteristic of a given organization or between organizations" (Barki and Pinsonneault, 2005, p. 166). Specifically, Das *et al.* (2006) suggest several structural characteristics for supplier integration, such as electronic data interchange, applications software and web-based integration systems. Additionally, relational characteristics in forms of collaboration and joint problem solving also indicate high levels of supplier integration (Gimenez and Ventura, 2005; Cagliano *et al.*, 2006; Flynn *et al.*, 2010; Shou *et al.*, 2017). Generally speaking, supplier integration includes the aspects of information sharing, collaboration, joint decision making and system coupling (Shou *et al.*, 2017).

In this paper, we argue that supplier integration can enhance the impact of SCRM on operational efficiency and flexibility. From the perspective of IPT, SCRM is an information intensive process, while supplier integration provides channels for external information acquisition, and enhances the firm's information processing capability. First, supplier integration serves as external routines for the companies to collect accurate supply chain information (Wong *et al.*, 2011). Information sharing with suppliers improves supply chain visibility and responsiveness, and is regarded as one key enabler for the effectiveness of SCRM practices (Christopher and Lee, 2004; Ritchie and Brindley, 2007). The adequate, timely and reliable internal and external information will complement with risk management practices and result in a higher level of operational efficiency and flexibility. Second, in the integrative relationship, the focal firm and its suppliers collaborate through risk and revenue sharing mechanism. It implies that suppliers can share positive outcomes if they put efforts into SCRM practices (Fan *et al.*, 2017). Thus, the effectiveness and efficiency of risk information gathering and processing can be ensured. Third, the focal firm and its suppliers make decisions jointly when they engage in collaborative and integrative relationship (Flynn *et al.*, 2010). Joint decision-making mechanisms improve the firm's information processing capabilities, particularly in complex and uncertain environments. Enhanced information processing capabilities enable the focal firm to operate businesses in

an efficient way and respond to external environment in a flexible way. Therefore, we propose the following hypotheses:

H4a. The level of supplier integration positively moderates the relationship between SCRM and operational efficiency.

H4b. The level of supplier integration positively moderates the relationship between SCRM and operational flexibility.

Figure 1 presents the conceptual model of this study.

3. Research method

3.1 Sample

In order to test the proposed hypotheses, this study used data collected through the sixth round International Manufacturing Strategy Survey (IMSS). The IMSS is a global survey executed by a research network of operations management scholars and manufacturing industry practitioners and completed by plant managers from manufacturing companies. The objective of IMSS is to establish a common database for the study of manufacturing practices and supply chain strategies. The IMSS is a mature and comprehensive international survey, which was originally developed in 1992 and was conducted every four to five years. The IMSS has been utilized by plenty of high-quality research publications in several research fields such as operations management and strategic management (e.g. Cheng *et al.*, 2016; Demeter *et al.*, 2016; Kauppi *et al.*, 2016; Wiengarten *et al.*, 2016).

The data used in this study were collected in 2013–2014. The local research groups in each country applied a centrally coordinated and rigorous procedure to collect data. A double parallel translation or back-translation method was strictly used to translate IMSS questionnaire into local languages. The respondents were contacted by e-mail and telephone call. Finally, 931 valid questionnaires were collected from 22 countries, with an aggregate response rate of 36 percent. For this study, 652 usable samples shown in Table I were obtained after deleting samples with missing data in related items.

Non-response and late-response bias were checked and controlled through a uniform protocol that each local research group was required to follow. The coordinators in each country compared the difference of size, industry, sales or proprietary structure between respondents and non-respondents and between early and late respondents by use of secondary data or questionnaire items. Evidence of non-response or late-response bias was not found in any of the cases (Cheng *et al.*, 2016). We also checked common method bias with Harman's single factor test. The results reveal five distinctive factors with eigenvalues above 1.0, of which the first factor explained 29.9 percent of the common variance and is not

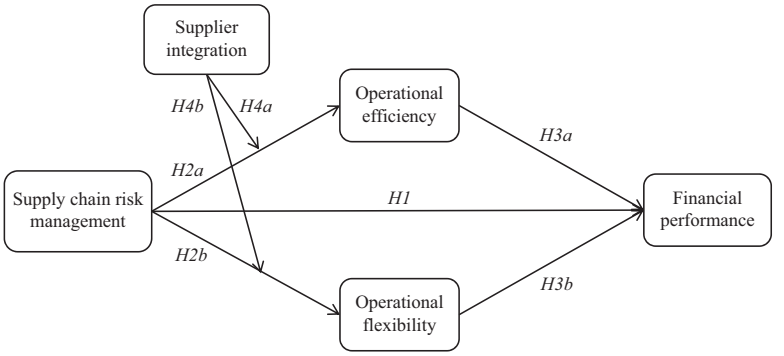

Figure 1.
Conceptual model

Demographic dimension	*n*	%	Demographic dimension	*n*	%
Europe	320	49.07	*Firm size*		
Belgium	18	2.76	Small (< 250)	302	46.32
Denmark	24	3.68	Medium (250–500)	120	18.40
Finland	27	4.14	Large (> 500)	230	35.28
Germany	9	1.38	Total	652	100.00
Hungary	37	5.67	*Industry (ISIC code)*		
Italy	25	3.83	25	204	31.29
The Netherlands	35	5.37	26	84	12.88
Norway	23	3.53	27	114	17.48
Portugal	23	3.53	28	154	23.62
Romania	33	5.06	29	67	10.28
Slovenia	17	2.61	30	29	4.45
Spain	18	2.76	Total	652	100.00
Sweden	15	2.30			
Switzerland	16	2.45			
Asia	258	39.56			
China	87	13.34			
India	68	10.43			
Japan	71	10.89			
Malaysia	10	1.53			
Taiwan	22	3.37			
America	74	11.35			
Brazil	27	4.14			
Canada	17	2.61			
USA	30	4.60			
Total	652	100.00			

Table I.
Sample overview

the majority of the total variance (Podsakoff and Organ, 1986). Further, confirmative factor analysis was applied to test Harman's single factor model. The model fit indices (χ^2/df = 16.578, CFI = 0.567, TLI = 0.505, RMSEA = 0.155, SRMR = 0.124) were all worse than the recommended threshold, which indicate that the single factor model is not acceptable. Thus, common method bias is not a serious concern in this study.

3.2 Measures

Researchers have measured SCRM from a process perspective. For example, Sinha *et al.* (2004) provide a methodology to mitigate supplier risks through risk identification, risk assessment, solutions planning and implementation, failure modes and effect analysis, and continuous improvement. Kleindorfer and Saad (2005) focus on the joint activities of risk assessment and risk mitigation. Sodhi *et al.* (2012) summarize four elements for managing supply chain risks, including risk identification, risk assessment, risk mitigation and responsiveness to risks. Further, Kırılmaz and Erol (2017) refine the processes into risk identification, risk measurement, risk evaluation, risk mitigation and the proposed procedure, and risk monitoring and control. Generally, the measurement of SCRM includes the activities of preventing, detecting, responding and recovering risks.

Financial performance is measured by sales and ROS (Wagner *et al.*, 2012; Zhou *et al.*, 2014). Operational efficiency indicates cost and time savings to maximize the ratio of output to input. Kortmann *et al.* (2014) divide operational efficiency into cost-based dimension (e.g. manufacturing costs) and time-based dimension (e.g. manufacturing lead time and delivery speed). Accordingly, this study measures operational efficiency as unit manufacturing cost, ordering costs, manufacturing lead time and procurement lead time

(Yeung, 2008; Kortmann *et al.*, 2014). Operational flexibility indicates the responsiveness capability to unanticipated situations and dynamically changing environments. There are many dimensions to measure flexibility, including labor, machine, material handling, routing, volume and mix flexibility. Zhang *et al.* (2003) advocate that process flexibility (labor, machine, material handling and routing) should be distinguished from operational flexibility (volume and mix), while the former indicates flexible competence, and the latter implies flexible capability. Besides, Koste *et al.* (2004) emphasize mix, new product and modification flexibility as higher-level flexibility dimensions due to their competitive importance for the market. The measurement of operational flexibility in this study focuses on volume flexibility, mix flexibility and product customization ability.

Supplier integration refers to collaborative and coordinative activities between the firm and its suppliers (Das *et al.*, 2006; Flynn *et al.*, 2010). Shou *et al.* (2017) elaborate integration from the structural and relational aspects. The structural integration indicates formal communication and information sharing, while the relational integration is concerned with joint actions and collaborative attitudes. Besides, Kim and Lee (2010) also emphasize the compatible communication and production systems between supply chain partners. Based on prior studies (Gimenez and Ventura, 2005; Flynn *et al.*, 2010; Kim and Lee, 2010; Shou *et al.*, 2017), this study measures supplier integration in terms of information sharing, collaboration, joint decision making and system coupling.

All the above constructs, including SCRM, financial performance, operational efficiency, operational flexibility and supplier integration, were measured by five-point Likert scales. Besides, this study included two control variables (i.e. firm size and industry). Firm size is included since larger firms tend to have more resources and better capabilities to implement management practices and can gain economies of scale from their implementation (Shou *et al.*, 2017). This study also controls for industry type (Li *et al.*, 2015; Wei *et al.*, 2017).

3.3 Reliability and validity

We conducted confirmatory factor analysis (CFA) using Mplus 7.4 to validate the measures of the constructs in our research. The CFA results are shown in Table II. The goodness of fit indices for CFA measurement model are $\chi^2/df = 2.244$, RMSEA = 0.044, CFI = 0.968, TLI = 0.961 and SRMR = 0.028. These indices are all better than the recommended threshold, which indicate a reasonably good fit (Hu and Bentler, 1999). Besides, Cronbach's α for each construct was calculated by SPSS 22.0. The results confirm internal consistency reliability of the five constructs.

We demonstrate construct validity in terms of content validity, convergent validity and discriminant validity. First, developed by a team of senior researchers and extracted from solid operations literature, the sixth round IMSS adopted scales tested by prior research and earlier versions of the survey, which guarantees the content validity of the items. Second, all constructs were measured by multi-item scales. The CFA results show that all factor loadings are above 0.50 and the *t*-values are all larger than 10.0. The factor loadings all exceed twice the value of their associated standard errors. A composite reliability (CR) value being greater than 0.70 is recommended (Shah and Goldstein, 2006), while a value between 0.60 and 0.70 is also acceptable provided that other indicators of reliability are good (Hair *et al.*, 2010). The CR values of all the constructs are greater than 0.70 except financial performance (with a value of 0.695). The estimates for average variance extracted (AVE) for SCRM, financial performance, operational flexibility and supplier integration are all above 0.50. The estimate for operational efficiency is 0.453, which is above 0.40 and still acceptable (Menor *et al.*, 2007). In addition, all AVE estimates are less than the corresponding CR values (Hair *et al.*, 2010). Given the above results, the degree of convergent validity is acceptable. Third, correlations of the constructs are calculated. As shown in Table III, the square root of AVE value for each construct is larger than any corresponding correlation coefficient

Construct and items		Factor loadings (standardized)	*t*-value	SE	R^2
Supply chain risk management (mean = 3.374, SD = 0.853, Cronbach's $\alpha = 0.877$; CR = 0.879; AVE = 0.646)					
RM1	Preventing operations risks (e.g. select a more reliable supplier, use clear safety procedures, preventive maintenance)	0.742	35.720	0.021	0.550
RM2	Detecting operations risks (e.g. internal or supplier monitoring, inspection, tracking)	0.847	55.794	0.015	0.718
RM3	Responding to operations risks (e.g. back-up suppliers, extra capacity, alternative transportation modes)	0.823	50.162	0.016	0.677
RM4	Recovering from operations risks (e.g. task forces, contingency plans, clear responsibility)	0.800	45.314	0.018	0.639
Financial performance (mean = 3.086, SD = 0.864, Cronbach's $\alpha = 0.695$; CR = 0.695; AVE = 0.533)					
FP1	Sales compared to the three years ago	0.721	10.178	0.071	0.519
FP2	ROS compared to the three years ago	0.739	10.233	0.072	0.546
Operational efficiency (mean = 3.078, SD = 0.567, Cronbach's $\alpha = 0.765$; CR = 0.768; AVE = 0.453)					
OE1	Unit manufacturing cost	0.619	18.470	0.034	0.383
OE2	Ordering costs	0.676	21.263	0.032	0.456
OE3	Manufacturing lead time	0.694	22.983	0.030	0.482
OE4	Procurement lead time	0.700	23.160	0.030	0.490
Operational flexibility (mean = 3.455, SD = 0.653, Cronbach's $\alpha = 0.729$; CR = 0.745; AVE = 0.500)					
OF1	Volume flexibility	0.742	25.283	0.029	0.551
OF2	Mix flexibility	0.809	28.039	0.029	0.655
OF3	Product customization ability	0.543	16.056	0.034	0.294
Supplier integration (mean = 3.134, SD = 0.882, Cronbach's $\alpha = 0.850$; CR = 0.856; AVE = 0.600)					
SI1	Sharing information with key suppliers (about sales forecast, production plans, order tracking and tracing, delivery status, stock level)	0.758	37.584	0.020	0.574
SI2	Developing collaborative approaches with key suppliers (e.g. supplier development, risk/revenue sharing, long-term agreements)	0.845	52.630	0.016	0.714
SI3	Joint decision making with key suppliers (about product design/modifications, process design/modifications, quality improvement and cost control)	0.816	46.785	0.017	0.666
SI4	System coupling with key suppliers (e.g. vendor managed inventory, just-in-time, Kanban, continuous replenishment)	0.668	26.712	0.025	0.446

Table II.
Survey items and confirmatory factor analysis results

Constructs	(1)	(2)	(3)	(4)	(5)	(6)
Supply chain risk management (1)	0.775					
Financial performance (2)	0.134**	0.730				
Operational efficiency (3)	0.179**	0.200**	0.673			
Operational flexibility (4)	0.279**	0.151**	0.205**	0.707		
Supplier integration (5)	0.561**	0.134**	0.214**	0.244**	0.775	
Firm size (6)	0.144**	0.096*	0.057	0.043	0.182**	–

Notes: The square root of AVE is in the diagonal. *,**Significant at the 0.05 and 0.01 levels, respectively

Table III.
Correlations of the constructs

(Fornell and Larcker, 1981). We also compared the unconstrained model with the correlations between each two constructs allowed to vary freely and the constrained model with the correlations constrained to 1. The significant differences in χ^2 provide further evidence for discriminant validity (O'Leary-Kelly and Vokurka, 1998).

3.4 Measurement equivalence

Since we used cross-sectional data to test the proposed hypotheses, the measurement equivalence across regions should be assessed. We analyzed the measurement equivalence in terms of calibration, translation and metric equivalence (Mullen, 1995). Calibration equivalence can be ensured when the measurement scales used are standardized Likert scales. In this survey, five-point Likert scales were applied to measure each construct. Furthermore, translation equivalence of all items is guaranteed as rigorous translation/back-translation processes were conducted during the execution of IMSS (Kauppi *et al.*, 2016). Metric equivalence is "the equivalence in the scoring process or the way respondents in different countries answer the same question" (Mullen, 1995). A multi-group CFA was recommended to determine metric equivalence (Rungtusanatham *et al.*, 2008; Patel *et al.*, 2012). In order to test metric equivalence, we compared the fit of two models: one is a fully constrained model in which all factor loadings were constrained to be equal across Europe, Asia and America, and the other is an unconstrained model with freely estimated factor loadings across continents. The goodness fit indices for constrained model are $\chi^2/\mathrm{df} = 1.733$, $\mathrm{CFI} = 0.942$, $\mathrm{TLI} = 0.932$ and $\mathrm{RMSEA} = 0.034$, while the indices for unconstrained model are $\chi^2/\mathrm{df} = 1.762$, $\mathrm{CFI} = 0.943$, $\mathrm{TLI} = 0.929$ and $\mathrm{RMSEA} = 0.034$. The results indicate that the data from different continents fit both models well. Further, model comparison results show that the fit of constrained model is not significantly different from that of unconstrained model with $\Delta\chi^2/\Delta\mathrm{df} = 1.339$ and $p = 0.124$. Thus, metric equivalence is confirmed.

4. Results

In this study, we used the SEM to test our proposed *H1–H3*, so that we can get the estimation of all hypothesized paths simultaneously. To test the moderating effects (*H4a* and *H4b*), we applied the latent moderated structural (LMS) equations approach, which is competent when the moderator is a multi-item latent variable (Kelava *et al.*, 2011). The LMS technique is a distribution-analytic approach, in which the non-normal distribution of the latent outcome variable is approximated with a finite mixture of normal distributions and the coefficients for the first-order and interaction effects are then estimated (Klein and Moosbrugger, 2000). Simulation studies show that LMS provides efficient and unbiased estimation of latent interaction effects (Hancock and Mueller, 2013; Patel *et al.*, 2012). Besides, the LMS technique is regarded as superior to the multi-group approach since it does not require splitting the sample, which eliminates the risk of sequencing the moderating effect (Wiengarten *et al.*, 2017). Mplus 7.4 was used to run the LMS approach to analyze the latent interaction effects generated by SCRM and supplier integration.

The standardized path coefficients and the *p*-values of the structural equation model for *H1–H3* are presented in Table IV. The relative and absolute indices of model fit show that the SEM model fits well to the data ($\chi^2/\mathrm{df} = 2.098$, $\mathrm{CFI} = 0.950$, $\mathrm{TLI} = 0.941$, $\mathrm{RMSEA} = 0.041$, $\mathrm{SRMR} = 0.049$). The standardized path coefficient for *H1* (SCRM → financial performance) is 0.064 with *p*-value being 0.232, which indicates that SCRM has no significant direct effects on

	Operational efficiency			Operational flexibility			Financial performance		
	Estimate	SE	*p*-value	Estimate	SE	*p*-value	Estimate	SE	*p*-value
Supply chain risk management	0.225***	0.046	0.000	0.317***	0.044	0.000	0.064	0.053	0.232
Operational efficiency	–	–	–	–	–	–	0.223***	0.054	0.000
Operational flexibility	–	–	–	–	–	–	0.111*	0.055	0.046
Firm size							0.068	0.046	0.141

Notes: Industry dummies are not shown. Standardized estimates. *$p < 0.05$; ***$p < 0.001$

Table IV.
Results for path analysis

financial performance. Hence, *H1* is not supported directly. The standardized path coefficient for *H2a* (SCRM → operational efficiency) and *H2b* (SCRM → operational flexibility) is 0.225 and 0.317, which are both significant at the level of 0.001. Thus, the results provide strongly support for *H2a* and *H2b*. The standardized path coefficient for *H3a* (operational efficiency → financial performance) and *H3b* (operational flexibility → financial performance) is 0.223 and 0.111, which are significant at the level of 0.001 and 0.05 respectively. Therefore, both *H3a* and *H3b* are supported.

To further test the potential indirect effects of SCRM on financial performance through operational efficiency and flexibility, we conducted bootstrap analysis (Li *et al.*, 2017; Preacher and Hayes, 2008). The results of bootstrap analysis for indirect effect are presented in Table V. The total indirect effect is 0.057 with the 95% confidence interval ranging from 0.027 to 0.094. The exclusion of 0 in the 95% confidence interval indicates the existence of significant indirect effect of SCRM on financial performance. As shown in Table V, the indirect effects through operational efficiency and flexibility are 0.034 and 0.024, respectively. The 95% confidence intervals for both operational efficiency and flexibility do not include 0 as well, which indicates the statistically significant indirect effects through both operational efficiency and flexibility. Hence, *H1* is supported. To conclude, SCRM improves a firm's financial performance indirectly via operational efficiency and flexibility.

To test *H4a* and *H4b*, we adopted the LMS approach to estimate the latent interaction effects between supplier integration and SCRM. The moderating results are presented in Table VI. The results show that the interaction effect of SCRM and supplier integration on operational flexibility is significant with *p*-value being 0.011. Thus, supplier integration positively moderates the relationship between SCRM and operational flexibility. However, the interaction effect of SCRM and supplier integration on operational efficiency is not significant, with *p*-value being 0.549. It can be concluded that supplier integration does not show significant moderation effect on the SCRM-operational efficiency relationship. Therefore, *H4a* is not supported, whereas *H4b* is confirmed.

				BC 95% CI	
	Point estimate	Boot	SE	Lower	Upper
Total	0.057	0.057	0.017	0.027	0.094
Operational efficiency	0.033	0.034	0.013	0.012	0.062
Operational flexibility	0.024	0.024	0.011	0.004	0.050
C1	−0.010	−0.010	0.017	−0.044	0.025

Notes: C1, contrast of the two indirect effects; BC, bias corrected; CI, confidence intervals. Number of bootstrap samples: 5,000

Table V. Bootstrap results for indirect effects

	Operational efficiency			Operational flexibility			Financial performance		
	Estimate	SE	*p*-value	Estimate	SE	*p*-value	Estimate	SE	*p*-value
Supply chain risk management	0.059	0.048	0.220	0.191**	0.064	0.003	0.064	0.086	0.461
Supplier integration	0.142**	0.048	0.003	0.117	0.065	0.071	0.010	0.093	0.917
Supply chain risk management × supplier integration	0.031	0.051	0.549	0.154*	0.060	0.011	–	–	–
Firm size	–	–	–	–	–	–	0.029	0.021	0.151

Notes: Industry dummies are not shown. Unstandardized estimates. *$p < 0.05$; **$p < 0.01$

Table VI. Results for moderating test

5. Discussion

5.1 Theoretical implications

Our research contributes to the risk management literature in three aspects. First, this study clarifies the performance effects of SCRM based on empirical evidence. The results indicate that SCRM has significant effect on financial performance even though the effect is not direct. The implementation of risk management may help reduce potential losses through risk prevention and control, and hence improve financial performance. However, SCRM practices indicate up-front investment in excess inventories, extra capabilities, product designs and human resources (Maffei *et al.*, 1993; Bode *et al.*, 2012), and also imply great efforts in planning, monitoring and recovering (Sodhi *et al.*, 2012). The up-front investment and costs are supposed to weaken financial performance. Therefore, the direct relationship between SCRM and financial performance is not significant because the positive and negative effects could offset each other. Further, the results reveal that SCRM can indirectly promote financial performance through improving operational performance. Although previous studies have confirmed the positive effect of SCRM practices on operational performance (e.g. Lavastre *et al.*, 2014; Kauppi *et al.*, 2016; Fan *et al.*, 2017), this paper extends the relevant research by revealing that the improvement of operational performance can ultimately lead to focal firm's financial performance. Therefore, this study establishes the link between SCRM practices and financial performance and demonstrates the role of operational performance.

Second, this study focuses on two critical dimensions of operational performance (i.e. operational efficiency and operational flexibility), and crystalizes the relationship between SCRM and operational efficiency and flexibility through the lens of IPT. Previous studies point out that efficiency and flexibility are sometimes contradictory and hard to be realized simultaneously (Ebben and Johnson, 2005; Kortmann *et al.*, 2014). The results of this study confirm that SCRM enhances both operational efficiency and flexibility. According to IPT, SCRM helps to provide a stable and reliable environment through buffering strategies, contingency planning and referable procedures, and reduces the information processing requirements from external environment. In addition, SCRM enhances information processing capability and problem-solving capability through the joint information sharing practices and operational buffers. Therefore, the firm can respond to upstream disruptions and customized demands timely and rapidly. The findings suggest that SCRM practices facilitate firms to meet diversified customer requirements in an efficient way, which enhances the understanding on the relationship between SCRM and operational performance.

Third, supplier integration, as an information processing mechanism, is identified to moderate the relationship between SCRM and operational performance. A few studies have emphasized the role of supplier integration, supplier collaboration and supplier relationships in risk management practices (Chen *et al.*, 2013; Lavastre *et al.*, 2014; Li *et al.*, 2015; Wiengarten *et al.*, 2016; Kauppi *et al.*, 2016). Our research extends prior studies by revealing the differential moderating roles of supplier integration. Specifically, the results show that supplier integration positively moderates the relationship between SCRM and operational flexibility. However, supplier integration does not significantly moderate the SCRM-operational efficiency relationship. It can be asserted that the focal firm has different information processing requirements for achieving operational efficiency and flexibility. Particularly, operational flexibility denotes the ability for product customization, higher levels of product variety and rapid responsiveness and so on to meet diversified customer requirements (Eisenhardt *et al.*, 2010). Thus, it is necessary to have more complicated and sophisticated information and associated higher information processing capability in order to realize operational flexibility (Adler *et al.*, 1999). In contrast, operational efficiency emphasizes the cost- and time-saving orientations and aims at achieving higher equipment utilization, labor productivity and the overall productivity (Kortmann *et al.*, 2014). As a

result, information required by operational efficiency is relatively simple and regular compared to the information required by flexibility. Therefore, the findings extend prior studies by revealing the different roles of supplier integration in complementing SCRM practices to realize operational efficiency and flexibility, and further support the theoretical standpoints of IPT.

5.2 Managerial implications

The results of our study also provide some managerial insights. First, this study suggests that the firm should put efforts in SCRM practices. Managers with low awareness of the increasing complexity and uncertainty may take risk management lightly, or they are not willing to invest in SCRM practices due to the up-front costs. However, in case of risk events, there could be huge loss for the firm. For example, BMW, the German automaker, had to shut down some plants and suffered a loss of profit due to its dependent supplier Bosch's inability to provide sufficient number of steering gears in 2017 (Boston, 2017). If BMW had back-up suppliers or had more supply information in advance, they would not suffer so much. The findings of this paper confirm that SCRM improves operational performance directly and promotes financial performance indirectly. We emphasize the importance of operational performance in the relationship between SCRM and financial performance. For firms pursuing financial benefits from SCRM practices, they are encouraged to first attach great importance to the improvement of operational efficiency and flexibility. With the increasing competition and differentiated demands, firms are required to provide diversified customer services in a cost- and time-saving way. Therefore, the firm should invest enough on the implementation of SCRM practices and the improvement of operational flexibility and efficiency.

In addition, our findings suggest that a high level of supplier integration enhances the effectiveness of risk management on operational flexibility. Some supplier information sharing strategies and technologies have been adopted by the industry to identify risks and provide precise supply information and customer expectations. For instance, Zaragoza Logistics Center in Spain is developing an estimated time of arrival predictor tool for shipments exported from China to Spain (Urciuoli, 2017) to speed up information circulation, which facilitates the focal firm's risk management and eventually helps improve operational flexibility. According to the findings of this study, it is suggested that firms that are implementing risk management invest in technologies, IT systems and inter-firm relationships to maintain better supplier integration and further improve the effectiveness of SCRM.

6. Conclusions

This study extends previous research on the relationship between SCRM and firm performance through the lens of IPT. Our results suggest that SCRM practices directly contribute to the improvement of operational efficiency and flexibility, and have indirect effect on financial performance. The findings clarify the performance effects of SCRM and enhance the understanding on the link between SCRM and firm performance. Moreover, this study incorporates the role of supplier integration in the implementation of risk management. By focusing on two aspects of operational performance, this study reveals that supplier integration significantly enhances the impact of SCRM on operational flexibility but does not moderate the SCRM-operational efficiency relationship due to the different information processing requirements for achieving operational efficiency and flexibility. Compared to the regular operations information required by operational efficiency, the information required by operational flexibility is more complicated and sophisticated. The results reveal the different roles of supplier integration in the effectiveness of SCRM and further support the standpoints of IPT. Thus, supplier integration practices (e.g. information sharing, IT technologies and systems) should be conducted by firms, so that they can deal with uncertainty and achieve better operational flexibility.

There are some limitations in this study, which also indicate further research directions. First, this study used cross-sectional data to test the proposed hypotheses. Longitudinal studies are suggested to investigate the evolutional patterns of risk management, supplier integration and firm performance. Second, our research aimed to identify how SCRM and supplier integration impact operational and financial performance, but did not consider other contextual factors. Indeed, there are different forms of risk, which may influence SCRM and supplier integration strategies. Further research could investigate the contingency effects of supply chain risks.

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