IJPDLM 50,1

80

Received 6 February 2019 Revised 12 July 2019 23 September 2019 Accepted 18 November 2019

Value of supply chain resilience: roles of culture, flexibility, and integration

Chunsheng Li School of Business, Macau University of Science and Technology, Taipa, China

Christina W.Y. Wong Institute of Textiles and Clothing, Hong Kong Polytechnic University, Kowloon, Hong Kong

Ching-Chiao Yang Department of Shipping and Transportation Management, National Kaohsiung University of Science and Technology, Kaohsiung, Taiwan

Kuo-Chung Shang Department of Transportation Science, National Taiwan Ocean University, Keelung, Taiwan, and Taih-cherng Lirn Department of Shipping and Transportation Management, National Taiwan Ocean University,

Keelung, Taiwan

Abstract

Purpose – Building supply chain (SC) resilience is crucial for business continuity given the ever-changing environmental conditions. Based on the resource orchestration and organizational culture theories, the purpose of this paper is to investigate the business value of SC resilience with the consideration of the roles of internal integration (II) and external integration (EI), risk management culture (RMC) and SC flexibility (SCF).

Design/methodology/approach – This study investigates how RMC, SCF and intra and interorganizational integration affect the performance of SC resilience. It collects primary and secondary data from 194 manufacturing firms listed in the Taiwan Stock Exchange and Taipei Exchange.

Findings – Results validate the authors' hypothesis that RMC, SCF and II improve the financial performance of firms through SC resilience efforts.

Research limitations/implications – This study uses firms from Taiwan manufacturing industry, which might introduce country and industry bias.

Practical implications – This study helps managers improve the financial performance of their SC resilience efforts by developing RMC, SCF, II and IE across functions and partner firms.

Originality/value – This study contributes to the literature by empirically testing the relationship between SC resilience and financial performance, and how the relationship is moderated by RMC, SCF, II and EI based on the theories of organizational culture and resource orchestration.

Keywords Supply chain resilience, Organizational culture, Flexibility, Financial performance, Integration, Resource orchestration

Paper type Research paper

International Journal of Physical Distribution & Logistics Management Vol. 50 No. 1, 2020 pp. 80-100 © Emerald Publishing Limited 0960-0005 DOI 10.1108/JJPDLM-02-2019-0041

The authors thank the editor and reviewers for their valuable and constructive comments on the earlier version of the paper. This research was partially supported by The Hong Kong Polytechnic University under Grant No. 4-ZZGM. The authors would also like to thank for the Taiwan Ministry of Science and Technology for financial sponsorship under research Project No. NSC 101-2410-H-019-024.



Introduction

Establishing risk management is crucial for the development of supply chain (SC) resilience given the ever-changing and uncertain business environment. SC resilience refers to the capacity to cope with and respond to unpredictable changes (Ambulkar *et al.*, 2015; Kochan and Nowicki, 2018; Ponomarov and Holcomb, 2009). It enables SC operations to recover from disruptions by maintaining continuity of operations at the desired level of connectedness and control over structure and function.

The extant literature is confined to the conceptualization of SC resilience (e.g. Hosseini *et al.*, 2019; Kochan and Nowicki, 2018) and investigation of its operational performance impact (e.g. Chowdhury *et al.*, 2019; Liu and Lee, 2018). Research on the effect of SC resilience on financial performance is still in its infancy. SC resilience and financial performance are positively and significantly correlated (Yu *et al.*, 2019). However, many scholars propose that the implementation of SC resilience is a buffer for the maintenance of excessive capacity, thereby causing a doubt to the relationship; for example, hiring additional people increases the wage cost, having back-ups leads to capital consumption and occupation (e.g. Bairamzadeh *et al.*, 2015; Ghaderi *et al.*, 2018). Further investigation on the financial impact is needed to respond to managers' concerns on the cost of SC resilience (Hohenstein *et al.*, 2015). Thus, we raise the first research question:

RQ1. Does SC resilience positively and significantly affect firms' financial performance?

Prior studies have identified various approaches that were used to mitigate SC disruptions. Such approaches range from organizational attributes, such as operational slack, diversification and vertical relatedness in risk mitigation and response (e.g. Braunscheidel and Suresh, 2009; Kovach *et al.*, 2015), to human resources management by increasing job satisfaction, decreasing turnover (e.g. Jiang *et al.*, 2009; Kumar *et al.*, 2018) and providing information about the value of organizational efforts in developing SC resilience. The business benefits of cross-functional integration have been conceptualized (Enz and Lambert, 2015), and the effects of culture and flexibility on the performance impact of asymmetry on SC management have been investigated (Dubey *et al.*, 2019; Kurniawan *et al.*, 2017; Wiengarten *et al.*, 2019). As such, culture, flexibility and integration about culture, flexibility and integration that would help (or challenge) firms enhance SC resilience-induced financial performance. Thus, we raise the second research question:

RQ2. How does culture, flexibility or integration affect the relationship between SC resilience and financial performance?

The theories of organizational culture (Denison and Spreitzer, 1991; McDermott and Stock, 1999) and resource orchestration (Sirmon et al., 2007, 2011) are integrated to investigate the SC resilience-induced financial performance and the roles of culture, flexibility and integration in this relationship. Organizational culture refers to a collection of values, beliefs and assumptions that are shared and reflected in organizational goals and practices (Khazanchi et al., 2007). Culture is what makes the members of a certain organization stand out from others (Hofstede, 1980). Organization culture, which is developed by sharing values and ideas, is positively related to firm performance (McDermott and Stock, 1999). Denison and Spreitzer (1991) suggest that organizational culture has two different value orientations, emphasizing independent willingness to focus on change or stability. One orientation refers to control-oriented activities, reflecting order, control and stability. The presence of risks leads to unstable environmental condition and imposes difficulties in decision making. Risk management creates value by reducing the damage of potential problems and maintaining an uncertain environment (Revilla and Saenz, 2017). Another type of value orientation refers to flexibility-oriented activities, which reflect the spontaneity and adaptability of organizational culture. The roles of organizational flexibility, such as procurement/sourcing, manufacturing and distribution/logistics flexibility, help reduce environmental uncertainty and increase mutual understanding (Obayi et al., 2017;

Pellathy *et al.*, 2018). Organizational culture can play a vital role in affecting firm performance to cope with SC disruptions due to orientation differences (Denison and Spreitzer, 1991).

Resource orchestration theory is regarded as the extension of the resource-based theory because it explicitly provides effective structuring, bundling and leveraging of firm's resources to create value for competitive advantages (Sirmon *et al.*, 2007, 2011). This theory advocates that utilizing and leveraging organizational resources are equally important as owning resources, and possessing resources does not guarantee better performance. SC strategy across functions is critical to increasing managers' awareness of the activities for proceeding resource orchestration (Sirmon *et al.*, 2011). Resource orchestration enables the accumulation of organizational resources (Sirmon *et al.*, 2007, 2011). Internal integration (II) and external integration (EI) can be used to sustain competitive advantage (Sirmon *et al.*, 2011). II enables the deployment and coordination of internal resources across functions. It helps firms structure and leverage internal resources effectively to perform, track and monitor management efforts across functions (Riley *et al.*, 2016; Wong *et al.*, 2015). EI allows firms to obtain valuable information and resources from suppliers and customers and manage the SC activities by orchestrating resources and competencies across the supply and customer bases (Wong *et al.*, 2015).

Organizational culture theory and resource orchestration theory have similarities and key differences. Both theories advocate the need for continuous efforts to efficiently and effectively carry out activities and thus create a stable organizational environment (Michailova and Hutchings, 2006; Sirmon *et al.*, 2011). The differences between these theories are about "how" firms can obtain stability. Organization culture theory suggests that firm commitment and openness with key partners enrich knowledge base and enlarge accessibility to resources (Michailova and Hutchings, 2006; Randall *et al.*, 2014). In addition, resource orchestration theory focuses on resource integration and encourages operational cooperation to compete in the dynamic marketplace (Sirmon *et al.*, 2011). These theories are integrated in the present study for their complementarity. Organizational culture theory specifically encourages participation, empowerment and teamwork to create a common value on how to arrange and fully utilize firms' resources. It complements resource orchestration theory, which advocates the efficient allocation of firm resources to retain productivity, by establishing a flexible and adaptable organizational culture that copes with uncertainties.

The present study contributes to the operation and SC resilience literature in several ways. First, it proves the business value of SC resilience, thereby addressing the concerns of researchers and managers on the costly adoption of SC resilience. Second, it takes the resource orchestration and organizational culture perspectives to empirically investigate the roles of SC flexibility (SCF), risk management culture (RMC), II and EI in the relationships of SC resilience and financial performance. Third, it helps managers determine how to improve the financial performance of their SC resilience efforts by developing culture, flexibility and integration across functions and partner firms.

Theoretical background and hypothesis development

Research framework

The current study uses organizational culture and resource orchestration theories to investigate how culture, flexibility and integration affect the performance of SC resilience. According to the organizational culture theory, RMC and SCF can be developed as a culture that enables control-oriented and flexibility-oriented activities (Denison and Spreitzer, 1991). On the one hand, RMC is considered as a part of control-oriented activities that involve such practices as collaborative and business continuity planning, information sharing and employee training to build resilience in internal operations (Das and Lashkari, 2015). On the other hand, SCF is referred to as the activities of SC partners to adjust tactics and operation scope to a certain degree (Gligor *et al.*, 2013). SCF is considered as flexibility-oriented activities that require efforts of firms to maintain the capacity to cope with disruptions (Erol *et al.*, 2010).

IJPDLM

Integration, on the other hand, is concerned with the exchange of knowledge and information to coordinate and streamline resources across the SC (Lee and Whang, 2004). Firms manage their resource portfolio that resides within firms and across partner firms to develop resource-based competitive advantages. In line with the theory of resource orchestration (Sirmon *et al.*, 2011), bundling and leveraging resources across internal and external (e.g. suppliers, customers) functions through integration effectively enable resource orchestration. Integration can be considered as an operational capability to support the orchestration of resource across functions and firms (Wade and Hulland, 2004). If and EI represent two core organizational dynamic capabilities of a firm that facilitates the use of resources. If is the extent to which the internal functions are working collaboratively and in synchrony to support organizational strategies and practices (Morash *et al.*, 1996). EI is considered as the extent to which a firm can integrate with its major customers and suppliers to coordinate interorganizational activities (Morash *et al.*, 1996).

Japanese automotive manufacturer Toyota can be used to illustrate the success in adopting SC resilience, as well as RMC, flexibility and integration. Toyota's production was stopped due to a fire incident at its Aisin Seiki plant in 1997 and earthquakes in 2007 and 2011 (Kubota, 2016). After 2011, Toyota has been building SC resilience (e.g. by sourcing each component from multiple suppliers and building a supply database) and a dynamic RMC (e.g. by reserving resource and keeping track of the impact of disruptions); it also increases SCF (e.g. using standardized parts that can be outsourced globally) together with II and EI (e.g. tightly integrating SC systems and integrating disaggregated production process) to handle the disruptions (Kubota, 2016; McCarthy-Byrne and Mentzer, 2011). Toyota suffered many disruptions since then, including the three-day suspension due to its two assembly factories near Tianjin port during the explosion in 2015 (Shirouzu, 2015). seven-day halt due to an explosion at a steel supplier in February 2016 and shutdown of 26 assembly lines due to the Kumamoto earthquakes in April 2016 (Kubota, 2016). Although these disruptions adversely affect Toyota's SC, its SC resilience together with its RMC, SCF and integration built after 2011 help reduce its downtime. Toyota's profitability from 2013 to 2017 becomes about thrice as high as its profitability from 2010 to 2012 (Morningstar, 2017).

Figure 1 depicts the framework of this study driven by the real-life cases and guided by organizational culture theory and resource orchestration theory.

SC resilience-financial performance relationship

Firm services or products are disrupted by unanticipated and unplanned events, such as workforce strikes, extreme weather and truck breakdowns (Kochan and Nowicki, 2018). Under such conditions, SC resilience comes into use to minimize the impact of SC disruptions and maintain business continuity (Ambulkar *et al.*, 2015; Li *et al.*, 2017). According to resource



Figure 1. Research framework

83

orchestration theory, resource utilization, and not resource possession, is what leads to improved performance (Sirmon *et al.*, 2011). SC resilience enables firms to cope with disruptions, maintain supply to customers, keep a positive trade relationship and optimize resource allocation (Roehrich *et al.*, 2014). From an organizational culture perspective, firms need to maintain the relationship among functions to provide a quick response and flexibility in operations when SC disruptions emerge (Denison and Mishra, 1995; Denison and Spreitzer, 1991).

Firms can minimize shortage risks through maintaining connectedness among their functions and partners to ensure stock availability and handle disruptions due to SC resilience (Ambulkar *et al.*, 2015; Golgeci and Ponomarov, 2013; Ponomarov and Holcomb, 2009), thereby enhancing firm profitability and reputation (Roehrich *et al.*, 2014). Moreover, delivery competence, which ensures reliable services, is improved via adoption of SC resilience practices like dynamic pricing (Liu and Lee, 2018). As suggested in prior studies (e.g. Christopher and Peck, 2004), SC resilience can keep a low inventory level through minimal batch sizes and short lead time (Azevedo *et al.*, 2013). Hence, the firm's financial liquidity and asset turnover can be improved. IKEA, a Swedish-founded company that designs and sells furniture, successfully delivers small batches to its market to avoid unsold inventory or deadstock in its warehouse (TradeGecko, 2018), thereby increasing its assets turnover and therefore financial performance. Thus:

H1. Firm's SC resilience is positively related to financial performance.

Roles of RMC and SCF on the relationship between SC resilience and financial performance Organization culture focuses on activities for the purpose of control and flexibility, termed as RMC and SCF, respectively, based on the organizational culture theory. RMC plays an important role in the relationship between SC resilience and financial performance. RMC practices, such as training personnel about resilient policies and developing RMC, allow personnel to recognize the nature of risks in their SCs, while developing internal efficiency and coordination to cope with disruptions and to attain business stability and continuity (Christopher and Peck, 2004; Denison and Spreitzer, 1991). According to Ambulkar et al. (2015), firms are aware of the occurrence of disruptions and learn from past disruption experiences. A high level of RMC is required to enhance the impact of SC resilience on a firm's productivity and profit. Such organizational capacity enables firms to serve customers well and operate efficiently with minimal downtime (Obayi et al., 2017; Ponomarov and Holcomb, 2009). Firms can cope with the disruptions in a short time. Hence, disruptions on meeting customer needs can be mitigated (Fattahi et al., 2017). The capability to handle unpredictable disruptions is critical for an organization to reduce loss from the disruptions and manage the mismatches of supply and demand (Cardoso et al., 2015; Roehrich et al., 2014). RMC helps firms with risk awareness and avoidance, which has an essential influence on the business value of SC resilience. Thus, we propose the following hypothesis:

H2. A high level of RMC enhances the relationship between SC resilience and financial performance.

SCF enables firms to adapt to the changing market needs and manage risks by allocating resources across SCs (Obayi *et al.*, 2017). Along with SCF, SC resilience could be seen as a mitigation tactic. SCF helps firms respond quickly to the supply and demand changes through maintaining resources and forming strategic partners; the product development time can be shortened, and the firm can offer products more frequently (Braunscheidel and Suresh, 2009). SCF facilitates interactive and effective teamwork among internal functions and across firms after disruptions to develop new markets and obtain most of the benefits, such as innovation, additional resources acquisition, business growth and improved

IJPDLM

financial performance (Denison and Spreitzer, 1991). With SC resilience and SCF, firms can adapt their operations according to the customers' preferences and satisfy the changing demand (Cardoso *et al.*, 2015). Karl Mayer, a leading knitting machinery manufacturer, keeps production in-house as much as possible and relies on digitization to increase overall flexibility (Dsouza, 2017). Its multiaxial warp knitting machines are continuously updated to satisfy knitting factories' requirement on the resilient production lines that can produce multiple fabric patterns (Davis, 2018). All these practices make Karl Mayer a great success in customer satisfaction and loyalty. The rate of customer switching is reduced, and the firm acquires new customers and generates profit (Davis, 2018). Thus, we propose the following hypothesis:

H3. A high level of SCF enhances the relationship between SC resilience and financial performance.

Roles of integration on the relationship between SC resilience and financial performance The ability to manage resources is important for a firm to complement existing operational weaknesses and recover from declining performance (Sirmon *et al.*, 2007, 2011). Bundling and leveraging resources across internal and external functions through integration effectively ensure resource management. According to Hill *et al.* (1992), managers need to build special channels to facilitate the information flow, make joint decisions and build trust among different departments or firms through integration.

Based on resource orchestration theory, a firm could own a lot of resources, but its performance depends on the ability of structuring and utilizing its resources. Successful operational collaboration could result in effective resource integration and orchestration (Sirmon et al., 2011). II enables process efficiency through cooperation and coordination across internal functions (Morash et al., 1996; Wong et al., 2011). It also coordinates production scheduling, demand planning and customer and material management (Riley et al., 2016). thereby enabling a firm's implementation of SC resilience. EI extends II across boundaries of firms by involving suppliers and customers' integration and strategic business processes alignment (Demeter et al., 2016; Morash et al., 1996). EI helps firms obtain requirements from customers and supply information from suppliers, thereby coordinating tasks with upstream and downstream SC partners (Wong et al., 2011). Such integration enables firms to respond to marketplace changes (Vanpoucke et al., 2017). II and EI help reduce the bullwhip effect (Vanpoucke et al., 2017). The communication and shared information among functions and partner firms reduce redundancy and wastage and improve customer service and delivery performance. Together with integration, SC resilience ensures the improvement of partner-related processes and routines with real-time collaboration to respond to the disruptions in the SC (Liu and Lee, 2018). Thus, we propose the following hypotheses:

- *H4.* A high level of II enhances the relationship between SC resilience and financial performance.
- *H5.* A high level of EI enhances the relationship between SC resilience and financial performance.

Research methodology

Questionnaire design

In this study, we collect data through a mass survey in combination with objective firm performance data. First, we carried out an extensive literature review to ensure the reliability and validity of our measurements, and we extracted our measure items adopted in the prior studies, as presented in Table II. Four items of SC resilience were adapted from

Golgeci and Ponomarov (2013) and Ponomarov and Holcomb (2009). Four items of EI and three items of II were based on Rodrigues *et al.* (2004) and Stank *et al.* (2001). Three measures of RMC were selected from Christopher and Peck (2004). Four items of SCF were adapted from Gligor *et al.* (2013) and Juttner and Maklan (2011). The measurement scales of this study, which come from the original literature, are in English. We designed our questionnaire in English and asked knowledgeable professors in this field to review the file and improve its reliability. We followed the translation and back-translation method to ensure the linguistic equivalence of our measurements (Ketterer *et al.*, 2010).

A pilot test was then conducted on a group of 30 manufacturing managers from Taiwan to ensure the readability of the questionnaire. The pilot test aimed to assess if the respondents correctly understood each question, and slight modifications were made according to the result.

Data collection

We chose Taiwan's manufacturing industry to be our empirical setting. It has been considered as one of the important production bases to supply electronic hardware products for global sourcing, such as chip, notebook and liquid crystal display (IDB, 2013). It is a global center of the production of flat panel displays and integrated circuits foundries, and it has a large market share in the production of golf heads, shoes and high-tech products. The output of the Taiwanese manufacturing industry reaches US\$413bn, which accounts for approximately 88 percent of the industrial sector's total output in Taiwan. Hence, the industry contributes to 30 percent of the country's GDP.

We collected a sample from the manufacturing firms listed in the Taiwan Stock Exchange (TWSE) and Taipei Exchange (TPEx) (i.e. over-the-counter market) in May 2014. A total of 1,180 firms were listed in our sample – 649 firms were listed in TWSE and 531 firms in TPEx. To improve the response rate, we prepared a cover letter containing the work's purpose and significance and mailed it together with our questionnaire and a return envelope, which had been prepaid and preaddressed. We contacted the respondents by telephone before sending the questionnaire out. A total of 142 responses were received in the first round. We reminded the nonrespondents through phone call, and sent the follow-up mailing to the remaining 1,038 nonrespondents. We received another 94 responses in the second round. From the two rounds, we received 236 questionnaires in total. Hence, the response rate is 20.0 percent. After screening, 33 questionnaires were disqualified because of incomplete responses. Therefore, 203 responses were used for our analysis. The respondents' demographic characteristics were summarized in Table I.

Following Kovach *et al.* (2015), return on assets (ROA) was used to measure financial performance, representing the efficiency and profitability of the assets utilization. We collected the firms' objective financial data of the fiscal year 2015 from the databases of TWSE and TPEx in April 2016.

We targeted top managers (see their job titles in Table I) as respondents in the mass survey because they are knowledgeable enough to provide the relevant information about the organizations (Montabon *et al.*, 2018). In addition, the combination of primary data from a mass survey and secondary data from the database is recommended by recent researchers to minimize the associated biases (e.g. common method and respondent bias) and enhance the relevance of the study findings (Flynn *et al.*, 2018; Montabon *et al.*, 2018).

Bias issues

We adopted the extrapolation method suggested by Armstrong and Overton (1977) to compare the early respondents and late ones across the measures by commencing a *t*-test analysis. The results showed that no statistical difference existed among the measures (p < 0.001). Hence, nonresponse bias is not an issue in this study.

IJPDLM

Demographic characteristics	Number of respondents	Percentage of respondents	Value of supply chain
Inh title			resilience
Vice president or above	62	30.5	resilience
General manager	47	23.2	
Manager	61	30.0	
Director	15	7.4	
Other	18	8.9	87
Tomura in current company (years)			
1_3	26	12.8	
1-0 A_9	58	286	
10–15	48	23.6	
16-20	24	11.8	
21 and above	47	23.2	
		2012	
Age of firm (years)	G	2.0	
1-10	6	3.0	
11-10 16 90	2ð 22	13.0	
21 and above	136	67.0	
	150	07.0	
Type of industry			
Electronic	45	22.2	
Semiconductor	21	10.3	
Information and communication	20	9.9	
Machinery	20	9.9	
Computers and consumer electronics	15	7.4	
Garments and textile	12	5.9	
Iron and steel	12	5.9	
Auto and parts	9	4.4	
Metal Construction motorials	9	4.4	
Construction materials	8	3.9	
Distigand rubber	7	0.4 2.4	
Food	7	0.4	
Others	ວ 12	2.5	
others	15	0.4	
Number of employees	22		
< 100	20	9.9	
101-200	38	18.7	
201-400	41	20.2	
401-600	22	10.8	
601-1,000	32	15.8	
> 1,001	50	24.6	
Annual revenue of firm (billion NT\$ ^a)			
< 1.0	32	15.8	
1.1–2.0	47	23.1	
2.1–3.0	30	14.8	
3.1–5.0	27	13.3	
5.1-10.0	22	10.8	Table I
> 10.1	45	22.2	Demographic data
Note: ^a One US dollar equals approximatel	y 32.5 New Taiwanese (NT) dolla	ars	of respondents

Perceptual inputs and objective data were collected as multiple-source data to address the common method variance issue. The perceptual measures of independent variable were self-reported, whereas the objective measures of dependent variables were collected from the sample firms' annual reports. We followed Podsakoff *et al.* (2003) to check if any common

method variance issue exists through the following procedural and statistics methods. First, respondents were guaranteed that their identity would be anonymous and confidential when we report the results to encourage the respondents to answer honestly. Second, the percentage of the respondents who held a senior position is 61.4 percent, and those who had tenure for more than seven years is 69.5 percent. The respondents are assumed knowledgeable about the operations and management of their firms. Third, Harman's one-factor test was conducted to ensure that no single factor exists, which led to the majority of covariance. Seven factors from the measurement items were extracted because their eigenvalue was greater than 1, and the proportion of these extracted factors in all the variances was 73.32 percent. The first factor accounted for 26.11 percent. No issue of common method variance existed in this study because no one factor accounted for a large proportion of the variance.

Assessing model assumptions, validation and reliability

We controlled for outliers that potentially influence the results through trimming the objective financial data at the 1 percent level in each tail (Hendricks and Singhal, 2005). Nine firms were excluded, and 194 firms' data were applied for further analysis. Table III shows the mean, standard deviations and correlations of the variables. The correlations among SC resilience and the four moderators are significant at the level of p < 0.001, ranging between 0.38 and 0.45. Thus, the criterion validity is acceptable (Nunnally and Bernstein, 1994). The variables were mean-centered to further mitigate the effects of multicollinearity, outliers and non-normality (Jaccard and Turrisi, 2003). The variance inflation factor values (VIFs) were calculated to test the potential multicollinearity (Hair *et al.*, 1998). The value of VIF is smaller than the expected cut-off value of 3.3 (Peng and Lai, 2012). Hence, multicollinearity is not a concern in this study. We adopted Shapiro–Wilk test to check the normality of the data (Dagostino *et al.*, 1990) and Levene test for variance homogeneity (Tabachnick, 2013). The insignificant results (p > 0.05) support the assumption of normality and variance homogeneity for our analysis.

Table II shows the composite reliability and Cronbach's α to measure the reliability and internal consistency of the scales and constructs. The results show that composite reliability and Cronbach's α of all constructs are greater than expected threshold of 0.7, from which the reliability can be ensured sufficiently (Nunnally and Bernstein, 1994). Anderson and Gerbing (1988) suggest the use of confirmatory factor analysis (CFA) to measure the factor structures' psychometric properties. We adopted the estimation of the maximum likelihood with the covariance. Table II summarizes CFA results and shows that the values of the comparative fit index (CFI), the incremental fit index (IFI) and the Tucker–Lewis index (TLI) are greater than the expected cut-off value of 0.9, whereas the values of the root mean square residual are below the expected threshold of 0.05. Therefore, all the constructs present a good fit with the data obtained (Hu and Bentler, 1999).

We assessed convergent validity through the factor loadings' statistics, significance and average variance extracted (AVE) (Anderson and Gerbing, 1988; Hair *et al.*, 1998). The results in Table II show that the loadings are between 0.51 and 0.91, and all indicators are significantly loaded to their respective constructs (p < 0.001), which proves the presence of convergent validity. Additionally, the values of AVE of the constructs are greater than the threshold value of 0.5, which provides further evidence of convergent validity.

We assessed the extent to which one construct is different from others to measure the discriminant validity. A series of tests on χ^2 difference between nested CFA models were tested for every pair of constructs. We found significant χ^2 differences (p < 0.001) between the constrained and unconstrained models, suggesting the discriminant validity (Bagozzi *et al.*, 1991). Table IV shows the results. Additionally, the square root of each construct's AVE in Table III is greater than the correlations among other pairs, which provides further evidence for the variables' discriminant validity (Table IV).

IJPDLM

Construct and reflective indicator	Loadings	Value of supply chain
Supply chain resilience ($\chi^2 = 4.18$, df = 2; CFI = 0.99; RMR = 0.01; IFI = 0.99; TLI = 0.98; Cronbach's Composite reliability = 0.84; AVE = 0.58)	$s \alpha = 0.84;$	resilience
(Scale: 1 = strongly disagree, 5 = to a strongly agree) (Sources: Golgeci and Ponomarov, 2013; Ponor Holcomb 2009)	narov and	
SCR1: our firm's supply chain can quickly return to its original state after being disrupted SCR2: our firm's supply chain has the ability to maintain a desired level of connectedness among its members at the time of disruption	0.55 0.86	89
SCR3: our firm's supply chain has the ability to maintain a desired level of control over structure and function at the time of disruption	0.91	
SCR4: our firm's supply chain has the ability to extract meaning and useful knowledge from disruptions and unexpected events	0.67	
External integration ($\chi^2 = 26.73$, df = 2; CFI = 0.95; RMR = 0.03; IFI = 0.95; TLI = 0.94; Cronbach's Composite reliability = 0.89; AVE = 0.67)	$\alpha = 0.89;$	
(Scale: $1 =$ strongly disagree, $5 =$ to a strongly agree) (Sources: Rodrigues <i>et al.</i> , 2004; Stank <i>et al.</i> , EII: our firm effective shares operational information with our key suppliers and customers	2001) 0.85	
E12: our firm has operational flexibility through supply chain collaboration E13: our firm and our suppliers and customers are under the supply chain arrangements that allow us to share rewards and risks with them	0.85 0.78	
EI4: our firm integrates with our suppliers and customers to share information	0.79	
Internal integration ($\chi^2 = N/A$, df = N/A; CFI = 1.00; RMR = N/A; IFI = 1.00; TLI = N/A; Cronbach's Composite reliability = 0.75; AVE = 0.51)	$\alpha = 0.74;$	
(Scale: $1 =$ strongly disagree, $5 =$ to a strongly agree) (Sources: Rodrigues <i>et al.</i> , 2004; Stank <i>et al.</i> III: our firm maintains an integrated database to facilitate information sharing across internal functions	., 2001) 0.76	
II2: our firm shares operational information across internal functions II3: the internal functions of our firm shares risk management information	0.84 0.51	
Risk management culture ($\chi^2 = N/A$, df = N/A; CFI = 1.00; RMR = N/A; IFI = 1.00; TLI = N/A; Crown a = 0.84; Composite reliability = 0.84; AVE = 0.64)	onbach's	
(Scale: 1 = strongly disagree, 5 = to a strongly agree) (Source: Christopher and Peck, 2004)	0.00	
RMC1. our firm provides risk management training to our employee orientation	0.82	
RMC3: risk management culture exists in our firm	0.71	
Supply chain flexibility (χ^2 = 5.97, df = 2; CFI = 0.99; RMR = 0.01; IFI = 0.98; TLI = 0.95; Cronbach's Composite reliability = 0.80; AVE = 0.51)	$\alpha = 0.79;$	
(Scale: $1 = \text{strongly disagree}$, $5 = \text{to a strongly agree}$) (Sources: Gligor <i>et al.</i> , 2013; Juttner and Mak SCF1: our firm considers the risk management capability of our supply chain partners when forming strategic partners	lan, 2011) 0.80	
SCF2: our firm allocates resources for production based on market change	0.58	
SCF3: our firm maintains excess resources to cope with market fluctuation	0.82	Table II.
SUF4: our firm considers the flexibility and ability to response to change when forming strategic partners	0.61	Confirmatory factor analysis results

Hypothesis testing and results

For the control variables, we included firm age, annual revenue, industry type and firm size in terms of employee number, as these influence organizational ability in resilience and experience in handling with disruptions. We established a structural equation model based on the construct of SC resilience and ROA to test *H1*. The first row of panel A in Table V shows the goodness of fit ($\chi^2 = 189.88$, df = 27, IFI = 0.96, TLI = 0.94, CFI = 0.96, RMSEA = 0.07). Table V shows a positive and significant relationship between SC resilience and ROA ($\beta = 0.13$, p < 0.05). Thus, *H1* was supported.

We then adopted a multi-group analysis to test H2–H5. A two-group model was created for each moderating factor by dividing the sample into low and high levels based on the mean of the composite score (Wong et al., 2011). Table V summarizes the results, including the χ^2 statistics, goodness of fit, path coefficients and significance. The parameters of the structural model varied freely between low and high groups in the baseline models. The parameters of all the paths were constrained to be the same in both groups in the constrained models, whereas the parameters of the paths from SC resilience to business performance were constrained in the constrained paths. The differences between baseline and constrained models in χ^2 statistics and their significance indicate variance of the models between the low and high moderating groups. The χ^2 differences between baseline models and constrained paths suggest the moderation effects.

Table V shows that the χ^2 differences between the baseline and the constrained models $(\Delta \chi^2 = 15.77, \Delta df = 8, p < 0.05)$ and the χ^2 differences between the baseline model and the constrained path $(\Delta \chi^2 = 11.28, \Delta df = 1, p < 0.01)$ are significant under low and high levels of RMC. The results further suggested that the impact of SC resilience on ROA is significantly enhanced under low ($\beta = 0.12$, p < 0.05) and high ($\beta = 0.19$, p < 0.05) levels of RMC. Therefore, H2 was supported.

Variables	Mean	SD	SCR	П	EI	RMC	SCF	ROA
SCR	3.81	0.65	0.76					
П	4.04	0.76	0.38***	0.71				
EI	3.48	0.82	0.39***	0.50***	0.82			
RMC	3.50	0.80	0.43***	0.58***	0.60***	0.80		
SCF	3.83	0.72	0.45***	0.62***	0.55***	0.65***	0.71	
ROA	3.73	6.94	0.12	-0.02	0.05	-0.01	0.097	_
Notes: Squ	are root of	AVE is on	n the diagon	al. SCR, supply	v chain resil	lience; II, interi	nal integrat	tion; EI,

external integration; RMC, risk management culture; SCF, supply chain flexibility. ***p < 0.001

Mean, standard deviations (SD) and correlations of the variables

		Unconst	rained	Constra	ined	
	Construct pairs	χ^2	df	χ^2	df	$\Delta \chi^2$
	Supply chain resilience					
	Internal integration	39.85	13	110.02	14	70.17***
	External integration	50.37	19	116.48	20	66.11***
	Risk management culture	24.07	13	91.10	14	67.03***
	Supply chain flexibility	29.36	19	80.22	20	50.86***
	Internal integration					
	External integration	61.91	13	115.15	14	53.24***
	Risk management culture	69.27	8	88.81	9	19.54***
	Supply chain flexibility	68.68	13	114.37	14	45.69***
	External integration					
	Risk management culture	42.26	13	78.02	14	35.76***
	Supply chain flexibility	54.75	19	87.82	20	33.07***
Table IV	Risk management culture					
Discriminant validity	Supply chain flexibility	46.07	13	63.36	14	17.29***
analysis results	Note: **** <i>p</i> < 0.001					

90

IJPDLM

50.1

Table III.

	~×	df	ΕI	TLL	CFI	RMSEA	$\nabla X^{\mathcal{J}}$	Δdf	þ	β (Low	//High)	Hypotheses
Panel A: hypotheses testing (DV: K SC resilience \rightarrow ROA (H1) SU resilience \rightarrow ROA (H1) SU resilience \rightarrow ROA (H1) SU \rightarrow ROA)	20A) 189.88	27	0.96	0.94	0.96	0.07				0.13*		Support H1
RWC (<i>HZ</i>) Baseline model Constrained model Constrained path ^a	231.36 247.13 242.64	54 55 55	86:0 96:0 96:0	$\begin{array}{c} 0.92 \\ 0.92 \\ 0.91 \end{array}$	$\begin{array}{c} 0.93 \\ 0.92 \\ 0.94 \end{array}$	0.05 0.06 0.06	15.77 11.28	8 1	< 0.05 < 0.01	0.12*	0.19*	Support H2
SGF (H3) Baseline model Constrained model Constrained path ^a	231.88 258.12 239.96	54 55	0.98 0.95 0.96	$\begin{array}{c} 0.94 \\ 0.92 \\ 0.93 \end{array}$	0.97 0.95 0.96	0.07 0.07 0.07	26.23 8.07	8 1	< 0.001 < 0.01	0.18*	0.15*	Support H3
II (174) Baseline model Constrained model Constrained path ^a	217.66 235.54 222.57	54 55 55	0.94 0.95 0.97	0.95 0.95 0.96	0.95 0.96 0.97	0.06 0.06 0.06	17.88 4.91	8 1	< 0.05 < 0.05	0.12*	0.20*	Support H4
El (<i>H2)</i> Baseline model Constrained model Constrained path ^a	244.25 256.37 248.42	54 55 55	0.89 10.0 10.0	0.90 0.91 0.90	16:0 16:0 19:0	0.06 0.05 0.06	$12.12 \\ 4.17$	8 1	0.15 < 0.05	0.13*	0.16*	Reject H5
Panel B: robustness analysis (DV: SC resilience \rightarrow ROE (H1) Multi-group analysis (DV: ROE)	ROE) 193.19	27	0.94	0.93	0.94	60.0				0.12****		Support H1
RMC (<i>H2</i>) Baseline model Constrained model Constrained path ^b	241.40 259.01 248.19	54 62 55	0.93 06.0 09.0	0.90 0.88 0.86	0.93 0.90 0.90	0.0 0.09 0.09	17.61 6.79	8 1	< 0.05 < 0.01	0.11*	0.16*	Support H2
SCF (H3) Baseline model Constrained model Constrained path ^b	231.41 252.93 239.75	54 55 55	0.94 0.90 0.90	0.91 0.87 0.87	$\begin{array}{c} 0.94 \\ 0.90 \\ 0.88 \end{array}$	00.0 00.0	21.52 8.34	8 1	< 0.01 < 0.01	0.14*	0.12*	Support H3
ll (<i>H4</i>) Baseline model	217.30	54	0.91	0.93	0.93	0.07						
												(continued)
Table V. Results of hypotheses testing and robustness checks											91	Value of supply chain resilience

DLM	Hypotheses	Support H4	Support H5	Support H1	Support H2	Support H3	Support H4	Reject <i>H5</i> it". * <i>p</i> < 0.05;
	High)	0.19*	0.21*		0.17**	0.16**	0.24***	0.27** → Net Prof
	β (Low	0.17*	0.10^{*}	0.20*	0.23**	0.30*	0.26***	0.29** SC resilience
	þ	< 0.05 < 0.05	< 0.001 < 0.001		< 0.001 < 0.001	< 0.05 < 0.01	< 0.01 < 0.05	0.32 < 0.05 ed the path "
	Δdf	8 1	-1 8		8 1	8 1	8 1	8 1 onstraine
	$\Delta \chi^2$	$16.46 \\ 3.87$	28.81 23.69		26.58 12.28	17.05 6.66	21.28 5.35	9.22 4.46 → ROE"; '
	RMSEA	0.07 0.07	0.07 0.06 0.07	0.06	0.06 0.07 0.08	0.07 0.07 0.07	0.10 0.09 0.09	0.05 0.04 0.05 SC resilience
	CFI	$0.93 \\ 0.94$	$\begin{array}{c} 0.94 \\ 0.93 \\ 0.93 \end{array}$	0.96	0.97 0.95 0.96	$\begin{array}{c} 0.96 \\ 0.93 \\ 0.94 \end{array}$	0.88 0.91 0.90	0.94 0.94 0.94 he path "
	TLI	$0.91 \\ 0.92$	$\begin{array}{c} 0.93\\ 0.93\\ 0.91\end{array}$	0.96	$\begin{array}{c} 0.94 \\ 0.93 \\ 0.93 \end{array}$	$\begin{array}{c} 0.94 \\ 0.91 \\ 0.91 \end{array}$	0.88 0.90 0.90	0.94 0.94 0.94 rained th
	IFI	$0.93 \\ 0.94$	$\begin{array}{c} 0.90\\ 0.94\\ 0.94\\ 0.94\end{array}$	0.94	0.97 0.95 0.96	$\begin{array}{c} 0.96\\ 0.93\\ 0.94\end{array}$	88.0 090 090	0.91 0.94 0.94 "; ^b Const
	df	62 55	54 55	27	54 55	54 62 55	54 55 55	54 62 55 ROA
	X2	233.76 221.17	220.32 249.13 244.01	<i>Net Profit)</i> 189.06 ofit)	216.15 242.73 228.43	225.16 242.21 231.82	214.62 235.90 219.97	220.32 229.54 224.78 C resilience < 0.1
e V.		Constrained model Constrained path ^b	El (<i>H3)</i> Baseline model Constrained model Constrained path ^b	Panel C: robustness analysis $(DV:$ SC resilience \rightarrow Net Profit (HI) Multi-group analysis (DV: Net Pr DMC (HI)	KWC (712) Baseline model Constrained model Constrained path ^c SCT (113)	Section model Baseline model Constrained path ^c n (12)	L (174) Baseline model Constrained model Constrained path ^c	El (<i>H3</i>) Baseline model Constrained model Constrained path ^c Notes: ^a Constrained the path "SV *** $p < 0.01$; **** $p < 0.001$; ***** p

IJPI 50,1

92

Tabl _____

Similarly, both χ^2 differences are significant under different levels of SCF ($\Delta \chi^2 = 26.23$, $\Delta df = 8$, p < 0.001; $\Delta \chi^2 = 8.07$, $\Delta df = 1$, p < 0.01) and II ($\Delta \chi^2 = 17.88$, $\Delta df = 8$, p < 0.05; $\Delta \chi^2 = 4.91$, $\Delta df = 1$, p < 0.05). Table V shows positive and significant results for the relationship between SC resilience and ROA when SCF is low ($\beta = 0.18$, p < 0.05) or high ($\beta = 0.15$, p < 0.05), or when II is low ($\beta = 0.12$, p < 0.05) or high ($\beta = 0.20$, p < 0.05). Hence, *H3* and *H4* were supported.

Investigating the moderating role of EI in the relationship between SC resilience and ROA, we found significant χ^2 differences ($\Delta \chi^2 = 4.17$, $\Delta df = 1$, p < 0.5) between the baseline and the constrained path, but we found insignificant χ^2 differences ($\Delta \chi^2 = 12.12$, $\Delta df = 8$, p > 0.05) between the baseline model and the constrained models. Hence, *H5* was rejected.

Robustness analysis and endogeneity tests

We chose two additional indicators of financial performance to verify the robustness of the study findings, namely, return on equity (ROE) and net profit to reconduct the hypotheses testing. ROE accounts for a financial perspective from a shareholder point, presenting profit generation of the stockholders' equity. Net profit measures how much revenues are left after excluding all expenses, appearing at the bottom of a firm's income statement. Firm managers, creditors and investors refer to these indicators for the judgment of the firm's financial position (Jegers, 1991). Panels B and C of Table V show the results. The moderating effect of EI (*H5*) was supported with ROE as the dependent variable. All other hypotheses testing results were consistent with panel A of Table V.

Three dependent variables can be affected by other factors that are not observed in this study, raising our attention on the issue of endogeneity. We addressed this concern by introducing a two-stage least squares (2SLS) method, as suggested by Larcker and Rusticus (2010) and Wooldridge (2009). In this study, we apply a reversed scale of risk/disruption management teams' hierarchy levels in their firms as the instrumental variable. First, an instrumental variable should be correlated with the independent variable (Wooldridge, 2009). The low hierarchy level of the risk/disruption management team represents a significant place in the firm, and the team can allocate more resources to handle disruptions (Porter, 1962), indicating the firm's higher level of SC resilience. Second, how the hierarchy level of the risk/disruption management team succear, suggesting the instrumental variable's exogeneity (Wooldridge, 2009). Same as main test, firm age, annual revenue, employee number and industry type were included as control variables.

Hansen's J-test was first conducted to measure the instrument's appropriateness following Larcker and Rusticus (2010). This test aims to investigate the association between the instrument and dependent variables from over-identifying restrictions. The insignificant results (p > 0.05) show the validity of the instrument. We then assessed the strength of the instrument. The instrument is positive and significant (p < 0.05) in the first-stage model of 2SLS, suggesting that we did not suffer from the weak instrument (Wooldridge, 2009).

The second-stage model was then adopted to address the concern on the endogeneity due to unobservable omitted variables. The positive and significant (p < 0.05) impact of predicted values of SC resilience from the first stage on financial performance is consistent with the results *H1*. Thus, we conclude that the results were robust and this study did not suffer from potential biases caused by endogeneity (Larcker and Rusticus, 2010; Wooldridge, 2009). Table VI shows the results of the endogeneity tests.

Discussion and implications

Discussion and theoretical implications

This study contributes to the SC resilience literature that calls for investigation on the financial impact of SC resilience (Hohenstein *et al.*, 2015). SC resilience is recognized as a

IJPDLM 50,1		SC resilience β	ROA_{eta}	$\substack{\text{ROE}\\ \beta}$	Net profit β
	Two-stage least squares esti	imation			
	Predicted SC resilience Control variables		0.152* (0.356)	0.169* (0.552)	0.260* (0.173)
	Firm age	0.038 (0.065)	-0.047 (0.086)	-0.069(0.086)	0.010 (0.085)
94	Annual revenue	0.111 (0.083)	0.007 (0.102)	-0.021(0.102)	-0.024(0.100)
	Number of employees	0.055 (0.075)	-0.078 (0.102)	-0.028 (0.102)	0.011 (0.101)
	Type of industry	0.138 (0.065)	0.048 (0.087)	0.058 (0.087)	0.062 (0.086)
	Instrumental variable	0.224* (0.075)			
	Intercept	0.000 (0.052)	0.000 (0.070)	0.000 (0.070)	0.000 (0.069)
	R^2	0.214	0.026	0.023	0.050
	ΔR^2	0.024	0.020	0.017	0.031
	Hansen's J-test				
	Instrumental variable		-0.121 (1.651)	-0.108(2.777)	-0.053 (0.852)
Table VI. Endogeneity tests	Notes: Standard errors in p variables only (not shown i	parentheses; ΔR^2 referred in the table). * $p < 0.0$	ers to R^2 change comp 5	paring with models th	nat include control

buffer for excessive capacity maintenance that increases expenses (Ghaderi *et al.*, 2018). However, the present study empirically confirmed that SC resilience positively affects the firm's financial performance, suggesting the business value of SC resilience for handling SC disruptions. The result supports our expectation and is consistent with prior research (e.g. Yu *et al.*, 2019). The present study advances the SC resilience literature by focusing on objective measures of financial performance, instead of several subjective items listed in the questionnaire (e.g. Li *et al.*, 2017; Yu *et al.*, 2019), which may result in common method variance (Podsakoff *et al.*, 2003).

The present study contributes to the theories of organizational culture and resource orchestration. The common view of organizational culture and resource orchestration theories suggests that organizations strive for reducing the influences of SC disruptions. However, beyond this common ground, organizational culture provides a theoretical foundation for RMC and SCF, which are regarded as a control- and flexibility-oriented organizational activities, whereas resource orchestration theory provides a foundation for integration. Complementing one another, these two theories are integrated to explain the relationship between SC resilience and financial performance, and how the roles of RMC, SCF and integration affect the relationship.

Handling disruptions is one of the most important elements of SC resilience. Considerable logically interrelated practices or approaches support one another and help firms build resilience (Dabhilkar *et al.*, 2016). RMC, SCF and integration are the strategies or the capabilities that help firms cope with disruptions and obtain good performance based on the literature and the above-mentioned theories. However, their roles in the relationship between SC resilience and business performance are still unknown. The present study contributes knowledge to the literature by providing insights into the moderating roles of the culture, flexibility and integration in the performance impact of SC resilience. It serves as a reference for future research to explore the impact of other activities and environmental conditions in the relationship.

This study proves the positive and significant effects of RMC, SCF and II on the relationship between SC resilience and financial performance. As a control-oriented activity, RMC has a significant effect on the SC resilience–financial performance as conjectured based on organizational culture theory (Denison and Spreitzer, 1991). The results suggest that having control-oriented activities is sufficient in helping firms to cope with the changing environmental condition, which is largely out of the firm's control. The significant moderating effect suggests that RMC as a cultural element offers firms with control of

changes in its business environment. SCF and II significantly affect the relationship between SC resilience and financial performance, which suggests the value of SCF and II for firms' financial performance when the firms maintain teamwork in the internal organization and build strategic partnership across SCs.

With respect to the role of EI, the results did not show support for the value of SC resilience on financial performance. A plausible explanation can be related to our sample group. Table I shows that many medium and large companies are listed in Taiwan. The large firm size and complication of external partners of the firms may make EI insufficient to positively affect the relationship between SC resilience and financial performance. SCs are complex due to the tiers of SC partners (e.g. suppliers and customers) from different countries and industries, thereby increasing the difficulty of EI (Shao *et al.*, 2018). Considerable efforts on administration, coordination and control over their actions are required to implement EI in large firms. Hence, the moderation of EI in the relationship between SC resilience and financial performance is insignificant. Firms' specific efforts on the adoption of certain strategies help them outperform their competitors but do not guarantee an improved financial performance based on resource orchestration theory (Sirmon *et al.*, 2011). In line with the theory, firms could find operational value in the process of EI implementation, considering as capability building activities, even in the absence of effects on the financial benefits of SC resilience.

Managerial implications

Managers currently face increasing disruptions in the SC management. In response, they increase the organizational capability to cope with disruptions to avoid the negative effect. Although some scholars find that firms can improve their operational performance and gain profit due to SC resilience (Chowdhury *et al.*, 2019; Wieland and Wallenburg, 2013), managers still believe that adopting SC resilience is costly. From the results of this study, managers are equipped with empirical evidence of the positive effect of SC resilience to protect the firms against negative impacts from SC disruptions. Although the adoption of SC resilience-related practices is a cost, considerable financial results can be achieved through the allocated resources and efforts on building resilient SCs.

Based on the findings, three out of four moderators (i.e. RMC, SCF and II) enhance the financial performance outcomes of SC resilience, whereas EI does not affect the relationship. Managers can now tell how to adopt strategies and get financial performance with SC resilience and why the efforts on the implementation of certain strategies and building SC resilience do not always cause desirable performance outcomes. Excessive practices adopted in a firm may lead to negative business performance impact, as severe disruptions (e.g. earthquakes and floods) do not happen frequently. Managers should adopt management practices with the consideration of the environmental conditions (e.g. political environments, industry characteristics, firm scale and market share) and disruption types that they learn to cope with. Most of Taiwanese firms are export oriented (Chen et al., 2015). They invest in factories in less-developed countries and operate internationally to gain market opportunities. This mode of operations introduces risks of managing their SC with cultural differences, which makes it difficult to develop RMC, SCF and II. The positive and significant effects of RMC, SCF and II on the SC resilience-performance relationship indicate the importance of work closely across functions, share the same culture in risk management and retain flexibility in SC. Due to the international operations nature of the sample firms, the study findings provide references for managers in other places as well.

Limitations and future research agenda

Several limitations of this study should be noted. First, our measurements for SC resilience capture firms' capabilities, such as adaptability and responsiveness to SC disruptions.

Managers still lack knowledge about the practices they can adopt to improve their capabilities (Ambulkar *et al.*, 2015). Thus, identifying specific organizational practices that constitute to SC resilience to handle disruptions is important. The practices of SC resilience and its measurement scales will provide useful references for firms to conduct an evaluation of their efforts on SC resilience and detect improvement areas. Second, we only conducted a survey to get primary data for measurements of SC resilience and the moderators (i.e. RMC, SCF, II and EI). Future studies are suggested to adopt a multimethod research design, including field studies and interviews, to obtain additional information from firms. Third, our sample was chosen from the manufacturing industry located in Taiwan. Other studies can choose different industries and/or different places to carry on further studies on the same relationships as well as validate and generalize our study findings. Last, as the limitation of the survey method, we did not collect data from a long term. Hence, further studies should focus on the impact of SC resilience and the role of culture, flexibility and integration on financial performance in the long run.

References

- Ambulkar, S., Blackhurst, J. and Grawe, S. (2015), "Firm's resilience to supply chain disruptions: scale development and empirical examination", *Journal of Operations Management*, Vols 33-34 No. 1, pp. 111-122.
- Anderson, J.C. and Gerbing, D.W. (1988), "Structural equation modeling in practice: a review and recommended two-step approach", *Psychological Bulletin*, Vol. 103 No. 3, pp. 411-423.
- Armstrong, J.S. and Overton, T.S. (1977), "Estimating nonresponse bias in mail surveys", Journal of Marketing Research, Vol. 14 No. 3, pp. 396-402.
- Azevedo, S.G., Govindan, K., Carvalho, H. and Cruz-Machado, V. (2013), "Ecosilient index to assess the greenness and resilience of the upstream automotive supply chain", *Journal of Cleaner Production*, Vol. 56, pp. 131-146.
- Bagozzi, R.P., Li, Y.J. and Phillips, L.W. (1991), "Assessing construct-validity in organizational research", Administrative Science Quarterly, Vol. 36 No. 3, pp. 421-458.
- Bairamzadeh, S., Pishvaee, M.S. and Saidi-Mehrabad, M. (2015), "Multiobjective robust possibilistic programming approach to sustainable bioethanol supply chain design under multiple uncertainties", *Industrial & Engineering Chemistry Research*, Vol. 55 No. 1, pp. 237-256.
- Braunscheidel, M.J. and Suresh, N.C. (2009), "The organizational antecedents of a firm's supply chain agility for risk mitigation and response", *Journal of Operations Management*, Vol. 27 No. 2, pp. 119-140.
- Cardoso, S.R., Barbosa-Povoa, A.P., Relvas, S. and Novais, A.Q. (2015), "Resilience metrics in the assessment of complex supply-chains performance operating under demand uncertainty", *Omega-International Journal of Management Science*, Vol. 56, pp. 53-73.
- Chen, Y.J., Wu, Y.J. and Wu, T.H. (2015), "Moderating effect of environmental supply chain collaboration evidence from Taiwan", *International Journal of Physical Distribution & Logistics Management*, Vol. 45 Nos 9-10, pp. 959-978.
- Chowdhury, M.M.H., Quaddus, M. and Agarwal, R. (2019), "Supply chain resilience for performance: role of relational practices and network complexities", *Supply Chain Management: An International Journal*, Vol. 24 No. 5, pp. 659-676.
- Christopher, M. and Peck, H. (2004), "Building the resilient supply chain", *International Journal of Logistics Management*, Vol. 15 No. 2, pp. 1-14.
- Dabhilkar, M., Birkie, S.E. and Kaulio, M. (2016), "Supply-side resilience as practice bundles: a critical incident study", *International Journal of Operations & Production Management*, Vol. 36 No. 8, pp. 948-970.
- Dagostino, R.B., Belanger, A. and Dagostino, R.B. (1990), "A suggestion for using powerful and informative tests of normality", *American Statistician*, Vol. 44 No. 4, pp. 316-321.

IJPDLM

- Das, K. and Lashkari, R.S. (2015), "Risk readiness and resiliency planning for a supply chain", International Journal of Production Research, Vol. 53 No. 22, pp. 6752-6771.
- Davis, H. (2018), "Multi-axial warp knitting options from Karl Mayer", available at: www.knittingtradejournal.com/warp-knitting-news/13328-multi-axial-warp-knitting-optionsfrom-karl-mayer (accessed January 1, 2019).
- Demeter, K., Szasz, L. and Racz, B.G. (2016), "The impact of subsidiaries' internal and external integration on operational performance", *International Journal of Production Economics*, Vol. 182, pp. 73-85.
- Denison, D.R. and Mishra, A.K. (1995), "Toward a theory of organizational culture and effectiveness", Organization Science, Vol. 6 No. 2, pp. 204-223.
- Denison, D.R. and Spreitzer, G.M. (1991), "Organizational culture and organizational development: a competing values approach", *Research in Organizational Change and Development*, Vol. 5 No. 1, pp. 1-21.
- Dsouza, H. (2017), "Karl Mayer sets up new unit to develop digital solutions for the textile industry", available at: www.textileexcellence.com/news/industry-news/karl-mayer-sets-up-new-unit-todevelop-digital-solutions-for-the-textile-industry/ (accessed January 1, 2019).
- Dubey, R., Gunasekaran, A., Childe, S.J., Fosso Wamba, S., Roubaud, D. and Foropon, C. (2019), "Empirical investigation of data analytics capability and organizational flexibility as complements to supply chain resilience", *International Journal of Production Research*, pp. 1-19.
- Enz, M.G. and Lambert, D.M. (2015), "Measuring the financial benefits of cross-functional integration influences management's behavior", *Journal of Business Logistics*, Vol. 36 No. 1, pp. 25-48.
- Erol, O., Sauser, B.J. and Mansouri, M. (2010), "A framework for investigation into extended enterprise resilience", *Enterprise Information Systems*, Vol. 4 No. 2, pp. 111-136.
- Fattahi, M., Govindan, K. and Keyvanshokooh, E. (2017), "Responsive and resilient supply chain network design under operational and disruption risks with delivery lead-time sensitive customers", *Transportation Research Part E-Logistics and Transportation Review*, Vol. 101, pp. 176-200.
- Flynn, B., Pagell, M. and Fugate, B. (2018), "Editorial: survey research design in supply chain management: the need for evolution in our expectations", *Journal of Supply Chain Management*, Vol. 54 No. 1, pp. 1-15.
- Ghaderi, H., Moini, A. and Pishvaee, M.S. (2018), "A multi-objective robust possibilistic programming approach to sustainable switchgrass-based bioethanol supply chain network design", *Journal of Cleaner Production*, Vol. 179, pp. 368-406.
- Gligor, D.M., Holcomb, M.C. and Stank, T.P. (2013), "A multidisciplinary approach to supply chain agility: conceptualization and scale development", *Journal of Business Logistics*, Vol. 34 No. 2, pp. 94-108.
- Golgeci, I. and Ponomarov, S.Y. (2013), "Does firm innovativeness enable effective responses to supply chain disruptions? An empirical study", *Supply Chain Management: An International Journal*, Vol. 18 No. 6, pp. 604-617.
- Hair, J.F., Black, W.C., Babin, B.J., Anderson, R.E. and Tatham, R.L. (1998), *Multivariate Data Analysis*, Prentice Hall, Upper Saddle River, NJ.
- Hendricks, K.B. and Singhal, V.R. (2005), "Association between supply chain glitches and operating performance", *Management Science*, Vol. 51 No. 5, pp. 695-711.
- Hill, C.W.L., Hitt, M.A. and Hoskisson, R.E. (1992), "Cooperative versus competitive structures in related and unrelated diversified firms", *Organization Science*, Vol. 3 No. 4, pp. 501-521.
- Hofstede, G.H. (1980), *Culture's Consequences: International Differences in Work-related Values*, Sage Publications, Beverly Hills, CA.
- Hohenstein, N.O., Feisel, E., Hartmann, E. and Giunipero, L. (2015), "Research on the phenomenon of supply chain resilience a systematic review and paths for further investigation", *International Journal of Physical Distribution & Logistics Management*, Vol. 45 Nos 1-2, pp. 90-117.

Value of supply chain resilience

97

IJPDLM 50,1	Hosseini, S., Ivanov, D. and Dolgui, A. (2019), "Review of quantitative methods for supply chain resilience analysis", <i>Transportation Research Part E-Logistics and Transportation Review</i> , Vol. 125, pp. 285-307.
	Hu, L.T. and Bentler, P.M. (1999), "Cutoff criteria for fit indexes in covariance structure analysis: conventional criteria versus new alternatives", <i>Structural Equation Modeling-a Multidisciplinary</i> <i>Journal</i> , Vol. 6 No. 1, pp. 1-55.
98	Idb (2013), "The 20th industrial cooperation consultation meeting", available at: www.moeaidb.gov.tw/ external/ctlr?lang=1&PRO=news.rwdNewsView&id=13805 (accessed September 5, 2018).
	Jaccard, J. and Turrisi, R. (2003), Interaction Effects in Multiple Regression, Sage Publications, Thousand Oaks, CA.
	Jegers, M. (1991), "Prospect-theory and the risk-return relation – some belgian evidence", Academy of Management Journal, Vol. 34 No. 1, pp. 215-225.
	Jiang, B., Baker, R.C. and Frazier, G.V. (2009), "An analysis of job dissatisfaction and turnover to reduce global supply chain risk: evidence from China", <i>Journal of Operations Management</i> , Vol. 27 No. 2, pp. 169-184.

- Juttner, U. and Maklan, S. (2011), "Supply chain resilience in the global financial crisis: an empirical study", Supply Chain Management: An International Journal, Vol. 16 No. 4, pp. 246-259.
- Ketterer, H.L., Han, K., Hur, J. and Moon, K. (2010), "Development and validation of culture-specific variable response inconsistency and true response inconsistency scales for use with the Korean MMPI-2", *Psychological Assessment*, Vol. 22 No. 3, pp. 504-519.
- Khazanchi, S., Lewis, M.W. and Boyer, K.K. (2007), "Innovation-supportive culture: the impact of organizational values on process innovation", *Journal of Operations Management*, Vol. 25 No. 4, pp. 871-884.
- Kochan, C.G. and Nowicki, D.R. (2018), "Supply chain resilience: a systematic literature review and typological framework", *International Journal of Physical Distribution & Logistics Management*, Vol. 48 No. 8, pp. 842-865.
- Kovach, J.J., Hora, M., Manikas, A. and Patel, P.C. (2015), "Firm performance in dynamic environments: the role of operational slack and operational scope", *Journal of Operations Management*, Vol. 37 No. 1, pp. 1-12.
- Kubota, Y. (2016), "Japan earthquakes rattle Toyota's vulnerable supply chain", available at: www.wsj.com/ articles/japan-earthquakes-rattle-toyotas-supply-chain-1460986805 (accessed September 5, 2018).
- Kumar, V., Bak, O., Guo, R.Z., Shaw, S.L., Colicchia, C., Garza-Reyes, J.A. and Kumari, A. (2018), "An empirical analysis of supply and manufacturing risk and business performance: a Chinese manufacturing supply chain perspective", *Supply Chain Management: An International Journal*, Vol. 23 No. 6, pp. 461-479.
- Kurniawan, R., Zailani, S.H., Iranmanesh, M. and Rajagopal, P. (2017), "The effects of vulnerability mitigation strategies on supply chain effectiveness: risk culture as moderator", *Supply Chain Management: An International Journal*, Vol. 22 No. 1, pp. 1-15.
- Larcker, D.F. and Rusticus, T.O. (2010), "On the use of instrumental variables in accounting research", Journal of Accounting & Economics, Vol. 49 No. 3, pp. 186-205.
- Lee, H.L. and Whang, S. (2004), E-Business and Supply Chain Integration, Springer, New York.
- Li, X., Wu, Q., Holsapple, C.W. and Goldsby, T. (2017), "An empirical examination of firm financial performance along dimensions of supply chain resilience", *Management Research Review*, Vol. 40 No. 3, pp. 254-269.
- Liu, C.L. and Lee, M.Y. (2018), "Integration, supply chain resilience, and service performance in third-party logistics providers", *International Journal of Logistics Management*, Vol. 29 No. 1, pp. 5-21.
- McCarthy-Byrne, T.M. and Mentzer, J.T. (2011), "Integrating supply chain infrastructure and process to create joint value", *International Journal of Physical Distribution & Logistics Management*, Vol. 41 No. 2, pp. 135-161.

- McDermott, C.M. and Stock, G.N. (1999), "Organizational culture and advanced manufacturing technology implementation", *Journal of Operations Management*, Vol. 17 No. 5, pp. 521-533.
- Michailova, S. and Hutchings, K. (2006), "National cultural influences on knowledge sharing: a comparison of China and Russia", *Journal of Management Studies*, Vol. 43 No. 3, pp. 383-405.
- Montabon, F., Daugherty, P.J. and Chen, H.Z. (2018), "Setting standards for single respondent survey design", *Journal of Supply Chain Management*, Vol. 54 No. 1, pp. 35-41.
- Morash, E.A., Dröge, C. and Vickery, S. (1996), "Boundary spanning interfaces between logistics, production, marketing and new product development", *International Journal of Physical Distribution & Logistics Management*, Vol. 26 No. 8, pp. 43-62.
- Morningstar (2017), "Toyota Motor Corp ADR", available at: http://financials.morningstar.com/ratios/r. html?t=TM®ion=usa&culture=en-US (accessed September 5, 2018).
- Nunnally, J.C. and Bernstein, I.H. (1994), Psychometric Theory, McGraw-Hill, New York, NY.
- Obayi, R., Koh, S.C., Oglethorpe, D. and Ebrahimi, S.M. (2017), "Improving retail supply flexibility using buyer-supplier relational capabilities", *International Journal of Operations & Production Management*, Vol. 37 No. 3, pp. 343-362.
- Pellathy, D.A., In, J., Mollenkopf, D.A. and Stank, T.P. (2018), "Middle-range theorizing on logistics customer service", *International Journal of Physical Distribution & Logistics Management*, Vol. 48 No. 1, pp. 2-18.
- Peng, D.X. and Lai, F.J. (2012), "Using partial least squares in operations management research: a practical guideline and summary of past research", *Journal of Operations Management*, Vol. 30 No. 6, pp. 467-480.
- Podsakoff, P.M., Mackenzie, S.B., Lee, J.Y. and Podsakoff, N.P. (2003), "Common method biases in behavioral research: a critical review of the literature and recommended remedies", *Journal of Applied Psychology*, Vol. 88 No. 5, pp. 879-903.
- Ponomarov, S.Y. and Holcomb, M.C. (2009), "Understanding the concept of supply chain resilience", International Journal of Logistics Management, Vol. 20 No. 1, pp. 124-143.
- Porter, L.W. (1962), "Job attitudes in management: I. Perceived deficiencies in need fulfillment as a function of job level", *Journal of Applied Psychology*, Vol. 46 No. 6, p. 375.
- Randall, W.S., Nowicki, D.R., Deshpande, G. and Lusch, R.F. (2014), "Converting knowledge into value Gaining insights from service dominant logic and neuroeconomics", *International Journal of Physical Distribution & Logistics Management*, Vol. 44 Nos 8-9, pp. 655-670.
- Revilla, E. and Saenz, M.J. (2017), "The impact of risk management on the frequency of supply chain disruptions a configurational approach", *International Journal of Operations & Production Management*, Vol. 37 No. 5, pp. 557-576.
- Riley, J.M., Klein, R., Miller, J. and Sridharan, V. (2016), "How internal integration, information sharing, and training affect supply chain risk management capabilities", *International Journal of Physical Distribution & Logistics Management*, Vol. 46 No. 10, pp. 953-980.
- Rodrigues, A.M., Stank, T.P. and Lynch, D.F. (2004), "Linking strategy, structure, process, and performance in integrated logistics", *Journal of Business Logistics*, Vol. 25 No. 2, pp. 65-94.
- Roehrich, J.K., Grosvold, J. and Hoejmose, S.U. (2014), "Reputational risks and sustainable supply chain management decision making under bounded rationality", *International Journal of Operations & Production Management*, Vol. 34 No. 5, pp. 695-719.
- Shao, B.B.M., Shi, Z., Choi, T.Y. and Chae, S. (2018), "A data-analytics approach to identifying hidden critical suppliers in supply networks: development of nexus supplier index", *Decision Support Systems*, Vol. 114, pp. 37-48.
- Shirouzu, N. (2015), "Toyota likely to divert shipments from China's Tianjin port after blasts", available at: www.reuters.com/article/us-china-blast-toyota/toyota-likely-to-divert-shipments-from-chinas-tianjinport-after-blasts-idUSKCN0Q007U20150819 (accessed September 5, 2018).

Value of supply chain resilience

99

IJPDLM 50,1	Sirmon, D.G., Hitt, M.A. and Ireland, R.D. (2007), "Managing firm resources in dynamic environments to create value: looking inside the black box", <i>Academy of Management Review</i> , Vol. 32 No. 1, pp. 273-292.
	Sirmon, D.G., Hitt, M.A., Ireland, R.D. and Gilbert, B.A. (2011), "Resource orchestration to create competitive advantage: breadth, depth, and life cycle effects", <i>Journal of Management</i> , Vol. 37 No. 5, pp. 1390-1412.

Stank, T.P., Keller, S.B. and Daugherty, P.J. (2001), "Supply chain collaboration and logistical service performance", Journal of Business Logistics, Vol. 22 No. 1, pp. 29-48.

1,

- Tabachnick, B.G. (2013), Using Multivariate Statistics, Pearson, Boston.
- TradeGecko (2018), "IKEA supply chain: how does IKEA manage its inventory?", available at: www. tradegecko.com/blog/ikeas-inventory-management-strategy-ikea (accessed December 31, 2018).
- Vanpoucke, E., Vereecke, A. and Muylle, S. (2017), "Leveraging the impact of supply chain integration through information technology", International Journal of Operations & Production Management, Vol. 37 No. 4, pp. 510-530.
- Wade, M. and Hulland, J. (2004), "Review: the resource-based view and information systems research: review, extension, and suggestions for future research", MIS Quarterly, Vol. 28 No. 1, pp. 107-142.
- Wieland, A. and Wallenburg, C.M. (2013), "The influence of relational competencies on supply chain resilience: a relational view", International Journal of Physical Distribution & Logistics Management, Vol. 43 No. 4, pp. 300-320.
- Wiengarten, F., Li, H.S., Singh, P.J. and Fynes, B. (2019), "Re-evaluating supply chain integration and firm performance: linking operations strategy to supply chain strategy", Supply Chain Management: An International Journal, Vol. 24 No. 4, pp. 540-559.
- Wong, C.Y., Boon-Itt, S. and Wong, C.W.Y. (2011), "The contingency effects of environmental uncertainty on the relationship between supply chain integration and operational performance", Journal of Operations Management, Vol. 29 No. 6, pp. 604-615.
- Wong, C.Y., Wong, C.W.Y. and Boon-Itt, S. (2015), "Integrating environmental management into supply chains a systematic literature review and theoretical framework". International Journal of Physical Distribution & Logistics Management, Vol. 45 Nos 1-2, pp. 43-68.
- Wooldridge, J.M. (2009), Introductory Econometrics: A Modern Approach, South-Western Cengage Learning, Mason, OH.
- Yu, W., Jacobs, M.A., Chavez, R. and Yang, J. (2019), "Dynamism, disruption orientation, and resilience in the supply chain and the impacts on financial performance: a dynamic capabilities perspective", International Journal of Production Economics, Vol. 218, pp. 352-362.

Corresponding author

Christina W.Y. Wong can be contacted at: tcchris@polyu.edu.hk