Openness to technological innovation, supply chain resilience and operational performance: Exploring the role of information processing capabilities

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Abstract

Increasing volatility in the global economy since the 2009 financial crisis, including the US-China trade war and recent COVID-19 outbreak, has compelled businesses to build resilience to respond quickly to unexpected disruptions. Consistent with organizational information processing theory (OIPT), we posit that openness to technological innovation helps to build information processing capabilities (i.e., inter-functional coordination and inter-partner informational justice), which are required to build supply chain resilience (SCR) and improve performance. Structural equation modelling is used to analyse survey data gathered from 241 Chinese manufacturers. The results reveal inter-functional coordination and inter-partner informational justice fully mediate the relationship between openness to technological innovation and SCR, and information processing capabilities and SCR are significantly and positively associated with operational performance. This study extends OIPT by elucidating the role of openness to technological innovation and enhances the SCR literature by providing empirical evidence of the important roles for information processing capabilities. The findings provide a unique information processing perspective to help managers broaden their solutions against disruptive events, and thus avoid or minimize potential negative impacts on firms.

Keywords: Openness to technological innovation; inter-functional coordination; inter-partner informational justice; supply chain resilience; information processing capabilities

1. Introduction

Supply chains fundamentally rely on stable supplies of raw materials and reliable access to markets and labour to remain efficient. These conditions have been disrupted by the escalating trade war between the U.S. and China (China Daily, 2019), geo-political tensions such as Brexit, and various nativist or populist governments worldwide (Gysegom et al., 2019). Moreover, the COVID-19 outbreak, which began in December 2019, and subsequent lockdown measures, add significant uncertainties to global supply chains (DHL Resilience360, 2020; Juan and Lin, 2020). These trends suggest an increasingly precarious and unpredictable business environment in the coming years (Craven et al., 2020). While such uncertainties affirm the need for supply chain resilience (SCR), i.e., the ability to respond to unanticipated disruptions and restore normal operations quickly and effectively (Ali et al., 2017; Yu et al., 2019a), effective responses to supply chain disruptions rely on the ability to exchange, coordinate and processing information (Huo et al., 2014; Yu et al., 2019b).

Organizational information processing theory (OIPT) suggests firms facing environmental uncertainty will have an increased need for information and information processing capacity to understand their external environment through gathering and processing pertinent information (Daft and Lengel, 1986; Galbraith, 1973). Informed by OIPT, past SCM literature argues fits between information need and information processing capacity increase a firm's cost efficiency, flexibility and delivery performance (Swink and Schoenherr, 2015; Wong et al., 2015; Yu et al., 2021). OIPT is used to explain how supply chain risk information sharing and analysis improve operational performance (Fan et al., 2016). However, an emphasis on fits can obscure research to reveal the complex mechanisms that enhance information processing capacity. One information processing problem related to SCR is that information sharing does not necessarily lead to concerted actions if individuals' interpretations of information are not coordinated or aligned (Daft and Weick, 1984; Hult et al., 2004).

This study extends OIPT to explain how information processing capacity is enhanced through appropriate integrating mechanisms (Galbraith, 1973). To avoid disparate interpretation of information, firms use integrating mechanisms that enable cross-functional coordination (using e.g., rules, hierarchies, targets, information system, liaisons, integrators) to increase information processing capacity (Galbraith, 1973). We name this mechanism *inter-functional coordination*, defined as information sharing and collaboration among functional departments within organizations (Flynn et al., 2010; Slater and Narver, 1994; Yu et al., 2020) through a clearly defined target and definition of customer value. Like internal integration (Droge et al., 2012; Williams et al., 2013), inter-functional coordination is a key to achieve supply chain resilience (Yu et al., 2019a).

The understanding of unexpected disruptions is often troubled by inaccurate information transmitted between supply chain partners. When facing unanticipated disruptions, multiple versions of information received make it hard to trust and distinguish which is accurate. Real-time information brings benefits only if it is used to coordinate material flows throughout supply chains (Huo et al., 2014; Tukamuhabwa et al., 2015). Coordination effectiveness is increased when supply chain partners trust information they receive from emergency response taskforces or non-routine communications in emergency situations (Majchrzak et al., 2007), especially from partners. Thus, an additional mechanism that OPIT has not considered, i.e., the commitment to share trustworthiness and timeliness of information between supply chain partners labelled as *inter-partner informational justice* (Ellis et al., 2009; Liu et al., 2012), is required. Informational justice is created by trust and candour of partners' communications, meeting each other's needs to jointly respond to disruptions in coordination (Liu et al., 2012). Thus, *inter-partner informational justice* and *inter-functional* coordination are two key mechanisms for increasing information processing capacity required for to achieve SCR and operational performance.

Supply chains today are coordinated in part by semi-automated information and data processing technologies. Firms that introduce advanced information technologies more rapidly than their competitors are expected to optimize supply chain and logistics decisions and better respond to changing environments (Yu, 2015) and achieve better business performance (Wang et al., 2008). Technological innovation, defined as "the incorporation of technology into the development of new products or processes" (Stock et al., 2002, p. 539), is paramount in developing supply chain solutions that enhance information processing. For example, DHL Resiliene360 is a technology developed to visualize, track, and protect operations (www.resilience360.dhl.com). DHL Resiliene360 uses real-time information technology to visualize and monitor potential disruptions caused by extreme weather, traffic, strikes, geo-political unrest, and other factors around the clock. Real-time risk assessment is enabled by big data analytics to inform adaptation strategies when an emerging or future disruption is detected. Even though new technologies can potentially support *inter-functional coordination* and *inter-*

partner informational justice, some early studies show few manufacturing firms are ready to adopt new smart technologies that can effectively process the large amounts of information generated (Brown et al., 2011; Williams et al., 2013). Today the issue is not about a lack of technological innovation, but rather the lack of openness to technological innovation (Dahlander and Gann, 2010; Fu, 2012) may result in an inability to share and use real-time information to coordinate responses to disruptions.

This study argues *openness to technological innovation,* which refers to the latent readiness and willingness to adopt and implement new technologies (Gatignon and Xuereb, 1997; Zaltman et al., 1973), may enhance *inter-functional coordination* and *inter-partner information justice*. Openness to new technologies, applications and ideas reflects a culture that drives innovativeness and operational excellence through technology (Hurley and Hult, 1998; Van de Ven, 1986). Firms with openness use advanced information processing technologies to facilitate information flows among different functional departments and/or supply chain partners (Huo et al., 2014; Wang and Wei, 2007; Wong et al., 2015) and perform SC analytics (Yu et al., 2021). However, the value of openness is still unclear. Technologies such as blockchain can make supply chain information trustworthy but not every firm believes openness to such novel technologies can bring them information justice. Open innovation has been lamented for not delivering the expected business benefits (Dahlander and Gann, 2010; Fu, 2012). Given the importance of resilience and the need to clarify the value of openness, this study establishes a framework to test whether a firm's openness to technological innovation helps achieve resilient supply chains and improve operational performance through *inter-functional coordination* and *inter-partner information justice*.

2. Theory and hypotheses

2.1. OIPT and shared interpretation

Every task involves information processing. The main premise of OIPT is that "the greater the task uncertainty, the greater the amount of information that must be processed among decision makers during task execution in order to achieve a given level performance" (Galbraith, 1973: 28). This information need applies to SCR because uncertainty increases when a supply chain is disrupted. OIPT implies gathering, analysing, and processing information in a structured, engaged and logical way to reduce uncertainty through developing a shared interpretation of the environment using data-driven decision making (Burns and Wholey, 1993; Daft and Lengel, 1986; Galbraith, 1973).

Supply chains can be viewed as information processing and interpretation systems (Hult et al., 2004). OIPT has been applied to SCM literature to understand how information processing capabilities of a firm are enhanced through information distribution (Hult et al., 2004), the fit between market complexity and information integration (Wong et al., 2015) and the ability to analyse data (Yu et al., 2021). To achieve SCR, firms may reduce information need through buffering or increase information processing capacity through bridging (Bode et al., 2011). When a supply chain disruption is new and unanticipated, it is hard to reduce information needs, and therefore information processing capacity is the key.

This study argues information process capacity for responding effectively to supply chain disruptions is enhanced by using appropriate integrating mechanisms that facilitate shared interpretation (Daft and Weick, 1984; Milliken, 1990; Thomas et al., 1993). Shared interpretation is required because individuals may receive different information and respond differently, especially when a SC is disrupted. Shared interpretation relies on cross-functional information sharing, and frequent updates of information among supply chain partners (Williams et al., 2013), sharing of trustworthy information, and integration of supply chain processes (Cai et al., 2010; Huo et al., 2014). Shared interpretation is paramount because firms need to know how other partners would respond to different situations. In a supply chain, response decisions must be coordinated to achieve shared interpretation. OIPT offers integrating mechanisms such as rules, goal setting and hierarchies within a firm to coordinate tasks when there are uncertainties about others' actions (Galbraith, 1973). Inter-functional coordination and external coordination (information integration) with supply chain partners to develop a joint interpretation of the information they gathered and shared need similar integrating mechanisms that share trustworthy information to enhance informational justice.

2.2. OIPT's integrating mechanisms for SCR

Supply chain resilience (SCR) refers to "the adaptive capability of the supply chain to prepare for unexpected events, respond to disruptions, and recover from them by maintaining continuity of operations at the desired level of connectedness and control over structure and function" (Ponomarov and Holcomb, 2009, p. 131). Some major SCR components include elasticity, amplitude, hysteresis, malleability, and damping (Ponomarov and Holcomb, 2009). A supply chain that is resilient can absorb/mitigate the impact of unexpected network disruptions, and maintain, resume, and restore operations after a disruption, leading to a sustainable competitive advantage (Ali et al., 2017; Hohenstein et al., 2015 Kamalahmadi and Parast, 2016; Yu et al., 2019a). Developing a resilient supply chain enables firms to effectively react to unexpected events and quickly recover and resume normal business operations (Golgeci and Ponomarov, 2013; Juttner and Maklan, 2011; Tukamuhabwa et al., 2015; Juan and Lin, 2020). The ability to anticipate and respond quickly (Ali et al., 2017) depends not only on sharing real-time information, but also on how fast the supply chain reaches a joint interpretation of the disruption. For this to happen, we argue two integrating mechanisms are required, one internal and one external.

For integrating internal interpretation, *inter-functional coordination* refers to the coordinated application of organizational resources to synthesize and disseminate business intelligence and information across functional departments within the organization, such as sales and marketing, manufacturing, and procurement (Im and Workman, 2004; Slater and Narver, 1994; Williams et al., 2013) through specifying a clear target and customer value to deliver. Coordination of activities using clear goals helps enhance meaning, understands worst consequences, systematically connects efforts, and avoids duplication and waste (Reich, 2006). In a supply chain context, inter-functional coordination (or internal integration) refers to strategic cross-functional cooperation, where functional departments work together and share data and information (Jacobs et al., 2007; Flynn et al., 2010; Yu, 2015; Yu et al., 2020). Internal integration entails developing cross-functional information sharing and collaboration within the firm, so that different departments and functional units operate within a cohesive process network (Williams et al., 2013; Yu et al., 2020). According to OIPT, inter-functional coordination is an integrating mechanism for enabling internal information processing capability (Swink and Schoenherr, 2015). The degree of coordination and information sharing is often increased when an operation moves from a normal circumstance to a crisis (Kamalahmadi and Parast, 2016; Tukamuhabwa et al., 2015) to maintain operational performance.

For external integrated interpretation, trust is as important as coordination. *Inter-partner informational justice*, in the supply chain context, refers to the extent to which information exchange and communication among members of the supply chain is trustworthy (Ellis et al., 2009; Liu et al., 2012). Information sharing is often troubled by distortion of information in a supply chain (Lee et al., 1997). Supply chain partners typically exchange information relating to demand, point of sale, forecasting, and inventory planning (Huo et al., 2014; Yu, 2015; Wong et al., 2015). When facing a disruption, supply chain partners share information about the sources and magnitudes of the disruptions, which could be inaccurate or not timely. A supply chain can receive vastly different information from various sources. Sharing inaccurate information could lead to catastrophic damages. Inter-partner informational justice refers to supply chain partners communicating openly, explaining procedures thoroughly and reasonably, and sharing details in a timely manner to meet each other's specific needs (Bies and Moag, 1986; Tyler and Bies, 1990). In a supply chain process, inter-partner information sharing that emphasizes justice and trustworthiness is the basis for an open communication and willingness to trust and support each other during bad times (Liu et al., 2012; Tyler and Bies, 1990). The willingness to trust information is the basis for investing efforts in using the information. In this study, inter-partner informational justice is considered an important mechanism for enhancing external information processing capability.

We need to recognize that information sharing and coordination across functions and supply chains are partly facilitated by technologies, some of which also have data analytic capabilities. However, not everyone trusts technologies and the information produced by them. Thus, openness to technology matters. Following Zaltman et al.'s (1973) work, we define *openness to technological innovation* as the management of the firm's attention to recognize the need for the incorporation of new technologies into the development of new products/services. The innovation process involves initiation and implementation (Zaltman et al., 1973). An essential part of the initiation stage is "openness to the innovation" (Zaltman et al., 1973, p. 64), which is determined by whether firms are ready and willing to adopt innovation or are reluctant to innovate (Hurley and Hult 1998). Openness to new technologies and new ideas is a firm's culture (Hurley and Hult 1998; Utterback, 1971; Van de Ven, 1986). Openness drives the adoption of technological innovation (Wu et al., 2013). Technological innovation occurs when a firm uses new technology (such as new tools, techniques, devices, or systems) to make changes in products/services, or the ways in which new products/services are produced (Damanpour, 1987; Stock et al., 2002). Technological innovations bring changes to firms. Introducing new technologies can drive the acquisition of technological knowledge (Damanpour, 1987; Gatignon and Xuereb 1997; Wu et al., 2013) that may improve information processing capacity (Williams et al., 2013; Yu et al., 2019a).

2.3. Theoretical framework

Figure 1 shows a conceptual framework that suggests the relationships between openness to technological innovation, inter-functional coordination and inter-partner informational justice, SCR, and operational performance, drawn from the organizational information processing arguments (Daft and Weick, 1984; Hult et al., 2004). The relationships can be divided into four stages. The first stage is openness to technological innovation, which enables the use of advanced information technologies to collect and analyse data. Building information processing capabilities occurs in the second stage. Consistent with OIPT, we characterize inter-functional coordination as an integrating mechanism for coordinating internal information processing across functional departments within a firm, and inter-partner informational justice as an integrating mechanism for improving external information processing capability through the sharing of trustworthy information between supply chain partners. We expect internal and external information processing capabilities to facilitate shared interpretation of the repertoire of possible actions for the supply chain to quickly respond to unexpected disruptions in a concerted manner.

-------------------------------- Insert Figure 1 --------------------------------

2.4. Research hypotheses

2.4.1. Effects of openness to technological innovation

This study introduces openness to technological innovation as an extension to the original OIPT. The OIPT established in 1970s does not consider technological advancement and the use of technology to create shared interpretation. Nowadays, new technologies are used to facilitate coordination of information processing activities. Firms that are open to new technologies tend to adopt advanced and state-of-the-art technologies, dedicate substantial resources to R&D, and collect and analyse updated technological information (Chen et al., 2014a; Hurley and Hult, 1998; Wu et al., 2013; Zhou et al., 2005). In open environments decision makers willingly use new technologies to generate and share information across functional departments, customers and suppliers. When a supply chain is disrupted, the existing information technologies and communication procedures may not provide enough real-time accurate data to facilitate coordination of responses. With openness, firms will explore new technologies and techniques to enhance the dissemination and assimilation of information and knowledge, the creation of new ideas and knowledge (Chen et al., 2014b; Hortinha et al., 2011; Zhou et al., 2005). This mechanism of trusting technology means decision makers use information generated by various technologies to understand and develop coordinated responses to new disruptions.

Many companies such as DHL have utilized information technologies to monitor and analyse potential disruptions in their own operations in real-time. This use of control towers and supply chain dashboards supported by advanced technologies (e.g., enterprise resource planning, blockchain, Internet of Things, and radio frequency identification) has become a model for many firms to improve cross-functional information exchange and facilitate the process of trustworthy information flow throughout the entire supply chain (Wang and Wei, 2007; Yu, 2015). However, not all firms are open to adopting such technologies for addressing supply chain disruptions. An increase in technology openness can increase the likelihood to use technology for sharing information and supporting cross-functional coordination. There are also technologies that sense critical information and increase the accuracy of shared information, which increases the trustworthiness of information – the basis for informational justice (Colquitt and Rodell, 2011; Ellis et al., 2009; Greenberg, 1993). Therefore, based on the extended version of OIPT that includes openness, we expect a significant effect of openness to technology innovation on the two mechanisms for increasing information processing capabilities: inter-functional coordination, and inter-partner informational justice.

H1. Openness to technological innovation has a significant positive effect on inter-functional coordination.

H2. Openness to technological innovation has a significant positive effect on inter-partner informational justice.

The third hypothesis considers the direct effect of openness on SCR without the above integrating mechanisms. According to OIPT, firms need to understand their external business environment through gathering and processing information (Galbraith, 1973) required to quickly respond to environmental uncertainty (Daft and Weick, 1984; Williams et al., 2013). In general, openness to technological innovation facilitates an increased tendency to adopt new technologies (Hurley and Hult, 1998). Such firms are technically proficient and flexible (Hortinha et al., 2011). There are new and advanced technological solutions to deal with environmental uncertainty and respond effectively to supply chain disruptions. Some studies argue resilience and robustness in supply chains can be enhanced by investing in advanced technologies that enable transparency and the use of real-time data through integrated information sharing (Brandon-Jones et al., 2014; Juttner and Maklan, 2011). Advanced technologies for processing of information flow such as Internet of Things, Blockchain and Artificial Intelligence are thought to increase the data analytic capability (Yu et al., 2021) required to respond effectively to unexpected disruptions (Tukamuhabwa et al., 2015; Zhou et al., 2005). Thus, we therefore propose the following hypothesis:

H3. Openness to technological innovation has a significant positive effect on SCR.

2.4.2. Effect of information processing capabilities on SCR

According to OIPT, information processing capabilities such as gathering, interpreting, synthesising coordinating information, and processing the information in a structured way enables firms to redesign their supply chains to operate effectively in a fast-paced business environment (Burns and Wholey, 1993; Williams et al., 2013). Past studies that apply OIPT tend to emphasize communication and analytics. Information and knowledge sharing, and collaboration are known as important antecedents of SCR (Kamalahmadi and Parast, 2016; Soni et al., 2014). Analysing, processing, and exchanging information across functional areas helps firms understand potential vulnerability and build resilience in supply chains (Scholten and Schilder, 2015). Effective communication and information sharing about risk events enable firms to access to essential resources to minimize vulnerabilities, and quickly recover from a disruption (Johnson et al., 2013; Tukamuhabwa et al., 2015). Internal coordination is required for firms to absorb and use information to integrate decisions that enhance SCR (Schoenherr and Swink, 2012; Williams et al., 2013). However, coordination for creating shared interpretation is an important integrating mechanism from the OIPT that has been largely overlooked. We argue inter-functional coordination is an integrating mechanism that enhances information processing capacity through meeting information needs and coordinating shared interpretation (Galbraith, 1973). This mechanism helps manage and update the information flows that are critical for different functional departments to quickly generate a coordinated response to unpredictable supply chain disruptions (Ponomarov and Holcomb, 2009; Tukamuhabwa et al., 2015). Thus, we posit:

H4. Inter-functional coordination has a significant positive effect on SCR.

A supply chain disruption can occur within a firm or somewhere in a supply network (Yu et al., 2019a). The key priority for reducing the effects of supply chain disruptions should be the creation of a network characterised by effective information exchange and communication within the firm and between supply chain partners (Blackhurst et al., 2011; Christopher and Peck, 2004; Kamalahmadi and Parast, 2016). When many versions of information about a new disruption are received, task uncertainty arises (Galbraith, 1973). Thus, sharing of trustworthy supply chain information is crucial. Informational justice among supply chain partners occurs when each party commits to share real-time information whenever they observe a potential risk, with the aim of protecting each other from being disrupted. Due to efforts to clarify changes, inter-partner informational justice is associated with establishing trust and credibility among supply chain partners (Colquitt and Rodell, 2011). With a high level of inter-partner informational justice (Ellis et al., 2009; Liu et al., 2012), a firm is more likely to accept the realities and be willing to integrate or align decisions. Coordinated and aligned decisions are required to adapt more quickly to fast-changing business environments, which in turn leads to greater SCR (Scholten and Schilder, 2015; Tukamuhabwa et al., 2015). We therefore expect that inter-partner informational justice enables firms to enhance resilience in supply chains.

H5. Inter-partner informational justice has a significant positive effect on SCR.

2.4.3. Mediating effects of information processing capabilities

Being open to new technology (see H3) serves as an important driver for adopting technologies that may inform solutions for adapting to supply chain disruptions. We extend OIPT because new technologies can support inter-functional coordination and inter-partner informational justice mechanisms crucial for developing resilient supply chains. This study revisits the organizational information processing model (Daft and Weick, 1984; Thomas et al., 1993) and offers the following extensions. Openness to technological innovation increases the chance to use real-time inter-functional coordination (i.e., internal information sharing and collaboration across functional areas within the firm) and develops inter-partner informational justice (i.e., extending internal information flows to its supply chain partners with the promotion of open communication and trust), which in turn leads to improved resilience in supply chains. Technology can be used to support the two information processing mechanisms while resilient supply chains require not only computing power but also the mechanisms for generating shared interpretation. Thus, the two information processing mechanisms act as mediators of the relationship between openness to technological innovation and SCR. Openness to technological innovation reflects an essential attitude to use innovative technologies; it is the information processing mechanisms (i.e., inter-functional coordination and inter-partner informational justice) that transform the attitude into concerted decisions for achieving SCR. Therefore, we propose the following hypotheses:

H6. Inter-functional coordination mediates the relationship between openness to technological innovation and SCR.

H7. Inter-partner informational justice mediates the relationship between openness to technological innovation and SCR.

2.4.4. Effects of information processing capabilities on operational performance

OIPT serves as a promising theoretical lens to explain the relationship between information processing capabilities and operational performance (Schoenherr and Swink, 2012; Swink and Schoenherr, 2015). When activities are integrated in the supply chain and associated information is shared across different functional areas, better delivery and cost performance are produced (Swink and Schoenherr, 2015). Aiming to achieved shared interpretation, cross-functional processes and collaboration help firms collect, interpret, and coordinate information to inform and coordinate decisions (Swink and Schoenherr, 2015; Williams et al., 2013), which leads to improved operational performance (Flynn et al., 2010). Inter-partner informational justice is an external information processing capability that enables firms to achieve operational performance (Flynn et al., 2010) through the use of trusted real-time data. Operational performance is improved when supply is coordinated with internal planning for meeting customer needs, which depends on effective cross-functional information sharing and the use of trusted data from supply chain partners. Therefore, the following hypotheses are posited:

H8. Inter-functional coordination has a significant positive effect on operational performance.

H9. Inter-partner informational justice has a significant positive effect on operational performance.

2.4.5. Effect of SCR on operational performance

SCR is a crucial and adaptive capability and dimension of firm performance (Golgeci and Ponomarov, 2013; Ponomarov and Holcomb, 2009). SCR is the ability of a supply chain to respond and recover quickly to unexpected disruptions or enable operations to return to its original operations or move to a new, more desirable condition faster after being disturbed (Ali et al., 2017; Tukamuhabwa et al., 2015). Pettit et al. (2013) found a positive relationship between SCR and operating performance (e.g., inventory position, order accuracy, lead time and availability). Building SCR presupposes that firms can manage risks more effectively than its competitors and recover promptly from unexpected events – either returning to normality or achieving even better operational performance after a temporary disruption (Ponomarov and Holcomb, 2009; Tukamuhabwa et al., 2015). Thus, SCR is important for operational stability. Recovering from disruptive phenomena and returning to their original configuration means a better operational performance (Christopher and Peck, 2004; Pettit et al., 2013; Tukamuhabwa et al., 2015). Based on the extant literature, we argue that developing SCR enables firms to achieve superior operational performance.

H10: SCR has a significant positive effect on operational performance.

3. Methodology

3.1. Data collection

We tested the proposed research hypotheses by gathering data in February–June 2017 using a questionnaire of manufacturing firms in China. To improve the response rate, we obtained supports from Provincial Economic and Information Technology Commission, and randomly selected a sample of 1000 manufacturing firms from the government directories provided by the Commission (Li et al., 2010). With the help of the Commissions, we contacted the key informants in the selected firms, and then sent the questionnaires to the 890 manufacturers who agreed to participate in this study. After a few email and telephone reminders, a total of 257 questionnaires were received, however, 16 were discarded because of remarkably high rates of missing data. Therefore, a 27.08 per cent effective response rate was obtained (241 out of 890).

Table 1 provides an overview of the demographic profile of the 241 respondents. Most participants held senior executive positions (e.g., CEO/president, vice president, director, and manager) and had been with their current employer for more than five years, which provides confidence that the respondents possessed adequate knowledge to answer the questionnaire items. As shown in Table 1, the survey data were collected from several major geographical regions that represent different economic development stages in China (Zhao et al., 2006). Table 1 also indicates that the survey data represents a heterogeneous sample of firms in terms of industry type and number of employees, which instils confidence in the survey findings.

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3.2. Measures and controls

To establish content validity and reliability, we conducted a pilot test by receiving feedback and comments from four academic researchers and senior executives from four Chinese manufacturers using semi-structured interviews, which helped to increase the relevance and clarity of the questionnaire and measurement items (see Table 2). As shown in Table 2, we adapted the measure of *openness to technological innovation* from the work of Zhou et al. (2005) and Stock et al. (2002), with items assessing a firm and its members' openness towards the adoption of state-of-the-art technologies for new product/service development. We adapted Liu et al.'s (2012) scale to measure *inter-partner informational justice*, which included items assessing the extent to which information communication and exchange between supply chain partners is fair. We adapted the measures of *inter-functional coordination* from Im and Workman (2004), which emphasized a firm's proactivity in sharing information across an organization's different functional areas. We adapted the measures of *supply chain resilience* from Golgeci and Ponomarov (2013), which included a firm's ability to respond to unexpected supply chain disruptions quickly and effectively. All items above were measured on a 7-point Likert scale anchored with 1 = strongly disagree and 7 = strongly agree. We adapted the perceptual measures of *operational performance* from the work of Wong et al. (2011) and Flynn et al. (2010), who included operational excellence in flexibility, delivery, cost, and quality. Respondents were requested to assess how their operational performance compared with those of their main industrial competitors using a 7-point scale (1 = much worse and 7 = much better), which has been extensively used in prior empirical studies (e.g., Flynn et al., 2010; Wong et al., 2011).

------------------------------ Insert Table 2 ------------------------------

Industry type (dummy variable) and *firm size* (number of employees) were used as two control variables in this research because firms in the different manufacturing industries may build different information processing capabilities for developing resilient supply chains, and larger firms may be more predisposed to implement new technologies to develop information processing capabilities for SCR than smaller ones.

3.3. Bias

We evaluated non-response bias and common method bias (CMB) in this study. We tested for non-response bias by performing a t-test: comparing the early and late respondents in terms of two demographic variables, namely, number of employees and annual sales (Hair et al., 2010). The results revealed that there were not significant differences ($p < 0.05$), which indicates that non-response bias is not a serious concern in this research.

CMB is routinely viewed as a pervasive problem in behavioural research that collects survey data from single respondents (Podsakoff et al., 2012). We therefore adopted several approaches to assess CMB. First, confirmatory factor analysis (CFA) was performed on Harman's single-factor model, as the latter is criticized for being insufficient to test for CMB (Podsakoff et al., 2012). The CFA results reveal poor model fit indices: χ^2/df (1599.150/189) = 8.461; RMSEA = 0.176; CFI = 0.557; IFI = 0.560; and TLI = 0.508 (Hair et al., 2010). Second, two different latent variable models were tested and compared: one included only the traits and the other included both the traits and a method factor (Podsakoff et al., 2012). The results reveal that the method factor only slightly increased the model fit indices (ΔCFI = 0.029 and ΔIFI = 0.03). Third, we adopted the marker variable technique by selecting a five-item scale for demand uncertainty (Cronbach's alpha = 0.741) as a method variance marker (Lindell and Whitney, 2001). Demand uncertainty refers to fluctuations and variations in the demand (Chen and Paulraj, 2004), which is theoretically unrelated to at least one theoretical construct in the study. We selected the lowest positive correlation (r = 0.051) between the method variance marker and other variables (see Table 3) to adjust the inter-construct correlations and statistical significance (Lindell and Whitney 2001). The results reported in Table 3 indicate that none of the significant correlations became insignificant after the adjustment. Thus, we conclude that CMB is unlikely to be an issue with our data.

4. Results

4.1. Measurement model: unidimensionality, reliability and validity analyses

We ran a CFA to assess unidimensionality (Gerbing and Anderson, 1988). As illustrated in Table 2, the measurement model had an acceptable fit (χ^2 / df = 1.962; RMSEA = 0.063; CFI = 0.946; IFI = 0.946; and TLI = 0.937), which indicates unidimensionality (Hair et al., 2010). We calculated Cronbach's alpha and composite reliability (CR) to assess construct reliability (Hair et al., 2010). Table 2 also indicates that the Cronbach's alpha ranged from 0.829 to 0.899, and the CR ranged from 0.848 to 0.902; the values of all theoretical constructs were significantly higher than the cut-off value of 0.70 (Hair et al., 2010). The results provide evidence of reliability. In addition, we also calculated a corrected item-total correlation (CITC) score for each item to assess item reliability (Kerlinger, 1986). Table 2 indicates that all CITC values (ranging from 0.558 to 0.814) were larger than the minimum acceptable value of 0.30, demonstrating the reliability of the results.

The CFA results reported in Table 2 also demonstrate convergent validity: the model fit indices were acceptable, all factor loadings were well above 0.50 and statistically significant (Hair et al., 2010). In addition, Table 2 also indicates that average variance extracted (AVE) values (which ranged from 0.595 to 0.691) for all theoretical constructs exceeded the cut-off value of 0.50, providing further evidence of convergent validity (Fornell and Larcker, 1981). With regard to discriminant validity, as shown in Table 3, the square root of each contract's AVE is greater than the inter-construct correlations, which confirms that discriminant validity is established (Fornell and Larcker, 1981).

------------------------------ Insert Table 3 ------------------------------

4.2. Structural model

4.2.1. Main effects results

We used SEM with AMOS 25 to test the hypothesised relationships and presented the results in Table 4 and Figure 2. As shown in Table 4, the structural model had an acceptable fit (χ^2/df = 2.024; RMSEA = 0.065; CFI = 0.915; IFI = 0.916; and TLI = 0.900) (Hair et al., 2010).

Although firm size and industry type were controlled in the analyses, except for industry type1: automobile, they did not have a significant impact on SCR. The results also reveal a significant positive effect of openness to technological innovation on inter-functional coordination (β = 0.371, $p < 0.001$) and inter-partner informational justice (β = 0.304, $p < 0.001$), but an insignificant effect on SCR (β = 0.113, *n.s.*). Thus, H1 and H2 were supported, but H3 was not supported. The structural model also indicates that inter-functional coordination (β = 0.515, $p < 0.001$) and inter-partner informational justice (β = 0.199, $p < 0.01$) have a significant positive effect on SCR, which lends support to H4 and H5. We also found that inter-functional coordination (β = 0.189, $p < 0.05$) and inter-partner informational justice (β = 0.141, $p < 0.05$) were significantly and positively associated with operational performance. Thus, H8 and H9 were supported. In addition, as shown in Table 4, SCR had a significant positive impact on operational finance (β = 0.354, $p < 0.001$), supporting H10.

------------------------------ Insert Table 4 ------------------------------

4.2.2. Mediation effects results

As shown in Figure 2, while H3 was not supported, H4 and H5 were. The results indicate that integrating mechanisms (inter-functional coordination and inter-partner informational justice) may serve as mediators of the relationships between openness to technological innovation and SCR. This sections investigates the possible mediating roles of the two mechanisms.

------------------------------ Insert Figure 2 ------------------------------

Bias-corrected bootstrapping method (with n = 2,000 bootstrap resamples) was used to test for the mediation (Preacher and Hayes, 2008; Zhao et al., 2010). Table 5 reports the mediation test results, indicating that the direct effect of openness to technological innovation on SCR was insignificant (β = 0.113, *n.s.*), and the indirect effect of openness to technological innovation on SCR via inter-functional coordination was positive and significant (β = 0.191, $p < 0.001$; 90% confidence interval [0.123, 0.324]). The results suggest the full mediation of inter-functional coordination on the relationship between openness to technological innovation and SCR. In addition, we performed Sobel test to provides extra support for the hypothesized mediation relationships. As illustrated in Table 5, the Sobel test (z = 3.616, $p < 0.001$) indicates that inter-functional coordination fully mediates the relationship between openness to technological innovation and SCR. Similarly, regarding the openness to technological innovation → inter-partner informational justice → SCR relationship, the results of the bootstrap test and the Sobel test reveal that the relationship between openness to technological innovation and SCR was fully mediated by inter-partner informational justice. Consequently, H6 and H7 are supported.

---------------------------- Insert Table 5 -----------------------------

4.3. Robustness tests

Two methods were employed to test the robustness of our results. First, 50% of the samples (n = 120) were randomly chosen and analysed using SEM. The results indicate a significant positive effect of openness to technological innovation on inter-functional coordination ($\beta = 0.328$, $p < 0.01$) and inter-partner informational justice ($\beta = 0.323$, $p < 0.01$). Inter-functional coordination ($\beta = 0.507$, $p < 0.001$) and inter-partner informational justice ($\beta = 0.214$, $p < 0.05$) were significantly and positively related to SCR, and SCR had a significant positive impact on operational performance ($\beta = 0.354$, $p < 0.01$). The results also show that no statistically significant effect of openness to technological innovation ($\beta = 0.047$, *n.s.*) on SCR was found. Overall, the results were essentially the same (see Table 5 and Figure 2).

Second, we ran the structural model with an alternate dependent variable (i.e., financial performance) to indicate that our proposed theoretical framework works with various types of firm performance outcomes. We used five financial performance measures, including return on sales, growth in profit and market share, return on assets, and return on investment, which have been commonly used in previous SCM research (Flynn et al., 2010; Yu, 2015). The results reveal a significant positive effect of openness to technological innovation on both inter-functional coordination ($\beta = 0.364$, $p < 0.001$) and inter-partner informational justice ($\beta = 0.295$, $p < 0.001$), but an insignificant direct effect on SCR ($\beta = 0.107$, *n.s.*). The results also indicate that information processing capabilities produced by the two mechanisms were significantly and positively associated with SCR, and that SCR has a significant positive impact on financial performance. Overall, the results were consistent with that of our proposed model (see Figure 2). Based on these analyses, we conclude that our original model and findings are robust.

5. Discussion

5.1. Contributions to theory

By establishing an empirical basis for extending the organizational information processing model (Daft and Weick, 1984; Thomas et al., 1993), this study contributes theoretically to OIPT and SCR literature in several important ways. First, this study adds the role of openness to technological innovation in the OIPT argument so that it reflects the use of technology for supporting important integrating mechanisms. This novel perspective is supported by the evidence that openness to technological innovation has a significant effect on inter-functional coordination and inter-partner informational justice. This is an important finding because information processing capabilities are mediated by technology. Complementing prior work demonstrating the importance of openness and technology orientation in new product development and/or product innovation, and innovation performance (e.g., Chen et al., 2014b; Gatignon and Xuereb 1997; Hortinha et al., 2011; Zhou et al., 2005), this study shows the roles of openness to technology for sharing information and coordinating responses to supply chain disruption.

The implication for OIPT is that openness to technological innovation should be considered as an important driver facilitating cross-functional information sharing and open information sharing among supply chain partners. SCR requires a greater technological competence (Slater et al., 2007) to complement the use of integrating mechanisms for coordinating responses to supply chain uncertainty. Technology-oriented firms have a predominant focus on creating new ideas and knowledge or adopting new technologies (Chen et al., 2014b; Zhou et al., 2005), but they must be incorporated to support decision coordination and business processes (Hurley and Hult, 1998) across a supply chain for it to be resilience.

Second, the study extends extant SCR literature by demonstrating the significant roles of information processing capabilities through two integrating mechanisms that emphasize the creation of shared interpretation. Inter-functional and inter-partner coordination are important for joint actions to respond to supply chain disruption because they not only facilitate information sharing but also coordination of decisions based on shared interpretation. Our study extends OIPT to better explain the effect of inter-functional coordination on SCR and operational performance. OIPT argues gathering, synthesizing, and coordinating information and knowledge across different functional departments within the organization help firms anticipate, respond to, and recover from supply chain disruption (Swink and Schoenherr, 2015) and improve operational performance (Wong et al., 2011). Our measurements for inter-functional coordination reflect the use of target and goal to guide the coordination of shared interpretation.

We also show the importance of trust creation using inter-partner informational justice through being open to new technologies and willingness to share and trust real-time data among partners. The uncertainty from supply chain disruptions not only increases information and information processing needs; it increases the needs for trusted partners. Inter-partner informational justice provides a safer condition for trading parties to jointly understand and develop procedures to address disruptions effectively (Ellis et al., 2009). When trustworthy information is communicated and shared among trading partners, they can rely on jointly developed procedures (Colquitt, 2001; Korsgaard et al., 1995) that minimize vulnerabilities to quickly recovering from supply chain disruptions. With inter-partner informational justice, a firm's trading partners provide business intelligence and required information that is important to the firm for improving performance (Liu et al., 2012), which can help firms effectively respond to emergency situations and adapt rapidly to changes in supply chains (Pettit et al., 2013).

This study is among the first to highlight the role of information justice in critical moments when firms are affected by supply chain disruption. We use this finding to suggest how OIPT's notion information processing capacity should be modified. The trustworthiness of information shared among supply chain partners has hitherto been ignored. The more uncertainty there is in the supply chain environment, the greater the need for trustworthy information. One implication is that more technologically based solutions may be required to remove human errors (e.g., distorted information) and biased interpretations. Another implication is the need to conceptualize integrating mechanism that provide informational justice.

Third, the study offers a fresh theoretical angle to investigate and demonstrate the mediating role of both internal and external information processing capabilities generated by the two integrating mechanisms. This study reveals that inter-functional coordination and inter-partner informational justice fully mediate the relationship between openness to technological innovation and SCR. This is a particularly important finding because we show claims that technologies are important for resilient supply chains are incomplete without considering the two integrating mechanisms. Technologies that facilitate information sharing alone will not be enough for SCR (Yu, 2015); technology must support the coordination of shared interpretation. Although researchers have recognized the important role of information sharing and collaboration in developing SCR (Ali et al., 2017; Hohenstein et al., 2015; Kamalahmadi and Parast, 2016), much of the SCR research has failed to reveal the mechanisms behind inter-functional coordination. Moreover, this study provides a new way to interpret studies of the role of technology. Many firms struggle to effectively analyse and process a large amount of data generated from investment in information systems and technologies (Williams et al., 2013). The emphasis on analysing large amounts of data masks an important argument of OIPT, which emphasizes the need to achieve shared interpretation using integrating mechanisms.

Fourth, this study extends a growing literature addressing SCR as the capacity of a firm to adapt, survive, and grow in turbulent and technological environments, and provides an initial examination of the association between SCR and operational performance. Our findings indicate that SCR has a significant effect on operational performance. This is another important contribution of our study, since there is limited empirical investigation of the impact of SCR on firm performance dimensions (such as operational performance) (Pettit et al., 2013). Our study responds to the call for more empirical research investigating the impact of SCR on firm performance (Hohenstein et al., 2015; Pettit et al., 2013). In the current volatile, uncertain, and complex global business environment, firms that build resilient supply chains are more likely to be able to recover quickly from unforeseeable disruptions and events, and improve operational performance (Pettit et al., 2013; Tukamuhabwa et al., 2015). Developing resilient supply chains enables firms to recover from disruptive phenomena quickly and efficiently, and consequently progress to an even better state of firm performance (Pettit et al., 2013).

5.2. Contributions to practice

Modern supply chains are increasingly complex, interdependent, and efficient, but by the same token they are also more vulnerable to potential disruptions of certain preconditions upon which they depend. This has been exposed in supply chain disruptions caused by the Brexit negotiations, emergent US-China trade war, and the fallout from the COVID-19 pandemic. Managers want to understand and proactively manage factors that promote the resilience and long-term survival of their firms. Our findings provide a novel information processing perspective for managers. Openness is an important cultural attribute to cultivate because it broadens the search for solution portfolio to address potential disruptive events. However, there is a proliferation of technologies and there is a need for a disciplined attention to what really matters. This study informs managers where to focus – information processing technologies that enhance inter-functional coordination of real-time information about ongoing disruption. Equally important is a factor most managers may take for granted; information processing solutions share trustworthy information between supply chain partners to maintain informational justice, without with responses of disruptions would be wasteful and uncoordinated.

Both academics and practitioners have long recognized that firm readiness to adopt new technological innovations in markets in which supply and/or demand is relatively uncertain involve complex phenomena. Openness to technological innovation is critical for searching information processing solutions for resilient supply chains. A firm must develop internal and external information processing capabilities through investment in information technology and systems that facilitate effective cross-functional information sharing and open communication among supply chain partners. Openness is an important culture of technology orientation that drives investment in R&D, adoption of advanced technologies in product and process innovation, and the rapid integration of new technologies into supply chain operations.

Over recent decades, many firms have already been actively investing in processing technologies, such as enterprise resource planning and radio frequency identification, in their operations and supply chain process. However, the results of this study suggest managers need openness to technological innovation so that they can identify technologies that facilitate inter-functional coordination and inter-partner informational justice, instead of buying any new technologies claimed to directly enhance resilience in supply chains. Openness to technological innovation does not automatically increase information process capabilities for building SCR. SCR is built through inter-functional coordination and inter-partner informational justice. When considering new technologies, firms should assess whether they enhance cross-functional information sharing and information justice among supply chain partners. We believe that this finding brings supply chain managers a new perspective to understand the roles of openness to technological innovation to support information processing capabilities for developing resilient supply chains.

Despite the importance of data and information (e.g., sales and inventory data, point of sale information, and forecast information) to business success, many managers do not have experience processing data related to various supply chain disruptions. According to a report published by Conference Board and Stanford University, only 7% of boards integrate big data and information into their decision-making processes (Libert, 2013). Our empirical findings suggest that this is partly because of the misalignment between data a firm collects and the capabilities the firm needs to effectively analyse and process the information for effective coordination. Companies fail to transform big information volumes into real information value (Fosso Wamba et al., 2015) because of a technological delusion that leads to more data but less coordination. Our study provides an information value realization framework for managers seeking to develop SCR through building information processing capabilities.

6. Limitations and future research

Although the empirical results of this study offer useful theoretical and practical implications, it also has several limitations and opportunities for future research. First, researchers argue that a lack of trust can increases supply chain risks (Sinha et al., 2004). Building trusted networks enables rapid access to resources necessary for rapid recovery from a disruption, and consequently enhances SCR (Kamalahmadi and Parast, 2016; Johnson et al., 2013). Researchers have demonstrated that inter-partner informational justice is a significant predictor of subsequent trust perceptions (Colquitt and Rodell, 2011). Future research should examine the relationships among inter-partner informational justice, trust, and SCR. Second, the organizational information processing model might be contingent upon external situational factors (e.g., technological and market uncertainty) (Daft and Weick, 1984; Milliken, 1990). Future research should investigate the contingent effects of the contextual characteristics on the data collection–information processing–action–performance relationship. Third, another limitation of this study is the cross-sectional nature of the survey data where the data was collected from only one respondent at one point in time. The cross-sectional design does not allow for establishment of causal relationships among openness to technological innovation, information processing capability, SCR, and performance. A longitudinal study would provide additional insights into the conceptual model developed in this study. Also, multiple cultural contexts and multiple respondents at each firm being included in future studies would give greater confidence in the generalizability of findings.

7. Conclusions

Drawing upon OIPT, past studies recommend enhancing information processing to improve supply chin resilience. This study adds novel insights by providing empirical evidence that information processing capabilities enhanced by inter-functional coordination and inter-partner information justice play important roles in developing resilient supply chains, and that this is enabled by being open to technological innovation. From a theoretical perspective, this study extends OIPT and it's relevance to advancing the SCR literature by considering information justice as an external information processing capability and openness to technological innovation as a cultural driver, in addition to the well-acknowledged role of coordination and information sharing. Our findings highlight mediating roles for internal and external information processing capabilities rather than a direct effect of openness on SCR. From a practical perspective, these findings inform managers to be open to technologies that process data and information for supporting inter-functional coordination and enhance information justice among supply chain partners in order to enhance SCR.

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Table 1: Demographic profile of respondents

	Percent (%)		Percent (%)
Industries		**Geographical regions**	
Automobile	30.7	Pearl River Delta	8.7
Chemicals and petrochemicals	10.4	Yangtze River Delta	8.7
Electronics and electrical	12.4	Bohai Sea Economic Area	20.7
Fabricated metal product	6.2	Northeast China	1.7
Food, beverage and alcohol	13.7	Central China	14.9
Rubber and plastics	2.5	Southwest China	38.6
Textiles and apparel	4.6	Northwest China	6.6
Others	19.5		
Job titles		**Number of employees**	
President / Chief executive officer (CEO)	5.4	1 – 100	19.1
Vice President	7.1	101 – 200	15.4
Director	4.6	201 – 500	13.3
Manager	49.4	501 – 1000	8.7
Other senior executive	33.6	1001 – 3000	17.8
Years in current position		> 3000	25.7
≤ 5	45.2		
6-10	24.5		
> 10	30.3		

Table 2: Measures and reliability and validity analyses

Theoretical Constructs and Items	Factor loadings	α	CR	AVE	CITC range
1. Openness to technological innovation (Stock et al., 2002; Zhou et al., 2005)		0.829	0.848	0.657	0.558–0.774
Our new products always use state-of-the-art technology	0.602				
Technological innovation based on research results is readily accepted in our organization	0.900				
Technological innovation is readily accepted in our program/project management	0.894				
2. Inter-functional coordination (Im and Workman, 2004)		0.846	0.853	0.595	0.597–0.787
We freely communicate information about our successful and unsuccessful customer experiences across all business functions	0.635				
All of our business functions (e.g., marketing, manufacturing, R&D, finance) are integrated in serving the needs of our target markets	0.710				
All of our managers understand how everyone in our business can contribute to creating customer value	0.892				
All functional departments work hard to thoroughly and jointly solve problems	0.824				
3. Inter-partner informational justice (Liu et al., 2012)		0.899	0.899	0.691	0.731–0.814
Our supply chain partners routinely exchange timely market demand or supply information	0.816				
Our supply chain partners are committed to developing and sharing supply chain-related information	0.825				
Our supply chain partners view information sharing and transparent communication between the sides as key	0.881				
Our supply chain partners inform the other side, in a timely way, of any event or change that may potentially affect that side	0.800				
4. Supply chain resilience (Golgeci and Ponomarov, 2013)		0.879	0.884	0.606	0.652–0.775
Our company's supply chain is able to adequately respond to unexpected disruptions by quickly restoring its product flow	0.677				
Our company's supply chain can move to a new, more desirable state after being disrupted	0.686				
Our company's supply chain is well prepared to deal with financial outcomes of supply chain disruptions	0.839				
Our company's supply chain has the ability to maintain a desired level of control over structure and function at the time of disruption	0.867				
Our company's supply chain has the ability to extract meaning and useful knowledge from disruptions and unexpected events	0.802				
5. Operational performance (Flynn et al., 2010; Wong et al., 2011)		0.898	0.902	0.651	0.661–0.813
Quickly introduce new products into the market	0.723				
An outstanding on-time delivery record to our major customer	0.880				
The lead time for fulfilling customers' orders (the time which elapses between the receipt of customer's order and the delivery of the goods) is short	0.894				
Provide a high level of customer service to our major customer	0.832				
Produce products with low costs	0.683				
χ^2 = 351.255; df = 179; χ^2 / df = 1.962; RMSEA = 0.063; CFI = 0.946; IFI = 0.946; TLI = 0.937					

Table 3: Correlations and summary statistics (n = 241)

	Mean	S.D.	OTI	IFC	IJ	SCR	OP
Openness to technological innovation (OTI)	4.848	1.123	**0.811**[a]	0.303**	0.235**	0.275**	0.356**
Inter-functional coordination (IFC)	5.065	1.077	0.339**	**0.772**	0.533**	0.513**	0.425**
Inter-partner informational justice (IJ)	4.947	1.012	0.274**	0.557**	**0.831**	0.433**	0.359**
Supply chain resilience (SCR)	5.020	1.029	0.312**	0.538**	0.462**	**0.778**	0.489**
Operational performance (OP)	5.267	1.051	0.389**	0.454**	0.392**	0.515**	**0.807**
Method variance marker (demand uncertainty)	3.832	1.139	0.069	0.051	0.053	-0.009	-0.025

Note: [a] Square root of AVE appears on the diagonal; unadjusted correlations appear below the diagonal; adjusted correlations for potential common method variance appear above the diagonal.

** $p < 0.01$.

Table 4: Hypothesis testing: main effects results

Hypothesised relationships	**Standardised coefficient**	**t-values**	**Hypothesis testing**
H1: Openness to technological innovation → Inter-functional coordination	0.371***	4.556	Accept
H2: Openness to technological innovation → Inter-partner informational justice	0.304***	4.045	Accept
H3: Openness to technological innovation → Supply chain resilience	0.113	1.618	Reject
H4: Inter-functional coordination → Supply chain resilience	0.515***	5.960	Accept
H5: Inter-partner informational justice → Supply chain resilience	0.199**	3.063	Accept
H8: Inter-functional coordination → Operational performance	0.189*	2.308	Accept
H9: Inter-partner informational justice → Operational performance	0.141*	2.164	Accept
H10: Supply chain resilience → Operational performance	0.354***	3.943	Accept
Control variables			
Firm size → Operational performance	-0.030	-0.486	
Industry1-automobiles → Operational performance	0.140*	2.064	
Industry2-food, beverage and alcohol → Operational performance	0.017	0.263	
Industry3-electronics and electrical → Operational performance	0.090	1.412	
Industry4-chemicals and petrochemicals → Operational performance	0.0003	0.004	
Variance explained (R^2)			
Inter-functional coordination	0.138		
Inter-partner informational justice	0.093		
Supply chain resilience	0.398		
Operational performance	0.324		
χ^2 = 558.530; df = 276; χ^2/df = 2.024; RMSEA = 0.065; CFI = 0.915; IFI = 0.916; TLI = 0.900			

*** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$.

Table 5: Hypothesis testing: mediation effects results

Hypothesised relationships	**Direct effect**	**Indirect effect**	**90% CI for indirect effect**	**Sobel test**	**Hypothesis testing**
H6: OTI→IFC→SCR	0.113	0.191***	0.123–0.324	z = 3.616***	Accept
H7: OTI→IIJ→SCR	0.113	0.061*	0.019–0.137	z = 2.437*	Accept

Note: OTI = openness to technological innovation; IFC = inter-functional coordination; IIJ = inter-partner informational justice; SCR = supply chain resilience; CI = bootstrap confidence interval; Standardized effects; 2,000 bootstrap samples.

*** $p < 0.001$; * $p < 0.05$.

Figure 1: Conceptual model

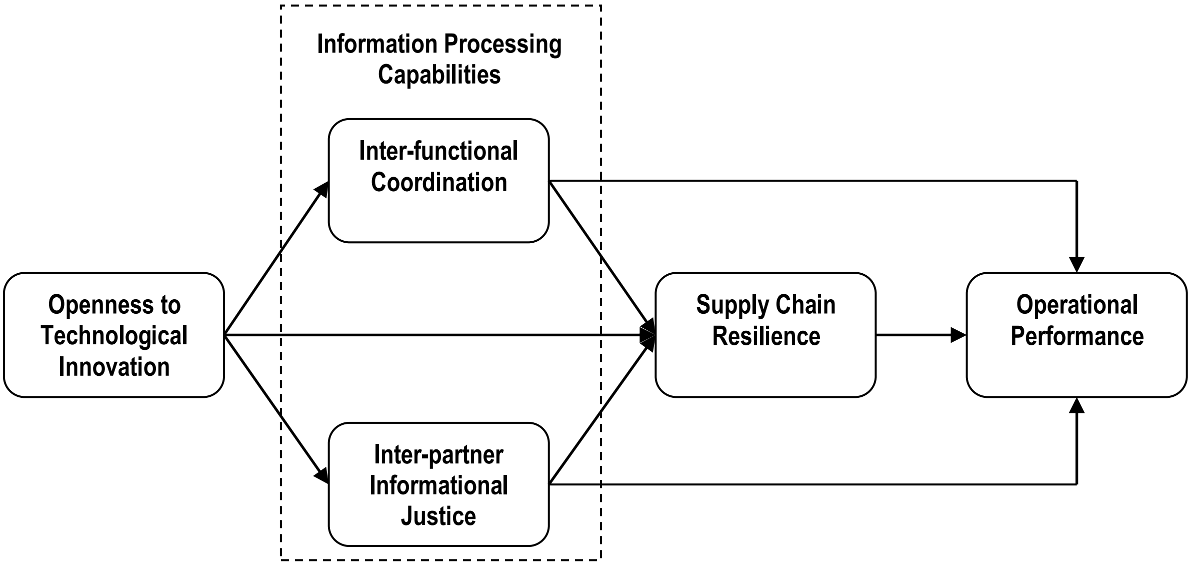
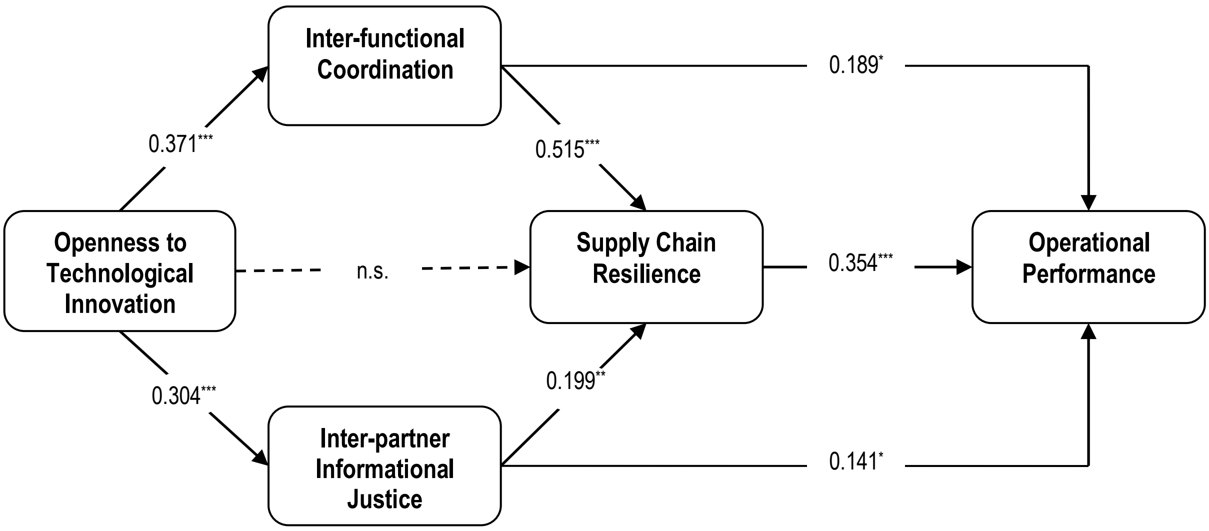


Figure 2: The model estimation results



$\chi^2/df = 2.024$; RMSEA = 0.065; CFI = 0.915; IFI = 0.916; TLI = 0.900
Note: *** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$.