Supplier Initiating Risk Management Behaviour and Supply-Side Resilience:

The Effects of Interpersonal Relationships and Dependence Asymmetry in Buyer-Supplier Relationships

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Abstract

Purpose: To explore how two dimensions of interpersonal relationships (i.e. size and range of relationships) affect supplier-initiating risk management behaviours (SIRMB) and supply-side resilience. Further, to explore the moderating role of dependence asymmetry.

Design/methodology/approach: Nine hypotheses are tested based on a moderated mediation analysis of survey data from 247 manufacturing firms in China. The data is validated using a subset of 57 attentive secondary respondents and archival data.

Findings: SIRMB positively relates to supply-side resilience. Further, SIRMB mediates the positive relationship between range and supply-side resilience, and this relationship is stronger at lower levels of dependence asymmetry. Yet, although dependence asymmetry positively moderates the relationship between range and SIRMB, it negatively moderates the relationship between size and SIRMB. We did not however find evidence that size has a conditional indirect effect on supply-side resilience through SIRMB.

Practical implications: Managers in buying firms can incentivise SIRMB to enhance supply-side resilience by developing a diverse rather than a large set of interpersonal relationships with a supplier. This might include allocating particular employees with a wide range of contacts within a supplier to that relationship, while it may be necessary to adopt different networking strategies for different supplier relationships. Firms in a highly asymmetrical relationship may seek to raise supplier expectations about the necessity to initiate risk management behaviour or look to change the dynamic of the relationship by managing contracts for fairness.

Originality/value: New knowledge on SIRMB as a mediating variable underpinning the relationship between interpersonal relationships and supply-side resilience is provided; and

empirical evidence on the opposing moderation effect of dependence asymmetry is presented.

Keywords: Interpersonal relationships, Dependence asymmetry, Supplier-initiating risk management behaviours, Supply-side resilience.

Paper Type: Research Paper

1. Introduction

The interconnectedness of supply chains, the accelerating pace and uncertainty of organisational activities, and the substantial losses that can occur from upstream disruptions have motivated many organisations to develop their supply-side resilience (Dabhilkar *et al.*, 2016). This is a particularly important focus given that the first-tier supply base is the predominant source of supply chain disruptions (Business Continuity Institute, 2017). Supply-side resilience has been defined as "the capability of a buying firm to prepare for, respond to and recover from unexpected upstream supply chain disruptions by returning to, or maintaining continuity of, operations at the desired level of connectedness and control over structure and function" (Dabhilkar *et al.*, 2016, p. 949). Collaborative relationships have been identified as a formative element of supply chain resilience in general (Scholten and Schilder, 2015), which can be built in the form of intentional relational strategies or practices (Zollo and Winter, 2002), including via information sharing, joint knowledge creation, and incentive alignment (Cao and Zhang, 2011). To date, the supply chain resilience literature has paid particular attention to understanding how practices can be developed and implemented by the focal firm. In contrast, only limited attention has been paid to the relational efforts or behaviours of upstream suppliers. Based on the conceptual arguments put forward by Juttner and Maklan (2011), that supply chain risk management is positively related to supply chain resilience, we consider whether initiating behaviours related to risk management can help buyers create supply-side resilience. We adapt the definition of supplier initiating behaviour by Leuthesser (1997) and refer to the relational behaviours associated with risk management as supplier-initiating risk management behaviours (SIRMB).

Although recent studies have shown that interpersonal relationships are important to supply chain resilience (Durach and Machuca, 2018), we do not know much about the mechanisms underpinning the link between interpersonal relationships and supply chain resilience. In this research, interpersonal relationships between buying and supplying firms refer to the set of relationships that employees in the buying firm have with individuals in the supplier firm. Importantly, interpersonal relationships differ in *size*, defined as the number of contacts, and *range*, defined as the diversity of contacts (Burt, 1982). Recognising that relational behaviour by suppliers can also contribute to relationship quality and better business performance (Leuthesser, 1997), we propose that SIRMB – an important but under-researched relational aspect underpinning buyer-supplier collaboration – influences supply-side resilience. Indeed, some leading firms

have begun to adopt the perspective that it is important for suppliers to proactively initiate efforts that help the buyer reduce risk and improve resilience. For example, the Volvo Group has stated that it expects suppliers to engage in initiatives that support the continuous improvement of quality and efficiency, and that suppliers should initiate corrective actions and report the results each time a deviation or defect is identified (Volvo, 2019). Thus, Volvo is raising the expectations of supplier relational behaviours in response to potential supply disruptions (namely SIRMB) – in this case, the threat of quality defects.

Against this backdrop, our study provides an empirical investigation of SIRMB, testing a series of hypotheses. Building on supplier relational behaviour (Leuthesser, 1997), our goal is to evaluate, refine and further develop a theoretical argument for SIRMB. In particular, we examine the theoretical linkage between SIRMB and supply-side resilience and explore the role of interpersonal relationships in promoting SIRMB. Further, we also explore the potential moderating role of dependence asymmetry. Within a buyer-supplier relationship (BSR), it is likely that there is an imbalance in the distribution of power, i.e. that Firm A needs Firm B more than Firm B needs Firm A, or *vice versa* (Kumar *et al.*, 1998). This is a particularly critical consideration in BSRs since relationships are often characterised by inter-firm asymmetry in terms of information or other types of resources (Gulati and Sytch, 2007; Nyaga *et al.*, 2013). Asymmetric BSRs are associated with lower resource complementarity (Sarkar *et al.*, 2001; Lin *et al.*, 2009) and poorer distributive fairness (Kumar *et al.*, 1995; Gassenheimer *et al.*, 1998; Poppo and Zhou, 2014). We therefore propose that any relationships between the two dimensions of interpersonal relationships (size and range) and SIRMB will be moderated by dependence asymmetry. Overall, we seek to address the following two research questions:

RQ1. Do interpersonal relationships (in terms of size and range) relate to supply-side resilience via SIRMB?

RQ2. Does the potential mediating effect vary according to the level of dependence asymmetry in a BSR?

We offer several contributions to the literature on BSRs and supply chain resilience. First, our study is among the first to advance a theoretical mediator in the relationship between interpersonal relationships and supply-side resilience. We argue that interpersonal relationships will be a route to incentivising suppliers to proactively initiate efforts that support buying firms in dealing with disruptions, thereby helping to develop

supply-side resilience. Second, our study is among the first to propose and empirically test an integrated moderated mediation model of the relationship between the two dimensions of interpersonal relationships and a buying firm's supply-side resilience. We argue and attempt to demonstrate that the indirect effect of interpersonal relationships on supply-side resilience is influenced by dependence asymmetry.

The remainder of this paper is organised as follows. Section 2 provides the theoretical background and presents the hypotheses. The data collection and research method are described in Section 3 before Section 4 presents the analysis and results. The theoretical and managerial implications of the findings are discussed in sections 5 and 6, respectively. Limitations and future research directions are outlined in Section 7.

2. Theory and Hypotheses

In this section we first clarify how supply-side resilience is viewed and SIRMB is conceptualised in our research context. We then offer theoretical accounts of the links amongst interpersonal relationships, SIRMB, dependence asymmetry, and supply-side resilience. This provides the foundations for developing our research model and nine hypotheses.

2.1 Supply-Side Resilience and SIRMB

There is an emerging literature on supply network disruptions and upstream supply chain resilience (e.g. Dabhilkar *et al.*, 2016; Lu and Shang, 2017), also referred to as supply-side resilience. Dabhilkar *et al.* (2016) shifted the focus of resilience in supply chains from redundant capacity and inventory to dynamic capabilities and suggested that supply-side resilience can be conceptualised as consisting of dynamic capabilities. Supply-side resilience, as one type of dynamic capabilities, can enhance a firm's ability to reconfigure its existing infrastructure to better manage upstream disruptions (Ambulkar *et al.*, 2015; Dabhilkar *et al.*, 2016).

Scholars have identified a wide range of strategies for improving supply chain resilience, with most attention being on strategies that can be used to prepare for, respond to and recover from supply chain disruptions (Ali *et al.*, 2017), such as increasing flexibility and creating redundancy (Sheffi and Rice, 2005), contingency planning (Ambulkar *et al.*, 2015), knowledge management (pre-disruption) (Stevenson and Busby, 2015), and forming collaborative supply chain relationships (Scholten and Schilder, 2015). The majority of the strategies have been suggested for the focal firm (or buying

firms) to either adopt, develop or implement in order to build supply chain resilience. In contrast, strategies or efforts that are proactively initiated by other supply chain actors, including suppliers, are largely neglected in the supply chain resilience literature. We argue this is an important void that needs to be filled for the following two reasons.

First, it is important to acknowledge a variety of relational behaviours that can be initiated by both buyers and suppliers (Leuthesser, 1997). Without an understanding of the relational behaviours of suppliers, there is an incomplete picture of collaborative BSRs – currently from the buyer's perspective only – or of how collaboration strategies can be fully utilised to improve relationship quality and business performance. Therefore, for a complete understanding of the implications of buyer-supplier collaboration, it is also important to examine the relational behaviour of the supplier (Leuthesser, 1997). Second, from an information asymmetry perspective, the buyer is typically better informed of downstream demand while the supplier has more information on its products and upstream supply markets (Pavlou *et al.*, 2007). This creates uncertainty, the perception of hidden information, and the suspicion of ulterior motives from partners with diverging interests (Eisenhardt, 1989a). But when a supplier takes deliberate, intentional actions (Zollo and Winter, 2002) and proactively initiates efforts to better understand a buyer's needs and requirements related to risk management (Leuthesser, 1997), it is likely that the buyer will be more proactive in terms of being alert, adapting, and responding to potential supply disruptions (Fan and Stevenson, 2018a).

Drawing on this research, we define SIRMB as the extent to which a supplier proactively initiates efforts to support a buyer's needs and requirements related to risk management. We acknowledge the differences between supply chain risk management and supply chain resilience and take the perspective of Juttner and Maklan (2011) that risk management from the supplier side (consisting of risk identification, assessment, mitigation, and monitoring) is positively related to buyer's supply-side resilience. Our first hypothesis thus relates SIRMB to supply-side resilience as follows:

H1. *SIRMB* is positively associated with *supply-side resilience*.

2.2 Interpersonal Relationships and SIRMB

Turbulent environmental conditions place a premium on both the speed and quality of decision making and firm actions (Eisenhardt, 1989b). A key factor in a buying firm's capability to achieve both speed and quality is the use of real-time information (Eisenhardt, 1989b). Within a BSR, interpersonal relationships, defined as the set of

relationships that employees in the buying firm have with individuals in the supplier firm, are a chief source of timely and relevant information on the state of both the external environment and the organisation itself (Tushman and Scanlan, 1981; Huang *et al.*, 2016). Importantly, interpersonal relationships differ in *size*, defined as the number of contacts, and *range*, defined as the diversity of contacts (Burt, 1982). Interpersonal relationships can be potentially large, but not necessarily diverse (Granovetter, 1973). For example, a purchasing manager may develop a very large number of contacts with the sales managers in its supplier organisation but may have very few contacts with individuals in other functions (e.g. finance, R&D, marketing, etc.). Firms with large and diverse interpersonal relationships provide favourable settings for managers with different information and knowledge bases to interact frequently; thus greater diversity can be a strategic asset that enables firms to gain competitive advantage (Barney and Wright, 1998; Collins and Clark, 2003) and create supply chain resilience (Durach and Machuca, 2018).

In general, a larger number of interpersonal relationships provides a greater capacity for information than a smaller number of interpersonal relationships (Granovetter, 1973; Burt, 1982). In addition, interpersonal relationships within BSRs that contain links to many different types of actors potentially contain more diverse and novel information (Mintzberg, 1973; Burt, 1982). Greater capacity for information from large ties combined with more diverse and novel information from diverse ties serves as a conduit for the transmission of valuable information, knowledge and opportunities from a supplier to the buyer. Moreover, the distinct information capabilities created through large and diverse interpersonal relationships may encourage suppliers to do favours for buyers in order to support them (Cai *et al.*, 2017). Such favours can take the form of risk management relational behaviours by the supplier, including supplier flexibility, providing assistance in the case of emergencies, changes, or supply problems (Noordewier *et al.*, 1990), and a supplier proactively initiating efforts to prioritise production plans, delivery or service for the buyer in anticipation of potential supply disruptions (Fan and Stevenson, 2018a). These initiating behaviours send a signal to the buyer that the supplier genuinely cares about learning the buyer's business and is motivated to perform in the buyer's interests (Leuthesser, 1997) of better dealing with potential supply disruptions. Therefore, we propose that there will be general positive effects on SIRMB from the *size* and *range* of interpersonal relationships.

H2. The *size* of interpersonal relationships is positively related to *SIRMB*.

H3. The *range* of interpersonal relationships is positively related to *SIRMB*.

2.3 Mediating effect of SIRMB

When we juxtapose the three hypotheses presented above, two full mediating models emerge. That is, interpersonal relationships in terms of size and range can indirectly affect supply-side resilience by influencing supplying firms to initiate risk management behaviours. On the one hand, researchers have found that a set of large and diverse interpersonal relationships positively relates to firm performance, including operational supply risk mitigation (Chowdhury *et al.*, 2019). On the other hand, favours and business support from suppliers, in the form of risk management activities, positively relate to supply-side resilience (Cai *et al.*, 2017; Fan and Stevenson, 2018a). Hence, if interpersonal relationships (both in terms of size and range) positively affect SIRMB (Hypothesis 2 and 3), which in turn affects supply-side resilience (Hypothesis 1), then we can expect SIRMB to transmit the effects of interpersonal relationships onto buying firms' supply-side resilience. A buyer, therefore, can attain supply-side resilience through SIRMB.

H4. *SIRMB* mediates the positive relationship between the *size* of interpersonal relationships and *supply-side resilience*.

H5. *SIRMB* mediates the positive relationship between the *range* of interpersonal relationships and *supply-side resilience*.

2.4 The Moderating Effect of Dependence Asymmetry

Dependence asymmetry measures the extent to which inter-firm relative dependencies are balanced or imbalanced (Casciaro and Piskorski, 2005; Gulati and Sytch, 2007). Asymmetry occurs as a result of discrepancies in resource endowments and/or accessibility (Emerson, 1962) and reflects the relative power between the parties (Casciaro and Piskorski, 2005). Dependence is a particularly critical concept in the context of BSRs. In such a principal-agent arrangement, perceived dependence asymmetry is almost inevitable (Camuffo *et al.*, 2007). Typically, set-up costs (i.e. relationship-specific investments) are higher for suppliers than for buyers, adding to the asymmetry of dependence and commitment (Corbett and De Groote, 2000). Moreover, supply chain position often equates to differences in access to physical resources and information. Generally, a buyer is better informed of the downstream demand market while a supplier has more information on its products and related upstream supply

markets (Pavlou *et al.*, 2007).

Dependence asymmetry has a significant bearing on resource complementarity (Sarkar *et al.*, 2001; Lin *et al.*, 2009) and perceptions of distributive fairness by both firms in a given relationship (Kumar *et al.*, 1995; Gassenheimer *et al.*, 1998; Poppo and Zhou, 2014). Dependence asymmetry also manifests in the perceived fairness of the relationship, which reflects the behavioural motives of the firms (Gassenheimer *et al.*, 1998). On the basis of assumed relative dependence, each firm evaluates *a priori* if there are any synergies between them and if there is a fair distribution of pay-offs, which then affects the extent to which firms transfer or combine resources. Employees, in asymmetric relationships with partnering firms (in which either the buyer or the supplier is relatively more dependent than its partner), may be more likely to feel tension and a sense of inequity (Casciaro and Piskorski, 2005). Here, the focus is on the magnitude of asymmetry. Much of the literature suggests that dependence asymmetry, regardless of its direction, tends to undermine relationship quality and prevent inter-firm activities (Kumar *et al.*, 1995). Below, we offer a more detailed discussion of the expected moderating effects of the size and range of interpersonal relationships.

By integrating interpersonal relationships with research on dependence asymmetry, we suggest that dependence asymmetry will moderate the relationship between the two dimensions of interpersonal relationships and SIRMB. We expect the relationships between the two dimensions of interpersonal relationships and SIRMB to be weaker when there is a higher level of dependence asymmetry than when dependence asymmetry (regardless of the direction) is lower. Buying firms' employees with large and diverse interpersonal relationships, in asymmetric relationships with supplying firms, may be more likely to feel tension and a sense of inequity. The superior party in resource terms anticipates that it will receive less useful resources from the other, resulting in relatively fewer payoffs from exchanging resources. The inferior party in resource terms assumes there to be a risk of appropriation and exploitation (Griffith *et al.*, 2017). Dependence asymmetry is also reflected in the perceived fairness of the relationship, which reflects the behavioural motives of the firms (Gassenheimer *et al.*, 1998). Even if employees in the buying firm have large and diverse personal ties with a supplier, asymmetrically paired firms are hesitant to actively exchange resources due to the perception of poor resource complementarity (Sarkar *et al.*, 2001; Lin *et al.*, 2009) and less fairness (Gassenheimer *et al.*, 1998). Drawing on this line of inquiry, we posit that a buying firm's employees with large and diverse interpersonal relationships exhibiting high levels of

dependence asymmetry may perceive such an inequity to be more salient and mean suppliers do not initiate risk management behaviour. Conversely, a buying firm's employees with large and diverse personal relationships in symmetric relationships with supplying firms may be less likely to feel and notice tension and a sense of inequity or be concerned about resource complementarity. Thus, suppliers with large and diverse interpersonal relationships may be less likely to initiate risk management efforts with lower levels of dependence asymmetry.

H6. Dependence asymmetry moderates the positive relationship between the *size* of interpersonal relationships and SIRMB such that the relationship is weaker (*vs*. stronger) among BSRs with higher (*vs*. lower) dependence asymmetry.

H7. Dependence asymmetry moderates the positive relationship between the *range* of interpersonal relationships and SIRMB such that the relationship is weaker (*vs*. stronger) among BSRs with higher (*vs*. lower) dependence asymmetry.

2.5 Moderated Mediation Model

Given the two moderation hypotheses above (i.e. Hypotheses 6 and 7) and the notion that interpersonal relationships influence supply chain resilience, dependence asymmetry could also influence the strength of the impact of the relationships between the size and range of interpersonal relationships and supply-side resilience, thereby demonstrating a pattern of moderated mediation. Figure 1 illustrates our research model. We predict that interpersonal relationships, both in terms of size and range, will indirectly affect supply-side resilience more strongly for buying firms in less asymmetrical BSRs. In contrast, for firms in symmetrical BSRs, we expect a small or non-existent mediating effect of SIRMB on the relationship between interpersonal relationships and supply-side resilience. Thus,

H8. Dependence asymmetry moderates the positive and indirect effect of the *size* of interpersonal relationships on supply-side resilience, such that this indirect effect is weaker (*vs*. stronger) among BSRs with higher (*vs*. lower) dependence asymmetry.

H9. Dependence asymmetry moderates the positive and indirect effect of the *range* of interpersonal relationships on supply-side resilience, such that this indirect effect is weaker (*vs*. stronger) among BSRs with higher (*vs*. lower) dependence asymmetry.

[Take in Figure 1]

3. Method

3.1 Survey Instrument Development and Data Collection

The nine hypotheses were assessed using a survey-based approach in the context of an ongoing BSR. The buyer reported on its fourth largest (rather than largest) supplier, which mitigates social desirability bias (Li *et al.*, 2010). To purify the items and ensure content validity, we used a Q-Sort approach over three rounds (Moore and Benbasat, 1991; Menor and Roth, 2007; Block, 2008). This produced strong evidence of convergent and discriminant validity (Moore and Benbasat, 1991) with a final round *inter-judge raw agreement* of 0.87, an item placement ratio of 90%, and a *Cohen's* Kappa of 0.85. These results suggest good quality measures. To pilot the instrument, 10 personal interviews and 20 online questionnaires were conducted with purchasing managers in Chinese manufacturing firms. Using the feedback, the wording of items that were difficult to interpret or caused unnecessary confusion were altered.

For the main data collection phase, we sought to obtain survey and secondary archival data on manufacturing firms headquartered in China. An electronic survey was used where the initial sample consisted of 1,641 manufacturing firms (SIC codes 20-51) listed by Dun & Bradstreet. A senior manager (e.g. purchasing manager or operations manager) from each firm was targeted as these managers are typically in charge of interactions with upstream suppliers. Wherever possible, we also targeted a second respondent knowledgeable in the same BSR.

As the survey was conducted in Chinese, a process of translation and back-translation was employed to ensure the consistent use of scales (Brislin, 1986). The managers received an email with a link to an online questionnaire. A personal email address was available for all 1,641 firms, but 460 emails were undeliverable, yielding a sampling frame of 1,181 firms. The total number of completed and useful responses was 247 (20.9% response rate). This can be considered sufficient, especially given the response rates of many recent relevant studies (e.g. Narayanan *et al.*, 2015). We applied multiple attention checks, e.g. honesty checks and logical statements (Abbey and Meloy, 2017), to analyse response quality. This provided confidence that the data were obtained from attentive respondents. Data were checked and cleaned to ensure validity (Hair *et al.*, 2010). Table I presents the demographic information for the sample.

[Take in Table I]

3.2 Non-Response Bias

To assess non-response bias, we compared responding and non-responding firms using a t-test (Lesser and Kalsbeek, 1992; Flynn *et al.*, 2010). We observed no significant differences between the two groups regarding key firm characteristics such as industry type (SIC code) (t = -1.224, $p = 0.222$), ownership type (t = -0.320, $p = 0.750$), firm size (number the employees) (t = -1.30, $p = 0.196$), or firm age (years since incorporation) (t = -0.177, $p = 0.859$). This suggests non-response bias was not a problem. Moreover, follow-up telephone calls and emails were undertaken with 10 non-responding firms revealing they only declined to participate because of a lack of time or a reluctance to reveal confidential information.

3.3 Common Method Bias

Two analyses to control for common method bias were undertaken (Podsakoff *et al.*, 2003):

1. Responses were collected from a subset of second respondents to validate the data, address single-informant bias concerns, and minimise common method bias concerns (Carey *et al.*, 2011). We ensured the competency of secondary respondents by including an item designed to measure specific knowledge of the firm's business relationship with a supplier. Of the 92 secondary informants, 16 responses were evaluated to have been reported by inattentive informants (Abbey and Meloy, 2017). These respondents were therefore removed. Of the 76 attentive secondary informants, 72 (96%) responded to the item "I am familiar with most aspects of our business relationship with Supplier X" by circling 5 or higher on a scale from 1 (strongly disagree) to 7 (strongly agree). The four informants responding 4 or lower were thus removed. Of the 72 qualified secondary informants, 57 had questionnaires that matched the primary respondents. The Interclass Correlation Coefficient (ICC) method (Futrell, 1995) was then used to evaluate the level of agreement between the primary and remaining secondary respondents. All correlations (for the 57) were >0.60 except for one of the items that measured supply-side resilience and one item that measured supplier dependence, which were consequently removed (see Table III in Section 4.1) (Boyer and Verma, 2000). This process indicates acceptable inter-rater reliability and adds validity to our results.
2. Archival data were used to triangulate subjective performance information and further minimise single-informant bias (Homburg *et al.*, 2012). Objective firm data was

extracted from the Factiva database, including annual sales, years in operation, and number of employees. Only data on 114 firms from our sample was available. The archival data were highly correlated with the data from the 114 primary and 16 relevant secondary respondents from this subset of firms (sales: r = 0.99, $p < 0.001$; years since incorporation: r = 0.98, $p < 0.001$; number of employees: r = 0.99, $p < 0.001$). This suggests that managerial evaluations are valid and not influenced by other survey questions.

Overall, the above demonstrates strong agreement between primary and secondary respondents and high consistency with archival data. This validates the primary respondent as a reliable informant; hence, the remainder of the analysis is based on primary respondent data only.

3.4 Measures

Unless otherwise indicated, a 7-point Likert scale from 1 (strongly disagree) to 7 (strongly agree) was adopted. *Supply-side resilience* was assessed based on six items to provide comprehensive coverage of its essential elements (Golgeci and Ponomarov, 2013; Ambulkar *et al.*, 2015). This is considered a unidimensional construct capturing the ability of the buyer firm to be alert to, adapt to, maintain and quickly respond to changes brought about by a supply disruption, and recover from disruptions and unexpected events (Dabhilkar *et al.*, 2016; Ali *et al.*, 2017).

Size of interpersonal relationships refers to the total number of contacts a buyer's representative has with employees in the supplier firm, whereby a large number of interpersonal relationships is comprised of more ties. Each respondent was asked to identify the total number of his/her contacts in each of the following seven categories of actors in the corresponding supplier organisation: CEOs & Leaders; Accounting & Finance; Marketing & Sales; Procurement; Production & Operations; Research & Development; Administration & Other. To create a company score for size of interpersonal relationships, we summed the number of personal ties across the seven categories for each primary respondent. To account for the fact that the managers of larger firms are likely to have more connections, we adjusted this variable by the square root of the buying firm's total number of employees. Such an adjustment is based on the assumption that given the same networking capability, an actor's number of contacts is positively related to the total number of nodes but at a diminishing rate (Wasserman and Faust, 1994). *Range of interpersonal relationships* refers to the diversity of contacts in a

buyer's interpersonal relationships. Range has been measured as the number of different groups or actor categories that a buyer's employee accesses (Collins and Clark, 2003; Scott, 2013).

Supplier-initiating risk management behaviours (SIRMB) refers to the extent to which a supplier proactively initiates efforts to better support a buyer's needs and requirements related to risk management. This measure was developed based on the work of Leuthesser (1997) and Fan and Stevenson (2018a). Respondents were asked to indicate to what extent the supplier initiates the behaviours listed in Table III using a 7-point scale (1 = "very unlikely to initiate"; 7 = "very likely to initiate"). The final measure for this construct was comprised of four items reflecting the main stages in the risk management process (i.e. risk identification, assessment, mitigation and monitoring) (Fan and Stevenson, 2018b). The reason for adopting risk management from the supplier side is to reflect the *proactive* nature of supplier relational behaviours to support the buyer's disruption management.

As a moderator, we focused on the magnitude, rather than the direction, of *dependence asymmetry* in a BSR. We operationalised this variable based on the relative dependencies between two firms (Kim and Choi, 2018), which is a function of resource criticality and the availability of alternative sources of supply/demand (Burt, 1982). According to equity theory, perceptual dependence levels are better predictors than the objective reality of dependence in terms of how partners actually behave and respond in their relationships (Astley *et al.*, 1990). To create a measure of dependence asymmetry, we used the dependence of the supplier (D_S) and dependence of the buyer (D_B) to calculate the absolute difference in relative dependencies $|D_S-D_B|$, which ranges from an asymmetry level of 0 (lowest) to a level of 7 (highest). Supplier dependence refers to the extent to which the supplier relies on the buyer, and buyer dependence refers to the extent to which the buyer relies on the supplier. Four items each, adapted from Lusch and Brown (1996) and Wang *et al.* (2014), measure D_S and D_B. To ensure that dependence asymmetry would be appropriately estimated by the above calculated score, D_S and D_B were established as distinct constructs. The fit indices failed to meet any of the recommended critical values for the one-factor model ($\chi^2(14) = 520.354$, CFI = 0.467, TLI = 0.200, RMSEA = 0.383, and SRMR = 0.236) but exceeded the recommended critical values for the two-factor model ($\chi^2(13) = 520.354$, CFI = 0.989, TLI = 0.982, RMSEA = 0.057, and SRMR = 0.031). From this analysis it can be concluded that D_S and D_B are distinct constructs, thus enabling the construct of dependence asymmetry to be estimated, where larger values represent highly asymmetric relationships.

Following Carlson and Wu (2012), we adopted a conservative approach to including control variables. We controlled for four variables that are theoretically and empirically linked to the relationships of interest (Spector and Brannick, 2011; Atinc *et al.*, 2012; Carlson and Wu, 2012): firm age, perceived supplier importance, relationship duration, and environmental uncertainty. *Firm age*, as a proxy for knowledge and experience, was measured as the natural logarithm of the number of years since a firm was founded. Older buying firms have more expertise than younger firms in managing and benefiting from supplier relationships to develop resilience (Durach and Machuca, 2018). The *perceived importance of the supplier* was measured based on the buyer's percentage of total annual purchasing spend with the supplier, which provides a proxy for relationship importance (Carey *et al.*, 2011). Five categories of purchasing spend were used: 1 (0–5%), 2 (6–15%), 3 (16–30%), 4 (31–50%), and 5 (>50%). The importance of the supplier might affect the way in which the buying firm interacts with it and may eventually impact firm resilience (Durach and Machuca, 2018). Further, given that prior research has established the effects of *relationship duration* on a partner's trust, joint actions, information sharing, and performance (e.g. Uzzi, 1999), we also controlled for this factor and operationalised it as the logarithm of the number of years that the two parties had conducted business together. Finally, we controlled for *environmental uncertainty* to level out the effects of disruptions across industries such that they become comparable (Brandon-Jones *et al.*, 2014). This variable was measured by a five-item scale adapted from Pagell and Krause (2004), Wong *et al.* (2011), and Azadegan *et al.* (2013). One item was removed as the factor loading was <0.50.

4. Data Analysis and Results

4.1 Measurement Model Results

The latent constructs were evaluated using confirmatory factor analysis (CFA). The CFA model was fit using robust maximum likelihood estimation in M*plus* (Version 7.4), inputting the raw data. We used a rescaling-based robust estimator, the robust MLR estimator since the multivariate normality test showed non-normality of the data (Wang and Wang, 2012). CFA with SIRMB, supply-side resilience and environmental uncertainty showed that the model fits the data well. The CFA results suggested that the model provided an acceptable fit to the data: $\chi^2(74) = 121.989$, CFI = 0.966, TLI = 0.959, RMSEA = 0.051, and SRMR = 0.046 (Hu and Bentler, 1999). The Chi-square value was below the ratio of χ^2/df of two (Browne and Cudeck, 1993). The RMSEA of the CFA for

the measures used in the model was 0.051, i.e. below the maximum value of 0.08 suggested by Browne and Cudeck (1993).

Discriminant validity was evaluated using Fornell and Larcker (1981). Table II presents the descriptive statistics for the constructs and correlations among them. The square root of the average variance extracted (AVE) was greater than the off-diagonal elements of the correlation matrix (see Table II), which demonstrates discriminant validity between the constructs. As shown in Table III, measurement items loaded on their intended factors ($p < 0.001$), indicating that the constructs exhibited convergent validity. Table III also shows that all congeneric reliability (i.e. composite reliability) values were >0.75, thus further confirming the reliability of the constructs. We also used the HTMT method (Henseler *et al.*, 2015) to further assess discriminant validity using R (Version 3.6.0). As Table IV shows, the HTMT ratio is below the cut-off of 0.85, indicating the presence of discriminant validity.

[Take in Table II, III and IV]

4.2 Hypothesis Testing

Structural equation modelling (SEM) was applied to test the hypotheses using M*plus* 7.4 (Muthén and Muthén, 2012). This enabled us to test the effects of the independent, mediator, and moderator variables simultaneously in the context of comprehensive models, as suggested by Edwards and Lambert (2007). The analytical procedure follows a logic similar to that which underlies hierarchical moderated regression analysis (Aiken and West, 1991; Cohen, 2003). Therefore, the first model included all basic effects and control variables, as well as the direct effects of the moderator on the dependent variables, to avoid confounding the main interaction effects (Irwin and McClelland, 2001). A subsequent model included an interaction (*Dependent Asymmetry*) with the independent variables (*Size* and *Range*).

4.2.1 Testing the Structural Models

The basic model (without any interaction terms) produced global fit statistics that indicated an acceptable fit of the model to the data (RMSEA = 0.024; $\chi^2/df = 1.14$; SRMR = 0.06). The completely standardised path coefficients of this basic model appear in Figure 2.

[Take in Figure 2]

The results of the first three hypotheses are shown in Figure 2. Hypothesis 1, predicting

that more SIRMB leads to higher supply-side resilience, was supported ($\beta = 0.286$, $p < 0.001$). Hypothesis 2 posited that the size of interpersonal relationships is positively related to SIRMB. But contrary to our expectation, we found that SIRMB is actually lower when there is a large size of interpersonal relationships ($\beta = -0.244$, $p < 0.01$). Hypothesis 2, as a result, was not empirically supported. Hypothesis 3 argued that the range of interpersonal relationships is positively related to SIRMB; and the standardised coefficient is significant ($\beta = 0.357$, $p < 0.001$), lending support to Hypothesis 3.

Although H1 received support, the relationship between the size and SIRMB was not in the predicted direction (H2). Therefore, we also conclude against Hypothesis 4. Through an indirect effect, the range of interpersonal relationships affects supply-side resilience, with SIRMB being the mediating construct. This provides empirical evidence in support of H5. Regardless of the direction of the effects, the range of interpersonal relationships contributed more strongly to SIRMB and thus to supply-side resilience than the size of interpersonal relationships.

The results remained robust even with the inclusion of several control variables, also evident from Figure 2. That is, the control variables that might affect the dependent variable of supply-side resilience were all significant (environmental uncertainty: $\beta = -0.200$, $p < 0.01$; relationship duration: $\beta = 0.145$, $p < 0.001$; perceive importance of the supplier: $\beta = -0.262$, $p < 0.001$) except firm age ($\beta = 0.031$, *n.s.*). However, a further test of the stability of the findings revealed the direct effect of the range of interpersonal relationships and supply-side resilience, showing that *range* positively enhances supply-side resilience ($\beta = 0.301$, $p < 0.001$); but this effect is weaker than the effect on SIRMB. Hypothesis 5 therefore received further support for the prediction that SIRMB serves as an important transmitter of the range of interpersonal relationships and supply-side resilience.

4.2.2 Moderation and Moderated Mediation Testing

To test hypotheses 6 to 9, a moderated mediation model, which included the interactions between each respective independent variable (*Size* and *Range*) and the moderator (*Dependence Asymmetry*) on the mediator (*SIRMB*), was estimated on the basis of the full mediation model. All the indicators were mean-centred to increase the interpretability of the results (Dalal and Zickar, 2012). Again, the results of the moderator analysis are included in Figure 2. This model (RMSEA = 0.020; $\chi^2/df = 1.09$; SRMR = 0.06; CFI = 0.990; TLI = 0.988) fits the data significantly better than the mediation model because

the Akaike information criterion (AIC) value of this model is lower than the AIC value of the mediation model (Burnham and Anderson, 2002).

In relation to the moderating effects of dependence asymmetry, Hypothesis 6 predicted an interaction between *size* and dependence asymmetry. As illustrated in Figure 2, the interaction between the size of interpersonal relationships and dependence asymmetry was significantly related to SIRMB (γ= -0.307, $p < 0.05$). Simple slope tests showed that when dependence asymmetry was high (1 *SD* above the mean), *size* was significantly related to SIRMB (γ= -0.769, $p < 0.001$); whereas, when it was low (1 *SD* below the mean), *size* was not related to SIRMB (γ= 0.377, *n.s.*). As shown in Figure 3, the negative relationship between *size* and SIRMB was stronger when there is higher dependence asymmetry, providing support against Hypothesis 6.

[Take in Figure 3]

The analysis confirmed a moderating effect of dependence asymmetry on the link between *range* and dependence asymmetry (γ= 0.465, $p < 0.001$), such that the positive relationship between *range* and SIRMB is weaker for high dependence asymmetry. Simple slope tests showed that when dependence asymmetry was high (1 *SD* above the mean), *range* was significantly related to SIRMB (γ= 0.177, $p < 0.001$); whereas when it was low (1 *SD* below the mean), *range* was not related to SIRMB (γ= 0.023, *ns*). As shown in Figure 4, the positive relationship between *range* and SIRMB was weaker when there is higher dependence asymmetry, providing support for Hypothesis 7.

[Take in Figure 4]

Based on this model, we also examined the conditional indirect effects following the recommendations by Preacher *et al.* (2007). Specifically, for high levels of dependence asymmetry, the indirect effect of *size* on supply-side resilience through SIRMB was not significant (conditional indirect effect = -0.264, *n.s.*); and the indirect effect of *range* on supply-side resilience through SIRMB was significant (conditional indirect effect = 0.071, $p < 0.05$). When dependence asymmetry was low, none of the indirect effects were significant. These results rejected Hypothesis 8 but supported Hypotheses 9.

4.3 Robustness Checks

We performed three sets of robustness checks to evaluate the sensitivity of the results.

First, to address the concern that the direction of dependence between two partners may exhibit different effects, we followed Scheer *et al.* (2003) to create a spline variable to better represent the asymmetry of relative dependence. Relative dependence refers to the comparative level of dependence between the buyer and supplier (Lusch and Brown, 1996). The spline regression analysis results are consistent with our earlier findings. Second, we used the index of diversity (Blau, 1977) to create an alternative measure of the range of interpersonal relationships. The index of diversity can be measured as $1-\Sigma (P_i)^2$, where P_i is the percentage of ties in the ith category. The more evenly the ties are spread across different functions within the supplier, the higher the index. The results still hold using this alternative measure. Third, we replaced the 57 primary respondents' data with the respective secondary response data and re-ran the current analysis. The results still hold and demonstrate strong agreement between primary and secondary respondents and that the primary respondent can be used as a reliable informant.

5. Discussion

5.1 Interpretation of Findings

This study has examined the process through which two dimensions of interpersonal relationships (i.e. size and range) influence supply-side resilience. We found that the two dimensions and dependence asymmetry jointly influence supply-side resilience via SIRMB. Based on data from 247 firms, we found support for the differences in the conditional indirect effects of the range of interpersonal relationships, but not for the size of interpersonal relationships.

Our analysis for Hypothesis 1 suggested that SIRMB can indeed affect supply-side resilience. When suppliers proactively initiate risk management relational behaviours, the buyer is more likely to attain supply-side resilience. This provides empirical support for previously untested conceptual arguments that supply chain risk management is positively related to supply chain resilience (Juttner and Maklan, 2011). But it should also be noted here that we are suggesting proactive risk management efforts by supplier firms (not buying firms) to enhance supply-side resilience. Thus, we expand the prevalent focus on buying firms to upstream supply chain angels. This is significant given that an upstream supplier is likely to have information that is not available to the buyer and may be in a position to identify certain threats before the buyer – thus, motivating the supplier to proactively initiate efforts can complement buyer initiating efforts thereby further enhancing supply-side resilience.

Hypothesis 2 posited a relationship between the size of interpersonal relationships and SIRMB; however, the observed relationship is in the opposite direction to that expected. We found that, while controlling for the effects of the range of interpersonal relationships and dependence asymmetry, the size of interpersonal relationships has a negative association with SIRMB. Perhaps this is because employees in buying firms having large ties with the supplier and these ties are also directly connected to one another (i.e. the networks are more likely to be dense). Previous research has established that dense networks are associated with lower levels of new information flowing to an individual (Reagans and Zuckerman, 2001). Such new information, or having access to the right information at the right time, is key for employees when preparing for disruptions. Consequently, we did not find that SIRMB mediates the relationship between *size* and supply-side resilience (H4) or dependence asymmetry moderates the positive and indirect effect (H8).

Notably, while controlling for the size of interpersonal relationships and dependence asymmetry, we showed that SIRMB mediated (H5) the positive relationship between the range of interpersonal relationships and supply-side resilience (H3). Furthermore, dependence asymmetry moderated the relationships between the range of interpersonal relationships and SIRMB (H7), and the indirect effect between range and supply-side resilience (H9). We have shown that SIRMB is an explanatory mechanism underpinning the relationship between the range of interpersonal relationships and supply-side resilience. Thus, diverse interpersonal relationships are more likely to incentivise supplier firms to initiate risk management efforts, thereby enabling buying firms to strengthen their supply-side, and this is particularly evident in symmetric BSRs.

Unexpectedly, we also found that dependence asymmetry exhibits opposing moderating effects on SIRMB, i.e. it has a negative moderation effect on the relationship between size and SIRMB and a positive moderation effect on the relationship between range and SIRMB. This indicates that the two dimensions of interpersonal relationships considered in this study are regulated by dependence asymmetry but in different ways. As both conceptual and empirical research on this topic is still underdeveloped, our research provides novel insights into supply chain resilience and offers significant theoretical and managerial implications, as outlined below.

5.2 Theoretical Implications

In response to RQ1, our study is among the first to advance SIRMB as a theoretical

mediator in the relationship between interpersonal relationships and supply-side resilience. Our focus on SIRMB is an important addition to the prevalent focus on the strategies that buying firms need to develop and adopt to improve supply chain resilience (e.g. Sheffi and Rice, 2005; Scholten *et al.*, 2014; Ambulkar *et al.*, 2015). Within the current supply chain resilience literature, scholars have been interested in how focal firms can develop capabilities for managing unanticipated changes along the supply chain (Fiksel *et al.*, 2015; Sheffi, 2015). There is however limited prior understanding about the strategies or efforts proactively initiated by other supply chain members. Our study is also consistent with wider studies that have recognised the importance of, and need to promote, supplier actions and behaviours, such as work on supplier investment (Zhang *et al.*, 2015) and especially on promoting supplier proactive behaviours (Leuthesser, 1997) related to risk management.

We argue that diverse interpersonal relationships are indeed a route to incentivising suppliers to proactively initiate efforts that support buying firms in dealing with disruptions, thereby helping them to develop supply-side resilience. This is in line with prior research that, in general, has advocated interpersonal relationships within BSRs as being an important antecedent of organisational-level resilience (Durach and Machuca, 2018), and that has found interpersonal relationships can improve firm performance (Collins and Clark, 2003; Huang *et al.*, 2016). We add to this body of knowledge by delineating two specific dimensions of interpersonal relationships and by showing their impact on supply-side resilience via SIRMB. In particular, we have found that interpersonal relationships that are broad in range can lead to more SIRMB, which in turn enhances supply-side resilience. We have shown that interpersonal relationships as "private" good can generate "public" benefit for the organisation – by developing diverse relationships with suppliers thus motivating suppliers to display more SIRMB. Yet, it is also possible that such "private" good may not always generate "organisational" benefits – that suppliers are less motivated to proactively initiate efforts simply from the increasing size of interpersonal relationships (controlling for the range of interpersonal relationships). Perhaps this is because although employees in buying firms have large ties with the supplier these ties are directly connected to one another (i.e. the networks are more likely to be dense). Previous research has established that dense networks are associated with less new information flowing to an individual (Reagans and Zuckerman, 2001), but having timely access to this information is key when preparing for disruptions. Although further investigation is required, we find that benefits accrue from diverse ties

but not from large ties. Therefore, it may be wiser to concentrate on forming diverse interpersonal relationships to promote SIRMB.

In response to RQ2, our findings on the moderating role of dependence asymmetry in the relationships between the two dimensions of interpersonal relationships and SIRMB further contribute to the supply chain resilience literature. Moreover, in a BSR context, we have revealed that dependence asymmetry exhibits opposing moderating effects, i.e. it negatively moderates the relationship between size and SIRMB and positively moderates the relationship between range and SIRMB. This informs us that mechanisms based on size and range are regulated by dependence asymmetry, but in different ways. This insight helps to resolve the opposing conceptual mechanisms in the BSR literature by specifying the conditions under which the size-SIRMB relationship is strengthened and the range-SIRMB relationship is weakened. Thus, our study builds on earlier work that has suggested interpersonal ties are good for firm resilience but that did not differentiate between the two dimensions (Durach and Machuca, 2018). Further, it challenges previous work that has suggested "the more, the better" in terms of both size and range if firms want to improve their performance (Collins and Clark, 2003).

One possible explanation for the differences between previous work and our study is that we have considered dependence asymmetry as a moderator. The overall moderated mediation results demonstrate that buying firms behave prudently when making strategic decisions, such as how to manage resources in a relationship. They weigh up both effective (i.e. social networking) and rational factors (i.e. resource complementarity and fair pay-off distribution) (Reimann *et al.*, 2017), yet neither type of factor plays a decisive role in the process (Kim and Choi, 2018). This adds an important condition to the mediating link between the range of interpersonal relationships and supply-side resilience (Busse *et al.*, 2017). In addition, we add to the extant supply chain resilience literature by identifying the indirect conditional effect of the range of interpersonal relationships on supply-side resilience, but this is not the case for the size of interpersonal relationships. Therefore, our study encourages researchers to examine range and size separately in future work when dependence asymmetry is considered as part of the research context. In the future, it may also be important to consider network density on the supplier side when examining the size of interpersonal relationships within BSRs.

6. Managerial Implications

Three important managerial implications can be identified from this study. First, based

on the mediating role of SIRMB on the link between interpersonal relationships and supply-side resilience, we suggest employees in buying firms involved in supply disruptions should realise that SIRMB drives supply-side resilience. To ensure that suppliers are more likely to proactively initiate risk management behaviours, managers should learn that it is more important to develop diverse, rather than large, interpersonal relationships with their suppliers, which is critical to creating supply-side resilience. If certain desirable boundary spanners with diverse ties are not available in the firm, top management might consider adopting specific practices that encourage the formation of diverse interpersonal relationships.

Second, we suggest that buying firms should implement strategies that encourage SIRMB in order to support their own disruption management. Referring to the example of Volvo, we suggest that managers are likely to encourage SIRMB by raising the expectations of supplier relational behaviours in response to potential supply disruptions. Managers could also be encouraged to discuss SIRMB and related disruptions with their suppliers. Third, the results clearly show that the range of interpersonal relationships works through SIRMB to improve supply-side resilience. Although the above strategies are likely to prove effective for those buying firms having diverse interpersonal relationships, they may play a particularly important role in creating supply-side resilience for those buying firms who are in symmetric BSRs. Therefore, managers in buying firms should consider different networking strategies to encourage the positive and indirect conditional effect of range on supply-side resilience through SIRMB in symmetric BSRs or determine how to alter the dependence dynamic in asymmetrical relationships (e.g. managing contracts for fairness) (Poppo and Zhou, 2014). Buying firms can assign employees who have the most diverse ties with individuals in a given supplier to that particular relationship in order to be more capable of managing supply disruptions. This should be particularly helpful for buying firms in symmetric relationships looking for ways to increase their supply-side resilience. This may suggest that it is important to consider the nature of the BSR and the characteristics of interpersonal relationships when allocating personnel to different supplier relationships as assigning them effectively could encourage SIRMB and help to build supply-side resilience.

7. Limitations and Future Research

This study has been conducted from the buyer's perspective only and focused exclusively

on manufacturing organisations in China. Our findings therefore have to be considered industry-specific and country-specific. For future studies, we encourage researchers to collect dyadic data so as to capture different relational motives and behaviours. Further, studying a wider array of businesses and other country contexts would improve the generality of the findings. In addition, this study has focused on size and range while future research could investigate other characteristics of interpersonal relationships.

The moderated mediation model suggests that the link between interpersonal relationships and supply-side resilience is more complex than a simple direct relationship. Our study raises interesting and yet-to-be-answered questions about the different effects of the two dimensions of interpersonal relationships. The question "why are suppliers less likely to initiative risk management behaviour when size is large?" needs to be explored further. Further, our research encourages researchers to examine range and size separately in future work when dependence asymmetry is considered as part of the research context. In addition, we have focused on only one mediator (SIRMB). Future research could identify other potential mediators to advance our understanding of the precise mechanisms that explain the relationship between interpersonal relationships and supply-side resilience or other aspects of the model. For example, the learning capability of firms (Scholten *et al.*, 2019) on either side of the BSR may moderate the relationship between the two dimensions of interpersonal relationships and SIRMB. Likewise, future research could also consider other critical intervention factors that influence the effects of interpersonal relationships or dependence asymmetry.

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Table I. Sample Demographics (N = 247)

Characteristic	**n**	**Percentage (%)**
Respondent's job title		
Director/CEO/GM	23	9.3%
Purchasing Manager	153	61.9%
Supply Chain Manager	30	12.1%
Operations Manager	39	15.8%
Other	2	0.8%
Total	*247*	*100%*
Firm size (number of employees)		
<=100	14	5.6%
101-500	107	43.3%
501-1000	63	25.5%
1001-2000	27	10.9%
>=2001	36	14.6%
Total	*247*	*100%*
Firm age (years since incorporation)		
<=5	10	4%
6-10	38	15.4%
11-15	85	34.4%
16-20	54	21.9%
21-50	51	20.6%
>=51	5	2%
Not specified	4	1.6%
Total	*247*	*100%*

Table II. Mean, Standard Deviation, Correlation, and Discriminant Validity

	Variables	Mean	SD	1	2	3	4	5	6	7	8	9
1	Size of interpersonal relationships (adjusted by firm size)	0.37	0.31	-								
2	Range of interpersonal relationships	4.15	1.70	0.57**	-							
3	Dependence asymmetry	1.48	1.18	-0.14*	-0.10	-						
4	SIRMB	4.59	1.02	-0.04	0.21**	0.06	***0.81***					
5	Supply-side resilience	4.92	0.82	-0.15	0.24**	0.05	0.35**	***0.76***				
6	Relationship duration	4.62	1.92	0.17**	0.27**	-0.14*	0.14*	0.13	-			
7	Firm age	1.16	0.23	-0.20**	-0.02	0.07	0.16*	0.18**	0.23**	-		
8	Perceived importance of supplier	1.91	0.68	0.23**	0.04	-0.16**	-0.08	-0.29**	0.09	-0.09	-	
9	Environmental uncertainty	3.66	0.95	-0.11*	-.11	-0.03	-0.18**	-0.25**	0.03	-0.12	0.02	***0.71***

Note: Significant at: *0.05, **0.01 levels (Pearson probabilities); the diagonal elements (i.e. italic values) are the square roots of the AVE.

Table III. Construct Measures and Sources

Constructs and Items	Sources
Supplier-Initiating Risk Management Behaviours (SIRMB) (CR = 0.883)	
SIRMB1. To inform/warn my company about potential threats that could affect my company.	Leuthesser (1997)[b]; Fan and Stevenson (2018a)[b]
SIRMB2. To assist in assessing the potential impact of the identified supply risks on my company.	Leuthesser (1997)[b]; Fan and Stevenson (2018a)[b]
SIRMB3. To respond to supply risks that affect my company.	Leuthesser (1997)[b]; Fan and Stevenson (2018a)[b]
SIRMB4. To monitor potential supply risks that could affect my company.	Leuthesser (1997)[b]; Fan and Stevenson (2018a)[b]
Buyer Dependence (BD) (CR = 0.912)	
BD1. We are dependent on this supplier.	Griffith *et al.* (2016)[c]; Shou *et al.* (2016)[a]
BD2. This supplier would be difficult to replace.	Griffith *et al.* (2016)[c]; Shou *et al.* (2016)[a]
BD3. This supplier would be costly to lose.	Griffith *et al.* (2016)[c]; Shou *et al.* (2016)[a]
BD4. If our relationship was discontinued with the supplier, our company would have difficulty in fulfilling order.	Wang *et al.* (2014)[a]
Supplier Dependence (SD) (CR = 0.925)	
SD1. This supplier is dependent on us.	Griffith *et al.* (2016)[c]; Shou *et al.* (2016)[a]
SD2. This supplier would find it difficult to replace us.	Dropped
SD3. This supplier would find it costly to lose us.	Griffith *et al.* (2016)[c]; Shou *et al.* (2016)[a]
SD4. If our relationship was discontinued with the supplier, the supplier would have difficulty in making up the sales volume.	Wang *et al.* (2014)[a]
Supply-Side Resilience (SSR) (CR = 0.891)	
SSR1. We are able to maintain high situational awareness and recognise early warning risk signals before being disrupted.	Ambulkar *et al.* (2015)[a]
SSR2. We are able to adapt to the supply risk easily at the time of disruption.	Ambulkar *et al.* (2015)[a]
SSR3. We are able to provide a quick response to the supply risk at the time of disruption.	Ambulkar *et al.* (2015)[a]
SSR4. We are able to maintain a desired level of control over the structure and function of our operation at the time of disruption.	Golgeci and Ponomarov (2013)[a]
SSR5. We are able to recover after a supply disruption to restore or return to our original operation state.	Golgeci and Ponomarov (2013)[a]
SSR6. We are able to move to a new, more desirable state after being disrupted.	Golgeci and Ponomarov (2013)[a]
SSR7. We are able to apply lessons learned from disruptions and unexpected events to help prepare for the future.	Dropped
Environmental Uncertainty (EU) (CR = 0.796)	
EU1. Our suppliers' performance is unpredictable.	Wong *et al.*, (2011)[a]

EU2. Our plant uses core production technologies that often change.	Wong *et al.*, (2011)[a]
EU3. Our customers often change their order over the month.	Wong *et al.*, (2011)[a]; Villena *et al.*, (2011)[a]
EU4. Our competitors' actions regarding marketing promotions are unpredictable.	Wong *et al.*, (2011)[a]
EU5. Government regulations that affect our industry often change.	Dropped

Note: [a]: adapted and modified from the source
[b]: developed based on the arguments presented in the source
[c]: uses the same items as in the source

Table IV. HTMT Ratio

	SIRMB	Supply-side resilience	Buyer dependence	Supplier dependence	Environmental uncertainty
SIRMB					
Supply-side resilience	0.393				
Buyer dependence	0.190	0.189			
Supplier dependence	0.488	0.500	0.068		
Environmental uncertainty	0.214	0.296	0.149	0.139	

Figure 1. Research Model

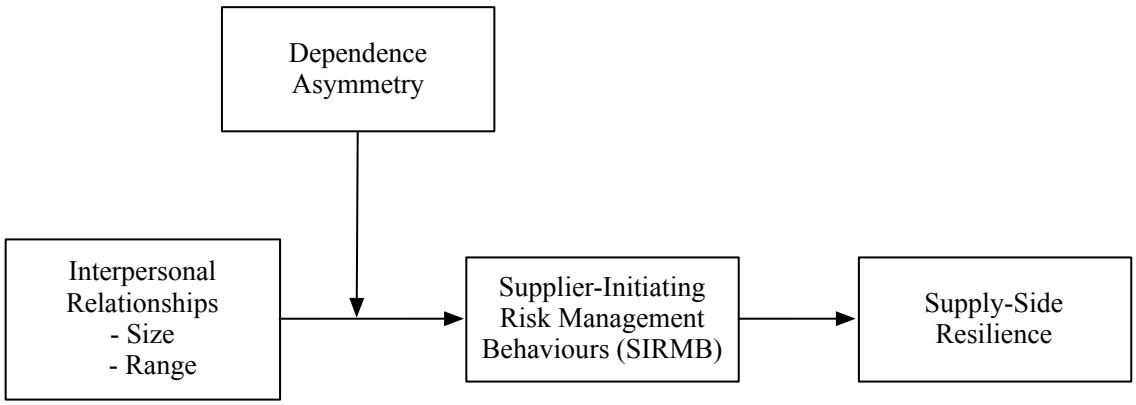
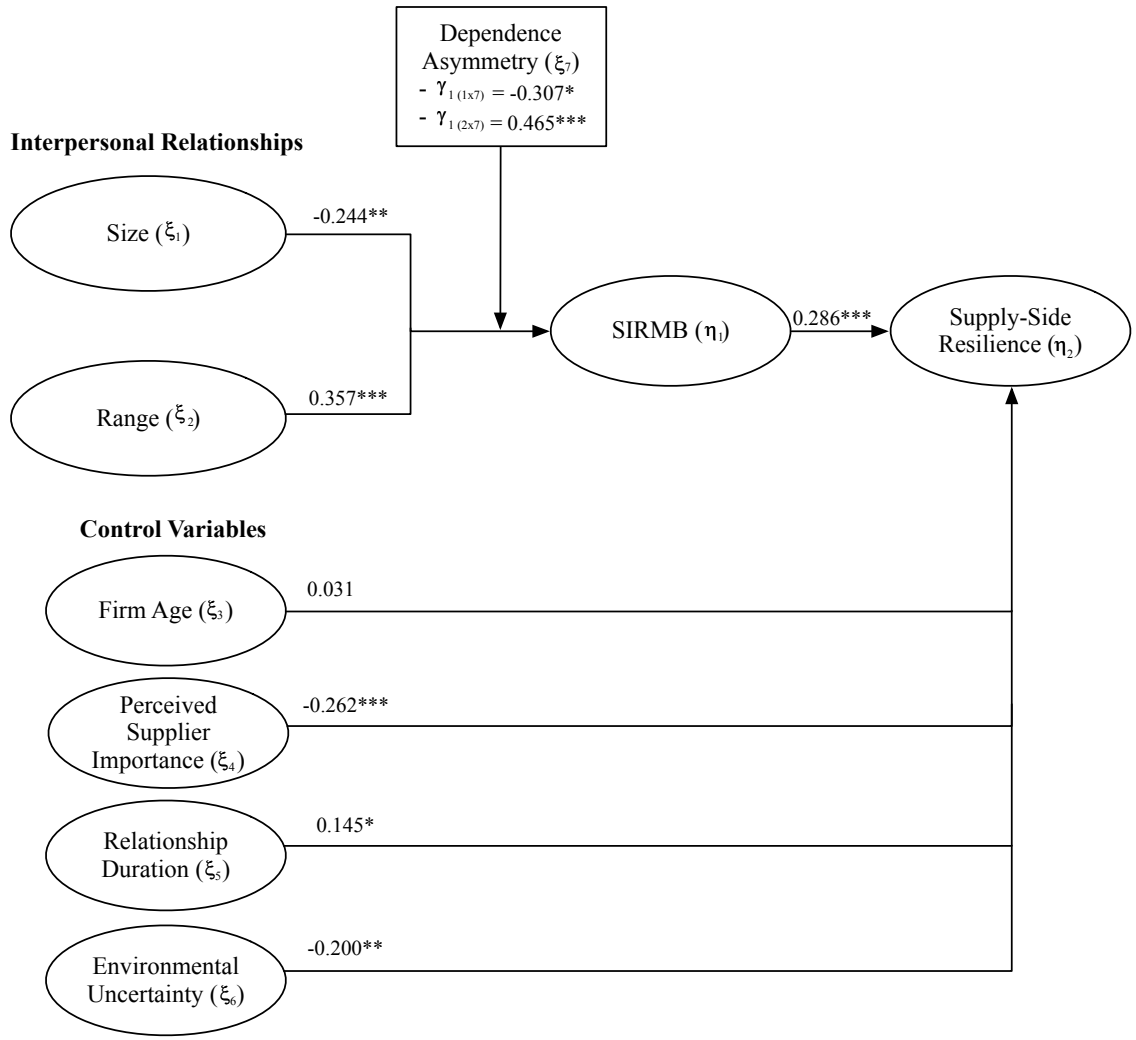


Figure 2. Results of the Structural Equation Modelling (SEM)



*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$; standardised parameter estimates are reported

Figure 3. Interaction between Size of Interpersonal Relationships and Dependence Asymmetry for Supplier-Initiating Risk Management Behaviours (SIRMB)

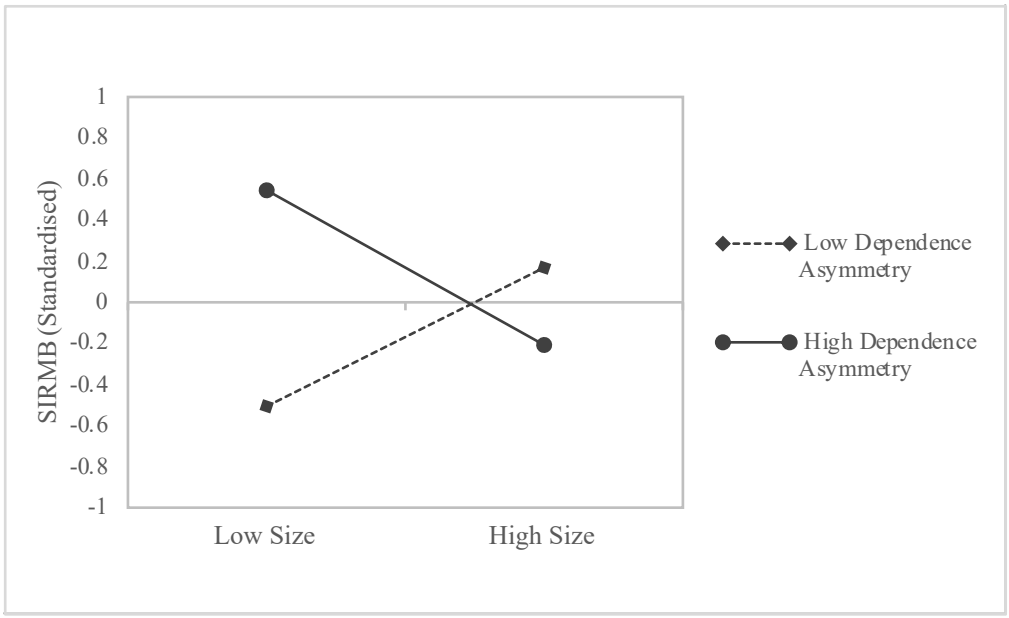


Figure 4. Interaction between Range of Interpersonal Relationships and Dependence Asymmetry for Supplier-Initiating Risk Management Behaviours (SIRMB)