Nonlinear effects of relational capital on supply-side resilience:

The moderating role of boundary spanners' personal ties

Yiyi Fan and Mark Stevenson

Lancaster University Management School

Abstract

Purpose: Prior studies have largely overlooked the potentially negative consequences of a buyer's relational capital (RC) with a supplier for supply-side resilience, assuming a positive linear relationship between the constructs. Meanwhile, the focus of research has been at an organisational level without incorporating the role of boundary spanning individuals at the interface between buyer and supplier. Drawing on social capital and boundary spanning theory, we: (i) re-examine the relationship between RC and supply-side resilience, challenging the linear assumption; and, (ii) investigate how both the strength and diversity of a boundary spanner's ties moderate this relationship.

Design/methodology/approach: Survey data is collected from 248 firms and validated using a subset of 57 attentive secondary respondents and archival data. The latent moderated structural equation (LMS) method is applied to analyse the data.

Findings: An inverted U-shaped relationship between RC and supply-side resilience is identified. Tie strength in particular has a positive moderating effect on the relationship. More specifically, the downward RC-Supply-side resilience relationship flips into an upward curvilinear relationship when boundary spanning individuals develop stronger ties with supplier personnel.

Research limitations/implications: A deeper insight into the RC-Supply-side resilience relationship is provided. Findings are based on Chinese manufacturing firms and cross-sectional data meaning further research is needed to determine their generalisability.

Practical implications: In evaluating how to enhance supply-side resilience, buying firms must decide whether the associated collaborative benefits of developing RC outweigh the potential costs. Managers also need to be concerned with the impact of developing RC between organisations and enhancing the tie strength of individuals simultaneously.

Originality/value: The paper goes beyond the linear relationship between RC and supply-side resilience. Incorporating the moderating role of boundary spanners identifies a novel phenomenon whereby the RC-resilience relationship flips from an inverted to a U-shaped curve.

Keywords: Relational capital, Buyer-supplier relationships, Boundary spanner, Tie diversity, Tie strength, Supply-side resilience

Paper Type: Research paper

Author Biographies

Yiyi Fan is a Lecturer in the Department of Management Science at Lancaster University in the UK. She obtained her MSc degree in Operations, Project and Supply Chain Management at the University of Manchester, UK. Her research interests relate to supply chain risk and sustainability, multi-level supply chain relationships, social capital, power asymmetry and joint dependence in supply chains, and supply chain finance and governance. Her research has been published in the *International Journal of Physical Distribution & Logistics Management* and *Supply Chain Management: An International Journal*. She has presented her research at the European Operations Management Association (EurOMA) conference.

Mark Stevenson is a Professor of Operations Management at Lancaster University in the UK. His research interests currently include sustainable supply chain management, supply chain risk and resilience, supply chain flexibility and uncertainty, production planning & control in high-variety manufacturing companies, and reshoring & the manufacturing location decision. His work has appeared in several operations and supply chain journals, including the *International Journal of Operations & Production Management (IJOPM)*, *Production & Operations Management (POM)*, the *International Journal of Production Economics (IJPE)*, the *International Journal of Production Research (IJPR)*, and *Supply Chain Management: An International Journal (SCMIJ)*. He regularly attends and presents his work at international conferences, including the European Operations Management Association (EurOMA) conference.

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1. Introduction

Trends such as global outsourcing, lean, and supply base reduction have not only increased firm exposure to supply chain disruptions, they have also magnified the consequences (Brandon-Jones *et al.*, 2014). The potential for substantial losses has motivated many organisations to enhance their supply chain resilience, including through greater inter-organisational collaboration (Scholten and Schilder, 2015), particularly with first-tier suppliers (Business Continuity Institute, 2017). The threats upon which we will focus, therefore, are upstream (supply-side) disruptions. Buying firms, realising that upstream events can have negative consequences, are now focused on building resilience in order to be alert to, adapt to, maintain, and quickly respond to changes brought about by a supply-side disruption (Dabhilkar *et al.*, 2016).

The recent extension in the literature on social capital theory to buyer-supplier relationships (BSRs) provides a fresh perspective for analysing how buying firms develop collaborative relationships with suppliers to build supply-side resilience (Johnson *et al.*, 2013; Scholten and Schilder, 2015; Dabhilkar *et al.*, 2016). The three dimensions of social capital theory, namely structural, cognitive and relational dimensions, may play an influential role in facilitating supply chain resilience (Johnson *et al*., 2013). However, considering that: (1) structural and cognitive social capital are antecedents of relational capital (RC) (Carey *et al*., 2011), which has been linked to various performance outcomes, such as supplier knowledge enrichment (Preston *et al*., 2017) and buyer cost improvements (Carey *et al*., 2011); and, (2) of the three dimensions of social capital, RC is the only one to exhibit significant quadratic effects on both strategic and operational performance (Villena *et al*., 2011), we focus exclusively on RC in this study. This approach is consistent with previous studies (Carey *et al*., 2011; Preston *et al*., 2017) linking RC directly to performance outcomes, and there is no apparent theoretical reason to replicate the finding that structural and cognitive social capital are antecedents of RC (Carey *et al*., 2011). RC consists of trust, reciprocity, expectations, and obligations between two partners (Nahapiet and Ghoshal, 1998). Prior research generally suggests a positive linear relationship between RC and supply-side resilience (Johnson *et al.*, 2013; Scholten and Schilder, 2015) arguing that RC results in superior access to resources and information held by others and enhanced capabilities to survive, adapt, and grow when confronted with change and uncertainty (Knemeyer *et al.*, 2009; Scholten and Schilder, 2015). Yet there are compelling reasons to posit that the relationship may not be linear – higher levels of RC may be subject to diminishing gains in supply chain resilience – as discussed below.

In light of recent theoretical advances, it can be questioned whether the association between RC and supply-side resilience is appropriately represented by a continuous, positive linear relationship. Specifically, the ‘too-much-of-a-good-thing’ (TMGT) effect (Pierce and Aguinis, 2013) challenges the assumption that more of a desirable trait is always better. Thus, the alternative to a linear model is a perspective in which ordinarily beneficial antecedents are no longer advantageous when taken too far. In the wider OM literature, Villena *et al.* (2011) found that, after a certain point, too much RC can be detrimental to strategic and operational performance. In the context of supply-side resilience, the critical question arises whether it is possible to have too much RC, meaning that at some point more RC is no longer advantageous or even becomes a hindrance to supply-side resilience. Therefore, our work extends the available literature by investigating the potentially curvilinear relationship between RC and supply-side resilience.

With regards to supply-side resilience, employees (e.g. purchasing managers) who operate at the interface between the buying organisation and its suppliers play a critical role in shaping BSRs (Huang *et al.*, 2016). Realising this, many executives encourage employees to forge productive boundary spanning personal ties (BSPTs) (Korschun, 2015), referring to the set of relationships individuals have with those from supplier organisations. Indeed, it has been claimed that the relationships individuals build in their social networks strongly determine the availability and accessibility of capabilities and resources for adaptive responses (van der Vegt *et al.*, 2015). In other words, the effect of RC on supply-side resilience is likely to be contingent upon BSPTs. Nevertheless, research that identifies the conditions under which RC leads to enhanced resilience is extremely limited.

BSPTs can vary in terms of their structure (tie diversity) (Burt, 1982) and strength (tie strength) (Granovetter, 1973). Drawing on boundary spanning theory (Aldrich and Herker, 1977), we identify and propose the strength and diversity of a boundary spanner’s ties as moderators in the RC-Supply-side resilience relationship. Data from 248 Chinese manufacturing firms has been collected, providing empirical evidence of an inverted U-shaped relationship between the two constructs. Further, the importance of tie strength in particular in moderating the influence of RC on supply-side resilience is highlighted.

The remainder of this paper is structured as follows. Section 2 reviews the literature and develops three hypotheses on the effect of RC on supply-side resilience and the moderating effects of tie diversity and tie strength. The research method is outlined in Section 3 before the results are presented in Section 4. Finally, Section 5 presents a discussion and conclusions, including theoretical and managerial implications, limitations, and future research directions.

2. Theoretical Background and Hypotheses Development

2.1 Relational Capital (RC) and Supply-Side Resilience

Supply-side resilience refers to the capability of a buying firm to be alert to, adapt to, quickly respond to, and recover from changes brought about by an upstream disruption, thereby "returning to, or maintaining continuity of, operations at the desired level of connectedness and control over structure and function" (Dabhilkar *et al.*, 2016, p. 950). Many contemporary organisations are interconnected and interdependent meaning the problems experienced by one organisation can impede the functioning of another (Tukamuhabwa *et al.*, 2017). Therefore, a focal firm needs to effectively collaborate with other organisations (Scholten and Schilder, 2015; Dabhilkar *et al.*, 2016), especially with first-tier suppliers as they are the predominant source of supply chain disruptions (Business Continuity Institute, 2017).

Social capital theory is understood as "the sum of the actual and potential resources embedded within, available through, and derived from the network of relationships possessed by an individual or social unit" (Nahapiet and Ghoshal, 1998, p. 243). Social capital is characterised along three major dimensions, reflecting its structural, relational and cognitive properties (Nahapiet and Ghoshal, 1998). Social capital theory has been used to connect BSRs and supply chain resilience, where the traditional theoretical explanation is that the higher the degree of collaboration the greater the supply-side resilience (Johnson *et al.*, 2013). However, scholars have begun to question the prevailing belief that social capital is uniformly beneficial by suggesting it has a 'dark side' (Pillai *et al.*, 2017). Villena *et al.* (2011) investigated the relationship between buyer-supplier RC and firm performance but did not find support for a positive linear relationship, instead concluding that it takes an inverted U shape. Given varied support for the contention that RC is beneficial to buying firm performance, it is surprising that the potential for RC to harm supply-side resilience has been largely neglected.

Our study seeks to contribute by examining the possibility that both high and low levels of RC restrict supply-side resilience, whereas intermediate RC enhances it, resulting in a curvilinear, inverted U-shaped function. Guided by Busse *et al.* (2016), we distinguish two mechanisms that may affect the posited relationship: improved performance through collaborative benefits, and lower performance, caused by costs incurred as a result of dysfunctional effects through information restriction. Note that terms such as "costs" are used to denote any undesirable immediate outcomes, not only in a direct monetary sense. We thus propose supply-side resilience as a performance outcome that is jointly influenced by both the benefits and costs associated with practices in developing RC.

2.1.1 The Positive Effects of RC on Supply-Side Resilience

Subsumed within the properties of RC is the notion that information, resources, and knowledge pertaining to the nodes of a dyad will flow abundantly between buyer and supplier (Kwon and Adler, 2014; Inkpen and Tsang, 2016) leading to four key benefits to the buying firm: (1) information benefits (i.e. *being informed*): unique, open access to information (Lawson *et al.*, 2008) required to prepare for, respond to, and recover from supply-side disruptions whilst also reducing their impact (Wieland and Wallenburg, 2013); (2) resource benefits (i.e. *being productive*): greater control over and access to resources, offering buyers capabilities for responding to and recovering from disruptions (Scholten and Schilder, 2015); (3) knowledge benefits (i.e. *being experienced*): facilitating knowledge accumulation and transfer from supplier to buyer (Inkpen and Tsang, 2016), enhancing the buyer's learning capabilities to understand events and improve future performance, thereby enhancing the buyers' capabilities to be alert to unexpected disturbances, to change and better adapt during a disruption (Juttner and Maklan, 2011); and, (4) timing benefits (i.e. *being proactive*): timely and fast dissemination of information, configuration of resources, and knowledge transfer (Knemeyer *et al.*, 2009), for example, through joint business continuity plans developed with suppliers (Juttner and Maklan, 2011). Meanwhile, timely coordination with the supplier, combined with the rapid dissemination of information and resource reconfiguration, can enable quick recovery after a disruption (Dabhilkar *et al.*, 2016). This notion is consistent with earlier studies, which revealed that increased collaborative benefits associated with RC have a positive effect on supply chain resilience (e.g. Johnson *et al.*, 2013; Scholten and Schilder, 2015). Indeed, each of the benefits reflects the improved capabilities of alertness, adaptation, response, and recovery required to build supply-side resilience. This would suggest that the positive effect of RC on supply-side resilience is indeed a linear function.

2.1.2 The Negative Effects of RC on Supply-Side Resilience

RC can negatively affect supply-side resilience through restricting rational and complete information acquisition. Pillai *et al.* (2017) have theorised information restriction as the generative mechanism of the dysfunctional (negative) effects of RC. First, a higher level of RC can inhibit the generation of counterfactual perspectives resulting in lost opportunities in the form of new ideas and knowledge (Xiong and Bharadwaj, 2011), which is required, in times of increasing turbulence, for decision synchronisation and incentive alignment. This is essential for increasing the speed of detection and of effective disruption responses (Juttner and Maklan, 2011), and for lessening the effects of a disruption (Scholten and Schilder, 2015). Second, higher levels of RC lead to inflexibility and dependence, which impedes knowledge transfer and problem solving (Weber and Weber, 2011) and negatively impacts knowledge acquisition (Presutti *et al.*, 2007), which otherwise plays a critical role in reducing supply chain risk and uncertainty (Cantor *et al.*, 2014). This is because knowledge of processes within the supply chain enables anticipation, readiness, and quick response to a disruption (Juttner and Maklan, 2011; Scholten and Schilder, 2015). Therefore, the higher the RC, the greater the dysfunctional effects raised from information restriction, which will hamper the capabilities of alertness, adaptation, response, and recovery in developing supply-side resilience. Thus, a convex curve is proposed, where the costs incurred as a result of dysfunctional effects rise more than proportionally with RC.

2.1.3 The Overall Effect of RC on Supply-Side Resilience

Overall, buying firms experience two opposing partial effects, referring to the collaborative benefits and dysfunctional effects associated with RC, both of which impact supply-side resilience. It is posited that the trade-off between these effects generates an inverted U-shaped relationship, as depicted in Figure 1. From low to intermediate levels of RC, the benefits associated with increased RC are greater than the additional costs. We expect this to be the case because the benefits of increasing RC materialise immediately in terms of access to required information and resources, whereas the costs increase slowly from low to moderate because firms can draw on other resources from alternative suppliers and avoid a disproportionate cost increase (Treleven and Bergman Schweikhart, 1988). But at higher levels of RC, the costs associated with dysfunctional effects may overtake the positive accumulation of supply-side resilience. As a result, returns for resilience diminish and become negative. We therefore theorise that, beyond a certain point, increases in RC will be counterproductive to gains in supply-side resilience meaning further RC will harm supply-side resilience. This leads to our first hypothesis:

Hypothesis 1. *The relationship between relational capital (RC) and supply-side resilience is curvilinear (i.e. an inverted U-shape).*

[Take in Figure 1]

2.2 BSPTs and the Moderating Effect on the RC-Supply-Side Resilience Relationship

Boundary spanning individuals are key organisational representatives who engage in various activities at the boundary of a firm, and who have two primary boundary-spanning roles: information processing and external representation (Aldrich and Herker, 1977). According to boundary-spanning theory (Aldrich and Herker, 1977), buying firms rely on their boundary spanners to ensure that social and economic exchanges with suppliers are executed smoothly and to protect the buying firm from disruptive external environmental forces (Tushman and Scanlan, 1981). The information processing function involves the selection, transmission, and interpretation of information from the external environment before passing it to relevant internal users (Aldrich and Herker, 1977). Boundary spanners also share appropriate internal information with external organisations. The external representation function of boundary spanners includes facilitating resource sharing, conveying perceptions and expectations, and providing coordinated assistance to the external environment (Aldrich and Herker, 1977).

Within BSRs, boundary spanners are in a favourable position to collect and manage information that enables the buying organisation to act effectively (Zhang *et al.*, 2015). Purchasing managers, for example, play a critical role in shaping BSRs (Huang *et al.*, 2016). Realising this, many executives encourage employees to forge productive BSPTs (Korschun, 2015) with individuals in a supplier organisation. Moreover, it has been claimed that the relationships that individuals build in their social networks strongly determine the availability and accessibility of capabilities and resources for adaptive responses (van der Vegt *et al.*, 2015). Hence, the effect of RC on supply-side resilience is likely to be contingent on BSPTs. Yet, research that identifies the conditions under which RC leads to enhanced resilience is extremely limited.

BSPTs can vary in terms of their diversity (Burt, 1982) and strength (Granovetter, 1973). Tie diversity refers to the structure of the social relationships that boundary spanning employees within the buyer have with individuals from a diverse set of hierarchical levels and functions within the supplier (Burt, 1982). Tie strength refers to the degree of emotional intensity and feelings of reciprocity, intimacy, and closeness that an individual has with another person (Granovetter, 1973). Although social capital theory has focused on organisational level BSRs, researchers have recently posited that interpersonal relationships within BSRs may allow a buying firm to enhance supply chain resilience. Durach and Machuca (2018) highlighted interpersonal management skills and management complementarity as antecedents of organisational-level resilience. The ability to leverage interpersonal ties was earlier emphasised by Aldrich and Herker (1977) as one possible manifestation of performing boundary spanning functions.

Theory suggests that the value of social capital varies across distinct conditions (Inkpen and Tsang, 2016), such as individual ties (Payne *et al.*, 2011; Todo *et al.*, 2016). Drawing on boundary spanning theory, we use tie diversity and tie strength to reflect the main characteristics of BSPTs. In addition to a direct relationship between RC and supply-side resilience, we hypothesise that buying organisations can leverage the proposed relationship *H1* by forging more diverse and stronger personal ties. We suggest that these two characteristics act as key contingency variables for the effects in *H1* and investigate how each one affects a buying firm's supply-side resilience.

2.2.1 The Moderating Role of Boundary Spanners' Tie Diversity

Based on theory (e.g. Burt, 1982; Reagans and McEvily, 2003; Burt, 2009), we investigate the possibility that the proposed curvilinear RC-Supply-side resilience relationship is moderated by tie diversity. The diversity of a boundary spanner's personal ties facilitates access to resources and contacts (Reagans and McEvily, 2003). Information acquired from diverse sources is then reconfigured and combined into commercially viable forms (Juttner and Maklan, 2011). When buying firms manage to acquire the necessary information, they experience a positive impact on resilience (Juttner and Maklan, 2011). The locus of possible combinations increases with greater variety of knowledge and resources (Weick, 1995), which will help to improve supply chain visibility by providing the transparency needed to detect and respond to disruptions (Scholten and Schilder, 2015) and, in turn, increase supply chain resilience (e.g Brandon-Jones *et al.*, 2014). Boundary spanners with diverse ties can gain access to a broader array of ideas, opportunities, information and knowledge resources than those restricted to a single point of contact (Smatt *et al.*, 2005). In the context of supply disruptions, it is assumed that supply chain partners lack certain capabilities for successfully managing disruptions independently (Tukamuhabwa *et al.*, 2015). Hence, various types of information and physical resources from diverse boundary spanners will allow buying firms, for example, to obtain feedback and status updates and to make better decisions in supply disruption management. Further, diverse BSPTs can facilitate exposure to different approaches, perspectives, and ideas that help circumvent intra-organisational biases (Cai *et al.*, 2017), thereby fostering supply-side resilience. This includes, for example, enhancing a firm's responsive capability, which gives managers a greater sense of mastery, control, and preparedness (Gu *et al.*, 2008). This is needed for being alert to, adapting to, responding to, and recovering from upstream disruptions (Dabhilkar *et al.*, 2016). As a result, we expect the beneficial impact of RC on supply-side resilience to persist longer for a boundary spanner with more diverse ties, such that the point when it turns negative occurs at a higher level of RC. For boundary spanners with narrow ties, the benefits of RC for enhancing supply-side resilience will be less pronounced and the inflection point will be encountered earlier. Based on the above, we expect that, with higher levels of tie diversity, the proposed relationship between RC and supply-side resilience will be amplified compared to the relationship in the presence of low levels of tie diversity. Thus,

Hypothesis 2. *Boundary spanners' tie diversity positively moderates the curvilinear (inverted U-shaped) relationship between RC and supply-side resilience.*

2.2.2 The Moderating Role of Boundary Spanners' Tie Strength

We also use theory (e.g. Granovetter, 1973; Tortoriello *et al.*, 2012) to examine whether tie strength similarly moderates the proposed curvilinear relationship. Tie strength can be measured by interaction frequency, relationship duration, and emotional intensity or bond closeness (Granovetter, 1973). Within a BSR context, it is reasonable that boundary spanners in buying firms can develop ties – of varying strengths – with individuals in their suppliers. It has been suggested that these ties function as conduits for the transmission of valuable information, resources, knowledge, and opportunities that can be leveraged to a firm's advantage (Acquaah, 2007), which provides the ability to anticipate, to quickly and readily adapt to changes, to respond, and to recover in the case of disruption (Ali *et al.*, 2017). For example, strong ties provide access to quality raw materials, superior service, and both fast and reliable deliveries (Park and Luo, 2001); and they could enable buyers to be more effective in their adaptive strategy implementation (Ahearne *et al.*, 2014).

We propose that tie strength also has the potential to moderate the curvilinear RC-Supply-side resilience relationship. With stronger ties, buying firms are more likely to gain access to timely information, scarce resources, and new knowledge ahead of the competition (Granovetter, 1973); therefore, they should respond with elevated supply-side resilience at an intermediate RC level. As RC increases, diminishing returns for resilience may be mitigated through more effective leveraging of the firm's information and resources. Information from stronger BSPTs will allow the buyer to know first-hand the urgency of a given disruption situation, allowing it to respond positively to changes from upstream suppliers (Dabhilkar *et al.*, 2016) or to any requests to implement disruption-recovery plans. Developing strong ties outside the firm may also provide access to private information that is unavailable to others (Uzzi and Dunlap, 2005) enabling the buyer firm to be proactive (Knemeyer *et al.*, 2009) in anticipating potential disruptions, devising more creative solutions (Tortoriello *et al.*, 2012) in response to and recovery from those disruptions. The established routines between the boundary spanners can also facilitate the exchange of disruption-related concepts and ideas (Durach and Machuca, 2018), resulting in collaborative learning in preparation for, response to, and recovery from disruptions (Scholten *et al.*, 2019). In contrast, boundary spanners with weaker ties will be less able to benefit from the heightened supply-side resilience associated with intermediate RC. Overall, like tie diversity, we expect RC to have a stronger effect on supply-side resilience when boundary spanning individuals have stronger personal ties. Thus,

Hypothesis 3. *Boundary spanners' tie strength positively moderates the curvilinear (inverted U-shaped) relationship between RC and supply-side resilience.*

3. Research Method

3.1 Survey Instrument Development and Data Collection

Our hypotheses were assessed using a survey-based approach in the context of an ongoing BSR, where the buyer reported on its fourth largest supplier. 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). In Round One, four participants classified a randomised item listing and gave each class a label (to create a construct). In

Round Two, another five participants sorted mixed-up items into sets according to provided construct definitions (structured sorting). In rounds one and two, the experts were academics and doctoral students knowledgeable in the literature. In Round Three, four industry experts (purchasing managers) repeated the exercise from Round Two. In each round, inconsistencies between the sorter's item placement and the researcher's expectations were identified and discussed. Sorters were asked to explain the reasoning for their placements and identify any ambiguous items. Unclear items/questions were either changed or removed.

The Q-sorting produced strong evidence of convergent and discriminant validity throughout the process (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. We then used the updated scales to conduct a pilot study with purchasing managers in Chinese manufacturing firms based on 10 personal interviews and 20 online questionnaires. 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 archival data on manufacturing firms headquartered in China. Focusing on the fourth largest (rather than the largest) supplier mitigates social desirability bias (Li *et al.*, 2010). 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 and considered to be boundary spanners. Wherever possible, we also targeted a second respondent knowledgeable in the same supplier relationship.

As the survey was conducted in Chinese, a rigorous process of translation and back-translation was employed to ensure 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 received was 248, i.e. a 21% response rate. This can be considered sufficient, especially given the response rates of many recent supply chain management studies (e.g. Narayanan *et al.*, 2015). We applied multiple attention checks, e.g. manipulation checks and logical statements (Abbey and Meloy, 2017), to analyse response quality. This provided confidence that the 248 responses were completed by attentive respondents. Data were checked and cleaned to ensure its 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 the potential for 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 suggested non-response bias was not a problem. Moreover, follow-up telephone calls and emails were undertaken with ten non-responding firms revealing they only did not participate because of a lack of time or a reluctance to reveal confidential information.

3.3 Common Method Bias

Two analyses aimed at controlling for common method bias were undertaken (Podsakoff *et al.*, 2003). First, we collected responses from a subset of second respondents and tested the level of agreement between respondents from the same organisation to verify the validity of our data, address concerns about single-informant bias, and minimise concerns related to common method bias (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 that provided complete responses, 16 responses were evaluated to have been reported by inattentive informants according to the same attention checks used for primary respondents (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 examine the level of agreement between the primary and remaining secondary respondents. All correlations (for the 57) were above the suggested 0.60 standard except for one of the items that measured supply-side resilience, which was therefore removed (see Table III in Section 4.2) (Boyer and Verma, 2000). The results indicate acceptable inter-rater reliability and lend validity to our results.

Second, and following Homburg *et al.* (2012), archival data were used to triangulate subjective performance information and further minimise single-informant bias. 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 corresponding information provided by 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.

Taken together, the above analyses reveal strong agreement between primary and secondary respondents and high consistency with archival data, thereby supporting the use of the primary respondent as a reliable informant. The remaining analysis is therefore based on primary respondent data only.

3.4 Variables

3.4.1 The Dependent and Independent Variable

Supply-side resilience was assessed based on six items to provide comprehensive coverage of its essential elements (Ismail and Serhiy, 2013; Ambulkar *et al.*, 2015; Dabhilkar *et al.*, 2016; Ali *et al.*, 2017). RC was measured using four items adapted from Carey *et al.* (2011) and Villena *et al.* (2011), and building on Kale *et al.* (2000). Seven-point Likert scales were used from 1 = "strongly disagree" to 7 = "strongly agree" for both variables.

3.4.2 The Moderating Variables

For BSPTs, we followed Collins and Clark (2003) by asking respondents to identify the number of contacts in each of seven categories of actors (CEOs & Leaders, Accounting & Finance, Marketing & Sales, Procurement, Production & Operations, Research & Development, Administration & Other) in the corresponding supplier organisation. Tie diversity was then measured using Blau's (1977) index of diversity: $1-\Sigma (P_i)^2$, where P_i is the percentage of ties in the *i*th category. The more evenly the ties are spread across different functions within the supplier, the higher the index.

Tie strength is a multifaceted construct consisting of three components: interaction frequency, relationship duration, and emotional intensity (Granovetter, 1973). As the three items used different scales, we normalised each before creating the overall variable. According to Collins and Clark (2003), tie strength can be measured as the linear combination of the standardised scores for the three components. Interaction frequency was measured as the average number of times per month that an individual in the buyer firm interacted with their identified contacts within the supplier. Relationship duration was measured using the question, "On average, how long have you known these critical contacts?" Finally, emotional intensity was measured by the item, "On average, how close is your relationship with these critical contacts?" (from 1 = "not at all close" to 7 = "extremely close").

3.4.3 The Control Variables

Following Carlson and Wu (2012), we adopted a conservative stance towards the inclusion of control variables. We controlled for three 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, and environmental uncertainty. Firm age, as a proxy for knowledge and experience, was measured as the natural logarithm of the number of years since the formation of the firm. 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 for the buying firm was measured by 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). Finally, we controlled for environmental uncertainty to level out the effects of disruptions across industries such that they became comparable (Brandon-Jones *et al.*, 2014). Transaction cost economics theory suggests that environmental uncertainty results in increased transaction costs; therefore, firms need to establish inter-organisational structures to cope with uncertainty (Williamson, 1979; Cai *et al.*, 2017). This variable was measured by a five-item scale adapted from Pagell and Krause (2004), Wong *et al.* (2011), and Azadegan *et al.* (2013). A seven-point Likert scale was used from 1 = "strongly disagree" to 7 = "strongly agree".

4. Data Analysis and Results

4.1 Analytic Strategy: Latent Moderated Structural Equation (LMS) Approach

To test our hypotheses, we performed latent moderated structural equations (LMS). Prior studies have shown that LMS is an effective approach to conduct moderation tests for psychometric data. It reduces the likelihood of biased estimates compared to other methods of estimating interaction effects (Maslowsky *et al.*, 2015). Compared to ordinary least square regression, LMS enables measurement errors to be corrected when estimating latent interaction terms, which is a critical concern when using psychometric data (Sardeshmukh and Vandenberg, 2016; Cheung and Lau, 2017).

Analyses were conducted in M*plus* 7 (Muthén and Muthén, 2017) using full information maximum likelihood with robust standard errors. Given that M*plus* does not produce traditional model fit indices for latent variable interactions, we evaluated model fit using a two-step procedure (Maslowsky *et al.*, 2015). In particular, LMS can be used to create an interaction variable that is the square of a latent variable (Muthén and Muthén, 2017), enabling us to test the quadratic effect of a given latent variable (RC) on an outcome (supply-side resilience).

Evaluating the research model involved three steps: (1) confirmatory factor analysis (CFA) to assess the fit between the measurement model and data (Klein and Moosbrugger, 2000; Maslowsky *et al.*, 2015); (2) testing the structural model without the interaction term as a prerequisite to evaluating model fit indices that are not computed using LMS: the comparative fit index (CFI), the root mean square error of approximation (RMSEA), and the standardized root mean square residual (SRMR); and, (3) testing the hypothesised structural model with the interaction term using the LMS method to evaluate its significance. Following Maslowsky *et al.* (2015), RC, supply-side resilience, tie diversity and tie strength were all standardised prior to model estimation.

4.2 Measurement Model

Table II reports the correlations and descriptive statistics for the observed variables. As the first LMS step, the measurement model was evaluated using CFA. As the normality test showed non-normality of the data, we used the rescaling-based robust estimator in M*plus* – maximum likelihood with robust standard errors (MLR) – to generate parameter estimates (Wang and Wang, 2012; Muthén and Muthén, 2017).

[Take in Table II]

Further, the construct validity of our measures was assessed following Anderson and Gerbing (1988). We computed the reliability coefficients (Cronbach's alpha), which were between 0.80 and 0.89 thereby well exceeding the minimum threshold of 0.6 (Nunnally *et al.*, 1967). We also computed composite reliability (CR), which took values above 0.7 thereby indicating high internal consistency of the measures. The results are shown in Table III.

[Take in Table III]

In addition, we conducted CFA to assess convergent and discriminant validity. The CFA results suggested that the model provided an acceptable fit to the data: $\chi^2(72)$ = 94.529, CFI = 0.984, TLI = 0.980, RMSEA = 0.036, and SRMR = 0.040 (Hu and Bentler, 1999). The Chi-square value was below the ratio of Chi-square/*df* of two (Browne and Cudeck, 1993). The RMSEA of the CFA for the measures used in the model was 0.036, which is below the maximum value of 0.08 suggested by Browne and Cudeck (1993). As shown in Table III, measurement items loaded on their intended factors ($p < 0.001$), indicating that the constructs exhibited convergent validity. Discriminant validity was evaluated using Fornell and Larcker (1981). 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.

4.3 Structural Model with Main Effects Only

For the second LMS step, one baseline model was tested, i.e. Model 1 containing the main structural paths plus the main effects of the two moderators. The main-effects-only model had acceptable fit with the data (Model 1: $\chi^2(123)$ = 184.739, CFI = 0.960, TLI = 0.952, RMSEA = 0.045, and SRMR = 0.065). The structural model also considered several control variables that could be related to supply-side resilience. The results are presented in Table IV.

[Take in Table IV]

4.4 Structural Models with Latent Interaction

The final LMS step was to test the model with the interaction term. In addition to estimating interaction effects between RC and two different moderating variables (i.e. tie diversity and tie strength), the LMS procedure can create an interaction variable equal to the square of a latent variable, enabling the quadratic effect of RC on supply-side resilience to be evaluated (Maslowsky *et al.*, 2015; Muthén and Muthén, 2017). We therefore applied the LMS approach across three further models: a nonlinear model (Model 2) and two moderation models (models 3 and 4).

Consistent with Hypothesis 1, we found evidence supporting an inverted U-shaped relationship between RC and supply-side resilience. This can be seen in Model 2 (Table IV) where the quadratic term is significantly (negatively) related to supply-side resilience (β = -0.159, $p < 0.05$). Further, and as suggested by Maslowsky *et al.* (2015), we used the likelihood ratio test to determine the significance of the quadratic effects of latent variable RC. The relative fit of Model 2 versus Model 1 was determined via a log-likelihood ratio test comparing the log-likelihood values for Model 1 and Model 2, yielding a difference of D = 7.086. The difference in free parameters between Model 1 (52) and Model 2 (53) was equal to 1, which represents the *df* value for the log-likelihood ratio test. This test proved significant using a chi-square distribution ($p < 0.001$), indicating that Model 2 with the quadratic effect fits the data better than the main-effects-only model, i.e. Model 1. Thus, Hypothesis 1 is supported.

To test the hypothesised moderating effects, we generated the interaction terms for RC and both tie diversity and tie strength, along with the quadratic interaction terms. Models 3 and 4 in Table IV report the interaction results. With regards to the interaction "$RC^2 \times$ tie diversity" (β = -0.355, $p > 0.1$), the statistically non-significant β in Model 3 suggests that it is not possible to confirm a positive interaction effect on supply-side resilience (H2). With Hypothesis 3, we argued for the moderation effect of tie strength on the proposed inverted U-shaped relationship between RC and supply-side resilience. The proposed interaction between the squared RC term and the linear tie strength term is significant (β = 0.121, $p < 0.05$ in Model 4). Following Maslowsky *et al.* (2015), we assessed whether the type of hypothesised moderation holds in statistical terms. Again, we performed a log-likelihood ratio test on models 1 and 4, yielding a difference value of D = 12.11. Based on a difference in free parameters between Model 1 (52) and Model 4 (55) of 3, the test proved significant (p <0.001), indicating that Model 4 fits the data better than Model 1. To determine the nature of the significant interaction, we plotted the effect of RC on the dependent variable for values of tie strength set to the mean and one standard deviation above and below the mean (Maslowsky *et al.*, 2015). Interestingly, the graph appears to flip as tie strength increases (see Figure 2). As hypothesised, the inverted U-shaped relationship becomes amplified at low to moderate values of tie strength. Above a tie strength threshold of 1.28 (when unstandardised), the shape turns into a U-shape.

Thus, Hypothesis 3 is partially supported. The implications of this shape flip are considered in Section 5.

[Take in Figure 2]

4.5 Sensitivity Analysis

We performed four sets of robustness checks to evaluate the sensitivity of the results. First, the techniques suggested by Haans *et al.* (2016) were applied to further confirm that the observed relationship is quadratic. Specifically, we added the cubic term of RC to Model 2 to test whether the relationship between RC and supply-side resilience is S-shaped rather than U-shaped; but this did not lead to significant results. Second, to corroborate the log-likelihood ratio results, we compared the Akaike information criterion (AIC) values from models 2 and 4 with Model 1. We found that AIC = 8799.234, 8742.467, and 8741.448 for models 1, 2 and 4, respectively. Compared to Model 1, models 2 and 4 have smaller AIC values indicating less information loss. Thus, they are preferable to Model 1 and more likely to be replicated (Sardeshmukh and Vandenberg, 2016). Third, we used Collins and Clark (2003) to create an alternative measure of tie diversity (range of ties) to check if the results of Model 3 still hold. The range of ties refers to the number of different actor categories that a boundary spanner is in contact with in the supplier company. The results showed that Model 3 still remained non-significant. Fourth, we used Ambulkar *et al.* (2015) to adopt a stricter definition of supply-side resilience that included four measurement items before rerunning our analysis. Both Hypothesis 1 and 3 remained robust ($p < 0.05$) while Hypothesis 2 remained non-significant.

5. Discussion and Conclusions

5.1 Implications for Research

It is typically assumed in the literature that there is a positive linear relationship between RC and supply-side resilience. This assumption is also common in the wider literature on supply chain resilience (Johnson *et al.*, 2013; Scholten and Schilder, 2015). Yet researchers have recently entertained the possibility that even positive organisational attributes have tipping points beyond which their effects may become less positive (Pierce and Aguinis, 2013; Busse *et al.*, 2016). Indeed, our study was motivated by the lack of research on the potential negative effects of RC on supply-side resilience. We have drawn on social capital and boundary spanning theory to theorise that the relationship between RC and supply-side resilience is non-linear (Hypothesis 1) and contingent upon boundary spanners' tie diversity (Hypothesis 2) and tie strength (Hypothesis 3). Theoretically and empirically, this paper provides three main findings to the supply chain resilience literature organised around the three hypotheses.

In our first hypothesis we proposed an inverted U-shaped relationship between RC and supply-side resilience. This hypothesis was based on the positive and negative effects associated with RC and the shift in the balance between these effects as RC increases. Our data supports this hypothesis by showing that an inverted U-shaped relationship exists. This means that moderate (rather than lower or higher) levels of RC may be optimal for buyer firms to develop supply-side resilience, with important theoretical implications. First, this finding supports the positive linear relationship previously described for the association between RC and supply chain resilience if we compare supply-side resilience at *moderate* relative to *lower levels* of RC. In this sense, our study is consistent with collaboration-related papers describing the benefits of buyer-supplier RC (Kwon and Adler, 2014; Inkpen and Tsang, 2016) for enabling buying organisations to foster supply-side resilience (Johnson *et al.*, 2013; Scholten and Schilder, 2015). Second, the finding supports a relationship between RC and supply-side resilience that takes the form of an inverted U shape if we compare supply-side resilience at *moderate* relative to *supra-optimal levels* of RC. Thus, a linear association does not capture the complexities of the RC-Supply-side resilience relationship. Instead, the inverted U-shaped finding, as we predicted, supports the likelihood that there can be negative consequences on supply-side resilience for buying organisations that develop either too little or too much RC with their suppliers. Providing evidence of this "RC threshold" enables us to help explain why RC may be positively related, negatively related, or unrelated to supply-side resilience. In this sense, our study reinforces theory and findings from Villena *et al.* (2011) on curvilinear relationships, in other words, that there is an inverted U-shaped relationship between RC and a buyer's strategic and operational performance. Furthermore, our finding combined with Villena *et al.* (2011) suggests that it may be appropriate for OM scholars to now revisit many assumed linear relationships to question when more of a good thing is no longer beneficial (Pierce and Aguinis, 2013). Such reflection seems especially critical in contexts where businesses need to manage supply disruptions and develop supply-side resilience (Dabhilkar *et al.*, 2016).

Although our first finding – relating to Hypothesis 1 – supported our decision to examine the possible non-linear relationship between RC and supply-side resilience, we also acknowledge the importance of contingencies on this relationship, as highlighted by

Busse *et al.* (2017). Drawing on boundary spanning theory (Aldrich and Herker, 1977), we proposed that the strength and diversity of a boundary spanner's ties would moderate the RC-Supply-side resilience relationship. For Hypothesis 2, our data (see Model 3 in Table IV) did not support tie diversity as a significant moderating factor. This second finding indicates that developing diverse ties is not always a sufficient condition to guarantee a higher level of supply-side resilience. Therefore, the contextual conditions that make this type of approach possible and beneficial deserves further research.

Our third finding relates to Hypothesis 3. Although we found support for tie strength as a significant moderating factor, we also discovered that at higher levels of tie strength the curve flips from an inverted U to a U-shaped curve. Haans *et al.* (2016, p. 1178) described such shape flips as "interesting research opportunities" that have remained largely unexplored in the literature. When tie strength is high, supply-side resilience increases as a firm moves from low to medium levels of RC and it decreases as a firm moves from medium to high levels of RC. This represents an important boundary condition on Hypothesis 1: the shape is U-shaped when boundary spanners' ties become fairly strong. Similar to how Uotila *et al.* (2009) described the shape flip in their study, our data could indicate that boundary spanners' tie strength has a lower impact on the RC-Supply-side resilience relationship around the flip point. Indeed, the amplifying effects occur when there is a low to medium level of tie strength.

One possible explanation for the shape flip phenomenon is that boundary spanners' tie strength not only widens the gap between the benefit and cost curves (see Figure 1), as per Hypothesis 3, but that increasing tie strength also changes their shape. We have argued that the moderating effect of tie strength is caused by a downward shift in the cost curve and/or an upward shift in the benefits curve. According to Haans *et al.* (2016), this form of shape-flipping arises when there is a very strong moderation effect that causes the curve to flatten out or steepen significantly and then change shape. The transformation of the relationship between RC and supply-side resilience is thus likely to be caused by a change in the shape, not just the position, of the benefit and/or cost curve shown in Figure 1. This could imply that, for boundary spanners with stronger ties, the benefits associated with increasing RC may not develop in a linear way.

By drawing on a boundary spanner's *strong* personal ties, a buying firm may be better positioned to reap the rewards of RC than a firm with *less strong* ties, and this advantage may grow at increasing, not constant, rates when RC is at higher levels. In terms of the cost curve, stronger ties may potentially increase the costs of RC (e.g. reducing options)

(Gu *et al.*, 2008; Villena *et al.*, 2011), but these extra costs are outweighed by the additional benefits of RC (e.g. access to key information, especially private information to avoid a supply disruption) (Uzzi and Dunlap, 2005). Taken together, the pursuit of developing stronger ties may alter buying firms' relational decisions to support boundary spanning behaviours and/or activities instead of supporting supply disruption management activities (i.e. fostering supply-side resilience). Given that firms face resource constraints, they may deploy their resources to support a few activities that closely conform to their relational decisions (Simatupang *et al.*, 2004). Buying firms' decreasing propensity to proactively develop and improve supply-side resilience, as they become more focused on establishing stronger ties, will subsequently reduce their ability to accumulate rich disruption management experience, which in turn diminishes their supply-side resilience at an accelerating rate. Thus, the curve between RC and supply-side resilience flips from an inverted U to a U-shaped curve. Finally, the shape flip reflects the complexity inherent in how tie strength influences a buying firm's development of supply-side resilience. Subsequent research could explore this interesting phenomenon further.

5.2 Implications for Managers

Our results have three main implications for practice. First, managers who are responsible for managing supply disruptions must be aware that an over-reliance on, or too much investment in, developing RC with a supplier can be detrimental to supply-side resilience. This implies that, in addition to gaining the benefits of RC, buying firms should purposefully analyse the potential costs associated with developing RC with a supplier, and not only in a direct monetary form. These costs incurred through the generative mechanism of information restriction (Pillai *et al.*, 2017) could result in dysfunctional effects, e.g. inhibiting the generation of counterfactual perspectives, thereby impeding knowledge transfer and problem solving (Weber and Weber, 2011) and leading to missed opportunities to obtain new ideas, knowledge, or more capable partners (Villena *et al.*, 2011; Xiong and Bharadwaj, 2011). Access to such information is required for buyers to be capable of anticipating, adapting to, responding to, and recovering from upstream disruptions (Dabhilkar *et al.*, 2016; Ali *et al.*, 2017). To avoid negative consequences, buying firms should proactively search beyond the dyad for new ideas and information so as to create visibility into their supplier network and to learn about the experiences of other organisations in dealing with supply disruptions. This can make it easier for buying firms to manage upstream disruptions and provides early warning signs of potential oncoming disruptions (Scholten and Schilder, 2015) thereby making the supply-side more resilient.

Second, our study offers particular insights into the nonlinear relationship between RC and supply-side resilience. Below a certain level of RC, buying firms should invest to increase the benefits of collaboration with suppliers, such as by carrying out activities aimed at rapid information dissemination (e.g. systematic, target-oriented communication activities) and coordination between firms (e.g. joint business continuity plans) (e.g. Juttner and Maklan, 2011; Dabhilkar *et al.*, 2016) required to prepare for, respond to, and recover from supply-side disruptions whilst reducing their impact. Above a certain level of RC, buying firms should invest in decreasing the costs derived from dysfunctional processes. For example, companies could create and enforce contracts that specify roles and responsibilities for extreme disruptive events (e.g. factory fires) to incentivise desirable supplier behaviour. This could promote decision synchronisation and incentive alignment, which are essential for an effective disruption response and recovery (Juttner and Maklan, 2011). Similarly, they could include a statement in their supplier code of conduct. Motorcar Parts of America (MPA), for example, states in its supplier code of conduct that it reserves the right to suspend all orders if a supplier is not performing as required (MPA, 2017). Buying firms can also take steps to re-evaluate their relationship with a supplier. Deloitte, for example, realised that its strategic supplier collaborations were not as effective as expected leading 34% of global chief procurement officers to redefine and restructure their supplier relationships (Deloitte, 2015). Buying firms can also simplify sourcing processes and reduce the associated costs. For example, recent technological developments such as additive manufacturing allow firms to print some of their own parts thereby reducing dependence on suppliers and increasing production flexibility (Giffi and Gangula, 2014). This reduces the buying firm's reliance on its supply base and enhances its own capabilities for adapting to and responding to supply-side disruptions. Taken together, when evaluating if and how to develop RC for supply-side resilience, managers must decide whether the associated benefits are worth the respective costs and investments (Busse *et al.*, 2016).

Third, managers in buying firms should recognise the dark side of tie strength. Scholars generally agree that stronger ties enable firms to acquire information and resources more effectively when responding to supply disruptions, thereby enhancing supply-side resilience (Dabhilkar *et al.*, 2016; Durach and Machuca, 2018). The findings of our research however support suggestions by Gu *et al.* (2008) that stronger personal ties can sometimes reduce the positive effects of RC on a firm's performance. Managers may also need to try to avoid personal biases in supplier evaluations through, for example, assigning alternative personnel or including multiple personnel in the evaluation process. Moreover, we find that when buying firms pursue RC and tie strength simultaneously, the downward curvilinear effect of RC on supply-side resilience flips to an upward effect. This finding implies that relational decisions based on RC alone cannot fully capture the multi-level nature of BSRs and could in fact be potentially misleading. When buying firms with limited resources choose to foster stronger boundary spanning personal ties, they often need to withdraw resources from other activities, e.g. in managing supply disruptions (Simatupang *et al.*, 2004). Therefore, managers need to consider the balance between developing RC and pursuing stronger ties, especially when they are facing resource constraints. It might also be useful for managers to consider monitoring and evaluation of boundary spanners' personal ties to evaluate whether tie strength changes over time. As a result, while each strategic posture may make its own unique contribution towards the development of supply-side resilience, managers in buying firms need to be concerned with the collective impact of developing RC and boundary spanners' tie strength.

5.3 Limitations and Future Research Directions

Our research represents a first step in examining the nonlinear relationship between RC and supply-side resilience. Additional research could explore in greater depth the processes that lead to nonlinear effects. We were not able to measure the costs of dysfunctional processes directly. Doing so would be empirically challenging, but a more exact and granular calculation of such costs, before testing the influence of each specific set of costs on the development of supply-side resilience, would provide additional understanding of the phenomenon.

Our study has relied on cross-sectional data. Although extant OM research commonly assumes relationships based on such data, it limits our ability to make causal inferences. Future research therefore could investigate the link between RC and supply-side resilience using longitudinal data. Further, it would be interesting to dynamically study buying firms' reactions to relational strategies when dealing with supply disruptions to determine whether these reactions change over time.

We have examined the moderating effects of boundary spanners' tie strength and tie diversity on the RC-Supply-side resilience relationship. Our findings imply that tie strength not only widens the gap between the benefit and cost curves, but also that increasing tie strength changes the shape of the benefit and/or cost curve in Figure 1. Future research can investigate what explains how tie strength creates this change and consider the role of other potential moderators, such as mutual dependence and power asymmetry. This study has focused on supply-side resilience as the dependent variable; but research could also investigate the non-linear relationship between RC and other operating (e.g. flexibility) and financial (e.g. market share and profitability) outcomes. In addition, although we did not find support for the moderating role of tie diversity, the contextual conditions that make developing diverse ties possible and beneficial warrants further attention. Moreover, our findings rely on the data from the primary respondents as the representative boundary spanner of the firm while future research could extend this to multiple boundary spanners and examine how their tie diversity and tie strength affects the main relationship. Finally, it would be interesting to examine how to dismantle or bridge existing ties to affect the interaction between a buyer's boundary spanner (or multiple boundary spanners) and their key suppliers in the right way, i.e. to better leverage relationships to manage supply disruptions and reinforce supply-side resilience.

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Table I. Sample Demographics (N = 248)

Characteristic	n	Percentage (%)
Respondent's job title		
Director/CEO/GM	23	9.3%
Purchasing Manager	153	61.7%
Supply Chain Manager	31	12.5%
Operations Manager	39	15.7%
Other	2	0.8%
Total	*248*	*100%*
Firm size (number of employees)		
<=100	14	5.6%
101-500	107	43.1%
501-1000	64	25.8%
1001-2000	27	10.9%
>=2001	36	14.5%
Total	*248*	*100%*
Firm age (years since incorporation)		
<=5	10	4%
6-10	38	15.3%
11-15	85	34.3%
16-20	54	21.8%
21-50	52	21%
>=51	5	2%
Not specified	4	1.6%
Total	*248*	*100%*

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

	Variables	Mean	SD	1	2	3	4	5	6	7
1	Relational capital	5.20	.68	*.74*						
2	Boundary spanners' tie diversity	.64	.19	.16**	-					
3	Boundary spanners' tie strength	.00	.71	.23**	.37**	-				
4	Supply-side resilience	4.93	.83	.60**	.19**	*.16**	*.76*			
5	Firm age	1.16	.23	.14*	-.01	.18**	.20**	-		
6	Perceived importance of supplier	1.92	.68	-.06	.03	-.05	-.29**	-.09	-	
7	Environmental uncertainty	3.66	.95	-.20**	-.10	-.05	-.26**	-.13	.01	*.71*

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

Table III. The Measures of Relational Capital, Supply-Side Resilience, and Environmental Uncertainty

Constructs and Items	**Std. Loading**
Relational Capital (RC) (α = 0.822; CR = 0.829)	
RC1. The business relationship with this supplier is based on trust.	0.815
RC2. The business relationship with this supplier is characterised by high levels of reciprocity.	0.680
RC3. My company's business relationship with this supplier is characterised by high levels of respect.	0.743
RC4. My company is committed to maintaining a close relationship with this supplier.	0.700
Supply-Side Resilience (SSR) (α = 0.886; CR = 0.891)	
SSR1. We are able to maintain high situational awareness and recognise early warning risk signals before being disrupted.	0.776
SSR2. We are able to adapt to the supply risk easily at the time of disruption.	0.797
SSR3. We are able to provide a quick response to the supply risk at the time of disruption.	0.821
SSR4. We are able to maintain a desired level of control over the structure and function of our operation at the time of disruption.	0.763
SSR5. We are able to recover after a supply disruption to restore or return to our original operation state.	0.660
SSR6. We are able to move to a new, more desirable state after being disrupted.	0.707
SSR7. We are able to apply lessons learned from disruptions and unexpected events to help prepare for the future.	Dropped
Environmental Uncertainty (EU) (α = 0.795; CR = 0.796)	
EU1. Our suppliers' performance is unpredictable.	0.757
EU2. Our plant uses core production technologies that often change.	0.648
EU3. Our customers often change their order over the month.	0.698
EU4. Our competitors' actions regarding marketing promotions are unpredictable.	0.726
EU5. Government regulations that affect our industry often change.	Dropped

Table IV. Fit Indices and Unstandardised Coefficients for All Four Models

	Model 1	Model 2	Model 3	Model 4
	Direct effects	Nonlinear effects	Moderation effects	
Controls				
Firm age	$0.322^{\dagger}$	0.398*	0.404*	0.429*
Perceived importance of supplier	-0.301***	-0.361***	-0.354***	-0.357***
Environment uncertainty	-0.097*	-0.154**	-0.15*	-0.128*
Direct Effects				
Relational capital (X)	0.598***	0.646***	0.671***	0.633***
Tie diversity (M)	0.086*	0.566*	0.767*	$0.508^{\dagger}$
Tie strength (W)	-0.021	-0.029	-0.027	-0.067
Nonlinear Effects				
Relational capital (X^2) [Hypothesis 1]		-0.159*	-0.161*	-0.155***
Moderation Effects				
Tie diversity × Relational capital			-0.254	
Tie diversity × Relational capital squared (X^2M) [Hypothesis 2]			-0.355	
Tie strength × Relational capital				$-0.151^{\dagger}$
Tie strength × Relational capital squared (X^2W) [Hypothesis 3]				0.121*

Notes. N=248, † $p < 0.1$; * $p<0.05$; ** $p<0.01$; *** $p<0.001$

Figure 1. Proposed Inverted U-Shaped Function for Relational Capital (RC)

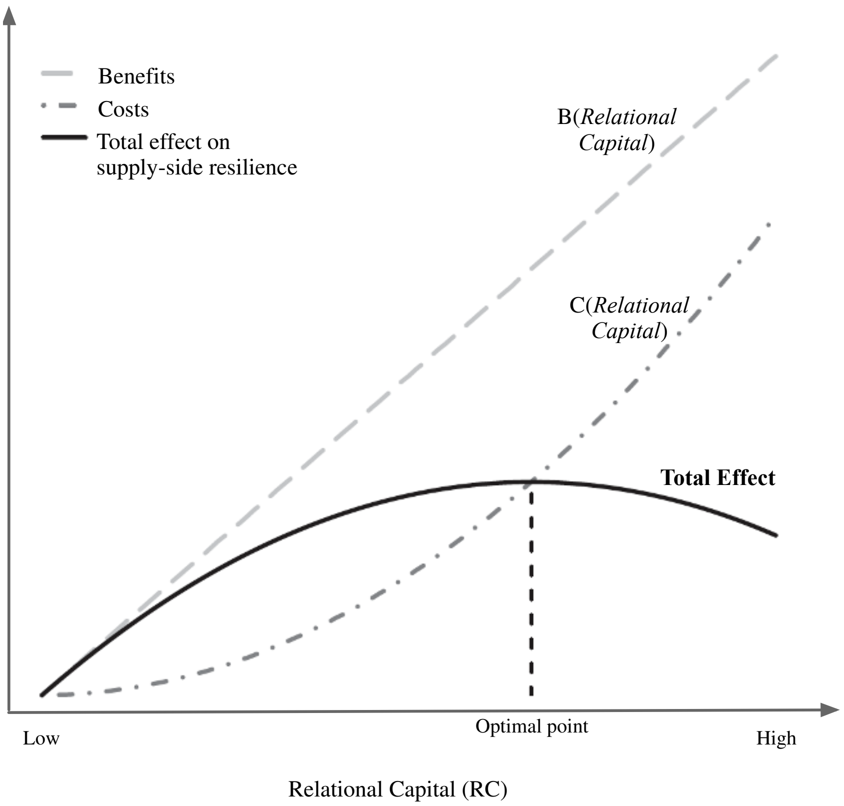

Figure 2. The Interaction between Relational Capital (RC) and Boundary Spanners' Tie Strength in Predicting Supply-Side Resilience