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A matter of perspective – the role of interpersonal relationships in supply chain risk management

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Abstract

Purpose – The purpose of this paper is to, first, explore the role of interpersonal relationships between buying and supplying firms in the management of supply chain disruptions (SCDs). Interpersonal connections are proposed as "social lubricants" that can advance the knowledge about conventional interorganizational antecedents of firm resilience. Differentiating between high- and low-complexity manufacturing industries, the study then looks into how managers from these industry clusters can leverage the efficacy of these relationships through the appropriate use of interorganizational governance mechanisms.
Design/methodology/approach – Structural equation modeling is conducted with data collected from 229 manufacturing firms in Austria, Germany and Switzerland. Industry clusters are formed via a Q-sort exercise.
Findings – Results support the assumption of a socially embedded, interpersonal dimension in buyer-supplier relationships that impact organizational-level resilience. It is suggested that investments in interpersonal skills and interpersonal complementarity are significant antecedents of both relational and re-deployable firm resilience. Surprisingly, no support was found for a positive impact of interpersonal information sharing on firm resilience, challenging findings from previous studies on an interorganizational level. Interorganizational governance and industry affiliation each have moderating effects on the performance of the resilience efficacy of interpersonal relationship antecedents, suggesting the existence of an important managerial lever.
Originality/value – Integrating the supply chain and behavioral science literature, this study is the first to investigate the interplay of interpersonal and organizational antecedents and their efficacy in the management of SCDs.

Keywords Risk management, Resilience, Supply chain management, Disruption management, Interpersonal, Multi-level research

Paper type Research paper

Introduction

The earliest entry in EBSCO's Business Source Complete database to discuss "supply chain risk management" is Harris's (1993) essay on corporate strategies and their linkage to the appearance of network risks. From Harris's pioneering work to the present day, researchers in this subject area have sought to show the negative effects of supply chain disruptions (SCDs) on both shareholder wealth (e.g. Hendricks and Singhal, 2005; Kumar *et al.*, 2015) and business performance (e.g. Dabhilkar *et al.*, 2016; Ritchie and Brindley, 2007). Furthermore, research approaches on the subject have either taken a network perspective (e.g. Bode and Wagner, 2015; Choi and Krause, 2006), a manufacturing perspective (e.g. Gualandris and Kalchschmidt, 2015; Yang and Yang, 2010) or an intraorganizational perspective (e.g. Schmitt *et al.*, 2010; Son and Orchard, 2013).

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Another research stream has sought to find ways to reduce SCDs by building interorganizational collaborative relationships (e.g. Leat and Revoredo-Giha, 2013), sharing information with partners (e.g. Durach and Wiengarten, 2017), allocating supplier investments (e.g. Talluri *et al.*, 2010) or governing supplier organizations (e.g. Wagner and Silveira-Camargos, 2012). Conducting research on an interorganizational level, these studies investigate the perception that one firm has of another. However, it has been shown that the interpersonal level often functions as an indispensable "social lubricant" for supply chain operation (Gligor and Autry, 2012). As outlined by Hutt *et al.* (2000), researchers have put tremendous efforts into showing firms how cooperating with other firms can help to gain new competencies and improve performance. However:

> [...] many alliances fail to meet expectations because little attention is given to nurturing the close working relationships and interpersonal connections that unite partnering organizations. While these personal relationships between 'boundary spanning' members, who work closely together, serve to shape and modify the evolving partnership, economic theories of exchange virtually ignore the role of people and their importance in the management of inter-organisational relationships. (Hutt *et al.*, 2000, p. 51)

Research has indicated that, as members of organizations, it is mostly individuals who identify, assess, treat and monitor events in the supply chain, especially in relation to the management of risks and disruptions in supply chains (Zsidisin *et al.*, 2005). We therefore suggest that the SCD management literature will benefit from revisiting the efficacy of buyer-supplier relational success factors on an interpersonal level ("person/s to person/s"). Interpersonal research does not look at how good organizations can get along, but how well people in both organizations work together. Findings from this study are expected to provide more fine-grained insights into the relational success factors in the development of firm resilience, as well as a theoretical discussion about the functioning of such relationships.

Today's literature on supply chain relationships often draws on the relational view theory (e.g. Blome *et al.*, 2013; Prajogo *et al.*, 2016; Wieland and Wallenburg, 2013) to explain the value of working in alliances. In contrast to the resource-based view, the relational view considers the dyad as the unit of analysis instead of individual firms (Dyer and Singh, 1998). It thus provides an explanatory value that is more conducive to the common understanding of supply chains (Chen and Paulraj, 2004; Durach *et al.*, 2017). The relational view theory proposes three sources of relational success – investments, information sharing and complementarity – along with a firm's capability to exert an effective means of governance. While this theory has looked at relationships between organizations, we expect to uncover new theoretical insights by researching personal relationships in organizational partnerships. The goal of this research is twofold: to examine firm resilience created by a buying firm's employees in their interaction with employees at the supplying firm; and to look into which interorganizational governance mechanisms can be used by managers to leverage the impact of the proposed interpersonal antecedents on the buying firm's resilience.

The remainder of this paper is structured as follows: the second section provides the theoretical backdrop to the proposed model, while the third section describes how the developed hypotheses were tested. The analysis and results are presented in the fourth section, followed by a discussion of the study findings and their implications in the fifth section. Finally, the sixth section provides limitations, future research possibilities and some concluding remarks.

Literature review

Harland *et al.* (2003, p. 53) defined risks as the "chance of danger, damage, loss, injury or any other undesired consequences." It was suggested that the management of these risks in supply networks should follow four key processes: identification, assessment, treatment and

monitoring (Zsidisin *et al.*, 2005). For the purpose of this study, we are interested in relationship-specific risk management practices that can be implemented by buying firms on an interpersonal level in order to make firms more resilient to potential SCDs. A firm's resilience is defined as "the capability of the firm to be alert to, adapt to, and quickly respond to changes brought by a supply chain disruption" (Ambulkar *et al.*, 2015, p. 112).

In this study, we consider two forms of firm resilience, relational resilience (RelRes) and re-deployable resilience (Re-depRes). Previous alliance literature has suggested a spillover effect in buyer-supplier relationships that enable factors such as knowledge and capabilities to be re-used in other partnerships (e.g. Dyer and Nobeoka, 2000; Mesquita *et al.*, 2008). The extent to which knowledge and capabilities are partnership exclusive, therefore depends on the locus of the acquired factors. If they are only present in the buyer-supplier interface, they will only and exclusively be deployable in the partnership in question. But if they are present (in part) within the buyer's ambit, the buyer will be able to re-deploy them with other suppliers. Mesquita *et al.* (2008), for example, identified a re-deployable performance improvement that suppliers can acquire from a buyer's investment in supplier training, indicating a spillover of capabilities in this interaction. Acknowledging the contribution of this literature to our understanding of the potential outcomes of the buyer-supplier partnerships, we propose that firm resilience established through partnership-specific exchanges may be both partnership exclusive (i.e. RelRes) and re-deployable by the buying firm across other partnerships (i.e. Re-depRes). This idea also draws on Borgatti and Li's (2009) concept of multiplexity (i.e. the property of purchasers having multiple ties with different firms/individuals simultaneously). In the following sections, we will develop our theoretical model building on both of these firm resilience constructs.

Investments in interpersonal SCD management skills (SCDInvest) and firm resilience

People have idiosyncrasies that make them unique in the way that they operate in their work environments (Micheli, 2008). Cooperating on an interorganizational level demands that personnel from both partner companies align and adjust their management skills and adapt to common procedures (Ramström, 2008). Such adjustment and alignment processes are understood as interpersonal level investments. These investments commonly include the exchange of personnel between buyer and supplier organizations (Newman and Rhee, 1990) or the provision of supplier-specific training activities (Galt and Dale, 1991). Such joint activities have been reported to enhance group identity by raising group awareness and bringing members closer together (Thompson, 2004). Thompson (2004) showed that enhancing group identity increases the efforts made by group members to avert exogenous events that are harmful for the group. We therefore postulate that SCDInvest, understood as the extent to which specialized investments have been made by the buying firm to develop employee-level disruption management skills and procedures, which are specific to a particular supplier relationship (adapted from Shervani *et al.*, 2007), increases RelRes for the buying firm by the following hypothesis:

H1a. SCDInvest are positively associated with a buying firm's RelRes.

These training activities and exchanges coach employees in improving process and delivery capabilities (Li *et al.*, 2007); we therefore also argue that the acquired capabilities can, to a lesser extent, be re-used in other supplier relationships by the following hypothesis:

H1b. SCDInvest are positively associated with a buying firm's Re-depRes.

Interpersonal SCD information sharing (SCDInfoSharing) and firm resilience

The importance of interorganizational information flows in supply chains has been clearly established (e.g. Kembro and Näslund, 2014). Jüttner and Maklan (2011) proposed that

when firms manage to acquire the required information, they experience a positive impact on firm resilience. On an interorganizational level, information sharing has been argued to increase supply chain visibility and, in turn, supply chain resilience (e.g. Brandon-Jones *et al.*, 2014; Wieland and Wallenburg, 2013). While we could not identify similar research on an interpersonal level, it has nonetheless been shown that exchanging information helps people to perform closer to the rational equilibrium (Croson and Donohue, 2003). We thus suspect that the exchange of information will provide benefits on an interpersonal level equal to those on an interorganizational level. SCDInfoSharing is understood as the routines established between the employees of the SC partners, which are aimed at exchanging SCD-related information, this includes performance feedback, status updates and the exchange of SCD management-related concepts. We propose the following hypothesis:

H2a. SCDInfoSharing is positively associated with a buying firm's RelRes.

This study further suggests that benefits acquired from information sharing on an interpersonal level can also be re-deployed by the employees across other partners, leading to Re-depRes. We propose the following hypothesis:

H2b. SCDInfoSharing is positively associated with a buying firm's Re-depRes.

Interpersonal SCD management complementarity (SCDComplimentarity) and firm resilience

Research has also long recognized the positive outcomes that arise from supply chain partners possessing complementary skills (e.g. Cadden *et al.*, 2013; Milgrom and Roberts, 1995). Researchers report that complementarity is achieved through two dimensions: accumulating similar capabilities and combining those that are different (Larsson and Finkelstein, 1999). Complementarity is understood as the degree to which partners are able to eliminate each other's shortcomings (Lambe *et al.*, 2002). In the context of SCDs, it is assumed that supply chain partners lack certain capabilities for successfully managing SCDs independently. This makes them dependent on their supply chain partner (Pfeffer and Salancik, 1978). SCDComplementarity allows people to generate actions that others can anticipate and understand. Complementary partners have been shown to make better supply chain-related decisions (Wu and Katok, 2006). Therefore, we argue through the following hypothesis that:

H3a. SCDComplimentarity is positively associated with a buying firm's RelRes.

We also argue that complementary SCD management capabilities can be unilaterally appropriated by the buying firm's employees and re-deployed across other suppliers. This leads to the following hypothesis:

H3b. SCDComplimentarity is positively associated with a buying firm's Re-depRes.

The moderating effect of interorganizational SCD governance

In the following, we hypothesize that managers can leverage the efficacy of proposed relationships *H2a* and *H3a* by implementing appropriate formal and informal governance mechanisms. Formal governance of suppliers usually builds upon the principles of transaction costs economics (Williamson, 2008). Following this notion, interorganizational formal SCD governance (FormalSCDGov) is understood in this study to be the extent to which the buying firm has specific, customized and detailed contractual agreements with the supplying firm specifically designed for the management of SCDs (Poppo and Zenger, 2002). Formal agreements are usually designed to achieve compliance with the partner organization according to defined targets. Multiple researchers have modeled the

impact interorganizational contracts have on the value and the type of information shared between supply chain partners (e.g. Corbett *et al.*, 2004; Ha, 2001; Li and Zhang, 2008). The basic notion in these studies is that managers can guide the sharing of correct information through appropriate interorganizational governance mechanisms.

On the other hand, interorganizational informal SCD governance (InformalSCDGov) may provide more flexibility to the supplier, giving the supplier freedom to take independent protective action (Claro *et al.*, 2003). Informal governance is understood as the reliance on personal relations; in effect, reputation as a governance mechanism. Behavioral experiments have shown that the less binding contracts are, the more they lead to personal attributions of cooperation (Malhotra and Murnighan, 2002). It is therefore reasonable to assume that the value of interpersonal information sharing is considerably higher when the level of detail in interorganizational contracts is low. Similarly, when interpersonal information sharing is high, very detailed contractual SCD agreements may hamper the value of interpersonal information sharing, as the resulting organizational actions are bound by the contractual agreements. Due to the lack of further research on the interplay between information sharing and supplier governance, we follow a similar approach to Naor *et al.* and propose a rather speculative hypothesis:

H4. When SCDInfoSharing is low, FormalSCDGov supports higher resilience efficacy, whereas when SCDInfoSharing is high, InformalSCDGov supports higher resilience efficacy.

Interorganizational FormalSCDGov can also function as a coordinating mechanism to make the best use of high interpersonal complementary skills. Huang *et al.* (2013) show that formal governance provides the coordination mechanism needed to allocate capacities according to the supply chain partner's individual capability. However, in line with Pilbeam *et al.* (2012), reliance on informal governance alone cannot provide the coordinative mechanisms needed to achieve more firm resilience. In relationships with low interpersonal complementarity, the coordinative mechanisms of FormalSCDGov become increasingly obsolete, and InformalSCDGov mechanisms suffice to support the benefit of low complementarity in relationships. Due to the lack of further studies on this subject, we again propose a rather speculative hypothesis:

H5. When SCDComplimentarity is low, interorganizational informal governance supports higher resilience efficacy, whereas when information sharing is high, FormalSCDGov supports higher resilience efficacy.

Dissociating low-complexity from high-complexity product industries

We now hypothesize about contextual differences in the efficacy of the proposed mechanism in different industry clusters. Organizational theorists have long argued that high-complexity product industries tend to be characterized by a high degree of reciprocal interdependence (Pfeffer and Salancik, 1978). Novak and Eppinger (2001) found a positive link between increased product complexity and vertical integration, as greater product complexity gives rise to coordination challenges.

Kotteaku *et al.* (1995) found that purchases of products with high complexity are often associated with high formalization scores. Firms in industries that deal with complex products commonly use detailed formal rules and written documents to describe all of the supplier's tasks in detail. Companies in these industries have been shown to involve many employees within the buying process, thereby negatively impacting the value of the individual interpersonal relationship (Kotler and Armstrong, 2015). Considering these different findings, we assume that differences in the purchasing structure, processes and the relationships between high- and low-complexity product industries also lead to differences

in the usefulness of interpersonal relationships in creating firm resilience through the following hypothesis:

H6. Differences in industry characteristics in terms of the complexity of their products lead to differences in the efficacy of the interpersonal relationships proposed in *H2a* and *H3a*, which result in low-complexity product industries benefitting more from interpersonal interactions than high-complexity product industries.

Figure 1 summarizes the above-developed hypotheses along with applied control variables.

Research methodology

This study applies covariance-based structural equation modeling to test the developed hypotheses. The authors compiled a mailing list of 1,888 purchasers at manufacturing firms located in Austria, Germany and Switzerland, and asked these purchasers to fill out an online survey focusing on a specific supplier (which they were free to choose) delivering a standard product, and the interaction of her/his purchasing team with the employees of this supplier. The survey yielded 229 usable responses with an effective response rate of 12.1 percent, which is comparable to other recent surveys in the area of SCM (e.g. Revilla and Knoppen, 2015; Wagner and Bode, 2014). Company characteristics of the sample are presented in Tables I and V.

Measurement items and survey instrument

Following the process suggested by Sperber *et al.* (1994), we conducted a double back-translation of the original English construct items (see following subsections) to ensure they had been adequately translated into German, and then conducted a pre-test to assess interrater agreement on content validity. To achieve this, we assembled two sets of raters to achieve two separate tasks (following Moore and Benbasat, 1991): the first group of five raters consisted of three academics specialized in SCM, and two academics not specialized in the field. The group was provided with definitions of the constructs and was asked to assign a single item to only one construct in each case. The items were given to the raters in random order. Fleiss's (1971) κ was computed to be 0.78, which is considered substantial

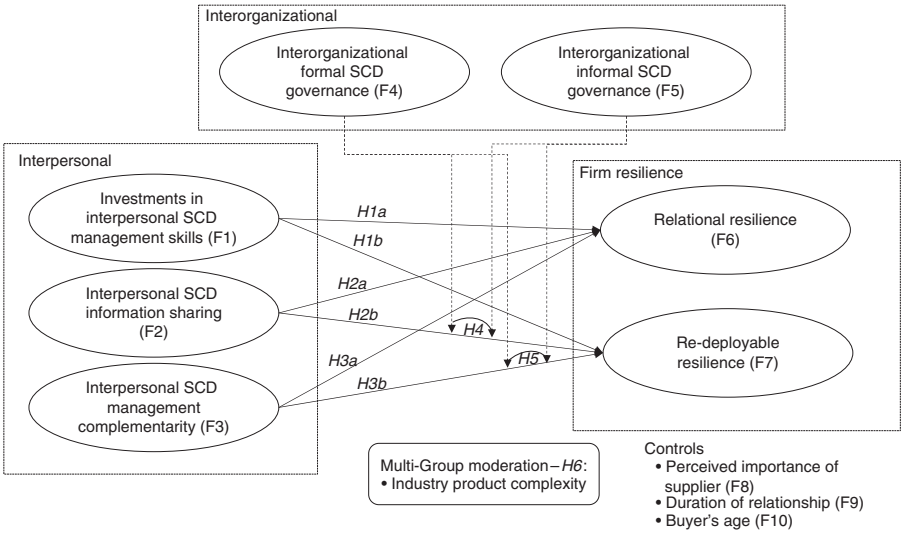

Figure 1.
Hypothetico-deductive model

	Freq.	Percent
Number of employees		
< 10	2	0.9
11–50	17	7.4
51-250	48	21
251-500	25	10.9
501-2,000	34	14.8
2,001-5,000	14	6.1
> 5,000	89	38.9
Total		100
Revenue in €		
< 10 m	17	7.4
10-50 m	32	14
50-100 m	19	8.3
100-250 m	18	7.9
205-500 m	55	24
500-1bn	12	5.2
1-5bn	24	10.5
> 5bn	52	22.7
Total	229	100

Table I. Sample characteristics

agreement between the raters according to Landis and Koch (1977), suggesting that the result is not a product of chance.

We then asked the second group of raters, consisting of seven supply chain and logistics academics, to assess the adequacy of each item by rating the degree to which it adequately measured the construct. The raters were asked to rate each item on a seven-point Likert scale. A rating of "1" indicated very low adequacy and a rating of "7" indicated very high adequacy. Average adequacy and standard deviation were calculated from the ratings. Indicators for removing or adjusting an item were an average score below 4.5 or a standard deviation above 1.5 (Rai, 2016). No item had to be removed from the original list.

Dependent variables

All survey items were reflective construct items adapted from previous literature to fit the particular research context (see Appendix). RelRes was measured drawing on Ambulkar *et al.* (2015) and Rai (2016), and Re-deplRes was measured using items adapted from Ambulkar *et al.* (2015), Rai (2016) and Mesquita *et al.* (2008). The respondents were asked to indicate their agreement on a seven-point Likert scale. Seven-point Likert scales were anchored at "totally disagree = 1" and "totally agree = 7" for all the measures in this study.

Independent variables

SCDInvest were measured using items adapted from Klein *et al.* (1990) and Shervani *et al.* (2007). Items for SCDInfoSharing were adapted from Bock *et al.* (2005) and Chen *et al.* (2004). Finally, SCDComplimentarity included items adapted from Lambe *et al.* (2002) and Deitz *et al.* (2010).

FormalSCDGov items were adapted from Li *et al.* (2010) and Rai *et al.* (2012). In keeping with the literature, informal SCD governance was measured as "goodwill trust" (Pulles *et al.*, 2014). Construct items were adapted from Whipple *et al.* (2013) and Pulles *et al.* (2014).

Control variables

Three control variables were included to extract possible confounding effects. First, the perceived importance of the supplier (F1) for the buying firm was controlled for with a

single item value on a seven-point Likert scale (anchored at very little = 1 and very high = 7). The importance of the supplier for the buying firm might affect the way the buying firm interacts with it. It could increase dependence and eventually impact firm resilience. Second, the duration of the relationship (F8) was included as a proxy for relation-specific experience, which may account for tacit knowledge in the relational management of SCDs between the two firms. Third, the buyer's age (F10) was included as a proxy for knowledge and experience. Older buying firms may have more expertise in managing and benefiting from supplier relationships than younger firms.

Sample and procedure

In screening the data, unengaged respondents and respondents with more than 8 percent of item values missing were removed. Missing item values were estimated with an expectation maximization algorithm. All observed variables were examined for skewness and kurtosis (i.e. the absolute values were below 1.4 for skewness and below 1.6 for kurtosis). No issues were detected by visual inspection. To test for non-response bias, the means of all construct items were compared via *t*-tests between the first and last third of responses. No statistically significant differences were detected between these groups.

Exploratory factor analysis showed high factor loadings and Cronbach's αs ranging between 0.856 and 0.949. Confirmatory factor analysis using Amos 20 was then conducted to estimate composite reliability. Several *ex ante* strategies were followed to address the potential for common method variance (CMV). Respondents were ensured complete anonymity in order to address social desirability effects. In order to reduce the likelihood that respondents were guided by a cognitive map, they were only given the general information needed to fill out the survey, and no clues about its objective(s) or relationships. The order of the items was randomized and different for each respondent. The constructs were further mixed with construct items unrelated to this study (Table II).

For an *ex post* diagnosis of CMV, the common latent factor method in AMOS and the confirmatory factor analysis marker technique (Williams *et al.*, 2010) were followed. "Job satisfaction" was chosen, a priori, as a marker variable as it is theoretically unrelated to the model. The marker was measured with items developed in Janssen (2001). The common latent factor method indicated no significant common method bias in the model; introducing the common latent factor did not change estimated item-construct correlations to any great extent, and statistical significance was retained. The same applied to the marker test, which provided no indication for CMV.

Discriminant validity on a construct level was tested using the heterotrait-monotrait (HTMT) ratio of correlations (Henseler *et al.*, 2014) and the Fornell-Lacker test (Fornell and Larcker, 1981). The $HTMT_{0.85}$ values in Table III and the values in Table IV indicated no validity concerns.

Curve estimation was then conducted for all relationships in the model. All relationships were sufficiently linear to be tested with a covariance-based structural equation model algorithm. Subsequently, multi-collinearity was tested and no issue was found to exist among the independent variables. Following the suggestions by Wieland *et al.* (2017), both statistical and judgmental criteria for scale purification were considered in the described process and it was possible to retain all items in the model.

Sorting low- and high-complexity product industries

In order to address *H6*, survey respondents had to be clustered into low- and high-complexity product industries. In the online survey, all 229 respondents stated their industry sector. This information was subsequently verified with secondary data available on the firms' homepages. In order to conduct a multi-group moderation, the data set was split along the values of the categorical variable of industry sector.

	Factor							
	F1	F2	F3	F4	F5	F6	F7	Marker
Cronbach's alpha	*0.909*	*0.856*	*0.928*	*0.923*	*0.920*	*0.885*	*0.949*	*0.913*
F1_4	*0.869*	−0.056	−0,086	−0,033	0,008	0.125	0.001	−0.032
F1_3	*0.865*	0.030	−0.088	0.084	0.067	−0.025	−0.013	−0.003
F1_1	*0.859*	0.119	−0.079	−0.047	−0.017	0.077	−0.068	0.014
F1_2	*0.823*	−0.003	0.047	0.076	0.049	−0.114	0.036	0.059
F1_6	*0.714*	−0.048	0.019	−0.017	−0.129	0.021	0.010	−0.005
F1_5	*0.663*	−0.086	0.159	−0.054	0.046	−0.170	0.068	−0.016
F2_5	0.137	*0.818*	−0.015	−0.102	−0.050	−0.021	0.089	−0.045
F2_1	0.100	0.777	0.074	−0.022	−0.107	0.004	0.018	−0.019
F2_2	−0.066	*0.708*	−0.055	0.089	0.054	0.025	0.036	−0.018
F2_3	−0.130	*0.678*	−0.017	0.073	0.098	−0.010	−0.052	0.026
F2_4	−0.029	*0.524*	0.161	0.030	0.170	−0.014	−0.103	0.073
F3_3	−0.056	−0.030	*0.941*	0.011	0.052	0.003	−0.054	−0.023
F3_1	−0.020	0.072	*0.921*	−0.016	−0.024	−0.061	0.012	0.014
F3_2	0.055	−0.072	*0.799*	0.030	0.038	0.052	0.039	−0.018
F3_4	0.016	0.133	*0.677*	−0.044	−0.023	0.118	0.056	0.015
F4_1	0.015	0.061	−0.012	*0.911*	−0.043	−0.040	0.004	0.009
F4_3	−0.056	−0.070	−0.024	*0.902*	−0.057	0.076	0.031	−0.025
F4_2	0.022	0.036	0.070	*0.883*	0.011	−0.095	0.019	−0.005
F4_4	0.029	0.030	−0.041	*0.705*	0.073	0.047	−0.025	−0.016
F5_6	0.032	−0.013	−0.047	−0.060	*0.939*	0.014	0.010	−0.041
F5_5	−0.040	0.021	−0.008	−0.107	*0.860*	−0.080	0.103	−0.091
F5_2	0.061	−0.017	0.044	0.045	*0.821*	−0.012	−0.066	−0.005
F5_1	−0.105	−0.076	0.046	0.022	*0.814*	0.005	0.082	0.067
F5_4	0.003	−0.001	0.078	0.045	*0.696*	0.031	−0.010	0.001
F5_3	0.084	0.133	−0.078	0.043	*0.683*	0.094	−0.098	0.066
F6_5	0.008	0.028	−0.005	−0.021	0.047	*0.874*	−0.078	−0.030
F6_4	−0.040	0.029	−0.014	−0.115	−0.034	*0.761*	0.089	−0.002
F6_3	−0.025	−0.005	0.032	0.063	0.072	*0.754*	-0.008	0.029
F6_1	−0.107	−0.059	−0.025	0.074	−0.013	*0.734*	0.159	0.026
F6_2	0.189	−0.034	0.157	0.050	−0.049	*0.551*	0.053	−0.030
F7_1	−0.014	−0.037	0.087	0.007	−0.028	−0.070	*0.956*	0.011
F7_2	0.068	−0.060	−0.008	0.006	0.087	0.001	*0.882*	0.031
F7_4	−0.004	0.008	0.043	0.033	−0.052	−0.016	*0.882*	0.007
F7_5	0.052	0.004	−0.028	0.021	0.010	0.056	*0.823*	0.003
F7_3	−0.056	0.115	−0.110	−0.039	0.026	0.136	*0.787*	−0.033
Marker_2	0.000	0.049	−0.057	−0.037	0.009	0.021	0.037	*0.933*
Marker_1	0.006	−0.030	0.019	−0.018	−0.028	0.025	−0.035	*0.915*
Marker_3	0.005	−0.026	0.024	0.020	0.002	−0.046	0.020	*0.808*

Table II.
Results from exploratory factor analysis

Notes: [a]Rotation converged in six iterations. Extraction method: maximum likelihood; rotation method: Promax with Kaiser normalization

	F1	F2	F3	F4	F5	F6	F7	Marker
F1								
F2	0.459							
F3	0.298	0.668						
F4	0.268	0.478	0.475					
F5	0.056	0.507	0.537	0.228				
F6	0.392	0.549	0.634	0.451	0.456			
F7	0.351	0.46	0.495	0.489	0.660	0.671		
Marker	−0.096	0.020	0.040	−0.056	0.032	−0.058	−0.101	

Table III.
Matrix of heterotrait-monotrait ratios of correlations

Following a Q-sort exercise (see Ellingsen *et al.*, 2010), four experienced SCM researchers were asked to independently categorize each firm into the different industry sectors according to the average complexity of its standard product. The results showed unanimous agreement on industry classifications. Table V shows the two industry groups identified. Measurement invariance was then tested between the two groups. No significant differences could be identified in the way that the constructs were measured across the two groups.

Results and analysis

Data analysis followed the two-step modeling approach proposed in Anderson and Gerbing (1988). This approach allows testing for whether any model that is less constrained or nested within the theoretical model would give a better representation of the data. Table VI provides an overview of the study results.

	CR	AVE	MSV	ASV	F1	F2	F3	F4	F5	F6	F7	Marker
F1	0.907	0.624	0.251	0.110								
F2	0.841	0.515	0.453	0.253	0.501							
F3	0.929	0.766	0.453	0.235	0.277	0.673						
F4	0.917	0.690	0.248	0.133	0.287	0.498	0.464					
F5	0.918	0.653	0.285	0.124	0.514	0.514	0.534	0.211				
F6	0.887	0.612	0.428	0.245	0.403	0.569	0.620	0.438	0.470			
F7	0.943	0.805	0.428	0.183	0.430	0.484	0.481	0.377	0.221	0.654		
Marker	0.915	0.783	0.010	0.004	−0.090	0.010	0.041	−0.079	0.042	−0.050	−0.098	

Table IV.
Correlation matrix of the latent variables with composite reliability, average variance extracted, maximum shared variance and average shared variance

	US-SIC	ISIC	Freq.
Low-complexity product industries (group 1)			
Food and kindred products	20	15	43
Tobacco products	21	16	2
Textile mill products	22	17	2
Apparel and other finished products made from fabrics and similar materials	23	18	6
Paper and allied products	26	21	2
Printing, publishing, and allied industries	27	22	3
Rubber and miscellaneous plastics products	30	25	7
Fabricated metal products, except machinery and transportation equipment	34	28	24
Furniture and fixtures	25	36	4
Stone, clay, glass, and concrete products	32	None	3
Miscellaneous manufacturing industries[a]	39	None	21
	Sum group 1		117
High-complexity product industries (group 2)			
Chemicals and allied products	28	24	23
Industrial and commercial machinery and computer equipment	35	30	14
Electronic and other electrical equipment and components	36	32	35
Measuring, analyzing and controlling instruments	38	33	6
Manufacture of motor vehicles, trailers and semi-trailers	37	34	29
Manufacture of other transport equipment	–	35	5
	Sum Group 2		112
Total			229

Notes: [a]Firms that stated to be from "miscellaneous manufacturing industries" were individually assessed. All 21 were sorted to group 1

Table V.
Complicated product industry grouping based on q-methodology

Table VI.
Standardized parameter estimates and goodness-of-fit indices for the three models

	Model 1 (measurement model)				Model 2 (theoretical model)				Model 3 (best model)			
					Dependent variables							
	RelRes (F6)		Re-deplRes (F7)		RelRes (F6)		Re-deplRes (F7)		RelRes (F6)		Re-deplRes (F7)	
Standardized estimates	Group 1	Group 2	Group 1	Group 2	Group 1	Group 2	Group 1	Group 2	Group 1	Group 2	Group 1	Group 2
Independent variables												
Interpersonal												
SCDInvest (F1)	0.255**	0.171**	0.311**	0.209**	0.249**	0.188**	0.297**	0.252**	0.239**	0.187**	0.297**	0.252**
SCDInfoSharing (F2)	−0.066	0.052	−0.014	0.270**	−0.048	0.065	0.028	0.302**	−0.066	0.076	0.028	0.302**
SCDComplementarity (F3)	0.522***	0.273**	0.393***	0.267**	0.530***	0.253**	0.410***	0.213*	0.524***	0.239**	0.410***	0.213*
Interorganizational												
FormalSCDGov (F4)	0.075	0.241***	0.060	0.155**	0.049	0.184**			0.044	0.189**		
InformalSCDGov (F5)	0.248**	0.126	0.026	−0.145	0.237**	0.180**			0.259***	0.172**		
Interaction terms												
F2 × F4	−0.062	−0.021***			−0.062	−0.210**			−0.084	−0.229**		
F3 × F4	0.145*	0.302			0.146*	0.302***			0.137	0.337***		
F2 × F5	−0.142*	0.107			−0.142*	0.107						
F3 × F5	0.031	−0.354**			0.031	−0.354**			−0.067	−0.273***		
Controls												
F8	0.141**	0.106**	0.086	0.079	0.146**	0.099**	0.098	0.061	0.146**	0.109**	0.098	0.061
F9	−0.078	0.051	0.067	−0.049	−0.079	−0.088	0.067	0.036	−0.080	0.076	0.067	−0.088
F10	0.076	−0.019	0.008	0.161**	0.076	−0.004	0.004**	0.201	0.073	−0.004	0.007	0.201**
Goodnes-of-fit indices												
GFI	0.975				0.972				0.971			
χ^2/df	1.147				1.196				1.197			
RMSEA	0.018				0.021				0.021			
SRMR	0.049				0.049				0.050			
CFI	0.997				0.995				0.995			
χ^2	86.015				96.898				100.516			
df	75				81				84			
p	0.181				0.110				0.106			

Notes: *$p < 0.10$; **$p < 0.05$; ***$p < 0.01$

Two-step modeling approach and model fit

Three models were built to assess the structural model. Model 1 is the measurement model and relates all independent and dependent variables to one another. Model 2 is the theoretical model, which is nested within model 1 and only includes the hypothesized relationships. Model 3 is the most parsimonious model and is nested within model 2. The lower part of Table VI displays a list of various fit indices, indicating an acceptable fit for all three models.

Conducting a χ^2-difference test between the measurement model and the theoretical model ($\chi^2_{M2} - \chi^2_{M1} = 10.883$; $df_{M2} - df_{M1} = 6$; $p = 0.092$) reveals no statistically significant difference between the two models for a significance level of 0.05 (Anderson and Gerbing, 1988). That is, the null hypothesis that M2–M1 = 0 (i.e. trimming model 1 to model 2) significantly reduces the model's ability to resemble the data is rejected. The more parsimonious model 2 is accepted. Thereafter, insignificant parameter estimates from the theoretical model were trimmed off. The marginal cut-off was a p-value above 0.05 in both groups. Thereafter, F2x×F4→F6 was deleted, while F2→F6 was retained, due to the significant effect of the interaction term F2×F5→F6. Following the procedure in Mesquita *et al.* (2008), all paths for the control variables were also retained. Comparing the more constrained model 3 with model 2 ($\chi^2_{M3} - \chi^2_{M2} = 4.514$; $df_{M3} - df_{M2} = 6$; $p = 0.607$) shows no significant difference between the models. Thus, model 3 was accepted as the most parsimonious structural model of the three hypothesized alternatives.

Model 3 explains 60.7 percent of the variance in RelRes and 38.0 percent of the variance in Re-deplRes. All three models exceed the recommended threshold for statistical power of 0.80 for both endogenous variables (MacCallum *et al.*, 1996). Thus, one can reasonably conclude that the sample size is adequate and the model has sufficient power to detect global model misspecification.

Model analysis and moderated moderation

The following analysis refers to the results of model 3, identified above as the best model. Taking *H6* into account (i.e. exploring whether significant differences regarding the efficacy of all three independent variables between low- (group 1) and high- (group 2) complexity product industries exist), we interpret each path for the two industry groups.

In *H1*, we proposed that SCDInvest are positively related to relational (*H1a*) and re-deployable (*H1b*) resilience. Confirming both hypotheses, we found a positive and significant effect of SCDInvest on each of the dependent variables. The identified effects are different between the two industry groups; however, a χ^2-difference test does not confirm a significant group difference.

In *H2a* and *H2b*, inspired by findings from the interorganizational literature stream, we proposed that SCDInfoSharing is positively related to both resilience variables. Surprisingly, we found no support for *H2a*; furthermore, *H2b* was only partially supported, as the results suggest that information sharing helps to increase Re-depRes for industry group 2 ($p < 0.05$).

H3a and *H3b* proposed that SCDComplimentarity predicts firm resilience. Supporting both hypotheses, a strong positive relationship between SCDComplimentarity and the dependent variables was detected for both industry groups. A significant group difference in the path loadings could be detected for *H3a* with a significance level of $p < 0.10$ for non-standardized path coefficients. This indicates that SCD management complementarity has a stronger effect on RelRes in low-complexity product industries (SE+0.524; $p < 0.01$) than in high-complexity product industries (SE+0.239; $p < 0.05$), supporting our conjecture in *H6*.

H4 proposed a moderating effect of interorganizational SCD governance on the resilience efficacy of SCDInfoSharing. In particular, *H4* suggests that, when SCDInfoSharing is low, FormalSCDGov supports higher resilience efficacy, whereas when information sharing is

high, InformalSCDGov should be preferred. In order to retain the full information contained in the continuous moderator variables of this study, the hypothesized moderated variable effects were modeled as multiplicative interactions. The interaction moderation test confirmed *H4* for industry group 2, and refuted *H4* for group 1. In group 2, a significant interaction effect was detected between SCDInfoSharing and interorganizational formal governance. The interaction effect was significant at a $p < 0.05$ level with SE−0.210 (see Figure 2). In detail, the results indicate that, when information sharing is low, high organizational formal SCD governance achieves higher resilience benefits. However, these benefits diminish when SCD information sharing increases.

H5 proposed that, when SCDComplimentarity is low, informal SCD governance supports higher resilience efficacy, whereas when information sharing is high, FormalSCDGov should be preferred. While the hypothesis is supported for industry group 2 ($p < 0.01$), it is refuted for industry group 1. The significant two-way interaction moderation results are depicted in Figures 3 and 4.

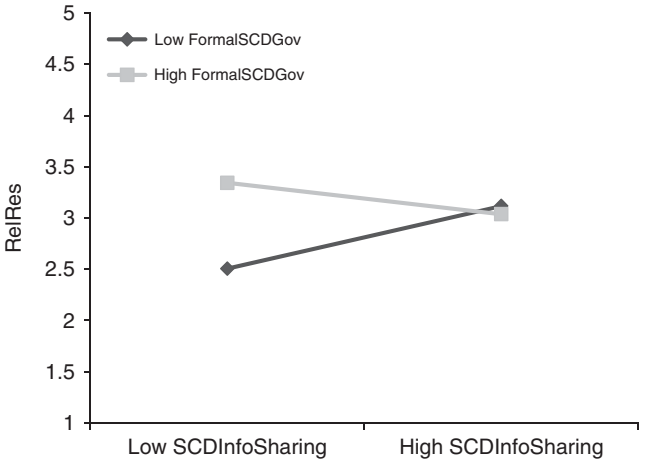

Figure 2.
Two-way interaction effects of unstandardized variables for *H4* (industry group 2)

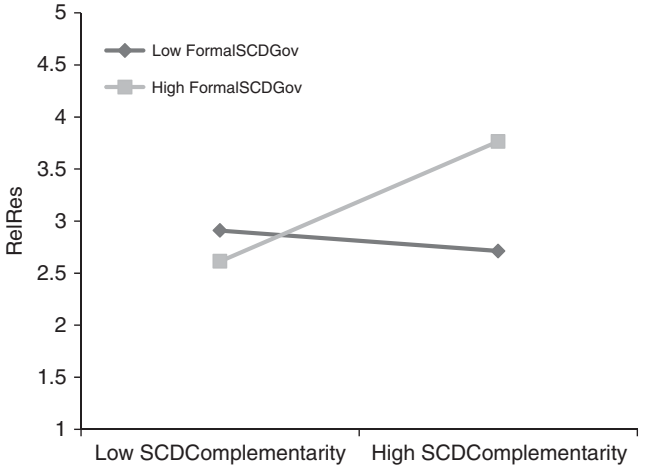

Figure 3.
Two-way interaction effects of unstandardized variables for *H5*-1 (industry group 2)

Discussion and implications

The aim of this study was to explore the disruption management value generated by employees at the buyer interacting with employees at the supplier. Theoretically and empirically, this paper represents a significant addition to current risk management literature. It provides four contributions to the supply chain literature. The first is framed around the fact that existing supply chain research has primarily used an interorganizational lens to examine supply chain relationships. Conversely, we discussed and tested the way that interpersonal upstream-linkages affect the resilience of the buying firm. Second, we investigated potential inferences from our proposed model for managers. Conducting a multi-level analysis, we researched which governance mechanisms should be deployed by managers on an organizational level to positively moderate the proposed interpersonal relationships. Third, we considered industry cluster as a second potential moderating variable for the efficacy of the proposed interpersonal antecedents, using a comparison study of two industry clusters. Fourth, in contrast to existing SCD research that has measured firm resilience as a single dependent variable (e.g. Wieland and Wallenburg, 2013; Ambulkar *et al.*, 2015), we distinguished between firm resilience improved "with a particular supplier" (RelRes) and firm resilience improved "with other suppliers" (Re-depRes).

Contribution to the literature

Hypotheses in this study were developed by drawing on insights from literature in the behavioral field of SCM (e.g. Cousins *et al.*, 2008; Croson *et al.*, 2013; Johnston and Staughton, 2009). In this regard, our study findings confirm the important position of interpersonal relationships in interorganizational research. The analysis has shown that investments in interpersonal skills and interpersonal complementarity are strong and significant antecedents of firm resilience, indicating a socially embedded, interpersonal dimension in buyer-supplier relationships that impacts organizational-level resilience. Drawing on Borgatti and Li's (2009) work on social network analysis, our tests confirm that benefits from these interpersonal effects cannot be tied to a single supplier relationship alone. That is, a buying firm's purchasers can make further use of their acquired know-how in other supplier relationships.

Surprisingly, our study does not support the assumption of a positive relationship between interpersonal information sharing and firm resilience, an assumption that has already been proposed, tested and confirmed at an interorganizational level (Brandon-Jones *et al.*, 2014; Wieland and Wallenburg, 2013). Clearly, information sharing is incorporated in any relationship, whether interorganizational or interpersonal, and it is an important part of general SCM.

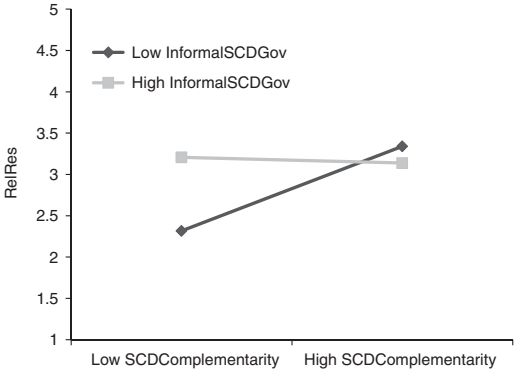

Figure 4.
Two-way interaction effects of unstandardized variables for *H5*-2 (industry group 2)

Yet, as opposed to the "the more the merrier" assumption that has been taken in the interorganizational research stream, we infer that this relationship does not follow this assumption on an interpersonal level. We interpret our findings as showing that employees who prepare for disruptions may not experience ever-increasing additional value through continuously increasing information sharing. The right information at the right time might be enough to appropriately implement mitigation measures with the supplier.

The findings also show that untangling the resilience variables provides new fine-grained insights into the mechanisms that generate benefits from interpersonal interactions. For example, while an increase in interpersonal information exchange is not significantly related to supplier-specific resilience, it still supports overall Re-depRes in high-complexity product industries, as it significantly increases resilience with other suppliers. It is reasonable to assume that the ratio of relational to Re-depRes will be higher when employees have more opportunities to apply what they have learned with suppliers outside the scope of the particular relationship, as is the case within industry group 2.

The data further confirm a very strong relationship between SCDComplimentarity and both resilience variables. We think this may be a valuable contribution to the supplier selection literature, where interpersonal complementarity has received only limited attention (e.g. Cadden *et al.*, 2013). Attention should be paid to identifying suppliers with personnel who are capable of eliminating deficiencies in the buying firm's disruption management portfolio, and vice versa. This finding provides a supplemental perspective to complementarity theory as disseminated in psychology (Fiske, 2000), adding to previous SCM-related studies that have borrowed from this theory (e.g. Blome *et al.*, 2013; Richey *et al.*, 2007; Swink and Nair, 2007).

Methodologically, the study disagrees with the findings of Priscila *et al.* (2014), who argued that relational complementarity cannot be measured individually, but should be considered as part of relational governance mechanisms. We were able to identify a clear difference between these antecedents in the context of SCD. It was possible to establish discriminant validity on an item and on a construct level. We were able to further show that the level of measurement is highly important in our discipline.

The interaction effects in our model have shown that interorganizational governance mechanisms may significantly moderate the proposed interpersonal relationships. Notwithstanding, the moderation effect seems to vary between the two industry groups. Though not significant for all relationships, it was found that the proposed interpersonal relationships are higher in industry group 1 (low-complexity product industry) than in industry group 2. However, we also found evidence that the more supplier relationships have to be handled by purchasers due to increasing product complexity (as is the case in group 2), the more the effect of these interpersonal relationships can be influenced through appropriate forms of interorganizational governance. For industry group 2, we can conclude that interorganizational governance can be utilized to significantly alter the efficacy of interpersonal relational antecedents.

Managerial implications

The study findings provide valuable managerial guidance. For example, the study data indicate that benefits can be gained from relation-specific investments in interpersonal SCD skills across all participating companies. Moreover, these investments are worthwhile even in short-lived supplier relationships, as it has been shown that employees' learnings derived from such investments can be re-used across other supplier relationships. That is, employees are capable of extracting important knowledge and capabilities even from supplier-specific investments, and of re-deploying those with other suppliers.

The data further show the importance of interpersonal complementarity in supply chains. These findings again demonstrate the necessity of conducting a thorough supplier

selection process. This process should not just consider the supplier organization, but look at the team of employees with whom their company will interact. This will certainly make the supplier selection process much more challenging than it often is today. However, as the data demonstrate, the benefit to firm resilience from finding the right supplier with the right personnel is exceptionally high.

Our findings also suggest that managers in high-complexity product industries (group 2) can significantly influence the efficacy of interpersonal relational antecedents through the appropriate use of interorganizational governance mechanisms. On the other hand, our study findings do not indicate the existence of this managerial lever for managers from industry group 1. Low-complexity product industries with fewer supplier relationships seem to obtain high benefits from interpersonal relationships that exist whatever interorganizational governance mechanisms are put in place.

Limitations and future research directions

The study has limitations that may provide directions for future research. First, this study has considered only one side of the dyadic relationship. Although this is common practice in supply chain risk management research (e.g. Bode and Wagner, 2015; Wieland and Wallenburg, 2013), collecting data from both sides would be an interesting and potentially fruitful task for future research. A variety of additional factors can only be examined by using dyadic data. For example, this study's analysis has focused on buying firms' investments in interpersonal skills, leaving the effects of suppliers' asset investments open for future research attempts. Further, the dependent variables have looked at the relational and Re-depRes of the buying firm, while future research could also seek to integrate the suppliers' perspectives.

As discussed, no significant positive relationship could be identified between interpersonal information sharing and RelRes. The multiple ways of interpreting this finding may hopefully spark subsequent research efforts to investigate interpersonal information sharing (as investigated in this paper) and interorganizational/impersonal factors such as information technology in a single study. It must be noted that, although it is quite a new element in supply chain risk research, interpersonal information sharing has been a core element of behavioral research for many years (e.g. Croson and Donohue, 2003, 2005). Future research may thus significantly benefit from further integrating findings from behavioral research into this discussion.

Finally, the authors acknowledge that industry sector codes are just a proxy and not a perfect metric for average product complexity. Future research efforts could and should take a closer look at the moderating effects of this contextual variable.

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Appendix. Measurement Items and Scales

Marker variable: job satisfaction (from Janssen, 2001)

How satisfied are you with […] ? (1: totally disagree – 7: totally agree)

Marker_1 […] your work performance

Marker_2 […] the quality of your performance

Marker_3 […] the way you perform your tasks

SCDInfoSharing (adapted from Chen *et al.*, 2004; Bock *et al.*, 2005) (1: totally disagree – 7: totally agree)

We employees, and "this" supplier's employees […]

F2_1 […] constantly exchange expert knowledge on dealing with supply disruptions.

F2_2 […] always give each other feedback about each other's performance when dealing with supply disruptions.

F2_3 […] provide each other with any information about the status of current supply disruptions.

F2_4 […] exchange information about potential supply disruptions frequently and in a timely manner.

F2_5 […] exchange many new ideas about avoiding supply disruptions.

SCDComplimentarity (adapted from Deitz *et al.*, 2010; Lambe *et al.*, 2002)

(1: totally disagree – 7: totally agree)

We employees, and "this" supplier's employees […]

F3_1 […] contribute capabilities to manage supply disruptions that greatly complement each other.

F3_2 […] possess distinct opportunities to avoid supply disruptions that greatly complement each other.

F3_3 […] possess distinct opportunities to fix supply disruptions that greatly complement each other.

F3_4 […] bring to the table management concepts to avoid supply disruption that greatly complement each other.

F3_5 If one of our employees despairs while managing a supply disruption, our supplier's employees can almost always help (and vice versa!).

F3_6 Strategically, you could not ask for a better fit between our employees and this supplier's employees to proactively manage disruptions.

SCDInvest (adapted from Klein *et al.*, 1990; Shervani *et al.*, 2007) (1: totally disagree – 7: totally agree)

Specifically for "this" supplier, we employees have made great efforts […]

F1_1 […] to learn the necessary capabilities to avoid supply disruptions.

F1_2 […] to learn the necessary soft skills (i.e. social competencies) to deal with supply disruptions.

F1_3 […] to learn the necessary hard skills (i.e. technical qualifications) to deal with supply disruptions.

F1_4 […] to adjust our usual way of dealing with supply disruptions to the employees of "this" supplier.

F1_5 It is very difficult for other companies to learn the specific way our employees do disruption management with "this" supplier's employees.

F1_6 To be effective in managing supply disruptions with "this" supplier's employees, our employees had to invest a lot of time.

FormalSCDGov (adapted from Li *et al.*, 2010; Rai *et al.*, 2012) (1: totally disagree – 7: totally agree)

Our organization has formal agreements with "this" supplier that precisely details […]

F4_1 […] its obligations to avoid supply disruptions.

F4_2 […] its procedure to deal with supply disruptions.

F4_3 […] consequences in case it causes a supply disruption.

Based on the formal agreements regarding supply disruptions, "this" supplier knows exactly […]

F4_4 […] which expectations have to be fulfilled.

F4_5 […] which goals our organization associates by working with it.

InformalSCDGov (adapted from Pulles *et al.*, 2014; Whipple *et al.*, 2013) (1: totally disagree – 7: totally agree)

Though not required by our formal agreement with "this" supplier, our organization can always be confident that […]

F5_1 […] in the case of supply disruptions, it would immediately seek to fix the problem.

F5_2 […] in the case of supply disruptions, our organization could always depend on it to treat us fairly.

F5_3 […] it always takes all initiatives possible to prevent supply disruptions.

F5_4 […] it would make huge sacrifices to fix supply disruptions.

F5_5 […] it will always be honest when responding to our organization's inquiries about potential supply disruptions.

F5_6 Our organization trusts this supplier, because it is always sincere with us when dealing with disruptions.

RelRes (adapted from Ambulkar *et al.*, 2015; Rai, 2016) (1: totally disagree – 7: totally agree)

Because of our employees' cooperation with "this" supplier's employees we have managed to […]

F6_1 […] much better protect ourselves against supply disruptions from "this" supplier.

F6_2 […] develop many new strategies to deal with supply disruptions.

F6_3 […] heavily reduce the likelihood of supply disruptions from "this" supplier.

F6_4 […] heavily reduce the impact of supply disruptions from "this" supplier.

F6_5 […] heavily reduce the duration of supply disruptions from "this" supplier.

Re-depRes (adapted from Ambulkar *et al.*, 2015; Mesquita *et al.*, 2008; Rai, 2016) (1: totally disagree – 7: totally agree)

The value that has been generated by our employees' cooperation with "this" supplier's employees has helped us to […]

F7_1 […] better protect ourselves against supply disruptions from our other suppliers.

F7_2 […] improve our dealing with supply disruptions with our other suppliers.

F7_3 […] reduce the likelihood of supply disruptions with our other suppliers.

F7_4 […] reduce the impact of supply disruptions with our other suppliers.

F7_5 […] reduce the duration of supply disruptions with our other suppliers.

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