Evaluating firm resilience through responsiveness and logistics outsourcing in the COVID-19 era

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Abstract

Purpose – This paper aims to investigate how firms can enhance their resilience in response to the disruptions caused by the COVID-19 pandemic. Specifically, the study focuses on assessing responsiveness as an antecedent and logistics outsourcing as a boundary condition to resilience.

Design/methodology/approach – Survey data collected from 286 manufacturing firms in Finland during 2021 are analysed to examine the relationships between supply chain responsiveness, logistics outsourcing and resilience.

Findings – Firm responsiveness is found to improve resilience, while an increasing level of logistics outsourcing weakens this relationship. Surprisingly, geographic dispersion does not significantly affect supply chain responsiveness.

Research limitations/implications – Limitations of the study include the focus on manufacturing firms in Finland and the reliance on survey data. Future research could explore additional factors influencing resilience and consider a broader range of industries and geographical regions.

Practical implications – The findings offer valuable insights for managers seeking to enhance their firms' resilience in the face of disruptions. By understanding the importance of responsiveness and the potential drawbacks of excessive logistics outsourcing, managers can make informed decisions to improve their firms' ability to cope with unexpected challenges.

Originality/value – This research contributes to the understanding of resilience in supply chain disruptions by addressing fundamental questions related to efficiency, responsiveness, control and complexity. By examining the interplay between responsiveness, logistics outsourcing and resilience, the study enriches the understanding of how firms can effectively navigate unexpected challenges.

Keywords Resilience, Supply chain responsiveness, Logistics outsourcing, Geographic dispersion, COVID-19

Paper type Research paper

1. Introduction

Global supply chains (SC) faced an unprecedented stress test during the COVID-19 pandemic, marked by production halts, logistical disruptions and limited access to raw materials and components (Ivanov and Dolgui, 2019; Burgos and Ivanov, 2021). *Fortune* magazine reported in early 2020 that pandemic-driven SC disruptions affected a staggering 94% of Fortune 1000 firms (Fortune, 2020). The pandemic revealed that global SCs resemble a house of cards, collapsing under pressure. An example of an industry that struggled greatly with SC disruptions is the automotive industry, which faced severe supply shortages and plunging sales (Belhadi *et al.*, 2021). Food retailers, in turn, faced a massive increase in demand for home delivery services, which forced them to adapt their SC configurations and processes (Mollenkopf *et al.*, 2021).

Due to the COVID-19 pandemic, building resilience to SC has attracted a great deal of attention (Linton and Vakil, 2020). During times of turbulent change, resilient firms demonstrate the ability not only to survive but also to adapt and thrive (Pettit *et al.*, 2010). Furthermore, resilient firms exhibit the capability to maintain their operations, fulfil customer demands and achieve targeted performance levels even in disruptive circumstances (Ambulkar *et al.*, 2015; Ge *et al.*, 2023). Resilience comprises two critical capabilities: the ability to withstand the disruption and the ability to recover from disruptions (Ponomarov and Holcomb, 2009; Melnyk *et al.*, 2014).

It is essential to draw lessons from the pandemic as a report by the World Economic Forum and Kearney (2021) revealed that only 12% of the studied firms were prepared for future disruptions. Also, van Hoek (2020) suggests that the industry

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lacks a research-based understanding of SC risks and resilience, advocating for increased, event-based research to fill this gap. There is an urgent need to evaluate how firms can enhance their resilience to deal with low-frequency, high impact SC disruptions, such as epidemic outbreaks (El Baz and Ruel, 2021). Therefore, this study aims to provide empirical evidence on whether resilient firms have outperformed others in navigating the challenges presented by the COVID-19 pandemic. Importantly, this study also contributes to the discussion on the antecedents of resilience to SC disruptions and thereby also adds to contingency perspective to enhance firm resilience (Parast, 2022).

Based on the classic framework of Fisher (1997), a firm's SC strategy typically falls into two generic categories: efficient SC and responsive SC (Wagner *et al.*, 2012). While the former focuses on fulfilling predictable demand cost-efficiently, emphasizing minimal inventory and maximized operational efficiency, the latter is configured to swiftly respond to unpredictable market changes, often by investing in excess capacity (Parmigiani *et al.*, 2011; Gunasekaran *et al.*, 2015). Nevertheless, it seems that the majority of companies pursue a combination of the two strategies (Fadaki *et al.*, 2020), perhaps because the responsiveness of traditionally cost-focused SC has been questioned (Kamalahmadi *et al.*, 2021). The traditional way of coping with the risk of disruptions is by adding redundancy and/or flexibility (Kamalahmadi *et al.*, 2021).

Implementing efficient (or lean) SC practices in isolation can lead to more vulnerable SC if firms with limited buffers are not able to face sudden events (Ruiz-Benitez *et al.*, 2018). For example, popular media has pointed to just-in-time (JIT) practices as the cause for shortages arising from the pandemic (Choi *et al.*, 2023; Saunders *et al.*, 2021) showed that a highly efficient SC benefits from micro-doses of flexibility. Therefore, this research investigates the fundamental question of the linkage between efficiency/responsiveness and resilience. We further contribute by testing how logistics outsourcing moderates this relationship. Typically, outsourcing has been considered a means for increasing efficiency and flexibility in the SC (Yuan *et al.*, 2020). However, much of the research has focused on analysing "normal" business conditions, with less consideration of what happens to SCs in case of disruptions. Less vertically integrated, outsourced SC may be less under the control of the firm, requiring additional resources and effort for coordination, possibly making them less resilient in case of a disruption (Herold *et al.*, 2021; Song *et al.*, 2022). As outlined by Goldsby *et al.* (2013), moderation analysis helps to identify boundary conditions to purported relationships, in this case logistics outsourcing and resilience.

Our third contribution relates to the antecedents of SC responsiveness. Globalization has given rise to geographically dispersed SC that are widely spread across countries and regions, encompassing a variety of suppliers, production facilities and customers (Lorentz *et al.*, 2012; Gligor, 2017). Reasons for this include seeking competitiveness from low-cost countries, diversifying export revenue, or broadening the supply base (Lorentz *et al.*, 2012). However, dispersed SC may face increasing logistics costs, long response times and additional requirements for coordinating activities (Gligor, 2017). Geographic dispersion is closely linked with spatial complexity, which may increase the risk of SC disruptions (Bode and Wagner, 2015). Large distances hinder firms from sharing information, engaging in collaboration and achieving effective coordination (Lawson *et al.*, 2019). Therefore, this research also examines whether a firm's ability to respond rapidly is hindered by the geographic dispersion of its SC. In essence, the research aims to explore SC responsiveness as an antecedent and logistics outsourcing as a moderating factor in the development of resilience during the COVID-19 outbreak.

Our research sheds light on the antecedents of resilience when SCs are disrupted. As Nikookar and Yanadori (2021) aptly concluded, the diversity in organizational capabilities that act as antecedents to SC resilience results in variations in SC resilience across different firms. We posit this diversity may extend to the structural characteristics of the SC beyond a focal firm or dyadic relationship, encompassing the diversity in geographic areas and actors with which the firms are engaged. After all, such network complexity and relational practices among SC members were found by Chowdhury *et al.* (2019) to be relevant factors in enhancing SC performance with resilience. Our findings offer valuable managerial insights into how firms can enhance their resilience against SC disruptions, particularly by leveraging SC responsiveness to effectively mitigate these challenges.

2. Theoretical background and hypothesis development

2.1 Firm resilience during the COVID-19 pandemic

The highly dynamic operational environment brought about by COVID-19 demanded rapid reactions. Firms required resilience capabilities to absorb the impact of SC disruptions brought by COVID-19 and to recover more effectively than their rivals, thereby securing a competitive edge (Dovbischuk, 2022). Given that resilience entails a dynamic interplay of conditions, firms must quickly reconfigure their capabilities to adapt to changes resulting from disruptions (El Baz and Ruel, 2021; Pereira *et al.*, 2020). In such a dynamic environment, firms capable of reconfiguring their resource base have a greater chance of building capabilities to mitigate the effects of disruptions (Ambulkar *et al.*, 2015). To develop resilience, a firm needs to cultivate effective capabilities in preparing for, responding to and recovering from unexpected events (Ponomarov and Holcomb, 2009).

While the COVID-19 pandemic may have prompted firms to consider reconfiguring resources, implementing such changes may not be straightforward (Kähkönen *et al.*, 2023). Previous studies have documented major cash flow problems, raw material shortages and shortage of labour resources (Shen and Sun, 2021; Buchheim *et al.*, 2020) surveyed over 6,000 German firms and concluded that key mitigation strategies included remote working, workforce reduction and postponement of investments. The pandemic affected industries and firms differently. Whereas the medical supplies and food industries experienced a surge in demand, the need

for many other commodities decreased (Shen and Sun, 2021). Despite presenting unprecedented challenges for businesses, firms that demonstrate resilience are likely to emerge strongest from the crisis. Thus, we suggest the following hypothesis:

H1. Firm resilience is positively related to COVID-19 impact, indicating that firms with greater resilience are likely to experience more positive outcomes.

2.2 Capabilities needed for firm resilience

Resilience requires integrating SC capabilities that can mitigate vulnerabilities to disruptions (Kochan and Nowicki, 2018). Here, we focus on Fisher's (1997) classic division of efficient versus responsive SC as capabilities leading to firm resilience. While efficient (lean) SC aims to reduce waste, lead times and inventory, responsive (agile) SC prioritises rapid responses to customers' ever-changing needs (Gunasekaran *et al.*, 2015; Ahmed and Huma, 2021). Ensuring alignment between a product's supply and demand characteristics and the corresponding SC strategy is essential (Fisher, 1997; Wagner *et al.*, 2012). Low uncertainty should be met with efficiency, and high uncertainty with responsiveness (Hallavo, 2015). Fadaki *et al.* (2020) assert that in today's hypercompetitive world, firms need to incorporate and optimize efficiency and responsiveness simultaneously.

For many years, firms have focused on economies of scale and inventory reductions (Christopher and Holweg, 2011). However, already 27 years ago, Fisher (1997) advocated responsiveness as a strategy for uncertain situations. Recent findings within resilience research support Fisher's argument and suggest that organisations focused on resilience should prioritise responsiveness (e.g. Pujawan and Bah, 2022; Delbufalo, 2022). Responsiveness facilitates identifying threats and mobilizing resources to respond to changes (Nikookar *et al.*, 2024). To address exceptionally unpredictable situations, such as those caused by the COVID-19 pandemic, it may be necessary to set aside existing plans and routines and rely on improvised responses (Munir *et al.*, 2022).

The COVID-19 pandemic laid bare the vulnerabilities and fragility inherent in global SC that had prioritised efficiency and minimal inventories (Dovbischuk, 2022). Possessing redundant capacity, such as multi-sourcing and having safety stock, excess capacity and backup suppliers, has been found to be key in developing resilience during a pandemic (Kamalahmadi *et al.*, 2021; Sodhi *et al.*, 2021). Nevertheless, previous research is inconclusive: the application of lean tools has also been found to improve the flow of goods and reduce SC disruptions (Manhart *et al.*, 2020). Choi *et al.* (2023) conclude that some of the problems that companies experienced during the pandemic may have been avoided if they had adhered to the original ideas of JIT, such as achieving high quality and short lead times instead of an excessive focus on inventory reduction. To contribute to this discussion, we propose the following hypothesis:

H2. Supply chain responsiveness is positively related to firm resilience.

Geographic dispersion has been identified as a contingency factor affecting when and how organisations can create SC resilience (Brandon-Jones *et al.*, 2014). Gligor (2017, p. 256) defines geographic dispersion as "the degree to which member firms of a specific industry are geographically densely or widely distributed". While having a large supply base may allow a firm to tap into a wider knowledge base and use alternative network configurations to respond swiftly to dynamic markets, a large number of geographically dispersed suppliers may also reduce SC responsiveness due to various factors such as cultural and linguistic differences, foreign trade regulations, reduced control over the supply base, inconsistent quality and varying lead times (Choi and Krause, 2006; Brandon-Jones *et al.*, 2014; Delbufalo, 2022). Therefore, this study investigates geographic dispersion as an antecedent to SC responsiveness.

Advocates of geographical concentration argue that increased geographical dispersion adds complexity to SC (Gurbuz *et al.*, 2023). Recently, Delbufalo (2022) found that suppliers' geographic dispersion had a detrimental effect on both SC agility and resilience. This is, on the one hand, because increased logistics and coordinating costs due to greater geographic distances have impeded the focal firms' ability to coordinate their SC, and, on the other hand, because offshoring production to distant low-cost countries has reduced responsiveness. The extended SC networks have increased the pipeline of goods and exposed firms to macro and micro-level factors (Inman *et al.*, 2024). Furthermore, spatial separation of manufacturing from other value chain activities (e.g. R&D, sales, marketing and after-sales services) can impede seamless inter-functional collaboration (Theyel and Hofmann, 2021). Reduced integration in highly dispersed networks poses challenges to information and material flows, which, in turn, negatively influences the resource utilisation and the alignment of plans (Chedid *et al.*, 2021). For example, the automotive industry faced notable disruptions because globally dispersed suppliers frequently struggled with order fulfilment, while original equipment manufacturers suffered from constrained freight capacities and sudden factory shutdowns (Spieske *et al.*, 2022). Thus, we posit the following hypothesis:

H3. Geographic dispersion is negatively related to supply chain responsiveness.

One possible factor affecting firm resilience is outsourcing. Traditionally, key motives for outsourcing have included efficiency gains (cf. Yuan *et al.*, 2020) and the possibility of accessing additional expertise and capacity outside the boundaries of the organization. However, outsourcing can also lead to a loss of control and visibility over outsourced activities, and it may cause an organization to become overly dependent on a single provider (König and Spinler, 2016). The extent of outsourcing is often associated with less vertical integration in the SC (Fan *et al.*, 2022). Such companies rely more on other firms, involving more parties in the process, diversifying their operations and making them harder to control in case of possible natural or man-made disruptions.

Outsourcing also involves a significant contractual dimension. While companies gain access to external expertise and capacity through outsourcing, the availability of these resources, especially in the short term, is limited to what is formally agreed upon between the companies. Especially long-term contracts may decrease flexibility to react if adjustments are needed for any reason. Statsenko *et al.* (2023) emphasize

that firms should pay more attention to the long-term impacts of their procurement decisions. If flexibility has not been considered and agreed upon in advance, it is likely not available when needed.

To cope with increased diversification, additional external coordination is required (Song *et al.*, 2022). For logistics, this necessitates internal cooperation between non-production logistics and purchasing, as well as coordination with third-party logistics service providers (Song *et al.*, 2022). According to Premkumar *et al.* (2021), this increases the challenges of external coordination. Based on this, Herold *et al.* (2021) and Jabbarzadeh *et al.* (2018) have previously identified a negative relationship between the extent of logistics outsourcing and resilience in a qualitative research setting. We build on their initial idea, but instead propose that the more the logistics functions are outsourced, the less impact the SC responsiveness has on resilience. In other words, when a company outsources its logistics functions, it may negatively affect the relationship between SC responsiveness and resilience. Therefore, we hypothesize:

H4. Logistics outsourcing has a negative moderating effect on the positive relationship between supply chain responsiveness and firm resilience.

The proposed research model is illustrated in Figure 1.

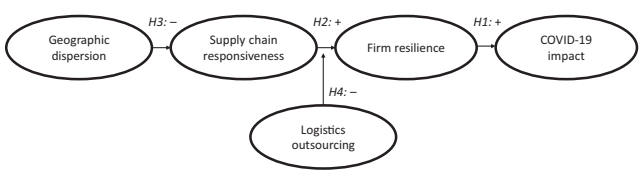
3. Research methods

3.1 Data collection

Data was collected through the Finland State of Logistics 2020 survey, a biennial multi-theme survey commissioned by the Finnish Transport Administration. The survey targeted three main groups of firms: manufacturing, trading and logistics service providers. The target population primarily consisted of members from three associations: the Federation of Finnish Enterprises (an association of SMEs), the Finnish Transport and Logistics (an association of commercial goods transport companies) and the Finnish Association of Purchasing and Logistics (SC professionals from manufacturing and trading firms operating in Finland). In addition, to ensure sufficient coverage among large firms, direct phone contacts were made with the 100 largest manufacturing and trading firms.

Data was collected between December 2020 and February 2021 via an email survey. The survey link was sent to 34,627 individual addresses, resulting in 1,661 responses. Therefore, the total response rate was 4.8%, which is reasonable given the tendency of response rates to decline as sample size increases (see Wagner and Kemmerling, 2010). For this study, only manufacturing firms were included in the sample. After excluding cases with more than 25% of missing data and imputing 62 missing values (0.8% of the remaining values) using the expectation-maximization algorithm, the final sample consisted of 286 cases.

Figure 1 Research model



Source: Authors' own work

Of the final sample, 130 firms were micro-sized (annual turnover below €2m), 74 were small (€2–€10m), 41 were medium-sized (€10–€50m) and 41 were large (over €50m). Concerning the total company population, the sample is slightly biased towards the larger end of the company population. The sample included firms from various sub-industries: electronics and machinery (51 firms), consumer goods (50), process industry (67), metal industry (63), as well as other sub-industries (55), namely other manufacturing and repair and installation of machinery and equipment. The individual respondents held positions in top management (225 respondents), middle management (33), operational personnel (10), specialists (6) and other roles (12).

To evaluate non-response bias, an independent samples *t*-test was used to compare early and late respondents (Armstrong and Overton, 1977). The analysis of key constructs between these two groups revealed no statistically significant differences at $p < 0.05$, which suggests that non-response bias is not a significant concern.

3.2 Measures

Resilience measures were drawn from Ambulkar *et al.* (2015) and modified to assess firm resilience during the COVID-19 pandemic. The scale ranged from completely disagree (1) to completely agree (5). SC responsiveness items were adopted from Wagner *et al.* (2012) and evaluated strategic priorities for the main product line on a scale from not important at all (1) to extremely important (5). COVID-19 impact measures were inspired by Ambulkar *et al.* (2015) and Baghersad and Zobel (2021). Respondents were asked to evaluate the impact of COVID-19 pandemic on various aspects of their business, including turnover, overall efficiency, order delivery time, procurement costs, number of employees and employee well-being. The measurement scale ranged from a very large negative impact (1), no impact (3), to a very large positive impact (5).

Following Lorentz *et al.* (2012), geographic dispersion of the SC was measured as a percentage distribution of purchases, production capacity and sales across eight geographic areas: Finland, other EU countries (including the UK, Switzerland, Norway and Iceland), Europe outside the EU, North America, South America, the Middle East and Africa, Asia and other regions. The calculation of the dispersion measures for sales, production and purchasing followed the methodology outlined by Stock *et al.* (2000), as follows:

$$DISP = 1 - \frac{\sum_{i=1}^{n} \left| G_i - \frac{100}{n} \right|}{200\left(1 - \frac{1}{n}\right)} \quad (1)$$

where *DISP* denotes the dispersion of sales, production and purchasing; G_i is the share of a given geographic area i and n is the number of geographic areas (in our case, $n = 8$). The dispersion measure ranges between 0 (complete concentration in one region) and 1 (an even spread across all regions).

Measures of logistics outsourcing were collected following Solakivi *et al.* (2018). Respondents were asked to what extent

their firm currently outsourced various logistics activities using a five-point Likert scale (1 = 0%, 2 = 1%–25%, 3 = 26%–50%, 4 = 51%–75%, 5 = 76%–100%). The logistics functions were categorized into four groups: OUTS1 = Domestic and international transportation, OUTS2 = Warehousing and inventory management, OUTS3 = Freight forwarding, order processing, invoicing, logistics IT-systems, and OUTS4 = Reverse logistics, value added services.

Our measures also include two control variables: firm size and industry, as they may be significant contingencies that impact firm resilience (Parast, 2022). Size is divided into ten groups based on reported annual turnover, while industry is coded as dummy variables for five sectors: electronics and machinery, consumer goods, process industry, metal industry and other. These control variables account for potential differences in the effects of our main constructs across various company sizes and industries. As exemplified by Lorentz *et al.* (2016), the covered industries represent different tiers within the manufacturing sector's SC, which helps to account for possibly differing influences of the COVID-19 pandemic.

Finally, the 22 individual measured variables were combined into composite variables representing the average scores of the respective items. For instance, the measured variables SALES_DISP, PRO_DISP and PURC_DISP for geographic dispersion were assessed for their unidimensionality with confirmatory factor analysis (CFA) and included in the resulting composite DISP. These measures were also applied to the variables supply chain responsiveness (SCR), firm resilience (RES), COVID-19 impact (COVIMP) and logistics outsourcing (OUTS). As described by Hair *et al.* (2010), using summated scales like this is useful for capturing the multiple aspects of a concept while providing generalizability and transferability of the measures across studies.

3.3 Model

To test our hypotheses, we used regression analysis using the following formulations. Equation (2) represents a linear regression model that includes only direct relationships between the variables. Equation (3) is a moderated linear regression model that allowed us to test for the proposed moderating effect. We also applied a heteroscedasticity-consistent standard error estimator (i.e. HC3) to estimate the standard errors of regression coefficients correcting for possible heteroscedasticity (see Long and Ervin, 2000).

To test *H1–H3*, we set up the following formulations:

$$Y = \beta_0 + \beta_1 Size + \sum_{i=1}^{4} \gamma_i Ind_i + \beta_2 X + \epsilon \quad (2)$$

where $Y = \{SCR, RES, COVIMP\}$ is the dependent variable, β_0 is the intercept, coefficient β_1 and β_2 indicate the influence of *Size* and variable $X = \{DISP, SCR, RSE\}$, respectively. Ind_i is a dummy variable for the industry i and γ_i is its coefficient. Here, we compared companies in electronics and machinery, consumer goods, process industry and metal industry against the reference category consisting of companies in other industries. The latter industry dummy was excluded from the analysis to avoid possible multicollinearity issues among the predictor variables. Finally, ε denotes the error term.

For *H4*, we set up the following formulation that includes the interaction term as follows:

$$RES = \beta_0 + \beta_1 Size + \sum_{i=1}^{4} \gamma_i Ind_i + \beta_2 SCR + \beta_3 OUTS + \beta_4 SCR * OUTS + \epsilon \quad (3)$$

where *RES* is the dependent variable, β_0 is the intercept and coefficient β_1 indicates the influence of *Size*. Ind_i is a dummy variable for the industry i and γ_i is its coefficient. Again, companies in other industries comprised the reference category for the industry covariate. Coefficients β_3 and β_4 denote the effects of variables OUTS and SCR, respectively, whereas β_4 is the coefficient for interaction term between OUTS and SCR, used to draw conclusions about the moderation. Finally, ε denotes the error term.

4. Results

Table 1 presents the research variables and constructs used in our study. To assess the validity and reliability of the measurement scales, we conducted CFA.

The variables SCR5, COVIMP3, COVIMP4 and COVIMP6 were dropped from subsequent analyses due to insufficient factor loadings. OUTS2 and OUTS4 exhibited high error covariance whereupon the former was dropped following Rintala *et al.* (2021). We then assessed the fit of the factor model in terms of the frequently recommended indices: the comparative fit index (CFI), Tucker–Lewis index (TLI), chi-square value (χ^2) and root mean square error of approximation (RMSEA), and cut-off criteria of 0.95, 0.95, $p < 0.05$ and 0.06, respectively (Jackson *et al.*, 2009). The goodness-of-fit indices suggest that our model fits the data well (CFI = 0.988, TLI = 0.985, $\chi^2 = 130.195$ with $p > 0.05$ and 109 degrees of freedom, RMSEA = 0.026). All factor loadings are statistically significant at the $p < 0.05$ level and range between 0.53 and 0.88.

Convergent validity, reliability and internal consistency were assessed by examining average variance extracted (AVE), composite reliability (CR, or Cronbach's α) and heterotrait-monotrait (HTMT) values. Apart from the SCR construct, all other variables exceed the common thresholds (AVE > 0.50; CR > 0.70). However, we are liberal in concluding the convergent validity of the above-mentioned construct adequate given its CR exceeds a lower threshold of 0.60, often deemed satisfactory in research (Taber, 2018; see Fornell and Larcker, 1981).

Table 2 depicts statistics about our main constructs and the control variable size. The statistics include means, standard deviations, below diagonal inter-construct correlations and above diagonal HTMT ratio of correlations. The HTMT criterion is used to assess discriminant validity, and a value under 0.85 signifies sufficient discriminant validity between the two constructs (Henseler *et al.*, 2015). In our study, all construct pairs meet this criterion, indicating good discriminant validity.

In terms of correlations, control variable size was observed to have a significant positive correlation with all constructs, particularly strong with geographic dispersion and outsourcing. This suggests that larger companies tend to outsource more and are more geographic dispersed. We also found a positive correlation between resilience and responsiveness. Furthermore,

Table 1 The research variables and constructs

Research construct or item	Description and references	AVE/CR loading
Geographic dispersion	*Please estimate how your company's sales, production capacity and direct purchases were distributed geographically in 2019*. (Stock *et al.*, 2000; Lorentz *et al.*, 2012)	0.62/.83
SALES_DISP	Estimates between 0 and 100% in the following geographical areas: Finland, other EU (including the UK,	0.88
PRO_DISP	Norway, Switzerland and Iceland), Europe outside EU, North America, South America, Middle East and	0.70
PURC_DISP	Africa, Asia, other	0.78
Supply chain responsiveness	*Please assess the following strategic priorities for your supply chain for your main product group*. (Wagner *et al.*, 2012)	0.32/0.65
SCR1	Improving security of supply	0.55
SCR2	Maintaining a safety stock of work in progress or finished goods	0.57
SCR3	Provisioning of excess production capacity	0.61
SCR4	Rapid response to uncertain demand	0.53
SCR5	More frequent launches of new products	–
Firm resilience	*Evaluate your company's business during the COVID-19 pandemic.* (Ambulkar *et al.*, 2015)	0.64/0.88
RESI1	We have been able to maintain performance despite the COVID-19 pandemic	0.74
RESI2	We have been able to easily adapt to the COVID-19 pandemic	0.79
RESI3	We have been able to respond quickly to the disruption caused by the COVID-19 pandemic	0.86
RESI4	We have been able to continuously maintain a good situational awareness	0.81
COVID-19 impact	*Please assess the impact of the COVID-19 pandemic on your company's business.* (Ambulkar *et al.*, 2015; Baghersad and Zobel, 2021)	0.55/0.79
COVIMP1	Turnover	0.82
COVIMP2	Overall efficiency	0.72
COVIMP3	Order delivery time	–
COVIMP4	Procurement costs	–
COVIMP5	Number of employees	0.68
COVIMP6	Employee well-being	–
Logistics outsourcing	*Please estimate what percentage of the following logistics activities of your company are currently handled by an external service provider.* (Solakivi *et al.*, 2018)	0.61/0.82
OUTS1	Domestic and international transportation	0.75
OUTS2	Warehousing and inventory management	–
OUTS3	Freight forwarding, order processing, invoicing, logistics IT-systems	0.74
OUTS4	Reverse logistics, value added services	0.85
Firm size (control)	*Please choose the turnover of your company (M EUR).* 1 = 0–2; 2 = 2,1–5; 3 = 5,1–10; 4 = 10,1–25; 5 = 25,1–50; 6 = 50,1–100; 7 = 100,1–500; 8 = 500, 1–1,000; 9 = 1,000, 1–5,000; 10 ≥ 5,000	
Industry (control)	*Please choose the industry of your company.* The 2-digit level manufacturing industry group based on the Standard Industrial Classification TOL 2008	

Source: Authors' own work

Table 2 Key statistics of constructs and control variable

	M	SD	1	2	3	4	5	6
1. Geographic dispersion	0.120	0.133	1	0.146	0.043	0.007	0.351	
2. SC responsiveness	3.175	0.679	0.112*	1	0.295	0.079	0.088	
3. Firm resilience	4.023	0.902	0.038	0.225***	1	0.548	0.114	
4. COVID-19 impact	2.624	0.744	0.008	0.058	0.449***	1	−0.012	
5. Logistics outsourcing	2.774	1.070	0.292***	0.065	0.098*	−0.007	1	
6. Size	2.840	2.349	0.559***	0.127**	0.247***	0.127**	0.453***	1

Notes: $^{*}p < 0.1$; $^{**}p < 0.05$; $^{***}p < 0.01$. Interconstruct correlations below the diagonal, HTMT ratios above the diagonal
Source: Authors' own work

both resilience and outsourcing correlate positively with the impact of the COVID-19 pandemic.

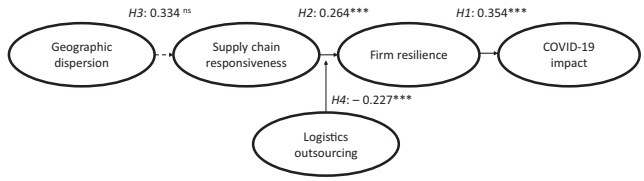
Table 3 presents the findings of our regression analysis, which aimed to test the research hypotheses. Our first hypothesis (*H1*), which proposed a positive relationship between firm resilience and the impact of the COVID-19 pandemic, was supported. We also found support for our second hypothesis (*H2*), indicating a positive relationship between SC responsiveness and resilience. However, we did not find evidence to support our hypothesis (*H3*) that geographic dispersion is negatively related to SC responsiveness. Overall, there was no significant relationship between these two variables.

Interestingly, we observed that the more a company outsources its logistics functions, the weaker the positive link between SCR and firm resilience (*H4*). In other words, outsourcing logistics functions may have a negative moderating effect on the relationship between SCR and resilience. More detailed simple slopes analyses revealed that the effect of SCR on RESI was positive and statistically significant at the −1 SD and mean values of logistics outsourcing (B = 0.479, $p < 0.01$; B = 0.236, $p < 0.01$, respectively) and non-significant at the +1 SD level of the conditioning value (B = −0.007, $p > 0.1$).

The results are illustrated in Figure 2.

Overall, these findings suggest that companies can enhance their resilience in response to low-frequency, high impact SC disruptions, such as COVID-19, by improving their SC responsiveness and carefully assessing their level of outsourcing. From the correlation analysis, we can further conclude that geographic dispersion and the level outsourcing tend to increase with the company size. Interestingly, size appears to have the least impact on responsiveness and the COVID-19 effect, despite larger firms reporting higher scores for COVID-19 impact.

Figure 2 Research model and results



Source: Authors' own work

5. Discussion and conclusions

5.1 Theoretical implications

The empirical findings of this study shed light on how resilient firms managed to address the challenges arising from low-frequency, high-impact SC disruptions like the COVID-19 pandemic. Furthermore, the study explored the significance of SCR as a predictor and logistics outsourcing as a moderating factor in enhancing resilience amidst supply chain disruptions. Our analysis included firms from the electronics and machinery, consumer goods, process industry and metal industries, two of which were among the most affected industries during the COVID-19 pandemic, according to Finland's national statistical institute (Statistics Finland, 2021).

H1, which proposed that firm resilience is related to the impact of the COVID-19 pandemic, was supported. Thus, there is strong evidence that resilience correlates with improved performance during disruptions. It is important to note that our sample consisted of companies of various sizes, with the majority being relatively small. The results thus support the resilience–performance linkage in the SME population, not just among larger companied typically studied.

Table 3 Results of regression analyses

Dependent variables		SC responsiveness B[1](SE/t)	Firm resilience B (SE/t)	COVID-19 impact B (SE/t)	Resilience (moderation) B (SE/t)
	Constant	3.009*** (0.104 / 28.810)	2.984*** (0.332 / 8.987)	1.292*** (0.229 / 5.636)	1.127 (0.778 / 1.448)
Control variables[2]	Firm size	0.030 (0.026 / 1.155)	0.085*** (0.018 / 4.671)	−0.004 (0.018 / −0.206)	0.089*** (0.022 / 4.125)
	Electronics and machinery	−0.006 (0.142 / −0.042)	−0.207 (0.181 / −1.146)	−0.299** (0.133 / −2.247)	−0.227 (0.177 / −1.279)
	Consumer goods	0.026 (0.141 / 0.187)	0.122 (0.173 / 0.705)	−0.053 (0.128 / −0.411)	0.118 (0.174 / 0.679)
	Process industry	0.009 (0.120 / 0.074)	−0.024 (0.159 / −0.150)	0.224 (0.133 / 1.685)	−0.028 (0.157 / −1.778)
	Metal industry	0.155 (0.125 / 1.236)	−0.086 (0.156 / −0.548)	−0.329*** (0.112 / −2.947)	−0.086 (0.153 / −0.559)
Main variables	Geographic dispersion	0.334 (0.386 / 0.865)			
	SC responsiveness		0.264*** (0.089 / 2.976)		0.866*** (0.226 / 3.828)
	Firm resilience			0.354*** (0.053 / 6.674)	
Interaction	Logistics outsourcing				0.703*** (0.262 / 2.683)
	SC responsiveness × logistics outsourcing				−0.227*** (0.076 / −3.007)
	Adj. R^2	0.006	0.093	0.267	0.126[3]
	F	1.281	5.843***	18.283***	6.304***
	df	6	6	6	8 (df1); 277 (df2)

Notes: [1]Unstandardized coefficient; [2]Industry dummy variables, industry labelled "other" is the reference category; [3]Test of highest order unconditional interaction: R^2-change = 0.0391; $F(1, 277) = 9.043^{***}$; $^{*}p < 0.1$; $^{**}p < 0.05$; $^{***}p < 0.01$

Source: Authors' own work

For many years, globalization and decreasing uncertainty were trends; firms sought economies of scale and inventory reductions (Christopher and Holweg, 2011) to achieve more efficient SC. However, it has been stated that firms focused on resilience should seek responsiveness (e.g. Pujawan and Bah, 2022; Delbufalo, 2022) and incorporate and optimize efficiency and responsiveness simultaneously (Fadaki *et al.*, 2020). Our findings support the argument that SC responsiveness is positively related to firm resilience. This highlights the necessity for firms to consistently adapt their resources and capabilities to match the evolving business environment (Brusset and Teller, 2017; Pereira *et al.*, 2020; El Baz and Ruel, 2021). This is important as responsiveness can be costly, and building more responsive SCs could potentially increase costs even further, if not managed cleverly.

Although the results indicate a positive relationship between SC responsiveness and firm resilience, the level of logistics outsourcing was found to negatively moderate this relationship, as hypothesised in *H4*. Specifically, as the level of logistics outsourcing increases, the positive link between SCR and firm resilience becomes weaker. This suggests that outsourcing logistics functions may have, at least beyond a certain level, a negative impact on the relationship between SC responsiveness and firm resilience. This might appear counterintuitive, as outsourcing is traditionally argued for efficiency and flexibility. However, it is possible that outsourcing logistics functions reduces a firm's control and visibility over its SC (see, e.g. König and Spinler, 2016), making it more difficult to swiftly adapt to changes in demand or disruptions. Furthermore, outsourcing contracts might be long-term without built-in flexibility for low-frequency major disruptions.

Following Delbufalo's (2022) suggestion that suppliers' geographic dispersion has a detrimental effect on both SC agility and resilience, we expected that geographic dispersion is negatively related to SC responsiveness (*H3*). We did not find evidence supporting this hypothesis. Geographic dispersion is positively related to level of outsourcing, which could indicate that its effect on responsiveness and resilience is complex. In addition to redundancy, Sodhi *et al.* (2021) suggest multi-sourcing and flexible manufacturing as strategies to overcome SC disruptions on future pandemics.

In the wake of recent global events – such as the COVID-19 pandemic, trade wars, conflicts in Ukraine and Gaza, and tensions in the Red Sea – scholars and managers have increasingly focused on SC structure and geographical dispersion from a risk mitigation perspective (Gurbuz *et al.*, 2023). Contrary to our initial expectation, it might be that firms with global sales, manufacturing, and suppliers do not treat their SC as a single entity, as those less dispersed might. It could be that the SCs of many (or some) companies may be regional, e.g. in Europe, Asia or the Americas, which work independently during a disruption and face problems at different times and magnitudes. When one region was having problems, another one worked well and could compensate. A dispersed supply base has proved advantageous even during global disruptions like the COVID-19 pandemic, as disruptions did not occur simultaneously across all regions (Gurbuz *et al.*, 2023). This finding could challenge the prevailing notion that strategies, such as backshoring and reducing globalization, should be considered key risk-reducing measures. Costa *et al.* (2020) in their study of the dairy industry and (Sabouhi *et al.*, 2021) in their study of the petrochemical industry also found that high geographic dispersion enhances flexibility. When multiple plants are spread across different locations, resource flexibility allows operations to be shifted between plants if disruptions occur at one or more sites. Hu *et al.* (2020) suggest that increased geographic dispersion may prompt firms to invest more in backup suppliers or maintain excess inventories as a risk management strategy.

However, it should be noted that establishing multiple facilities or maintaining a geographically dispersed supply base may incur additional costs. For example, Choi *et al.* (2023) highlight that geographically dispersed SC necessitate extra pipeline inventory due to the need for shipping products and components globally. In addition, outsourcing all production to a single location, such as China or India, does not inherently promote geographic dispersion. For example, van Hoek and Dobrzykowski (2021) noticed that companies were moving sourcing from China because of the pandemic and other supply disruptions, but they relocated to other equally distant locations. Therefore, reshoring production does not inherently alter the degree of geographic dispersion. However, relocating production closer to home may facilitate improved coordination.

5.2 Managerial implications

As a managerial contribution, we identified a correlation between responsiveness and resilience. Improving the responsiveness of SC to enhance resilience is likely to incur increased costs, particularly in the short term (e.g. Choi *et al.*, 2023). However, the benefits become evident during turbulent times. Top-level managers, especially the Board of Directors, need to understand this trade-off, which may lead to misaligned incentives: while building more responsive and resilient SC during "business-as-usual" times may be costly, the full benefits are realized during rare occurrences of high-impact disruptions. Such disruptions might not occur during the tenure of an average manager.

Importantly, we have found evidence that while outsourcing might result in measurable cost and efficiency gains (e.g. Yuan *et al.*, 2020), it may have negative effects during turbulent times. Overall, the negative moderating effect of logistics outsourcing on the relationship between SC responsiveness and firm resilience suggests that companies need to carefully weigh the potential risks and benefits of outsourcing logistics functions. While outsourcing can offer benefits such as cost savings and flexibility in a normal market situation, it can also compromise the ability to respond quickly and recover from disruptions if the adjustment requires external coordination and adjustment of service providers (Premkumar *et al.*, 2021; Song *et al.*, 2022).

Even if the availability of capacity (such as manufacturing, transportation, or warehousing capacity) were guaranteed through binding contracts, adjusting during a disruption would likely be less efficient than if the capacity were under the firm's own direct control. As previously suggested by Premkumar *et al.* (2021), in the event of a SC disruption, additional internal and external coordination is required for an appropriate response. The wider the extent of logistics outsourcing, the higher the need for external coordination. Our results align with

the suggestions of Herold *et al.* (2021) and Jabbarzadeh *et al.* (2018), indicating that the complexity in external coordination does indeed have a negative impact on resilience during times of crisis. Firms should weigh the potential risks and benefits of outsourcing and take steps to mitigate any negative effects. Statsenko *et al.* (2023) emphasize the long-term impacts of procurement decisions, and this applies to logistics outsourcing as well. If outsourcing contracts with LSPs focus too much on efficiency, flexibility may be overlooked. One solution would be to negotiate outsourcing contracts that allow the flexibility and capacity needed in the case of low-frequency, high impact SC disruptions.

Furthermore, geographic dispersion is not clearly good or bad in terms of resilience but requires careful consideration. Our results, along with existing theoretical discussions (e.g. Delbufalo, 2022, Gurbuz *et al.*, 2023), are mixed on this issue. While a dispersed SC can offer greater redundancy and flexibility (e.g. Holgado and Niess, 2023), it can also be more difficult to coordinate and manage. In some cases, dispersed SC may resemble a collection of regional SC experiencing issues at different times and with varying severity. Managers should be cautious of the interconnected negative effects of outsourcing and geographic dispersion, the impact mechanisms of which remain unknown.

5.3 Limitations and future research

The limited geographic coverage of the sample may restrict the generalizability of the findings. Thus, future studies would benefit from expanding the scope to include broader geographical samples. An opportunity for further research lies in investigating whether firms have altered their SC configuration in response to the COVID-19 pandemic. Although we did not examine the cost effects of building and maintaining resilience, further analysis in this area might reveal virtuous or vicious cycles between resilience, performance, and costs. In addition, the interaction between geographic dispersion and outsourcing warrants further analysis from various types of logistics service providers. Furthermore, future research could benefit from investigating the specific conditions under which outsourcing logistics to an LSP proves advantageous. For instance, if the buying firm lacks the necessary skills and capabilities, outsourcing logistics to a third-party logistics provider may enhance its responsiveness to SC disruptions. Finally, the inconclusive results regarding geographic dispersion and resilience highlight the need for further analysis, including consideration of different dimensions such as sourcing, manufacturing, and sales, as well as the impacts of multi-sourcing.

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