Sustainable supply chain management – a key to resilience in the global pandemic

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Abstract

Purpose – The purpose of this paper is to investigate the potential synergy between companies' sustainable supply chain management (SSCM) activities and their supply chain resilience (SCRES). The authors propose hypotheses about the impact of buying companies SSCM activities on the inflicted damage by unexpected supply chain disruptions and the recovery time afterwards and test these empirically using data from companies during the global COVID-19 pandemic.

Design/methodology/approach – The authors investigate a sample of 231 of the largest publicly traded companies in the European Union with 4.158 firm-year observations. For the analysis, the authors generate variables capturing the companies' intensity and years of experience of their SSCM activities targeted at the supply chain and run regression analyses on the inflicted damage due to the COVID-19 pandemic and the recovery time after the disruption.

Findings – Buying companies' SSCM activities have a positive effect on their SCRES. The damage inflicted by unexpected supply chain disruptions is lower when companies have higher levels of SSCM and longer experience with it. The recovery time afterwards is significantly reduced by longer experience with SSCM efforts.

Research limitations/implications – The authors suggest SCRES is reinforced by transparency, situational awareness, social capital and collaboration resulting from companies SSCM activities translate into increased SCRES.

Practical implications – The authors show that companies with superior SSCM are more resilient in a crisis and conclude that, therefore, companies should invest in SSCM to prevent future supply disruptions.

Originality/value – To the best of the authors' knowledge, this is the first empirical study analyzing a data set of multi-industry companies, linking their SSCM activities to SCRES during the pandemic.

Keywords Supply chain, Resilience, Sustainable management, Disruptions, COVID-19, Recovery time, Damage control, Environmental management, Sustainability

Paper type Research paper

1. Introduction

Since the COVID-19 outbreak in early 2020, the resulting pandemic challenged global supply chain ecosystems at an unprecedented scale (Ivanov, 2021). The pandemic forced countless companies to temporarily close or curtail operations (Simon, 2021) and the transportation of goods was disrupted by labor shortages, interrupted transportation and border closures (Amankwah-Amoah, 2020; Gray, 2020; Herold *et al.*, 2021; Ivanov and Dolgui, 2020; Nagurney, 2021). Such interruptions do not only inflict operational harm on the companies themselves but also result in disruptions in the extended supply network leading to downscaling in demand fulfilling through so-called ripple effects (Dolgui *et al.*, 2020; Ivanov and Dolgui, 2021b). The pandemic-ascribed disruptions affected 94% of the Fortune 1000 companies (Fortune, 2020) and, at the time this manuscript was crafted, material shortages, empty shelves and month-delays in shipments persist (Karp, 2021).

However, anecdotal evidence suggests that not all firms were equally affected by pandemic-induced supply disruptions. Schneider Electric, for example, continued to grow and more so than competitors as exemplified by its 2020 EBITDA (Bloomberg, 2021). While it is not exactly clear what Schneider did differently but given that it heavily relies on its supply chain for value creation, at least part of the continued success can probably be ascribed to the company's superior supply chain strategy which places sustainability, fair supply chain relationships and open collaboration at the heart (Botwright and Bezamat, 2022; Schneider Electric, 2021a). According to Schneider Electric's CEO, the companies' resilience to the crisis was made possible because the company entertains specifically close relationships with key suppliers which collaborated to quickly find solutions to unexpected situations (Schneider Electric, 2021b). Other companies also seem to consider that sustainability may make their companies less vulnerable to disruption. In a recent practitioner survey on supply chain resilience (SCRES), 32% of respondents said they are

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increasing environmental, social and governance due diligence with suppliers to mitigate the risk of supply chain disruptions (Dib, 2020).

Scholars also assert that sustainable supply chain management (SSCM) and resilience might be mutually reinforcing for the benefit for organizations but acknowledge that knowledge about the relationship between the two is still scant (Negri *et al.*, 2021). SSCM aims to improve environmental and social conditions within the supply chain while ensuring sustainable economic viability (Carter and Rogers, 2008; Ortas *et al.*, 2014). SSCM activities include long-term trust-building collaboration with suppliers, providing trainings as well as investments, and reducing the information asymmetry (Belhadi *et al.*, 2021; Gimenez and Tachizawa, 2012; Tachizawa and Wong, 2014). This may create a more communal environment and a supply chain in which the actors rely on each other more, work closer together and share more and more current information. These circumstances in supply chains were seen as enablers of resilient supply chains both before (Ali *et al.*, 2017; Han *et al.*, 2020; Karl *et al.*, 2018; Pereira *et al.*, 2014) and after the outbreak of the pandemic (Ali *et al.*, 2021; Hobbs, 2020; Ibn-Mohammed *et al.*, 2021; Ivanov and Dolgui, 2021a, 2021b; Sharma *et al.*, 2020a, 2020b).

Considering the overlaps between the two concepts, it is surprising that the two research streams have developed separately for the most part (Fahimnia *et al.*, 2019; Negri *et al.*, 2021; Swanson *et al.*, 2018), and since the outbreak of the pandemic, there have been calls to investigate whether SSCM had an impact on organizational resilience to disruption (Chowdhury *et al.*, 2021; Su *et al.*, 2021). The objective of this study is to set the assumption that companies with more SSCM proved to be more resilient to unforeseen disruptions and negative consequences during the global pandemic on empirical grounds. In so doing, this study concurrently studies SSCM and SCRES by investigating how much damage is inflicted by the disruption on companies with higher versus lower levels of SSCM and how quickly companies recover afterwards from those disruptions. In so doing, we contribute to the emergent stream of research on the global pandemic and supply chains (Chowdhury *et al.*, 2021). The few studies that exist until today impressively illustrate how the pandemic has aggravated global problems of human rights infringements, pollution or modern slavery (Christ and Burritt, 2021; Sharma *et al.*, 2020a, 2020b; van Barneveld *et al.*, 2020) but they fall short in pointing out the benefits of sustainability. Herein, we take a different stance and try to show that sustainability-oriented supply chain strategies that existed prior to the breakout of the pandemic have made companies less vulnerable.

To assess this assumption, we collect longitudinal data from a sample of 231 of the largest publicly traded companies in the European Union (EU) with 4.158 firm-year observations. We measure companies' tenure and intensity of experience in SSCM and regress these variables on the degree and duration of economic damage during the COVID-19 pandemic. We find that companies with higher levels of SSCM suffered less and shorter from economic loss and, thereby, prove to be more resilient to the negative effects of the pandemic. This finding adds to the nascent body pandemic and supply chain-related research by showing that firms which foster sustainability fare better in the global crisis. We discuss important managerial and academic implications of these findings and contribute to the ongoing public discussion about the impact of corporate sustainability on economic value creation (Rätzel, 2020). Lastly, our study emphasizes the important role that may be played by secondary data which allow us to assess how certain pre-crisis strategies fold out during an unexpected event of global reach. In such a unique setting, it is rare to have primary, e.g. survey, data readily at hand and secondary data may assist in overcoming this problem.

2. Literature review

2.1 Supply chain disruption and resilience

2.1.1 Conceptual foundations

Due to their scale and international reach, today's supply chains are exposed to great risks of being disrupted (Finch, 2004; Tummala and Schoenherr, 2011). Bode and Macdonald (2017, p. 3) defined supply chain disruption as "the combination of an unintended and unexpected triggering event that occurs somewhere in the upstream supply chain (the supply network), the inbound logistics network, or the purchasing (sourcing) environment, and a consequential situation, which presents a serious threat to the normal course of business operations of the focal firm." Such disruptions can emerge from natural disasters (Scholten *et al.*, 2014), financial crises (Jüttner and Maklan, 2011), cyber risks (Khan and Estay, 2015) or terrorist attacks (Caniato and Rice, 2003; Sheffi, 2001) to a global epidemic outbreak (Golan *et al.*, 2020).

Disruptive events often have severe impacts on organizations and their supply chains. According to the McKinsey Global Institute (2020), a 100-day supply chain disruption could cost companies an average of half their annual earnings or more. In the longer run, companies affected by supply chain disruption suffer a nearly 40% decline in share price compared to industry peers over a three-year period (Hendricks and Singhal, 2005). Therefore, it is increasingly important for companies to create resilient supply chains, as not all risks can be avoided (Hohenstein *et al.*, 2015).

The resilience denotes how well the focal organization and its supply chain are able to weather a disruptive event or crisis (Blackhurst *et al.*, 2011; Caniato and Rice, 2003; Christopher and Peck, 2004; Klibi *et al.*, 2010; Peck, 2006; Pettit *et al.*, 2010; Ponis and Koronis, 2012; Sheffi and Rice, 2005). SCRES has been defined as "The adaptive capability of the supply chain to prepare for unexpected events, respond to disruptions, and recover from them by maintaining continuity of operations at the desired level of connectedness and control over structure and function" (Ponomarov and Holcomb, 2009, p. 131). SCRES is usually parsed into three dimensions and each dimension builds on distinct supporting capabilities (Ali *et al.*, 2017; Jüttner and Maklan, 2011; Kochan and Nowicki, 2018; Ruiz-Martin *et al.*, 2018): the *readiness* for an unexpected event or crisis, the *response* to it and the *recovery* from it (Manning and Soon, 2016; Ponis and Koronis, 2012;

Ponomarov and Holcomb, 2009; Tukamuhabwa *et al.*, 2015). The different capabilities assigned to the respective dimensions varied over the years (Brusset and Teller, 2017; Chowdhury and Quaddus, 2017; Johnson *et al.*, 2013; Jüttner and Maklan, 2011; Pettit *et al.*, 2010; Ponis and Koronis, 2012; Rajesh and Ravi, 2015; Ruiz-Martin *et al.*, 2018), but were eventually compiled in the systematic literature review by Han *et al.* (2020), who identified eleven capabilities assigned to the three SCRES dimensions.

The dimension readiness captures the preparedness of an organization to detect and minimize the disruption to the supply chain by an unexpected event (Ponomarov and Holcomb, 2009). The four capabilities assigned to readiness are situation awareness, visibility, security and redundancy (Ali *et al.*, 2017; Christopher and Peck, 2004; Colicchia *et al.*, 2019; Dubey *et al.*, 2019; Han *et al.*, 2020; Ivanov and Dolgui, 2020; Kumar and Anbanandam, 2019; López and Ishizaka, 2019; Voss and Williams, 2013; Yu *et al.*, 2019). SCRES readiness is measured by how successfully an unexpected supply chain disruption is anticipated and therefore the inflicted damage mitigated (Chang and Lin, 2019; Hohenstein *et al.*, 2015; Ponomarov and Holcomb, 2009).

After the triggering event occurred and crisis has begun, the dimension of response outlines the management of the disruption to the supply chain (Ali and Gölgeci, 2019; Hohenstein *et al.*, 2015). Decisive for the dimension of response are the capabilities agility, flexibility, leadership and collaboration (Abeysekara *et al.*, 2019; Adobor and McMullen, 2018; Gunessee *et al.*, 2018; Han *et al.*, 2020; Jüttner and Maklan, 2011; Manning and Soon, 2016; Scholten and Schilder, 2015; Sheffi, 2001; Skipper and Hanna, 2009). This dimension is measured by the pace at which an organization responds to the disruptive event (Chang and Lin, 2019; Chowdhury and Quaddus, 2017; Han *et al.*, 2020).

The dimension recovery refers to the aftermath of a supply chain disruption and the restoration and return to normal operations (Ponomarov and Holcomb, 2009). It may even involve the creation of a strategic advantage, through better recovery compared to competitors (Brusset and Teller, 2017; Christopher and Peck, 2004). The critical capabilities for this dimension are knowledge management, contingency planning and the companies' market position (Birkie *et al.*, 2017; Han *et al.*, 2020; Jüttner and Maklan, 2011; Scholten and Schilder, 2015; Tukamuhabwa *et al.*, 2017; Zsidisin and Wagner, 2010). The recovery dimension is measured by how long it takes for an organization to recover and return to its normal operations after the disruptive event (Chang and Lin, 2019; Hohenstein *et al.*, 2015; Raj *et al.*, 2015; Tan *et al.*, 2020).

Of the three SCRES dimensions, the response dimension centers on how quickly and effective an organization reacts to a supply chain disruption (Han *et al.*, 2020; Hohenstein *et al.*, 2015; Pettit *et al.*, 2013). However, the COVID-19 pandemic is not a singular disruption but rather an extensive event that lasted several months. Thus, given the size of our sample and the companies in it, it is not possible to attribute individual responses to distinct supply chain disruptions (e.g. lockdowns at different points in time, in different locations with different reach). Therefore, we focus our work on the dimensions readiness and recovery herein.

In sum, prior research established a quite compelling basis of SCRES. The question is whether and to which extent SCRES has the potential to buffer from negative events. Empirical research on measurable effects of real-life crises is still scarce (Ali and Gölgeci, 2019; Golan *et al.*, 2020; Han *et al.*, 2020). Up until the outbreak of the pandemic, the majority of research publications explored the theory-building conceptual definition of SCRES and the identification of its dimensions and capabilities, also called drivers, enablers, elements and principles (Ali *et al.*, 2017; Han *et al.*, 2020; Karl *et al.*, 2018). Some authors examined real-life supply chain disruption events as a UK rail crash (Johnson *et al.*, 2013) or Hurricane Katrina (Dowty and Wallace, 2010; Scholten and Schilder, 2015).

2.1.2 Global pandemic and resilience

However, the impact of a global pandemic is much more devastating than such singular-event-immediate-impact disruptions, and maintaining SCRES during a pandemic period is considerably more complex (Ivanov, 2021, p. 1). Today's supply chains are so tightly connected that disruption in one function in the supply chain leads to a ripple effect that affects other functions as well (Chowdhury *et al.*, 2021; Ivanov and Dolgui, 2020). Hence, the overall operations can be disrupted if one segment in the supply chain is not functioning properly (Queiroz *et al.*, 2020). This makes the disruptive effects more diverse, longer lasting and need to be responded to while the pandemic is still ongoing.

Since the outbreak of the pandemic, numerous studies have been published on how to mitigate the effects of supply chain disruptions during the pandemic and what restructuring strategies can ensure SCRES in the aftermath of the pandemic (Chowdhury *et al.*, 2021; Paul *et al.*, 2021). These studies highlighted the very capabilities that were previously attributed to the respective SCRES dimensions. Gunessee and Subramanian (2020) and Ivanov and Dolgui (2021a, 2021b) highlighted the importance of visibility and situation awareness; Singh *et al.* (2021) and Xu *et al.* (2020) referred to the capability of redundancy; Sharma *et al.* (2020a, 2020b) emphasize the significance of agility and flexibility; Hobbs (2020) that of collaboration; and Jabbour *et al.* (2020) accentuate knowledge management and contingency planning during and after the COVID-19 pandemic. Yet, there were no empirical studies using comparable real-life company data to examine which supply chain management activities taken *before* the outbreak of the pandemic strengthened companies' SCRES, thus mitigating the disruptive effects of the pandemic. SSCM is a case in point because it may well increase focal firm's awareness about the risks that lie dormant in complex supply chains and strengthen capabilities in cross-organizational collaboration (Klassen and Vachon, 2003). And yet, this fertile ground in which resilience may unfold during the pandemic has not yet been studied as recent literature review shows (Chowdhury *et al.*, 2021).

2.2 Sustainable supply chain management

2.2.1 Conceptual foundations

Multinational companies are under increasing pressure from internal as well as external stakeholders such as customers, employees, unions, shareholders, business partners, governments, NGOs and the media to pay more and more

attention to environmental and social conditions, especially in developing countries (Maloni and Brown, 2006; Miemczyk *et al.*, 2012). Many organizations have responded to the pressures and expectations by developing and implementing systems and procedures that reduce negative impacts on their sphere of influence (Andersen and Skjoett-Larsen, 2009; Whitelock, 2019). The targeted expansion of these efforts to companies' supply chains leads to SSCM (Carter and Rogers, 2008; Ortas *et al.*, 2014; Seuring and Müller, 2008), denoting efforts to improve the environmental and social conditions within their supply chain (Broadstock *et al.*, 2020; Huang, 2021; Rajesh and Rajendran, 2020).

Environmental SSCM activities may include the adoption of environmental standards and directives (e.g. ISO 14001) vis-a-vis suppliers and evaluating suppliers in terms of their environmental performance (Bowen *et al.*, 2001; Pagell and Wu, 2009; Sarkis *et al.*, 2010; Wiengarten *et al.*, 2013). Companies may provide environmental trainings and certificates for suppliers (Simpson *et al.*, 2007; Vachon and Klassen, 2008, 2006), conduct environmental audits (Lee and Klassen, 2008; Rao, 2002; Zhu and Sarkis, 2004) and implement monitoring systems and processes to follow up their suppliers' environmental performance (Reuter *et al.*, 2010; Zhu *et al.*, 2007). Some companies even directly collaborate with their suppliers by jointly redesigning products and processes to reduce consumption of material, minimize waste, promote recycling, avoid hazardous materials and optimize transportation (Bowen *et al.*, 2001; Min and Galle, 2001; Pagell and Wu, 2009; Sarkis *et al.*, 2010; Savaskan *et al.*, 2004; Sharma and Henriques, 2005; Simpson and Power, 2005; Vachon and Klassen, 2008; Waage, 2007; Wu and Dunn, 1995).

Social SSCM activities directed at the supply chain evolve around ensuring the health, safety and well-being of suppliers (Marshall *et al.*, 2015a). Practices vary from providing social trainings to promoting fair wages, health and safety management and measures to combat slavery as well as forced and child labor (Awaysheh and Klassen, 2010; Klassen and Vereecke, 2012; Levi and Linton, 2003; Pfeffer, 2010; Waage, 2007). To this extent, some companies reconceptualize their supply chains and products in collaboration with their suppliers, local communities and third parties like social NGOs (Pagell and Wu, 2009; Sharma and Henriques, 2005; Tate *et al.*, 2010; Waage, 2007). To ensure social supply chain sustainability beyond direct collaboration, new and current suppliers are assessed and certified as requirement for supply contracts, audits are being conducted and monitoring mechanisms are put in place (Awaysheh and Klassen, 2010; Ciliberti *et al.*, 2008; Klassen and Vereecke, 2012; Marshall *et al.*, 2015b).

Governance SSCM activities combine stake- and shareholder-oriented strategies (Xie *et al.*, 2018) and are defined by Wang and Sarkis (2017, p. 1610) as the "control mechanisms that companies voluntarily adopt to integrate social and environmental concerns in their business operations." These mechanisms range from accounting environmental and social impacts to the inclusion of board members who are in charge of considering non-economic impacts of business operations (Darnall *et al.*, 2009; Henri and Journeault, 2010; Lewis *et al.*, 2014; Verheyden *et al.*, 2016; Walls and Hoffman, 2013; Wolf, 2014).

2.2.2 The global pandemic and sustainable supply chain management

In recent literature on pandemic-related supply chain studies, there are two types of studies regarding sustainability in the supply chains (Chowdhury *et al.*, 2021). The first type investigates the current impact on and interplay of economic, social and environmental dimensions in supply chains during the pandemic. Areas considered here are the adoption of social and environmental standards (Sharma *et al.*, 2020a, 2020b), social and health injustice (Ibn-Mohammed *et al.*, 2021), the impact on the labor market (van Barneveld *et al.*, 2020), low-carbon power generation (Hosseini, 2020) and ethical violations (Govindan *et al.*, 2021). The second type addresses how SSCM activities in the post-COVID period can ensure continuity of operations. These include proposals such as the elimination of unauthorized subcontractors (Majumdar *et al.*, 2020), the generation of renewable energy (Chiaramonti and Maniatis, 2020) and the optimization of waste management (Sharma *et al.*, 2020a, 2020b). However, according to recent literature reviews (Chowdhury *et al.*, 2021; Su *et al.*, 2021) and also to the best of our knowledge, we do not yet know if and to what extent SSCM that companies adopted prior to the breakout of COVID-19 made firms more resilient to the negative consequences of the pandemic.

3. Theoretical background and hypotheses development

3.1 Sustainable supply chain management and readiness

Achieving resilience along the supply chain requires both company internal and external efforts (Pereira and Silva, 2015). Although disruptions can occur anywhere in the supply chain, they have been shown to be more critical when they occur external in the upstream value chain (Pournader *et al.*, 2016). As procurement acts as a bridge between internal and external businesses upstream, activities that originate in this area may have a large impact on SCRES (Pereira *et al.*, 2014). SSCM activities may be triggered by the procurement function and directed at the upstream supply chain (Andersen and Skjoett-Larsen, 2009). Therefore, we expect SSCM activities to have a particularly strong impact due to the hinge role of procurement.

SSCM activities not only ensure better environmental, social and governance performance. Through these activities, upstream supply chain partners increasingly understand the supply chain as one entity and recognize their responsibilities toward supply chain partners (Kumar and Rahman, 2016, 2015). Suppliers are better guided to identify and eliminate environmental and social concerns, problems, vulnerabilities and risks (Gouda and Saranga, 2018). These are then remedied either independently or in cooperation with buying companies (Friday *et al.*, 2018). Through this deeper and collaborative view of vulnerabilities throughout the supply chain, buying companies should be better prepared for and able to respond to supply chain disruptions.

Although there is paucity of studies on SSCM and SCRES (Fahimnia *et al.*, 2019; Negri *et al.*, 2021; Swanson *et al.*, 2018),

the few studies that exist recognize the importance of this integration (Rajesh, 2018). Jain *et al.* (2017) identified sustainability in supply chains as an antecedent for SCRES and Bag *et al.* (2019) discovered a positive link between sustainable manufacturing and SCRES. Gölgeci and Kuivalainen (2020) found that social capital building practices within the supply chain led to practices that have been evidenced to increase SCRES and Hamdy *et al.* (2018) asserted that environmental SSCM practices may lead to SCRES practices (without testing this assumption empirically, though).

Two of the most critical capabilities regarding SCRES dimension readiness are visibility and situation awareness (Ali *et al.*, 2017; Dubey *et al.*, 2019; Han *et al.*, 2020; Kumar and Anbanandam, 2019). Situation awareness denotes that in global and dynamic supply chains, it is critical that companies are aware of the dynamics and vulnerabilities of their supply chains to be able to respond accordingly (Ali *et al.*, 2017; Yu *et al.*, 2019). Visibility is being created through information technology and seamless information sharing (Dubey *et al.*, 2019; Kumar and Anbanandam, 2019), which provides the required transparency in the supply chain (Han *et al.*, 2020). It allows supply chain partners to see from one end to the other (Christopher and Peck, 2004) and therefore bolsters readiness (Colicchia *et al.*, 2019). Each of these capabilities involve supply chain information exchange and transparency that are fostered through SSCM.

A major effort of SSCM is to build a stable information infrastructure and network to obtain reliable and up-to-date information from suppliers (Hutchins and Sutherland, 2008; Schaltegger and Burritt, 2014; Sloan, 2010). Although this information exchange was originally designed to monitor suppliers in terms of their social and environmental performance, we ascertain that it will also bring supply chain risks, vulnerabilities and disruptions to the attention of the buyer. With this knowledge, companies can prepare better for unexpected events to take quicker action to respond to disruptions (Cheng *et al.*, 2014a, 2014b; Fahimnia *et al.*, 2019; Jüttner and Maklan, 2011):

H1a. Higher sustainable supply chain management intensity leads to an increased readiness for unexpected supply chain disruptions.

A tighter integration between supply chain partners was found to raise organizational knowledge of external risks (Brusset and Teller, 2017; Zsidisin and Wagner, 2010). We argue that these aspects will also increase over time and with growing experience in SSCM and are thus also reflected in elevated readiness for further unexpected supply chain disruptions. In addition, building a reliable information network to monitor SSCM activities takes time and this network becomes more effective with experience. Hence, we conclude that:

H1b. Longer experience with sustainable supply chain management increases companies' readiness for unexpected supply chain disruptions.

3.1 Sustainable supply chain management and recovery

The elements of SSCM that increase the SCRES dimension of recovery after an unexpected supply chain disruption are manifold. One decisive factor is the creation of social capital, which includes trust, shared values and mutually beneficial relationships (Lee and Ha, 2018; Min *et al.*, 2008). The social aspects of SSCM in particular are aimed at improving working and health conditions in the supply chains and fostering this through trainings, incentives and investments, thus building up social capital in the supply chain (Dubey *et al.*, 2018; Prusak and Cohen, 2001; Yim and Leem, 2013). Johnson *et al.* (2013) and Dubey *et al.* (2019) found that social capital acted as significant facilitator to build responsiveness and the ability of the supply chain to return to its original state after being disturbed. We, therefore, believe that the social capital built through SSCM triggers a synergy effect, which leads to an increase in the SCRES dimension of recovery. Further, when dealing with supply chain disruption, cultural bias (Dowty and Wallace, 2010) and behavioral uncertainty (Dubey *et al.*, 2019) are a hindrance for quick and effective responses. SSCM activities can reduce cultural bias (Zhao *et al.*, 2007) and behavioral uncertainty (Belhadi *et al.*, 2021), which we believe is consequently reflected in a shorter recovery time after the unexpected supply chain disruption.

Another critical pillar on which the recovery dimension of companies' SCRES stands is collaboration (Brusset and Teller, 2017; Han *et al.*, 2020; Jüttner and Maklan, 2011). Collaboration includes decision synchronization, incentive alignment, resource and information sharing and goal congruence (Cao *et al.*, 2010). Wu *et al.* (2013) found that collaboration can help buying companies to be supplied with higher priority after a disruption, which provides an increase in the recovery dimension. The relevance of collaboration has also become prevalent in relation to SSCM, and in this context in particular includes direct engagement with suppliers, including trainings, support and development (Gimenez and Tachizawa, 2012). It has been recognized as an inevitable element of SSCM (Delbufalo and Bastl, 2018; Gimenez and Tachizawa, 2012; Vachon and Klassen, 2008; Whitelock, 2019), therefore an increase in SSCM activities also entails an increase in collaboration between buying companies and suppliers. Accordingly, as SSCM leads to an increase in collaboration, we believe that it simultaneously has a positive impact on the SCRES dimension of recovery. Based on these observations we conclude:

H2a. A higher intensity of companies' sustainable supply chain management leads to a quicker recovery after an unexpected supply chain disruption.

In regard to SCRES, Scholten and Schilder's (2015) findings point exclusively to positive effects through collaborative activities, and the more companies collaborate with each other in joint relationship efforts and mutual knowledge creation, the more resilient the supply chain is. As companies continue to pursue their SSCM efforts over a longer period of time, they also collaborate with more and more companies, which consequently strengthens the SCRES dimension recovery. Furthermore, prior experience with supply chain disruptions can strongly contribute to the organizational learning of companies in regard to building up SCRES (Bode *et al.*, 2011). If companies were able to learn from prior supply chain disruptions or vulnerabilities, based on their earlier collaborative SSCM activities, or if other benefits came to bear,

we believe that these aspects will be further developed in the course of organizational learning, collaboration and over time. What is more, social capital takes time to build up among suppliers (Lee, 2015; Min *et al.*, 2008) and will therefore have a greater impact after a longer period of time. We therefore argue further:

H2b. Longer experience with sustainable supply chain management translates into faster recovery for companies after an unexpected supply chain disruption.

4. Methodology

To empirically test our hypotheses, we sample multi-industry firms that were affected by the COVID-19 pandemic in a similar geographic, social and political setting, i.e. in Europe. To analyze these companies' SCRES dimensions and their SSCM efforts, we collected secondary data from both the Bloomberg Terminal and the Refinitiv database, two of the most well-known market, company, financials and environmental, social, and governance (ESG) databases used for academic research (Cheng *et al.*, 2014a, 2014b; Eggert and Hartmann, 2021; Gong *et al.*, 2019; Hawn and Ioannou, 2016; Ioannou and Serafeim, 2012; Ortas *et al.*, 2014; Rajesh and Rajendran, 2020; Sachin and Rajesh, 2021; Wetzel and Hofmann, 2019).

Refinitiv provides more than 450 different ESG metrics, covering companies that account for more than 70% of global market capitalization (Refinitiv, 2021), and Bloomberg covers the entire financial reporting process for more than 85,000 companies and 99.9% of global equity market capitalization (Bloomberg, 2022).The main sources of information for the Bloomberg and Refinitiv data are real-time market data, company annual reports and corporate social responsibility or sustainability reports, followed by company websites, press releases or other public statements, and media reports. This data is compiled by Bloomberg and Refinitiv analysts and made available as machine-readable quantitative data. Variables were derived from these data for subsequent evaluation through ordinary least squares (OLS) regression.

This study uses this secondary data primarily for two reasons. First, the emergence of the pandemic was unforeseen and, therefore, the number of data collections that were done on organizations at the naissance of the pandemic is scarce. Second, though possible, it is rather cost expensive to collect longitudinal data using survey instruments. Relying on secondary, regularly updated data allows us to examine developments over an extended period of time including what strategies and capabilities organizations developed *before* the pandemic, SSCM in our case and how these impact day-to-day economic developments *after* the start of the pandemic and over time.

Scholars proposed that the SCRES field of research should move beyond qualitative case and survey data analysis (Ali and Gölgeci, 2019; Pereira *et al.*, 2014; Pires Ribeiro and Barbosa-Povoa, 2018), to also include longitudinal, field and secondary data studies (Hohenstein *et al.*, 2015; Kochan and Nowicki, 2018; Tukamuhabwa *et al.*, 2017), involve companies' real-life performance key performance indicators (Ali *et al.*, 2017; Birkie *et al.*, 2017; Kamalahmadi and Parast, 2016; Karl *et al.*, 2018; Yu *et al.*, 2019), and measure the impact of large-scale disruptions and systemic threats such as epidemic outbreaks like the pandemic (Golan *et al.*, 2020; Han *et al.*, 2020). Thus, this study taps the potential of secondary data to answer the calls for rigorous studies using empirical data to demonstrate real-world scenarios of how the pandemic impacts various issues related to supply chains (Chowdhury *et al.*, 2021; Queiroz *et al.*, 2020; van Hoek, 2020). Therefore, our research not only strengthens the theoretical foundation of SCRES research and increases the acceptability and generalizability of the findings and strategies proposed in previous articles (Chowdhury *et al.*, 2021) but also provides important insights for practice and adds new, comparable measurements to the literature for future research and practitioners.

4.1 Sample

To create a sample in which firms are subject to similar conditions and experience the same supply chain disruption at the same time, we chose buying companies in EU member states during the year 2020 and the disruptive impacts of the global pandemic. These companies are geographically clustered together and were subject to the similar work regulations, as well as lockdown and border closure requirements in regard to the pandemic with only a few days difference (Hirsch, 2020). This makes the disruption to the supply chains of these companies comparable. For the selected companies, we chose those listed by Handelsblatt as the 500 largest publicly traded companies in Europe. From this sample, 49 companies were excluded because they do not belong to EU states and, therefore, had different underlying legal and political conditions in countries outside of the EU, such as the UK, Turkey and Switzerland; 220 professional service companies that do not rely extensively on supply chains were also excluded. These covered the industries financials, real estate investments, utilities, media, travel and leisure, as well as software, computer and telecommunication services. Our final sample included 231 companies for which longitudinal data were available.Table 1 below describes the industry affiliation of the sampled companies.

4.2 Measures

Dependent variables: To examine how resilient the supply chains of the companies in our sample are, we chose two dependent variables. First, the extent of the inflicted damage by the supply chain disruption, representing the SCRES dimension *readiness* (Ambulkar *et al.*, 2015; Ivanov, 2018; Munoz and Dunbar, 2015) and second, the duration of time it took the companies to recover from the disruption, which represents the SCRES dimension *recovery* (Christopher and Peck, 2004; Pant *et al.*, 2014; Tan *et al.*, 2020). To operationalize these variables, we follow the example of previous research and used company stock prices to measure the impact of supply chain disruptions on the buying companies (Hendricks *et al.*, 2009; Hendricks and Singhal, 2005, 2003; Jacobs and Singhal, 2017). The research of Hendricks and Singhal (2005, 2003) shows that disruptions in companies' supply chains translate into negative stock market reactions, regardless of which link in the supply chain is

Table 1 Overview of industry affiliations of sampled firms

Sector	No.	(%)	(%) cum
Construction and Materials	25	10.8	10.8
Industrial Metals and Mining	19	8.2	19.0
Automobiles and Parts	18	7.8	26.8
Oil, Gas and Coal	16	6.9	33.8
Chemicals	15	6.5	40.3
Industrial Engineering	15	6.5	46.8
Industrial Transportation	15	6.5	53.2
Personal Care, Drug and Grocery Stores	14	6.1	59.3
Industrial Support Services	12	5.2	64.5
Electronic and Electrical Equipment	10	4.3	68.8
Retailers	9	3.9	72.7
Aerospace and Defense	8	3.5	76.2
Food Producers	7	3.0	79.2
Personal Goods	7	3.0	82.3
Pharmaceuticals and Biotechnology	7	3.0	85.3
Medical Equipment and Services	6	2.6	87.9
Technology Hardware and Equipment	5	2.2	90.0
Beverages	4	1.7	91.8
General Industrials	4	1.7	93.5
Household Goods and Home Construction	4	1.7	95.2
Health Care Providers	3	1.3	96.5
Alternative Energy	2	0.9	97.4
Consumer Services	2	0.9	98.3
Industrial Materials	2	0.9	99.1
Telecommunications Equipment	2	0.9	100.0
Total	*231*	*100*	*100*

responsible for the disruption. As we could not distinguish which interruption at which point led to which effect, this measurement is ideal for the purposes of our analysis. The determination of the two dependent variables is based on prior research by Munoz and Dunbar (2015) and presented graphically in Figure 1.

The variable *extent of the inflicted damage* indicates how severe the damage was due to the disruption of the pandemic in percentage ratio to the annual average value of the company's stock. It is calculated as follows:

$$extent\ of\ the\ inflicted\ damage = \frac{year\ average - year\ low}{year\ average} * 100$$

The variable *recovery time* indicates the number of days it took for the companies to recover from their annual low due to the pandemic enough for their stock to reach the annual average value again:

$$recovery\ time = day\ of\ recovery - day\ of\ year\ low$$

On average, the companies' stock value declined 34.5%. It reached their lowest value on the 1st of April and it took 101 days for them to recover. In 20 cases, companies were not able to recover from the disruption within 2020 at all. In these cases, we chose the end of the fiscal year as the end date for the recovery period and calculated the duration accordingly.

Independent variables: Information on companies' SSCM activities was obtained from the Refinitiv database. Prior research provided evidence that organizations which score higher on Refinitiv's sustainability assessment have more environmental, social and governance measures in place than those firms that do not (Eccles *et al.*, 2014). It has, therefore, become common practice among corporate social responsibility and sustainability researchers to use Refinitiv data when examining corporate SSCM activities (Cheng *et al.*, 2014a, 2014b; Eggert and Hartmann, 2021; Gong *et al.*, 2019; Hawn and Ioannou, 2016; Ortas *et al.*, 2014).

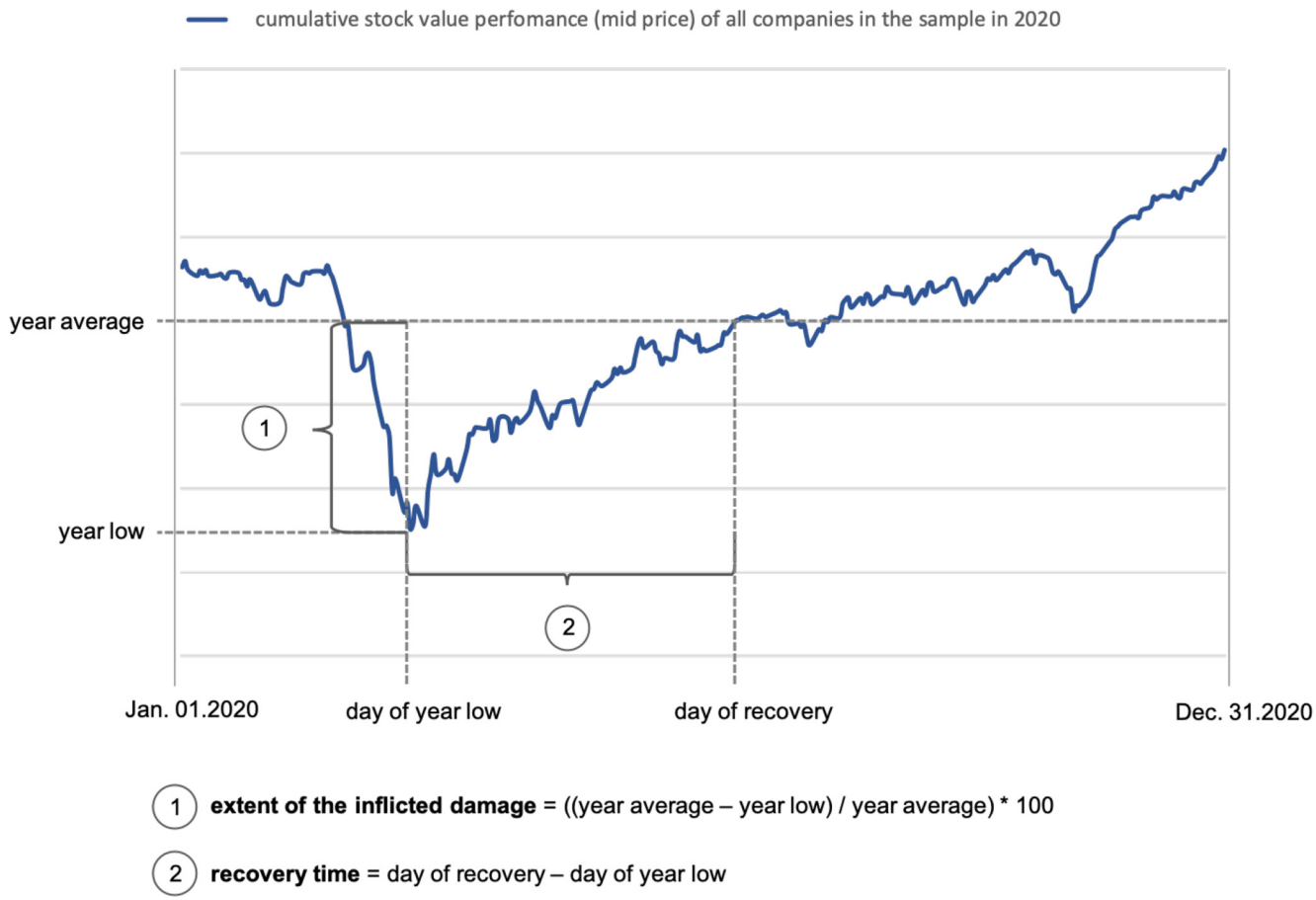
To measure SSCM, we follow the procedure introduced by Ortas *et al.* (2014). First, we searched the Refinitiv database to identify dummy variables representing the companies' key SSCM activities targeted at the upstream supply chain. If a company adopted any one of these activities within a year, it was marked 1, and 0 otherwise. Subsequently, we conducted an exploratory factor analysis to extract the decisive indicators for our SSCM variable. We computed a matrix of tetrachoric correlations for the factor analysis because all variables are binary and, therefore, Pearson correlation matrix can be misleading. The eigenvalue of our extracted factor is 5.80 and it is the only factor with an eigenvalue above one. This factor explains 93.64% of the variance of the variables loading on the factor. The factor loadings of each different variable are significant. The Kaiser–Meyer–Olkin test of sampling adequacy value is 0.92 and considered very good (Frohlich and Westbrook, 2001). Bartlett's test of sphericity is significant (p = 0.000) with a chi-square of 33,395.12 and 45 degrees of freedom. This suggests that the single-factor solution is significant. Cronbach's alpha is 0.93, thus assuring internal consistency as it is above the recommended 0.70 threshold (Cronbach, 1951; Nunnally, 1978). Based on the high variance of the variables explained by the extracted factor and the results of the other diagnostics, we are satisfied with the results of the factor analysis. The items used for measurement, their definitions and factor loadings are listed in Table 2.

The sum of these SSCM dummy variables in 2019, the year before supply chain disruptions from the pandemic occurred, represents companies' *SSCM intensity*. For our entire sample, this variable is between 0 and 10, with a mean of 7 SSCM activities conducted that year.

We measure the degree of *SSCM experience* as the number of years since the buying companies first engaged in SSCM activities, as any of the dummy variables was coded one for a company. We started our count in 2002, as this was the first year standardized data was available on companies' SSCM activities (Thomson Reuters EIKON, 2017). The value for SSCM experience ranges from 0 to 18 years with a mean of 11 years.

Control variables: Although the companies and their supply chains in our sample are comparable as they are all headquartered in the EU, there are differences in the impact of the pandemic. Different industries as well as countries offered companies dissimilar opportunities and support services. Hence, we controlled for country and industry affiliation by including dummy variables to this account. Company size also plays a role in terms of SCRES (Bode *et al.*, 2011; Pettit *et al.*, 2019) and dealing with SSCM efforts (Kotsantonis and Serafeim, 2019; Min and Galle, 2001). Therefore, we controlled for company size by including the number of employees (Bode *et al.*, 2011). This variable has been

Figure 1 Determination of the dependent variables



standardized to have a mean of 0 and a standard deviation of 1. Table 3 summarizes the descriptive statistics and correlations.

5. Results

To test our hypotheses, we used OLS regressions with our two 2020 SCRES variables as outcome variables and the 2019 SSCM variables as predictors. The obtained results are displayed in Table 4.

In Models 1 and 2, the dependent variable is the *extent of the inflicted damage* through the supply chain disruptions by the COVID-19 pandemic, representing the SCRES dimension of *readiness*. In Model 1, the effects of companies' SSCM intensity on the dimension of readiness is investigated, and in Model 2, the effects of companies' SSCM experience on the same dimension. In Models 3 and 4, the dependent variable is the *recovery time* after the supply chain disruption, representing the SCRES dimension of *recovery*. In Model 3, the effects of companies' SSCM intensity on the dimension of recovery is investigated and in Model 4, the effects of companies' SSCM experience on the same dimension.

In *H1a*, we predicted that a higher intensity of companies' SSCM activities leads to an increased readiness for unexpected supply chain disruptions. The results of Model 1 show that the *extent of inflicted the damage* by the supply chain disruption is significantly less severe if companies' SSCM intensity is higher ($\beta = -0.551$, t-stat = -2.14), confirming this hypothesis. The results suggest that one (of ten possible) more SSCM activity in the year before the disruption resulted in a reduction of the inflicted damage by 0.55%.

In *H1b*, we predicted that companies' longer experience with SSCM activities will increase their readiness for unexpected supply chain disruptions. This hypothesis is confirmed as shown in Model 2 by the significant and negative effect of companies' years of SSCM experience on the *extent of inflicted the damage* to the supply chain by the pandemic ($\beta = -0.354$, t-stat = -2.73). In this case, one (out of 18 possible) more year of SSCM experience results in a reduction of the inflicted damage by 0.35%.

In *H2a*, we assumed a higher intensity of companies' SSCM activities to lead to a faster recovery after an unexpected supply chain disruption. The results in Model 3 did not support this hypothesis as the effect is insignificant ($\beta = -1.584$, t-stat = -0.86). This shows that the *intensity of SSCM activities* in the previous year to disruption has no impact on the *recovery time*.

In *H2b*, we assumed that longer experience with SSCM translates into faster recovery for companies after an unexpected supply chain disruption. The results of Model 4 confirm this hypothesis ($\beta = -2.259$, t-stat = -2.46). The results indicate that one more year of companies' experience in SSCM activities is reflected in about 2.26 days of shorter *recovery time* after the supply chain disruption by the pandemic.

Table 2 Companies' sustainable supply chain management (SSCM) activities and factor loadings

Eikon code	Title	Description	Loading
ENRRDP029	Environmental Materials Sourcing	Does the company claim to use environmental criteria (e.g. life cycle assessment) to source or eliminate materials?	0.749***
ENRRDP058	Environmental Supply Chain Management	Does the company use environmental criteria (ISO 14000, energy consumption, etc.) in the selection process of its suppliers or sourcing partners?	0.849***
ENRRDP059	Environmental Supply Chain Partnership Termination	Does the company report or show to be ready to end a partnership with a sourcing partner, if environmental criteria are not met?	0.749***
ENRRDP066	Environmental Supply Chain Monitoring	Does the company conduct surveys of the environmental performance of its suppliers? – company monitors its suppliers on environmental issues through surveys, audits, supplier site visits and questionnaire	0.796***
ENRRDP0125	Policy Environmental Supply Chain	Does the company have a policy to include its supply chain in the company's efforts to lessen its overall environmental impact? – legal compliance data – data on collaboration with suppliers	0.856***
SOHRDP026	Human Rights Contractor	Does the company report or show to use human rights criteria in the selection or monitoring process of its suppliers or sourcing partners?	0.844***
SOHRDP029	Human Rights Breaches Contractor	Does the company report or show to be ready to end a partnership with a sourcing partner if human rights criteria are not met?	0.741***
SOHSDP0083	Supply Chain Health & Safety Training	Does the company train its executives or key employees on employee health and safety in the supply chain? – company provides training on health and safety to its suppliers and/or procurement staff	0.557***
SOHSDP0123	Policy Supply Chain Health & Safety	Does the company have a policy to improve employee health and safety in its supply chain? – company strives to select and/or work with suppliers who apply security standards for their employees – company visits suppliers' sites, monitoring, inspection, guiding and working with suppliers	0.745***
SOTDDP030	Supplier ESG training	Does the company provide training in environmental, social or governance factors for its suppliers? – training, programs or any other collaboration with suppliers to improve their ESG performance – audits leading to collaboration with suppliers on ESG issues	0.680***

Notes: We identified those items from the Refinitiv database by using the search terms environmental, social, purchasing, procurement, supply, supply chain, supplier or contractor. ***$p < 0.001$

Table 3 Descriptive statistics and correlations

Variable	Mean	SD	Min	Max	1	2	3	4	5
1. Inflicted damage (%)	34.47	10.88	4.52	71.89	1				
2. Recovery time (days)	101.11	72.21	5	301	0.33***	1			
3. SSCM intensity	7.15	2.72	0	10	−0.16*	−0.08	1		
4. SSCM experience	10.63	5.31	0	18	−0.16*	−0.12	0.47***	1	
5. Firm size	0	1	−0.7	6.38	−0.03	−0.05	0.18**	0.26***	1

Notes: *$p < 0.05$; **$p < 0.01$; ***$p < 0.001$

5.1 Post hoc analyses: environmental vs social SSCM activities

As a robustness test and to investigate whether there are undifferentiated effects, we split our SSCM variables into their environmental and social subcomponents. Subsequently, we conducted the same analyses as in Table 4 with these variables as well and captured these non-hypothesized results in Tables 5 and 6. With one exception, the results are strongly consistent with the alignment and significance of the combined variable. The exception is that social SSCM intensity has no significant effect on the SCRES dimension of readiness and, consequently, does not reduce the inflicted damage. In the following section, we discuss what this and the other results indicate.

Table 4 OLS regression results

	Inflicted damage		Recovery time	
Dependent variable	**Model 1**	**Model 2**	**Model 3**	**Model 4**
Main effects				
SSCM intensity	−0.551* (−2.14)		−1.584 (−0.86)	
SSCM experience		−0.354** (−2.73)		−2.259* (−2.46)
Frim size	0.056 (0.08)	0.426 (0.61)	1.275 (0.27)	4.47 (0.90)
Industries				
Basic materials	−7.785**	−8.005**	−50.570*	−51.369*
Consumer cyclicals	−5.791*	−7.262*	−63.485**	−70.870***
Consumer non-cyclicals	−17.357***	−18.748***	−53.790*	−60.853**
Energy (reference level)	0.000	0.000	0.000	0.000
Health care	−19.816***	−21.313***	−47.350	−55.157*
Industrials	−7.432**	−8.692**	−66.636***	−74.410***
Technology	−3.103	−3.850	−56.607	−60.208*
Countries				
Austria	−5.030	−3.878	−24.883	−20.106
Belgium	−4.966	−4.247	−31.216	−28.682
Denmark	−1.288	−1.112	−13.579	−10.017
Finland	−3.507	−2.776	−2.372	5.802
France	−4.308*	−3.600	8.468	12.186
Germany (reference level)				
Greece	−12.077	−10.697	140.301**	146.693**
Hungary	−22.221*	−21.941*	−133.150	−130.994
Ireland	−1.292	−1.281	−5.745	−6.295
Italy	−4.574	−4.742	59.915*	61.554*
Luxembourg	−3.343	−4.268	−1.953	−6.787
Spain	−8.080**	−6.605*	−34.416	−28.650
Netherlands	−1.572	−0.972	−3.197	0.832
Norway	−12.084**	−11.538*	−48.115	−43.615
Poland	3.349	4.515	66.852	64.638
Portugal	−15.572**	−15.107**	−5.769	−3.431
Sweden	−7.475**	−6.406**	−1.338	5.729
Constant	45.250*** (10.12)	47.152*** (10.03)	147.321*** (4.62)	165.947*** (4.99)
Observations	231	231	231	231

Notes: $^{*}p < 0.05$; $^{**}p < 0.01$; $^{***}p < 0.001$; *t*-values in parentheses

Table 5 OLS results – environmental SSCM activities targeted at the upstream supply chain

	Inflicted damage		Recovery time	
Dependent variable	**Model 1**	**Model 2**	**Model 3**	**Model 4**
SSCM intensity (environmental dimension)	−1.274* (−2.59)		−4.250 (−1.21)	
SSCM experience (environmental dimension)		−0.364** (−2.78)		−2.164* (−2.32)
Firm size	−0.024 (−0.04)	0.454 (0.65)	1.115 (0.24)	4.355 (0.88)
Industry dummies	Yes	Yes	Yes	Yes
Country dummies	Yes	Yes	Yes	Yes
Constant	47.811*** (9.85)	46.590*** (10.08)	151.202*** (4.36)	158.246*** (4.82)
Observations	231	231	231	231

Notes: $^{*}p < 0.05$; $^{**}p < 0.01$; $^{***}p < 0.001$; *t*-values in parentheses

6. Discussion

Our results demonstrate the influence of companies' SSCM intensity and experience on the two SCRES dimensions readiness and recovery, respectively, in the context of the COVID-19 pandemic. Companies' current SSCM intensity reduces the inflicted damage by unexpected disruption due to the pandemic, but does not have a significant effect on the recovery time afterwards. We believe that the impact of SSCM

Table 6 OLS results – social SSCM activities targeted at the upstream supply chain

	Inflicted damage		Recovery time	
Dependent variable	**Model 1**	**Model 2**	**Model 3**	**Model 4**
SSCM intensity (social dimension)	−0.567 (−1.47)		−1.191 (−0.45)	
SSCM experience (social dimension)		−0.326* (−2.49)		−2.130* (−2.30)
Firm size	0.013 (0.02)	0.269 (0.39)	1.014 (0.21)	3.442 (0.71)
Industry dummies	Yes	Yes	Yes	Yes
Country dummies	Yes	Yes	Yes	Yes
Constant	43.154*** (9.70)	45.137*** (10.00)	134.674*** (4.26)	150.775*** (4.72)
Observations	231	231	231	231

Notes: $^{*}p < 0.05$; $^{**}p < 0.01$; $^{***}p < 0.001$; *t*-values in parentheses

intensity on the readiness dimension particularly resonates from an intensive exchange of information with suppliers. A high SSCM intensity indicates a more intensive information exchange (Harms *et al.*, 2013; Köksal *et al.*, 2017) supported by the use of state-of-the-art information technology (Giannakis and Papadopoulos, 2016; Park and Li, 2021), which allows buying companies to learn about vulnerabilities and problems in their supply chains at an earlier stage and can respond to them more quickly (Jüttner and Maklan, 2011). This aligns with Han *et al.'s* (2020) theoretical assessment that situation awareness and visibility along the supply chain have a positive influence on the SCRES dimension of readiness. Thus, SSCM built in "normal times" safeguards during sudden, extensive shocks shielding from some of the worst effects. This finding complements the nascent findings on supply chain viability which seeks to identify the factors, skills and capabilities that assist companies in mastering the challenges resulting from the pandemic (Gunessee and Subramanian, 2020; Ivanov and Dolgui, 2021b).

Unlike theorized, the result of SSCM intensity on the recovery time is insignificant. When parsing the predictor variable into its environmental and social subcomponents, we found that environmental SSCM intensity significantly affects SCRES readiness but social SSCM intensity does not. It is possible that environmental SSCM requires more intensive exchange than social SSCM which might explain this somewhat counter-intuitive finding. For example, Park and Li (2021) describe how with social SSCM activities, snapshots of socioeconomic conditions of supply sources are passed on to buying companies, but with environmental SSCM activities, there can be a permanent exchange on the location and quantity of all emissions (such as carbon, waste, toxins) from material extraction to the end of the supply chain. However, this reinforces the theoretical assignment, that situation awareness and visibility are attributed to the dimension of readiness, but not to that of recovery (Han *et al.*, 2020; Kochan and Nowicki, 2018).

Regarding SSCM experience, we find both of our hypotheses confirmed: the length of experience in SSCM lowers both the extent and the length of the damage caused by the pandemic. SSCM experience thus has a significant effect on both measured SCRES dimensions readiness and recovery. Results from the post hoc analysis reveal that experience in environmental as well as social aspects of SSCM matter significantly. The increasing transparency in the supply chain as well as the growing knowledge about suppliers' operations enhance the readiness of purchasing companies. This will have increased over the years leading up to the pandemic as supplier knowledge has grown and monitoring techniques have improved.

Further, ongoing collaboration on SSCM activities increases social capital and trust among suppliers, which have continuously been cited as a critical factor in building SCRES (Brusset and Teller, 2017; Dubey *et al.*, 2019; Gölgeci and Kuivalainen, 2020; Hamdy *et al.*, 2018; Johnson *et al.*, 2013) but need time to build up (Lee, 2015; Min *et al.*, 2008) and therefore time to show effects. Long SSCM experience implies that firms had more time to establish such a relationship with their suppliers before the pandemic. It is likely that especially these purchasing companies have then been treated favorably after a disruption and, therefore, especially an ongoing experience in SSCM shows a significant effect on the SCRES dimension of recovery rather than companies' current SSCM intensity.

For several years now, socially responsible investment grew the attention and attraction from investors. Companies' sustainability information gained importance and the impact of scores on the financial performance of publicly traded companies has been examined (Amel-Zadeh and Serafeim, 2018; Chatterji *et al.*, 2016; Chatzitheodorou *et al.*, 2019; Eccles *et al.*, 2012; Luo *et al.*, 2015; Verheyden *et al.*, 2016). These investigations continued at the time of the pandemic, as this period provided researchers with a golden opportunity to contrast the financial performance of firms with different sustainability scores and ratings. Researchers used this opportunity to examine which stock returns showed to be more resilient during the disruptive times of the pandemic (Broadstock *et al.*, 2021; Cheema-Fox *et al.*, 2020; Fasan *et al.*, 2021; Garel and Petit-Romec, 2021). Although at first glance these studies show similarities to our work, the differences are substantial. On the one hand, their observations period is much more narrower and began no earlier than February 3 (Broadstock *et al.*, 2021) and ended no later than March 31 (Fasan *et al.*, 2021). As our descriptive statistics display, most companies have by no means recovered from the supply chain disruptions during this period. On the other hand, these studies only examined the impact of scores and ratings on investors, but completely neglected the potential impact of the SSCM activities themselves, from which these sustainability scores and ratings are derived.

Lastly, our study contributes to the methodological toolkit typically used by scholars of supply chain management who often rely on primary data collected from cases and surveys. While these often provide for rich information on organizations and their supply chain strategies, it is difficult to quantitively measure impacts on performance outcomes such as resilience over extended periods of time. Here, our study assists in illustrating that there are situations where the use of secondary data may be adequate. Our measure of *SSCM experience*, which was captured independently of the companies' current sustainability scores, shows the most significant results. In doing so, we demonstrate that the long-term engagement with SSCM activities has a significant impact on SCRES and thus also enrich the research area of finance and accounting. In future, this may lead researchers to look not just at the impact of sustainability scores on investor behavior but consider the actual impact of SSCM activities on firms' SCRES. Indeed, the positive results found by finance and accounting researchers during this period for companies with high sustainability scores (Broadstock *et al.*, 2021; Cheema-Fox *et al.*, 2020; Fasan *et al.*, 2021; Garel and Petit-Romec, 2021) might also be explained by an increased SCRES response dimension from SSCM activities in addition to solely investors' behavior.

7. Implications, limitations and avenues for future research

7.1 Implications for theory

This study contributes to the foundation of a new research stream connecting SSCM and SCRES to sustainable and resilient supply chain management. In particular, our research demonstrates that a long-term commitment to SSCM is especially rewarding with regard to SCRES. When considering the capabilities required for SCRES, long-term commitment has not been specifically considered in previous research. We show that it can significantly alter the beneficial impact of activities or strategies. Buying companies that had adopted sustainable strategies and actions *vis-à-vis* their suppliers benefitted from more stable supply relationships and were less affected by supply disruptions during the COVID-19 pandemic. We can only speculate about the reasons for this, but apparently suppliers rewarded those buyers that showed an inclination to not only look into prize and quality with a higher propensity to continue to supply. Definitively, this finding warrants further research to substantiate this interpretation and, ideally, unveil other reasons for this finding.

Short-term SSCM intensity does help to reduce the resulting damage from a disruption, but does not shorten the recovery time afterwards. We suspect that increased information exchange with suppliers due to SSCM activities helps buying companies better prepare for an unexpected disruption and thus reduce the damage inflicted. However, shortening recovery time requires not only early knowledge of suppliers' vulnerabilities, risks and difficulties but their assistance in the aftermath of the disruption. To obtain this assistance, however, the relationship seems to have to be established over the longer term. This finding provides an interesting basis for further research into the degree of SSCM implementation needed to significantly increase supplier assistance in disruptive times.

Previous research on SSCM has repeatedly addressed the insufficient attention paid to the social component of SSCM activities in empirical studies in relation to the environmental component (Beske-Janssen *et al.*, 2015; Carter and Washispack, 2018). We answer to the call to separate SSCM activities into the environmental and social dimension (Tachizawa and Wong, 2014) and provide empirical evidence for the significant impact of not only environmental but also social SSCM activities. Moreover, by splitting SSCM into its different elements, we show that the separated segments of a procurement strategy produce partially different results. The additional results obtained lead to a more pronounced interpretation of the results and demonstrating this creates incentives to scholars to proceed likewise in future research, especially in the supply chain management area.

In light of the pandemic, supply chain viability has emerged which denotes the set of factors that strengthen the survivability of supply networks in the face of long-term, severe and unpredictable disruptions such as the pandemic (Ivanov, 2020; Ivanov and Dolgui, 2020). In contrast, the more traditional understanding of SCRES is that it should ideally enable supply chains to bounce-back to an "old normal" after experiencing disruption, supply chain viability addresses how supply chains can bounce-forward-and-adapt to a "new normal" in radically changing internal and external conditions (Ruel *et al.*, 2021). Our research shows that SSCM may be one such enabler. We demonstrate that particularly long-term SSCM activities had a significant positive impact on the ecosystem and thus supply chain performance during the extreme and fundamental shift in the business context in which supply chains operate during the pandemic.

Furthermore, we establish a bridge to the research field of finance and accounting. Although there already is a substantial body of research measuring the impact of SSCM on firms economic performance, the performance measurements are mostly operational or perception-based measures (Golicic and Smith, 2013). By basing our measurement on daily stock prices, we create an intersection to improve the investor view of supply chains. In our analysis, we demonstrate how effectively SCRES can be measured in this way, extending the research of Hendricks and Singhal (2005, 2003) with new metrics and thereby expanding the SCRES research field. Sustainability, sustainable finance and sustainable investments are becoming increasingly important to investors, and our research highlights the point that sustainability information is being seen and positively assessed in relation to the supply chain. By demonstrating, especially through our variable of SSCM experience, that SSCM activities have a sustainable impact on the SCRES and, therefore, financial performance of companies, we also make a valuable contribution to this area. So far, the focus there has been on the impact of sustainability scores and ratings on the investment landscape, but not on the impact of SSCM activities from which these ratings are derived. Our work demonstrates that the activities themselves also need to be taken into account and that there are different effects of SSCM intensity (i.e. current sustainability scores) and companies' SSCM experience. This demonstrates how important supply chain management strategies and their various elements are to the research field of finance and

accounting, as they are clearly reflected in the companies' stock performance.

7.2 Implications for practice

The particularly severe supply chain disruptions during the pandemic weakens a company's SCRES and its ability to design and implement recovery strategies (Li and Zobel, 2020). Our study sheds light on the types of strategies and capabilities focal companies should build in "normal times" to be better prepared for large-scale disruption. We are confident that our findings can be transferred to less extreme supply chain disruptions and will have an impact on business practice in the long-run and after the effects of the pandemic have faded as supply chain practitioners have now experienced how vulnerable their supply chains are. From our point of view, this may result in long-term and fundamental shifts in how supply chains will work in future. Our findings suggest that collaborative partnerships, social capital and sustainable development may serve as one avenue for future supply chain management.

The finding that financial investors evidently trust responsible buyers more than less responsible ones should encourage supply chain decision-makers to do more to environmentally and socially responsible supply chains. Supply chain decision-makers often lament the fact that efforts to improve social and environmental conditions in the supply chain go unnoticed by the market and offer little – if any – returns.

Sheffi (2018) concluded that companies cannot control most of their environmental impacts, most consumers are not willing to pay more for greater sustainability, and jobs and economic development are more decisive than sustainability. Hence, many companies are still reluctant to engage in SSCM. Our study does away with some of these prejudices as our findings show that responsible firms proved to be more resilient in the most recent global crisis and that financial investors indeed value these efforts. Our findings are also highly relevant for future discussions with stakeholders who tend to see SSCM activities as a financial disadvantage for a company, as our results clearly show that the opposite is the case. In a recent study, Menon and Ravi (2021) found that the most significant barriers to the implementation of SSCM activities is the lack of awareness of the benefits, followed by a lack of top management support, and financial constraints. These findings have the consistent support of other researchers who have also studied the barriers of SSCM (Govindan *et al.*, 2021; Oelze, 2017; Tumpa *et al.*, 2019). In addition to the social and environmental benefits of SSCM activities, our results demonstrate that resilience in supply chains is increased, which is reflected in significant financial and competitive advantages. These results should encourage top management of buying companies to give their support to SSCM activities and to lift financial constraints where possible.

7.3 Limitations and avenues for future research

Although empirical evidence of a link between SSCM and SCRES is an important contribution to the academic literature and our analyses show practitioners ways to gain competitive advantage by strengthening their SCRES through SSCM, our work is not without limitations that pave avenues for future research.

The pandemic triggered countless global supply chain disruptions. Therefore, from the three SCRES dimensions readiness, response and recovery, we were not able to address the dimension of response in our analysis. To this end, we would have had to capture the individual disruptions within all of the companies' supply chains and analyze their individual responses to them and their effects. Given the size of our sample and the duration of our observations, this was not possible. However, the SCRES dimension of response still has a severe impact on our results. A quick and effective response dampens the inflicted damage and thus also helps to achieve a shorter recovery time as the damage to be compensated is lower. Therefore, our work is not any indication that SSCM activities do not have an impact on the SCRES dimension of response, we just do not explicitly measure the impact. Future research could accordingly examine singular disruptions, such as the case of the ship Ever Given getting stuck in the Suez Canal, from the same or a similar perspective as we did. Through such considerations, the SCRES dimension of response could also be specifically addressed in future research.

To the best of our knowledge, this is the first study using daily stock-price data to study the impact of SSCM. The use of secondary data in purchasing and supply chain management is rather scarce, but scholars pointed out that the use of such data could substantially enrich the insights gained for this field (Ellram and Tate, 2016). Therefore, this work could serve as a precursor for other researchers who may leverage the potential of secondary data. This may substantiate the credibility of our field of research and overcome some of the biases often inherent in studies relying on primary data collected from, e.g. surveys or case studies.

We also acknowledge that our independent variables have their own shortcomings that future research might address. The actual effort – in terms of varying degrees - that companies invest in individual SSCM activities is not reflected in our measure coded from Boolean variables. Future research could, therefore, examine differences in the extent to which companies invest effort in individual SSCM activities and the differential impacts. As an example, it would be interesting to not only know whether a company has adopted a policy to monitor supplier's sustainability levels but to also understand the proportion of suppliers subjected to an audit each year. This would be a more fine-grained measure for buyer SSCM engagement which can provide for more nuanced insights.

We further limit our analyses to large publicly traded and exclusively European companies. Future research should extend these analyses to other regions and also to small and medium-sized companies (SMEs). Supply chains of large purchasing companies are globally distributed. Therefore, it would be interesting to see whether different locations of the purchasing companies from which the SSCM efforts originate lead to different SCRES effects, and if so, why. Conversely, an interesting approach would be to investigate whether the regions of the suppliers included in the SSCM activities show different effects on the buying companies' SCRES. As SMEs are not publicly traded, the inflicted damage and the recovery time could not be measured using our research design. For this, it would be very feasible to use primary research methods to

selectively capture individual SSCM efforts and measure specific resulting SCRES effects. Also, a comparison between the impact of SSCM activities of large buying companies and of SMEs would be of great relevance. SMEs do not necessarily have the financial resources to invest in their suppliers or the production scale to collaborate closely with them. How this affects the SCRES effects resulting from SSCM activities is an interesting question for research.

Furthermore, our measurement of companies' SSCM activities on their SCRES is straightforward. As this is still quite an unexplored research area, our study sets an important baseline. Future research, however, could seek to look more specifically at the impacts of individual SSCM activities and consider moderating contingency factors. Factors that could play a decisive role here are the degree of the size of the buyer and the supplier, digitization of the companies, the different transport routes within the supply chains and different political and legal framework conditions. Further, a consideration of cross-industry patterns provides an interesting path for future research.

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