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Operational and Supply Chain Resilience During Geopolitical Disruptions: A Multiple Perspective Analysis

By

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Abstract

In the last ten years, global supply chains have been affected by numerous geopolitical events. Although there have been many studies focusing on the concept of resilience, firms still reportedly struggle to recover from the impact of disruption caused by geopolitical events. Therefore, this thesis, which consists of three empirical studies, aims to investigate how to achieve operational and supply chain resilience under the impact of disruptive geopolitical events, based on two different perspectives of resilience, namely the engineering perspective and the social-ecological perspective.

Prior to inspecting two perspectives of resilience, the first study investigates how different theoretical perspectives are embedded to explain the current body of supply chain resilience knowledge. This study applied the typical systematic literature review method. The findings of the study show which factors affect the relationship between two opposing forces: supply chain disruptions and supply chain resilience. This study shows how relationships among factors such as structural complexity, environmental uncertainty, performance, and capability could be interpreted differently or even divergently based on the theoretical lens applied by studies. From a theoretical perspective, the findings of this study point to how theory could be used more effectively in SCRES studies to make a stronger contribution. It formulates a cohesive conceptual framework grounded in theories used in past supply chain resilience studies and offers suggestions for future empirical research to explore and explain SCRES.

The second study draws attention to the engineering perspective of resilience. This study revisits the accumulation of slack resources, a well-known practice for building operational resilience. Adopting the attention-based view, agency theory, and using the panel-data regression method, this study proposes two competing hypotheses to explore how three

different types of slack resources, including capacity slack, inventory slack, and financial slack, impacted firms' operational resilience during COVID-19, and how these slack resources were affected by firms' perception of COVID-19-related risks. The findings show that firms with a higher level of risk perception of COVID-19 possessed more capacity slack and financial slack, but only capacity slack enhanced firms' operational resilience during COVID-19, whereas financial slack, conversely, damaged operational resilience.

Using the US-China trade war as a research context, the third study focuses on the social-ecological perspective of resilience. Employing institutional theory and the difference-in-differences method, this study investigates whether firms adapt their supply networks to achieve supply network social-ecological resilience under the impact of geopolitical events, based on the level of regulatory distance and perceived political risk. The findings suggest that firms adapt their supply networks in terms of regulatory distance after being exposed to the trade war. Furthermore, the results suggest that the buying firms' perception of political risk negatively moderates the relationship between their exposure to the trade war and the extent of supply network adaptation.

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Chapter 1. Introduction

1.1 Background and Motivation

1.1.1 Geopolitical Disruptions

Starting from the last decade of the twentieth century, supply chains have expanded significantly into international locations, marking the globalisation of business (Meixell and Gargeya, 2005; Srai et al., 2023). This trend, whilst increasing the flow of trade and opening new markets, has also increased the vulnerability of supply chains through the heightened exposure to many types of risks, resulting in a greater proliferation of operations and supply chain disruptions (Bogataj and Bogataj, 2007). For example, natural disasters such as the Japanese earthquake and associated tsunami caused catastrophic operational, financial, and supply chain disruption to Japanese firms and firms that rely on Japanese suppliers (Son et al., 2021). Man-made incidents, such as the Suez Canal blockage caused by the "Ever Given" megaship severely affected the global supply chain by cutting 0.2%–0.4% global trade in 2021 (Tran et al., 2025). Besides such one-off incidents, long-term events, such as the economic recession and the financial crisis from 2007 to 2009, also caused significant damage to global supply networks (Jüttner and Maklan, 2011).

In considering the range of disruptions that can impact operations and their supply chain disruptions, one particular type of disruption namely geopolitical events, is gaining attention from both academics and practitioners. Geopolitical events are events that cause tensions between several nations (Bednarski et al., 2025), which can create uncertainties in the global business environment, affecting a firm's operations and its global supply network (Zhu et al., 2025). Geopolitical events are a category of slow-evolving disruptions in which early signals may be detectable by managers before a crisis fully unfolds, or only understood

retrospectively. These signals can provide additional insights that help managers reassess how the crisis is developing and what its potential impacts may be. As a result, such evolving information can shape managerial decision-making during the event and influence how supply networks adapt in order to build and maintain resilience (Grewal et al., 2007).

Over the past decade in particular, global supply chains have been affected by numerous geopolitical events. In 2016, the UK voted to leave the European Union. It took 4 years to complete the Brexit process, and the EU and UK supply chains still face significant uncertainty and disruption due to products being delayed at the border and regulatory compliance challenges (Moradlou et al., 2021; Roscoe et al., 2020). In the same year, Donald Trump was elected to start his first US presidency with a largely protectionist and nationalist ideology and initiated a trade war with China in 2018. $300 billions of products across 3805 categories from China and $75 billions of products from the US were affected by the trade restriction policies imposed by the US and China (Fan et al., 2022).

COVID-19 in late 2019 represents one of the most severe disasters, forcing governments from many countries to impose restrictions on the key medical, pharmaceutical, and health products exportation, and implement lockdown policies that limited production of many goods and services, making a number of scholars identify COVID-19 as a representative geopolitical event (Bednarski et al., 2025). Not long after COVID-19, Russia's invasion of Ukraine in 2022 reshaped the map of global trade as many multinational enterprises decided to decouple from Russia by withdrawing their business (Shu et al., 2025). The war had a global impact as it significantly disrupted the global energy supply chain due to the EU's dependence on Russian energy (Maneejuk et al., 2024). A more recent geopolitical event, the war in Gaza which started in 2023, caused long-term humanitarian supply chain disruptions as the Israeli government intentionally restricted the humanitarian supplies into areas controlled by Palestinians (Son et al., 2025).

The disruption risk that originates from geopolitical events pushes firms and their supply chains to actively look for strategies and practices that could prevent or mitigate the risk of disruption (Zheng et al., 2025). Concerns about supply chain disruptions and their impact have led to the concept of resilience attracting growing attention from both operations and supply chain management (OSCM) academia and practitioners. Resilience is not a new concept in OSCM studies as it first appeared over 20 years ago (refer to Christopher and Peck, 2004). Over the last two decades, discussions around resilience in OSCM studies have contributed multiple insights into the antecedents and impact of resilience at both the firm level and supply chain level (Gunasekaran et al., 2015; Jiang et al., 2024; Nikookar and Yanadori, 2022; Tukamuhabwa et al., 2017). Despite the fact that there is a considerable number of OSCM studies focusing on operational and supply chain resilience, firms still reportedly struggle to recover from the impact of disruption caused by geopolitical events. This infers that there are still areas that require investigation when it comes to resilience scholarship, given the complexity of global trading environments. Therefore, to address this research gap, this thesis examines how firms and their supply networks can leverage resilience in the context of increasing levels of geopolitical disruption. Before addressing this gap, it is necessary to understand what perspectives have been used in OSCM studies to interpret the concept of "resilience" appropriately (Wieland and Durach, 2021).

1.1.2 Two Perspectives of Resilience and Geopolitical Disruptions

Two different perspectives on resilience have appeared in resilience literature - the engineering perspective and the social-ecological perspective (Holling, 1996). Both perspectives indicate essential differences in how firms and supply networks can establish resilience in the context of geopolitical disruptions.

The engineering perspective of resilience has been the focus of early OSCM scholarship (Vega et al., 2022) with studies positing that firms and their supply chains are

considered distinct or independent from their business environment (Borgatti and Li, 2009). Under such a setting, a firm and its supply chain should achieve an optimal equilibrium state, regardless of changes in the business environment, and a resilient firm or supply chain should be able to return to this state after disruption (Lin et al., 2023). Therefore, firms and supply networks need to be controlled by managers with increasing amounts of time, money, and effort to achieve engineering resilience (Choi et al., 2001). Essentially, the approach to measurement or operationalisation of the engineering perspective of resilience is usually by laying out performance-related variables' value in order to set up a baseline to compare to after events take place (Novak et al., 2021). For example, one pair of representative measurements is time-to-survive and time-to-recover, both of which are measured based on the pre-disruption and post-disruption performance gap and the time that firms and supply chains need to return to pre-disruption performance (Simchi-Levi et al., 2015). Despite being dominant for a decade in OSCM studies, engineering resilience has recently been criticised. Emerging studies argued that resilience should not be evaluated using only economic or performance-related scales such as time-to-survive or time-to-recover, because business environments are constantly changing, and there is no such "optimal equilibrium" existing in the supply chain (Novak et al., 2021; Wieland and Durach, 2021). In response to this, the social-ecological perspective of resilience has gradually been attracting increasing attention from scholars.

The social-ecological perspective of resilience underscores the importance of flexibility, diversity, and learning from disruptions to create more adaptive and sustainable supply chains (Kahiluoto et al., 2020; Lin et al., 2023). The fundamental premise of this perspective is that because the supply chain constantly interacts with the external business environment, new and unexpected structures, patterns, properties, or processes will constantly emerge from supply chains, making firms and their supply chains too complex to be fully controlled by managers (Choi et al., 2001; Wieland and Durach, 2021). Therefore,

supply chains will continue to evolve based on their interactions with the social, political, or ecological environment, transforming into the desired state in a dynamic manner (Wieland, 2021). In contrast to the engineering perspective, trying to define and maintain an equilibrium state for supply chains is considered impossible, because business environments are constantly changing, and each actor in the supply chain has its unique scale of resilience (Novak et al., 2021). Rather, a social-ecological resilient supply chain should be able to constantly transform and adapt to disruptive events from the external business environment by monitoring, anticipating, and responding to the environment, as well as learning from it (Lin et al., 2023). Although the social-ecological perspective of resilience was proposed based on a more accurate description of the characteristics of the supply chain and the relationship between the supply chain and the business environment, the application of such a perspective in OSCM studies is still at an early stage (Adobor, 2020).

Indeed, given the nature of the fast-changing geopolitical environment over the last ten years, social-ecological resilience offers appropriate insights to firms and supply networks to respond to geopolitical disruptive events (Lin et al., 2023). However, the engineering perspective on resilience is still valuable and appreciated, especially at the firm level, in relation to firms' operational resilience, for example. Engineering resilience measurements, such as market and financial performance changes during disruption, directly impact firms' survival under the impact of disruptive events (Essuman et al., 2022). Besides that, one of the priorities for firms under the threat of disruptive events is to resume or continue operations as soon as possible (Hepfer and Lawrence, 2022; Holdago et al., 2024). Based on these two perspectives of resilience, the following section will discuss the research gap existing in both engineering and social-ecological resilience under the geopolitical disruption context.

1.2 Research Gap and Objectives

The increasing frequency of disruptive geopolitical events has driven scholarly interest in their effects on operational and supply chains. However, there remain significant gaps when it comes to understanding the relationship between geopolitical events and firms' operational or supply chain resilience, regardless of the perspective (engineering or socio-ecological) that has been adopted. Therefore, the overall aim and objective of this thesis is to explore: **How to achieve operational and supply chain resilience under the impact of geopolitical disruptive events**. There are three research gaps identified based on the engineering perspective of resilience, the social-ecological perspective of resilience, and the theoretical approach to conceptualising and measuring resilience. This thesis will address these research gaps through three independent studies. Due to the page limit and data availability considerations, this thesis chooses two geopolitical disruptive events that have been investigated with several secondary databases, namely the US-China trade war and COVID-19, to investigate this research question of the thesis.

The prerequisite of addressing the research gaps related to resilience is to systematically investigate what has been done by previous resilience studies. Several systematic literature reviews (SLR) on resilience have provided clear and insightful summaries of studies so far (Ali et al., 2017; Datta, 2017; Han et al., 2020). However, these reviews do not examine supply chain resilience from a theoretical perspective. An SLR with the theoretical perspective observes how different theoretical lenses have been used in the former study to understand the current state of knowledge and refine the description or explanation of complex phenomena (Carter and Rogers, 2008; Kembro et al., 2014). To observe resilience knowledge from a theoretical perspective, it is necessary to investigate how different theoretical lenses explain resilience knowledge. The absence of a theoretical analysis of resilience knowledge presents limitations. Although these reviews manage to

categorise resilience knowledge into different sections, they offer only limited insight into the relationships among the constructs. For instance, they suggest that dimensions such as capabilities (Ali et al., 2017; Han et al., 2020; Tukamuhabwa et al., 2015), performance (Han et al., 2020; Datta, 2017), and context (e.g., disruption, risks, and vulnerability) (Datta, 2017) are closely tied to the development of resilience. Yet, the interconnections among these constructs have not been systematically addressed. Besides that, conducting a theoretically focused systematic literature review is a unique method to identify any research gaps in resilience studies so far, as theory lenses that were underexplored by resilience studies could be a viable direction for observing both engineering and social ecological resilience. This research gap will be addressed by the first study, which is Chapter 2 of the thesis, titled "Supply chain resilience: a systematic literature review under the theory lens". This study is a systematic literature review that examines what theoretical perspectives have been used by OSCM studies that focus on supply chain resilience, and how they were used to explain and understand supply chain resilience by explaining the relationship between SCRES and other constructs. This chapter focuses on a broad theoretical perspective of SCRES to establish the current state of SCRES knowledge. While the thesis focuses specifically on geopolitical disruptions, a general SCRES review is necessary to present the full picture of the current state of SCRES knowledge, so it is possible to further identify the knowledge, theory, and phenomena that have not been addressed by geopolitical disruptions. Based on the findings and research gap identified from this chapter, two empirical studies in Chapters 3 and 4 were developed from an engineering and social-ecological perspective of resilience.

From the engineering perspective, studies have proposed strategies and practices to build engineering resilience, such as building inventories, developing redundant suppliers, or information technology adoption (Tukamuhabwa et al.,2015). However, studies that examine how to achieve engineering resilience were based on a target of achieving an optimal equilibrium state without considering the interaction between the supply chain and

the external environment (Borgatti and Li, 2009). Although these strategies and practices were deemed useful by OSCM studies, they don't examine how the supply chain can return to pre-disruption status following geopolitical disruptive events like COVID-19 due to its unanticipated appearance and consequences (Ge et al., 2023; Jacobs et al., 2022; Sodhi and Tang, 2021). Therefore, strategies and practices derived from the engineering perspective should be re-evaluated in the context of geopolitical disruptions to determine whether they are still effective and, if not, why not. This research gap will be addressed by the second study, which is Chapter 3 of the thesis, titled "A dual perspective on slack: How risk perception and slack resources shape operational resilience during COVID-19". This study revisited one practices firms would use to gain operational resilience – slack resources, because development of slack resources is widely recognised as a key strategy used in the development of operational resilience (Holgado et al., 2024). Under the context of COVID-19, Chapter 3 examines how firms' perception of COVID-19 pandemic risk affects the accumulation of different types of slack resources, and how different types of slack resources affect firms' operational resilience during COVID-19. As the definition of operational resilience is the ability of a firm's operations system to absorb the negative impact of external adversity and return to pre-disruption status (Essuman et al., 2020; Jiang et al., 2023), the research on operational resilience fits the engineering resilience narrative.

From the social-ecological perspective, whether firms and supply chains could transform into a "desired state" that adapts to a "new normal" is an important criterion to define whether they are resilient enough (Wieland and Durach, 2021; Wieland et al., 2023). There are several studies investigating what the new normal is for firms and their supply networks after disruptive events, with context such as the Japanese earthquake (e.g., Son et al., 2021), or other geopolitical events and risks in general (Moradlou et al., 2025; Zhu et al., 2025). Indeed, studies have found that the supply network will change to adapt to the post-disruption business environment, but the changes that were observed are mainly about

physical supply network characteristics such as network centrality or supply network concentration (Son et al., 2021; Zhu et al., 2025),

As geopolitical disruptive events impact business environments from a social-political angle, it is necessary to investigate how social-political aspects of firms' supply networks change as a result. Therefore, this thesis investigates the impact of the US-China trade war, a geopolitical event with strong social-political characteristics, on the institutional distance changes in supply networks, which is identified as an important social-political aspect of supply networks. This research gap will be addressed by the third study, which is Chapter 4 of the thesis, titled "Adapting supply networks to achieve resilience: The impact of geopolitical disruption and institutional distance". This study used the US-China trade war breaking out in 2018 as a research context to examine whether firms adapt their supply networks based on the consideration of regulatory distance between themselves and their overseas supply network to foster supply network resilience under the impact of the trade war. Besides that, this study also investigated how firms' risk perception of political risk affects supply network adaptation. As this study focuses on how supply networks constantly adapt and transform based on an ongoing geopolitical event, it fits the narrative of social-ecological resilience.

1.3 Research Questions

In line with the research aims and objectives of the thesis, the following six research questions are explored across three separate studies.

Research question 1: How are different theoretical perspectives embedded to explain the current body of supply chain resilience knowledge?

Research question 2: How can supply chain resilience knowledge be extended based on existing studies and theory?

Research question 3: How did firms' risk perception towards COVID-19 affect their accumulation of slack resources, namely capacity slack, inventory slack, and financial slack during COVID-19?

Research question 4: How did firms' slack resources, namely capacity slack, inventory slack, and financial slack, impact operational resilience during COVID-19?

Research question 5: Do buying firms adapt their supply networks, based on the regulatory distance with their suppliers, to maintain supply network resilience in the face of slow-evolving, long-term geopolitical disruptions?

Research question 6: How does buying firms' perception of political risk (political process and economic policy risks) impact the adaptations made by buying firms to their supply network in response to slow-evolving, long-term geopolitical disruptions?

1.4 Research Contribution

The thesis contributes to different perspectives on resilience. The first study of the thesis explores the overall picture of supply chain resilience knowledge by investigating what theories were used by supply chain resilience studies and how these theories explain the phenomenon. Building on the first study, the second and third studies employ three theoretical lenses that have not been fully utilised by resilience studies to date, namely attention-based view, agency theory and institutional theory, to investigate both the engineering view and the social-ecological view of resilience under the impact of geopolitical disruptions.

Chapter 2 - the first study - examines how supply chain resilience is understood from a theoretical perspective. By analysing the theories applied in supply chain resilience research, this study identifies constructs that may influence or be influenced by supply chain

resilience and explores how these theories are employed to interpret the relationships between supply chain resilience and these constructs. Based on this analysis, a conceptual framework is developed to illustrate the relationships among the various constructs. Building on this framework, the study offers conceptual and empirical directions for future research that utilise specific theoretical perspectives.

Chapter 3 - the second study - adopts the attention-based view and agency theory to investigate how firms' perception of COVID-19 pandemic risk affects the accumulation of different types of slack resources, and how these resources have a differential impact on firms' operational resilience during COVID-19. Findings show that during COVID-19, a higher risk perception of COVID-19 led to a higher level of capacity slack and financial slack in the firm. However, through the examination of a pair of competing hypotheses, which were drawn from the proposition of the attention-based view and agency theory, and the differences among capacity, inventory, and financial slack, this study found that only capacity slack benefited firms' operational resilience during COVID-19, while financial slack negatively influenced firms' operational resilience. Such a result suggests that firms' attention towards geopolitical disruptive events can affect their decision-making around resource allocation, and the impact of different types of slack resources on operational resilience differs because of the different characteristics of slack resources. This study offers insight for firms about how to achieve engineering resilience under the impact of geopolitical disruptive events.

Chapter 4 - the third study - employs institutional theory and a social-ecological perspective on resilience to examine whether firms adapt their supply networks to foster resilience, based on the level of regulatory distance and perceived political risk. This study finds that firms adapt their supply networks in terms of regulatory distance after being exposed to the US-China trade war. Furthermore, results suggest that the buying firms'

perception of political risk negatively moderates the relationship between their exposure to the US-China trade war and the extent of supply network adaptation. The finding contributes to existing literature by offering insights into the broader discussion on how to achieve social-ecological resilience under the impact of geopolitical disruptive events.

1.5 The Structure of the Thesis

The thesis consists of five chapters. This chapter has introduced the thesis and provided an overview. It is followed by Chapter 2, which presents the first study, titled "Supply chain resilience: a systematic literature review under the theory lens", aiming to answer the first and second research questions of the thesis. Chapter 3 includes the second study, titled "A dual perspective on slack: How risk perception and slack resources shape operational resilience during COVID-19", addressing the third and fourth research questions. Chapter 4 presents the third study, titled "Adapting supply networks to achieve resilience: The impact of geopolitical disruption and institutional distance", focusing on the fifth and sixth research questions of the thesis. Chapter 5 offers a conclusion, highlighting the implications and limitations of the thesis, and proposing future research directions based on limitations.

Chapter 2. Supply Chain Resilience: A Systematic Literature Review Under the Theoretical Lens

2.1 Introduction

Supply chain resilience (SCRES) is a term that has been investigated extensively by supply chain management (SCM) scholars since it was first proposed (Datta, 2017; Kochan and Nowicki, 2018). It has received different representations across the literature: as a capacity (Hosseini et al., 2022; Pettit et al., 2013); system property (Dubey et al., 2021; Hosseini et al., 2022; Kim et al., 2015); ability (Borekci et al., 2015; Cheng and Lu, 2017; Modgil et al., 2021); and most commonly, as a capability (Ali et al., 2022; Bhattacharjya, 2018; Chowdhury and Quaddus, 2016; Dabhilkar et al., 2016; Fan and Stevenson, 2019; Mubarik et al., 2021).

Discussion in the literature around SCRES covers many aspects, including its components (Ali et al., 2017; Nikookar and Yanadori, 2022; Tukamuhabwa et al., 2015), antecedents (Ruel and El Baz, 2021; Gabler et al., 2017; Jain et al., 2017) and outcomes (Ali et al., 2022; Lee and Rha, 2016; Wong et al., 2020). The number of SCRES studies has grown steadily in the past few years (Ali et al., 2017; Datta, 2017; Han et al., 2020; Kochan and Nowicki, 2018), attributed to the fact that supply chain (SC) disruptions are becoming more frequent (Hendry et al., 2019; Herold et al., 2021; Pettit et al., 2013). These disruptions can be triggered by events outside of the scope of firms and supply networks, such as natural disasters (floods, earthquakes, and tsunamis) and geopolitical disruptions (Brexit, COVID-19, and Russia's invasion of Ukraine), (Ivanov and Dolgui, 2020; Kähkönen et al., 2023). Meanwhile, disruptions also emerge from the inside of firms or supply networks due to supply chain complexity or glitches (A. Marley et al., 2014; Hendricks et al., 2003; Wiedmer et al., 2021). Although the thesis focuses specifically on geopolitical disruptions, a broad

review of supply chain resilience (SCRES) is necessary to establish a comprehensive understanding of the current state of the field, thereby enabling the identification of knowledge gaps, theoretical limitations, and underexplored phenomena related to geopolitical disruptions.

A number of SCRES systematic literature reviews (SLR) have made a cogent summary of work to date (Ali et al., 2017; Datta, 2017; Han et al., 2020; Kochan and Nowicki, 2018; Tukamuhabwa et al., 2015). Nevertheless, none of these reviews observes SCRES studies from a theoretical position - a unique perspective that could refine the description and explanation of complex phenomena (Carter and Rogers, 2008; Halldórsson and Aastrup, 2003; Kembro et al., 2014). Review papers that conduct analysis based on theories have appeared across management fields, such as CSR (Frynas and Stephens, 2015; Kraus and Brtitzelmaier, 2012; Lee, 2008), marketing (Johnsen et al., 2017; Waqas et al., 2021), HRM (Van Beurden et al., 2021), and hospitality management (Ulker-Demirel and Ciftci, 2020). In the SCM field, theory-focused review papers are fewer in number but still exist and tend to focus on a specific research context, such as information sharing in SC (Kembro et al., 2014), sustainable SCM (Touboulic and Walker, 2015), or SC risk management (Fan and Stevenson, 2019) for example. Some SLR studies also focus on one theory in depth (i.e. institutional theory (Kauppi, 2013) or agency theory (Matinheikki et al., 2022)), examining how it has been applied in an SCM context.

Focusing on SCRES SLR studies (Kochan and Nowicki, 2018; Tukamuhabwa et al., 2015), it appears that the approach to investigating the role of theory remains mostly at the descriptive level, instead of investigating how theories are integrated with the body of SCRES knowledge. This could be attributed to the fact that the number of SCRES studies that appropriately applied theories was relatively small and not substantive enough to deliver valuable conceptual or theoretical findings. Therefore, there has not been a exclusive

theoretical perspective SLR focusing on SCRES knowledge. This gap in SCRES knowledge from a theoretical perspective has several limitations. First, although these reviews generate a comprehensive categorisation system for existing SCRES knowledge, their interpretation of the connection between themes and constructs is relatively weak. Studies infer that constructs such as capabilities (Ali et al., 2017; Han et al., 2020; Kochan and Nowicki, 2018; Tukamuhabwa et al., 2015), performance (Datta, 2017; Han et al., 2020), and context (such as disruption, risks, and vulnerability) (Datta, 2017; Kochan and Nowicki, 2018) strongly correlate with the establishment of SCRES. To date, however, there remains little investigation of the link or relationship between these constructs. Secondly, these studies do not offer any insight into the contingent constructs that interact with SCRES in a more dynamic and realistic way. For example, studies such as Ali et al. (2017) and Han et al. (2020) provide an exhaustive list of constructs that can interact with SCRES, but since they only focus on the relationship between SCRES and certain constructs, they don't capture the contingent effect of constructs such as trust, uncertainty and complexity on the relationship between SCRES and performance or certain other capabilities.

These limitations indicate the importance of a SLR on SCRES from the theoretical perspective. Theories define a scientific field and develop insight into motivated research questions (Carter, 2011; Rindova, 2011). Most SCM studies borrow theories from other disciplines (Durach et al., 2021) and given that new theory development can explain a phenomenon that has never been adequately investigated (Carter, 2011), there is a risk that SCM falls behind other disciplines in this regard. An SLR could prove helpful in identifying trends across theory application, use and gaps in SCM that could identify new concepts or challenge findings formed by borrowed theories (Durach et al., 2021). It follows that a review paper for SCRES from a theoretical perspective can offer a theoretically insightful contribution. This study identifies how theory is applied across SCRES studies, in order to

understand how theory might help us better explain the relationship between SCRES and constructs that interact with, or facilitate, SCRES.

Besides summarising existing knowledge by focusing on the findings and implications already appearing in the literature to date (Cronin and George, 2023), SLR should also enable researchers to reimagine existing literature in ways that inspire new and improved perspectives on specific phenomena, by developing an alternative set of assumptions that could serve as the foundation for a novel theoretical contribution (Alvesson and Sandberg, 2020). An SLR that observes knowledge from a theoretical perspective is a great tool to achieve this goal by critically evaluating the existing assumptions embedded in theoretical perspectives that have been intensively used in the former literature. Therefore, another aim of this study is to offer fresh insights into how theory can be applied in future SCRES studies. Based on the motivations above, two research questions are proposed:

RQ1: How are different theoretical perspectives embedded to explain the current body of supply chain resilience knowledge?

RQ2: How can supply chain resilience knowledge be extended based on existing studies and theory?

Based on the findings, this study will develop a conceptual framework illustrating how theories are applied across the SCRES body of knowledge. It will classify the main constructs that interact with SCRES and identify gaps in the literature which inform the suggestions made around future research opportunities for conceptual or empirical SCRES studies that rely on specific theoretical lenses.

The remainder of this paper is structured as follows. Section 2.2 outlines and justifies the research methodology used to identify relevant literature whilst Section 2.3 presents the results of the analysis. Finally, Section 2.4 provides a discussion of the study's critical

findings, offers a conceptual framework and discusses the implications and limitations, before making several recommendations for future research.

2.2 Methodology

This study applied the SLR method proposed by Denyer and Tranfield (2009), adopted also by other SCRES SLR studies (Hohenstein et al., 2015; Ali et al., 2017; Han et al., 2020). This method comprises five stages: research question formulation, research locations, study selection and evaluation, analysis and synthesis, and results reporting (Denyer and Tranfield, 2009). Each of these stages will now be described in turn.

2.2.1 Research Question Formulation

Research question formulation is the first step of conducting an SLR (Denyer and Tranfield, 2009). A clear research question is compulsory for an SLR as it defines the review's scope and identification (Hiebl, 2021). Two research questions of this study are "RQ1: How are different theoretical perspectives embedded to explain the current body of supply chain resilience knowledge?" and “RQ2: How can supply chain resilience knowledge be extended based on existing studies and theory?” These two questions were proposed based on the research background outlined in the introduction. Besides that, it is also in light of the contention of Durach et al. (2017), who stated that in the SCM field, SLRs could increase scholars' understanding of the usefulness of a theory in a specific phenomenon. Therefore, the two main research questions are divided into four sub-questions to offer more granularity for this review question and increase its contribution.

1. *What constructs are addressed by SCRES studies?*
2. *What theories are applied by SCRES studies?*
3. *How do these theories interpret the relationship between SCRES and constructs that could affect or be affected by SCRES?*

4. How can SCRES knowledge be extended based on existing studies and theory?

Among these four sub-questions, the first three aim to address RQ1 and the fourth aims to address RQ2.

2.2.2 Research Locating

Standard SLRs need to locate, pick, and evaluate studies that are related to research questions (Denyer and Tranfield, 2009). The method of research locating in this study is journals based instead of database based, as in most SLR studies. This decision is based on the trade-off between the quantity and quality of studies. Several former SLR studies have verified that the number of SCRES papers has significantly increased in the past few years (Tukamuhabwa et al., 2015; Han et al., 2020). A SLR should include various sources to be comprehensive and reduce potential biases in findings (Ali et al., 2017). However, from the quality perspective, Durach et al. (2015) found that it is easier to see theoretical contributions and different insights in studies published in higher-ranking and better-quality journals in the SCM field. This points to the validity of the journal-based selection process, and several SLRs in the SCM field have adopted this method (Kembro et al., 2014; Matinheikki et al., 2022).

Journals were selected from the Academic Journal Guide 2024 (ABS journal list) developed by the Chartered Association of Business Schools (CABS). In total, 35 journals were chosen as the database of this study. 13 of them from the Operations Strategies and Technology category above three stars, as these journals are OSCM field journals that SCRES studies are most likely to feature in. "Decision Science" in Operation Research and Management Science was listed as a supplement. Also, 21 of them are from the general management (Ethics-CSR-Management) category above three stars. Several high-quality SLRs in OSCM disciplines (e.g. Jia et al., 2017; Matinheikki et al., 2022; Netland and

Aspelund, 2014) have included studies from high-quality general management journals, because these studies offer an inter-disciplinary scope that can effectively enhance the development of theory and the understanding of complex phenomena in OSCM topics (Matinheikki et al., 2022).

Following the identification and selection of appropriate journals, keywords that will help to identify relevant studies for further analysis, are then defined. Keywords used in this study include 'supply chain', combined with any of the following terms: 'resilience', 'resiliency', or 'resilient'. These terms were searched under the scope of "all fields" (full-text research). The time scope of this study is set from 2004 to 2025 because this study focuses on "supply chain resilience", and 2004 is the year that SCRES was proposed for the first time in a study (Christopher and Peck, 2004).

2.2.3 Study Selection and Evaluation

SLRs need a clear criteria list and screening process to verify the relevance of selected papers because of the requirement of transparency (Denyer and Tranfield, 2009). Based on the research locating guidelines, 1217 studies were derived through the search results, and they were then selected and evaluated based on the inclusion criteria, as stated in Table 2.1. These inclusion criteria were followed throughout the review of the full paper. First, after reading through each study, studies that didn't meet the requirements of the inclusion criteria were excluded, leaving 515 studies. Then, the remaining 515 studies joined the screening process based on another round of review. During this step, studies were divided into two categories based on whether they adopted theoretical perspectives, or not. The screening result showed that 211 of 514 studies adopted theoretical perspectives, with the remaining 303 not. It follows then that these 211 studies formed the basis of the data sample of this review study and the basis for further analysis. Table 2.2 shows the number of studies left after each step in different journals.

Table 2.1: Inclusion criteria and rationale

Inclusion	Rationale
The language of the selected research should be English	English is the dominant language in OSCM field.
Resilience as one of the variables or contexts of the research	The study aims to review the papers that discuss supply chain resilience.
Types of articles: Systematic literature review, empirical, conceptual.	Mathematical modelling studies were excluded as they are not likely to adopt management theory.
Studies that were published from 2004 to 2025	The term "supply chain resilience" was first proposed in 2004.

Table 2.2: Studies selection results

Located journals	Initial search result	Studies fit inclusion criteria	Adopted theoretical perspective
Supply Chain Management: An International Journal	161	79	33
International Journal of Production Economics	170	62	32
International Journal of Operations and Production Management	97	48	30
IEEE Transactions on Engineering Management	50	34	20
International Journal of Production Research	315	88	18
Journal of Business Research	67	31	18
Journal of Business Logistics	66	31	13
Production Planning and Control	84	43	11
Journal of Supply Chain Management	39	19	11
Journal of Purchasing and Supply Management	53	21	8
Journal of Operations Management	28	15	7
British Journal of Management	6	5	3
California Management Review	5	4	2
International Journal of Management Reviews	4	3	2
Decision Sciences	17	8	1
Business and Society	1	1	1
Journal of Management Studies	3	1	1
Production and Operations Management	23	8	0
MIT Sloan Management Review	7	6	0
Harvard Business Review	5	5	0
European Management Review	2	2	0
Manufacturing and Service Operations Management	8	1	0
Journal of Business Ethics	3	0	0

Academy of Management Journal	2	0	0
Academy of Management Discoveries	1	0	0
Computers in Industry	0	0	0
Academy of Management Annals	0	0	0
Academy of Management Review	0	0	0
Administrative Science Quarterly	0	0	0
Journal of Management	0	0	0
Academy of Management Perspectives	0	0	0
Business Ethics Quarterly	0	0	0
Gender and Society	0	0	0
Gender, Work and Organization	0	0	0
Journal of Management Inquiry	0	0	0
Total	1217	515	211

2.3 Analysis and Findings

Studies analysis and synthesis aim to extract critical information from selected studies (Denyer and Tranfield, 2009), and this stage of the SLR process should inform the known and unknown knowledge attached to the research question (Denyer and Tranfield, 2009). This section will analyse and report the findings of this review by identifying the constructs discussed in SCRES studies and articulating how theories are used to interpret the relationships between these constructs and SCRES.

2.3.1 The Disruption Versus SCRES: An Analysis of the SCRES Definition

Although this review will mainly focus on the theoretical perspective of SCRES studies, some investigation into the definition of SCRES that studies applied or proposed is deemed meaningful given that SCRES is often criticised as a term because of its 'inconsistent definition' (Kochan and Nowicki, 2018; Mensah and Merkuryev, 2014). Hence, the definition in a study may reflect its perception of SCRES, including constructs they considered and tried to explain through the adoption of a particular theoretical lens. Therefore, an analysis of the SCRES definitions appearing in collected studies is conducted. The analysis shows that among 211 collected studies, 112 offer a definition for SCRES. Table 2.3 shows the terms that appeared in SCRES definitions.

Given the plethora of terms that appear in the SCRES definitions, they were subdivided into five categories modified from the ontology of resilience proposed by Madani and Parast (2021). This ontology explains components of an SCRES definition, with categorisation based on ontology showing the consistency and inconsistency of the SCRES definition in collected studies.

Table 2.3: SCRES definition analysis

Entity		Expectation		Ability		Respond		Changes	
supply chain/SC	70	operat(e)/(ion)	39	abilit(y)/(ies)	50	recover(ing)/(ey)	59	disrupt(ed)/(ion)	97
firm	23	state	31	capabilit(y)/(ies)	45	respond(ing)/response	43	event(s)	36
system	13	continuity/continue	20	capacity	10	adapt(ing)/adaptive	36	disturb(ed)/(ance)	17
structure	12	function(al)	19	extent	3	prepare(d)/preparation	23	unexpected	17
organis(z)ation(s)	11	original	18	property	1	maintain(ing)	23	change(s)/changing	16
network(s)	5	desirable/desired	17			return(ing)	22	risk	10
entities	1	time(ly)	16			absorb(ing)/absorptivity	13	shock	5
enterprise	1	performance	16			transform(ing)/(ation)	9	turbulent	5
		effective(ly)/(ness)	13			resist(ing)/(ance)	6	unforeseen	3
		quick(ly)	12			anticipate/ing	5	interruptions	2
		control	11			restor(e)/(ing)	5	damage	1
		connectedness	9			alert(ness)	4	failure	1
		better	8			react(ive)	4	incidents	1
		dynamic	8			readiness	4		
		normal(ity)	8			cope	3		
		acceptable	7			persist	3		
		grow(th)	7			prevent	3		
		bounce/bouncing back	5			proactive	3		
		rapid(ly)	5						
		cost-effective	4						
		equilibrium	3						
		evolv(ing)/(olution)	3						

The analysis shows that most studies are consistent around "Entity", "Ability", and "Change" being a feature of SCRES definitions. "Entity" is the subject that is supposed to be resilient (Madani and Parast,2021). The majority of SCRES studies recognise SCRES as a supply chain (Laguir et al., 2024; Nayal et al., 2024) or supply network level (Chowdhury and Quaddus, 2017; Kim et al., 2015) feature, but some studies will directly phrase the SC or supply network as a "system" (Hearnshaw and Wilson, 2013; Mirzabeiki and Aitken, 2022) when they use theories such as complex adaptive system or panarchy theory to emphasise the interaction between SC and social-political or planetary environment. However, a small number of studies recognise SCRES as an organisation or firm-level feature (Gölgeci and Ponomarov, 2013; Stentoft et al., 2023). "Ability" is the term that describes the function of resilience itself. SCRES definitions usually apply either "capability" (Altay et al., 2018; Dubey et al., 2020; YaroSon et al., 2021) or "ability" (Blackhurst et al., 2011; Lorentz et al., 2021) to describe SCRES. However, since capabilities are organisational abilities utilised to assemble, assimilate and use resources (Bharadwaj, 2000), these two descriptions overlap. "Change" refers to the alteration that affects entities and establishes SCRES (Madani and Parast,2021). Terms such as disturbance or turbulence were occasionally used, but disruption (or disruptive) was used the most, as it was included in 86% of SCRES definitions. This indicates that some form of disruptive context is common when defining SCRES.

Inconsistency around the terms used across SCRES definitions coalesces around "Respond" and "Expectation" components, which have a deep connection with disruption ("Change"), with "Expected outcomes" expressing the ideal post-disruption status of entities, for example. Depending on the business environment, it could be either the original state compared with the pre-disruption time point (Dey et al., 2024) or a new desired level (Ryan et al., 2022). It also covers conditions for reaching this status, such as time and cost

effectiveness (Luqman et al., 2023; Polyviou et al., 2019), and operations continuity (Ryan et al., 2022). "Respond" is the component that describes the entities' behaviour and reactions to disruption (Madani and Parast,2021). A diverse group of terms were used in this category (18 in total). Still, these responses can be categorised into three stages: proactive (prepare, alert, proactive, resist, robust), reactive (recover, maintain, return, etc.), and transformation (transform, adapt), each representing distinct methods and time scales for addressing disruption. However, such responses will be affected by the disruption, as SC or supply networks' resilience capacities might not be enough with the increasing frequency and severity of disruptions.

Several observations can be made from the analyses of SCRES definitions: first, these definitions are consistent with the understanding that SCRES is an SC (or network) capability that responds to and tackles disruption. Second, there is a degree of misalignment around the response to disruption and the expected outcome, post-disruption. In general, regardless of the terms used in defining SCRES, most of these definitions contend that disruption is a central component. In considering the misalignment, on one hand, the establishment of SCRES is said to undermine the impact of disruption by decreasing the time taken and cost of returning the supply network to normal operating status (van den Adel et al., 2021; Vann Yaroson et al., 2023). On the other hand, the increasing frequency and severity of disruptions are said to increase the time taken and cost for SC to recover from such disruptions (Tukamuhabwa et al., 2015). Therefore, this study posits that SC disruption and SCRES are opposing forces. This is proposed as a helpful starting point for investigating how theories can be applied and understood to explain SCRES. This disruption-resilience opposing relationship will be the foundation of divergent and contrasting findings in the later section.

2.3.2 Descriptive Analysis from Theoretical Perspectives

The next stage of the SLR process is a descriptive analysis which informs understanding around the development of SCRES studies and the theories applied. The findings are presented in Tables 2.4 and 2.5. First, in Table 2.4 there are 54 theories adopted by SCRES studies. Although 211 studies were collected as data samples, 54 theories were applied 262 times by these studies as 50 studies adopted two or more theories. Using multiple theories can be beneficial for the theoretical development of a study, as a single theory might have limited explanatory power and fail to address the full scope of a complex phenomenon (Kembro et al., 2014).

Second, it is observed that the number of SCRES studies that adopt a theoretical lens increases over time, especially after 2022. The reason could be that OSCM scholars pay more attention to theoretical rigour now than before in response to feedback in the journal review process (Carter, 2011). It could also be that this upward trend is mirroring the increase in SCRES studies (Ali et al., 2017; Han et al., 2020). Third, dynamic capability theory is the most used theoretical lens, appearing in 22.7% of studies, followed by organisational information processing theory, resource-based view, complex adaptive system theory, and resource dependence theory. These five theories appeared 132 times in collected studies, inferring that one of two SCRES papers will likely adopt one of these five theories in their theoretical development.

Table 2.4: Theoretical lenses across years

Theory	2011	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	Total
Dynamic capability		1			1	2	2	1	3	4	8	12	17	8	59
Information process theory			1			1		1	4	3	2	1	6	5	24
Resource-based view	1		1			1		1		3	2	5	5		19
Resource dependence theory									1		3	4	5	2	15
Complex adaptive system		2		1				2		4	2	3		1	15
Contingency theory			1		1	1		1		1	3	2	1	1	12
Institutional theory											1	4	3	1	9
Social capital theory		1						2		1	2	2	1		9
Normal accident theory			1		1	2				1	2	1		1	9
Relational view								1	1		1	1	2		6
Knowledge-based view										1	1	3	1		6
High reliability theory					1	2		1		1		1			6
Panarchy theory										1	3		1	1	6
Transaction cost economics										1			3	1	5
Social exchange theory			1			1	1		1	1					5
Network theory								1			1	1	2		5
Resource orchestration theory											1	2	1		4
Graph theory				1				1					1		3
Practice-based view											2		1		3
Attention-based view										1	1				2
Internalization theory											2				2
Game theory										1				1	2
Systems theory	1										1				2

Organizational learning theory									2	2
Paradox theory							1	1		2
Portfolio theory	1				1					2
Risk compensation theory				1						1
Socio-technical system theory								1		1
Complexity theory							1			1
Actor-network theory									1	1
Transactive memory				1						1
Organisational readiness for change theory					1					1
Sensemaking theory								1		1
Organizational capability theory								1		1
Social network theory									1	1
Boundary spanning theory			1							1
Neo-gramscian theory		1								1
Conservation of resources theory							1			1
Nexus suppliers theory								1		1
Change management theory							1			1
Risky decision-making theory			1							1
Enactment theory							1			1
Signalling theory		1								1
Goal interdependence theory									1	1
Corporate reputation theory							1			1
Punctuated equilibrium theory									1	1
Social system theory						1				1
Behavioural decision theory				1						1
Structural contingency theory						1				1
Competing values theory			1							1
Governance theory			1							1

Resource efficiency view												1				1
Knowledge management theory													1			1
Agency theory														1		1
Total	2	4	6	3	5	12	3	14	13	26	40	49	56	29		262

*There is no study from 2012 in the data sample

Table 2.5 presents the constructs that SCRES studies address and how different theories are applied to examine these constructs. Several constructs that frequently appear are identified, including capability, relational embeddedness, structural embeddedness, environmental uncertainty, performance, individual behaviour, system-node conflict, and strategies and practices (these terms will be introduced in the following sections). The analysis indicates that: first, *capability* is the construct that was discussed the most with 91 studies examining the function of capabilities during the establishment of SCRES. There is also a good deal of attention paid to other constructs such as relational embeddedness, structural embeddedness, environmental uncertainty, strategy and practice, and performance. The analysis also indicates that theories tend to focus on one or two constructs rather than deal with SCRES on a comprehensive basis. For example, most of the studies that used social exchange theory and the relational view focus on relational embeddedness, while studies that adopt network theory focus on structural embeddedness. It is postulated that valuable insights could be derived from a more detailed analysis of how each construct is interpreted across different theories.

The following analysis will be based on the findings of the definition analysis and descriptive analysis. The remainder of the paper will now focus on 1. What constructs are examined around the opposing relationship between SCRES and disruption, and 2. How different theories address constructs that could explain the opposing relationship between SC disruption and SCRES.

Table 2.5: Theoretical lenses adopted by constructs

Theory	Capability	Strategies or practices	Structural embeddedness	Relational embeddedness	Environmental uncertainty	Other	Performance	Individual	Total
Dynamic capability	34	11	1		7	2	12	1	68
Information process theory	13	10	2		6	1	3		35
Resource dependence theory	3	4	6	6	1	1	1		22
Resource-based view	8	8	1			2	3		22
Complex adaptive system	2	2	5	1	3	6			19
Contingency theory	4		2	2	4	2	2	1	17
Social capital theory	2		3	6		1		1	13
Institutional theory		2		2	6			2	12
Normal accident theory	2	1	5	2		2			12
Panarchy theory	4	1			4				9
Relational view	1			6					7
Transaction cost economics	2		1	2	1		1		7
Social exchange theory	1			5					6
High reliability theory	3		1			2			6
Knowledge-based view	3	1				2			6
Network theory			5			1			6
Resource orchestration theory	3					1			4
Systems theory	1		2						3
Graph theory			3						3
Practice-based view		3							3
Organizational learning theory	1	1		1					3
Game theory				2					2
Punctuated equilibrium theory	1			1					2
Socio-technical system theory		1			1				2
Internalization theory						2			2

Portfolio theory				2								2
Social system theory				1		1						2
Attention-based view											2	2
Paradox theory	2											2
Signalling theory								1				1
Transactive memory								1				1
Governance theory						1						1
Behavioural decision theory											1	1
Risky decision-making theory											1	1
Conservation of resources theory			1									1
Neo-gramscian theory								1				1
Enactment theory			1									1
Nexus suppliers theory				1								1
Boundary spanning theory						1						1
Organizational capability theory								1				1
Change management theory								1				1
Sensemaking theory											1	1
Corporate reputation theory										1		1
Complexity theory				1								1
Knowledge management Theory							1					1
Social network theory				1								1
Competing values theory						1						1
Structural contingency theory			1									1
Resource efficiency view								1				1
Actor-network theory								1				1
Goal interdependence theory						1						1
Organisational readiness for change theory	1											1
Agency theory						1						1

Risk compensation theory								1	1
Total	91	48	43	42	34	32	23	11	324

2.3.3 The Antecedents and Drivers: Environmental Uncertainty and Complexity

Many SCRES studies were conducted in the context of disruptions that were incubated by a particular type of event or structural changes to the system that might be triggered by such events (Hendry et al., 2019; Kähkönen et al., 2023; Wiedmer et al., 2021). For example, thirty-two studies explicitly state that their studies were conducted under the context of COVID-19 (e.g. Karaosman et al., 2023; Munir et al., 2022), six studies were under the context of other geopolitical events, such as Brexit or the US-China trade war (e.g. Fan et al., 2024; Hendry et al., 2019; Zheng et al., 2025), and five studies were under the context of extreme weather events (Bag et al., 2022, 2025; Patel, 2025; Tsvetkova and Gammelgaard, 2024; Wang and He, 2024). These contexts can be categorised into external environmental uncertainties or structural complexities (including structural embeddedness and relational embeddedness) that reside in, or characterise, the supply network (Tukamuhabwa et al., 2015). Henceforth, these terms serve to structure or categorise how SCRES is discussed in this paper.

The descriptive analysis shows that environmental uncertainty and complexity appear together in most SCRES studies. However, how they have been positioned is often contradictory with one school of thought presenting them as sources of disruption (Kiessling et al., 2025; Manhart et al., 2020; Wu et al., 2023; Xiao et al., 2024) using theories including organisational information processing theory, institutional theory, normal accident theory, or resource dependence theory to support this perspective. The alternative school of thought is that environmental uncertainty and complexity can aid in the establishment of SCRES across supply networks and firms inside them, adopting theories such as dynamic capability, social capital theory, or social exchange theory to support this contention. It is clear from the analysis of the literature to date, that the relationship between complexity, environmental

uncertainty and SCRES, and the theoretical foundations that are used to examine their interrelationships, deserves more attention. As such, the following sections will examine these important constructs in more detail.

2.3.3.1 Environmental Uncertainty

Thirty-four studies discuss the role of environmental uncertainty on SCRES or SC disruptions. The term "environment" in the supply network context refers to the macro background where the supply network operates. It could refer to any social, political, economic, or technological context, and natural phenomena (such as geological, meteorological, or pathological) (Peck, 2005). The change of these contexts or phenomena is usually not under the control of the supply network or firms. Environmental uncertainty is one of the primary sources of disruption that the supply network needs to defend itself from. Environmental uncertainty can present in various forms, such as natural disasters, terrorist attacks, economic decline, or regulatory changes (Day, 2014; YaroSon et al., 2021). These events can trigger changes in the supply and demand of the upstream and downstream SC and lead to disruption.

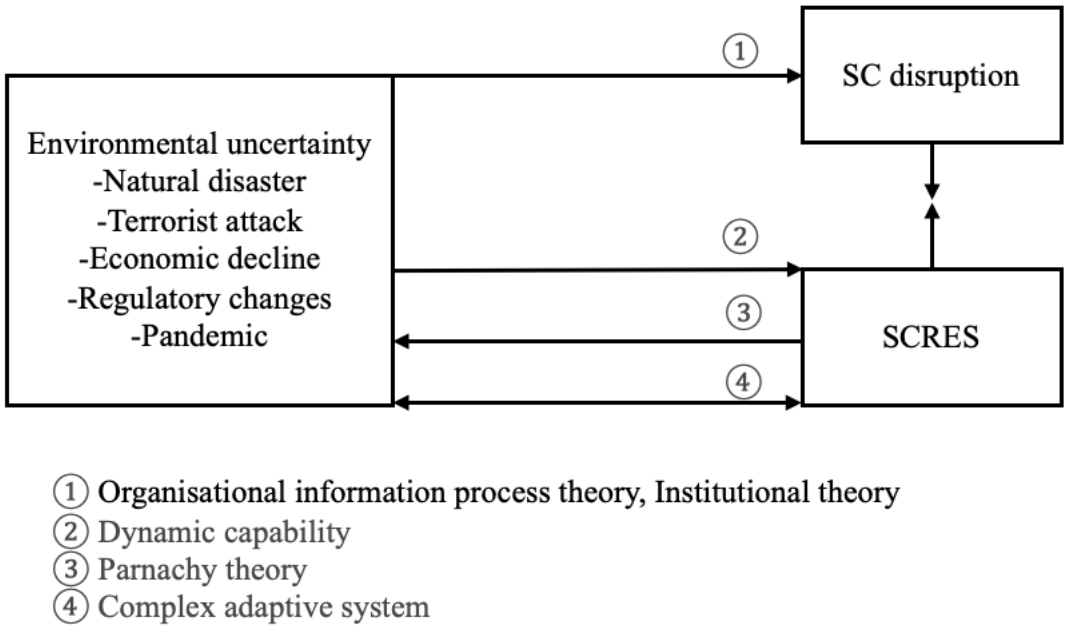


Figure 2.1: Interactions among environmental uncertainty, SC disruption, and SCRES

In considering environmental uncertainty, as Figure 2.1 illustrates, the literature to date has applied five different theories to understand its influence on disruption and SCRES, namely organisational information processing theory, dynamic capability, institutional theory, complex adaptive system theory, and panarchy theory. These five theories offer contrasting views on the position of environmental uncertainty.

As aforementioned in the definition analysis section, SCRES enables a response to disruption. Based on this view, environmental uncertainty does not positively affect SCRES building since it triggers disruption. The increasing number and severity of disruptions could increase the difficulty of responding to them (Zheng et al., 2025). Six studies adopt organisational information processing theory to define these environmental uncertainties as 'the difference between the amount of information required to execute a task and the level of information already available with the organisation' (Galbraith, 1974) (point 1 in Figure 2.1). The degree of difference shows the severity of uncertainties and reflects the impact level of the SC disruption (Ellis et al., 2011). Increasing disruption severity will require organisations to invest more resources or time to address this difference, hence undermining firms' SCRES. Therefore, studies that use organisational information processing theory will posit that a higher level of environment uncertainty, pointing to more frequent or unpredictable disruptions (Ivanovic et al., 2025; van den Adel et al., 2021), or a higher level of disruption impact (El Baz and Ruel, 2021), will lead to a lower level of SCRES or a longer recovery time.

Similar to organisational information processing theory, institutional theory also examines the negative impact of environmental uncertainty on SCRES, but institutional theory focuses on a particular aspect of environmental uncertainty – uncertainty from the social and political environment (point 1 in Figure 2.1). Institutional theory interprets institutions as "humanly devised constraints that structure political, economic, and social

interaction, and these can be formal (rules and laws) or informal (norms of behaviour") (North, 1990, p. 3). Each country has a unique institutional system, where normative rules, heuristics, and values reside outside of its direct control, and these institutions define a country's business environment uncertainty (Aguilera and Grøgaard, 2019). Based on these propositions, six SCRES studies adopting institutional theory posit that countries that have a weak institutional environment will bring risk and uncertainty to the supply network (Wu et al., 2023), hence undermining firms' efforts in building SCRES (Kiessling et al., 2025). Presentations of a weak institutional environment vary in SCRES studies, but can include insufficient police protection (Freitas et al., 2023), unstable legal or regulatory systems (Freitas et al., 2023; Kiessling et al., 2025; Napier et al., 2024), rapid regulatory changes (Roscoe et al., 2022; Srai et al., 2023), lack of policy support (Napier et al., 2024; Tsvetkova and Gammelgaard, 2024; Wu et al., 2023), and corruption (Kiessling et al., 2025).

However, instead of regarding environmental uncertainties as the source of disruption and a threat to the firms' and supply networks' operation, some theories position it as an opportunity to build SCRES. For example, dynamic capability theory is often used to evidence that environmental uncertainties could help firms and supply networks leverage and foster SCRES (point 2 in Figure 2.1). Seven SCRES studies adopting dynamic capability theory conceptualise SCRES as a type of dynamic capability. Although the definition of dynamic capabilities varies based on the research content and the field of study, a changing environment is always the background of any discussion of dynamic capabilities (Ali et al., 2022; Faruquee et al., 2024; Kähkönen et al., 2023; Wang and He, 2024). Dynamic capability theory states that dynamic capabilities can let firms "integrate, build, and reconfigure internal and external competencies to address rapidly changing environments" (Teece, 1997, p. 516). Meanwhile, dynamic capability theory also highlights the importance of environmental uncertainties in forming dynamic capabilities. Studies that adopted dynamic capability theory would investigate and discuss environmental uncertainty through

a generic context such as environmental dynamism (Faruquee et al., 2024; Gupta et al., 2023; Yu et al., 2019) or a specific event such as temperature extremes (Wang and He, 2024) or COVID-19 (Ali et al., 2022). Studies that adopt dynamic capability theory posit that dynamic capabilities are a learned pattern of collective activity (Teece et al., 1997). Therefore, it can be said that supply networks and firms that were exposed to a more uncertain or dynamic business environment have more opportunities to learn from this uncertainty and leverage dynamic capabilities (Faruquee et al., 2024; Gupta et al., 2023; Laguir et al., 2024; Yu et al., 2019). Based on such an argument, studies such as Ali et al. (2022) and Kähkönen et al. (2023) use dynamic capability theory to conceptualise SCRES as a dynamic capability and summarise that the environmental uncertainty will enable firms in the establishment of SCRES.

In contrast to the theories and studies aforementioned which mainly focus on the influence of environmental uncertainty on SCRES, four studies adopting panarchy theory propose that the change in resilience in the supply network level can influence the environment and create new uncertainties (point 3 in Figure 2.1). Panarchy theory contends that the supply network is an adaptive cycle with three dimensions: potential, connectedness, and resilience, which will change over time (Altuntas Vural et al., 2024; Steffen et al., 2018; Wieland, 2021). Meanwhile, the political-economic environment and the planet environment could also be conceptualised as another adaptive cycle. Panarchy theory posits that adaptive cycles at different levels can influence each other, rather than operating in isolation (Mirzabeiki and Aitken, 2022). Revolt is the link that connects the adaptive cycle of the supply network and the political-economic environment in panarchy theory. Although the supply network is operated at a lower level than the political-economic environment, a critical change in the supply network level adaptive cycle, including its resilience, can potentially affect the political and economic environment under high vulnerability (Berkes

et al., 2002). In general, panarchy theory proposes that the change of resilience in the supply network might bring new uncertainty to the environment.

Compared with dynamic capabilities and panarchy theory, both of which consider the relationship between environmental uncertainty and SCRES to be one-way, three studies using complex adaptive systems consider that "co-evolution" is the term that accurately describes the relationship between SCRES and a challenging environment (point 4 in Figure 2.1). As a complex adaptive system, the supply network is under threat of environmental uncertainty, and needs to develop certain system properties like SCRES to adapt to these uncertainties (Choi et al., 2001; Tukamuhabwa et al., 2015). Meanwhile, the change in these system properties and the decision-making process related to these properties could also influence the environment (Day, 2014). This co-evolution process doesn't necessarily suggest a virtuous cycle or constant conflict between SCRES and the supply network environment: since it is a co-evolution process, the outcome of resilience decision-making that aims to counter the impact of environmental uncertainties could change the environment in a positive or a negative way, so it is difficult to predict the effectiveness of resilience-building measures (YaroSon et al., 2021).

In general, this discussion around environmental uncertainty indicates some divergence in how SCRES studies conceptualise and examine the relationship among disruption, SCRES and environmental uncertainty. The first point of divergence is around how the environment impacts the relationship between SC disruption and SCRES. Based on this divergence, the following proposition is developed:

Proposition 1: Environmental uncertainty can positively affect the establishment of SCRES, while it is also one of the main sources of disruption.

The second point of divergence focuses on the causality between SCRES and

environmental uncertainty. Based on this, the following proposition is forwarded:

Proposition 2: The establishment of SCRES is necessary to respond to environmental uncertainty, but its development can also foster new forms of environmental uncertainty.

2.3.3.2 Complexity

Besides environmental uncertainty, complexity is another construct that could impact the opposing relationship between SC disruption and SCRES. However, unlike environmental uncertainty, a construct that firms or supply networks cannot control, complexity is a system characteristic that can be manipulated (Jacobs and Swink, 2011). In social sciences, high "complexity" describes a system that "includes a large number of parts that interact in a non-simple way" (Simon, 1962; p. 468). This definition generates two central dimensions of system complexity: structural complexity and dynamic complexity (Anderson, 1999; Perrow, 1981). There are many other categorisations of complexity appearing in SCM literature, such as upstream, manufacturing, downstream (Bozarth et al., 2009), production, interactive (process), task and location complexity (Handley and Benton Jr., 2013). However, they are not as comprehensive as structural/dynamic complexity categorisation, and do not associate with any particular theoretical lens.

In the SC context, the definition of structural complexity is “the structure of the supply chain, the variety of its components and strengths of interactions” (Serdarasan, 2013, p. 534). Meanwhile, dynamic complexity is the uncertainty, unpredictability or randomness of the supply network members’ operational behaviour (Fernández Campos et al., 2019). From the papers under review in this SLR, there is no study that investigates the effects of dynamic complexity from a theoretical perspective, and the theories adopted mainly focus on structural complexity. Figure 2.2 shows key theories that were adopted to interpret the relationship between the structural complexity and disruption/SCRES. These theories

discuss the impact of structural complexity based on its two dimensions derived from its definition. 'The structure of the supply chain' and 'the variety of its components' constitute the structural embeddedness dimension of structural complexity (Gölgeci and Ponomarov, 2015; Granovetter, 1985), including the number of nodes (entities) and links (buyer-supplier relationships) within the supply network, the length of the supply network (the number of tiers), and the spatial complexity of the network (geography distribution) (Bode and Wagner, 2015). 'Strengths of interactions' refers to structural complexity's relational embeddedness, which represents the relationship dependencies or closeness between entities (Gölgeci and Ponomarov, 2015; Granovetter, 1985; Serdarasan, 2013). Theories suggest that both dimensions could either be the main sources of disruption or positively affect the establishment of SCRES, as Figure 2.2 suggests.

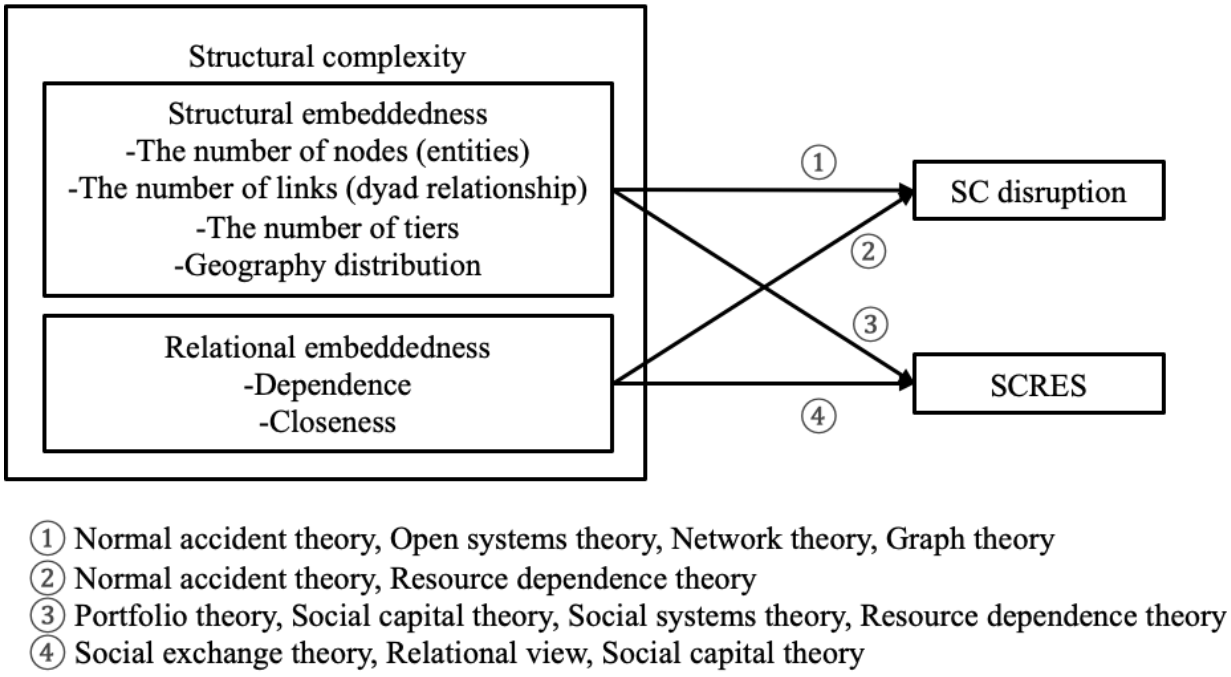


Figure 2.2: Effects of structural complexity on SC disruption and SCRES

Relational Embeddedness

Relational embeddedness is the dimension of structural complexity that explains how firms interact with other entities in the supply network. The discussion regarding relational

embeddedness's impact on disruption or SCRES is in line with two aspects of relational embeddedness: the closeness or dependence between entities (Gölgeci and Ponomarov, 2015; Granovetter, 1985; Serdarasan, 2013). Closeness refers to the intimacy of the relationship (Nikookar and Yanadori, 2022). Meanwhile, dependence refers to the reliance of one entity on another entity's actions to accomplish certain goals (Emerson, 1962). In a supply network, dependence among actors is created by an asymmetrical distribution of resources (Zhang and Huo, 2013). A high-dependence supply network means that components in the supply network, including firms and processes inside the network, are highly interdependent and rely on each other or share many variables (Scheibe and Blackhurst, 2018; Weick, 1979) Based on the observation on the sample studies in this SLR, dependency tends to be conceptualised as a source of disruption, while closeness tends to be conceptualised as a source of SCRES improvement.

From the disruption perspective, resource dependence theory is the main theoretical lens that was adopted to conceptualise relational embeddedness as a source of disruption. Six studies adopt resource dependence theory to explain how the dependence aspect of relational embeddedness constitutes a source of disruption for supply networks. Resource dependence theory recognises that dependence limits the entities' ability to respond to crises and magnifies the impact of disruption (Manhart et al., 2020; Xiao et al., 2024) (point 2 in Figure 2.2). Resource dependence theory originally contended that no organisation could be self-sufficient, so each must build relationships with others to acquire critical resources for operations and development (Pfeffer and Salancik, 2003). However, these inter-organisational relationships will eventually develop a dependency on external actors, bring power imbalance, and potentially impact the operation of organisations (Gebhardt et al., 2022). In SCRES studies, this damage could present as disruption of the supply network, so studies that adopt resource dependence theory state that the increasing dependency on other organisations or entities, including suppliers (Manhart et al., 2020; Spieske et al., 2022),

customers (Miocevic and Srhoj, 2023; Xiao et al., 2024), or even governments (Fan et al., 2024), could lead to the disruption and magnified disruption severity.

Examination around the benefit of relational embeddedness on SCRES mainly focuses on the level of relationship closeness in the supply network (Durach et al., 2020; Jain et al., 2017; Kaufmann et al., 2018). Theories such as the relational view (six studies) and social exchange theory (five studies) offer a foundation to explain why and how firms could build SCRES by strengthening relationships with other firms in the supply network. The relational view states that firms could gain a competitive edge and relational competencies through relational rents or benefits that emerge from collaboration and their partners' contributions (Dubey et al., 2019; Dyer and Singh, 1998; Razak et al., 2023). Social exchange theory builds on the necessity of relationship competencies, which come from a relational view, addressing how to build and maintain the relationship (Durach et al., 2020; Jain et al., 2017; Kaufmann et al., 2018; Shin and Park, 2021; Yilmaz Borekci et al., 2015).

Interactions between two entities exist because these entities received or expected to receive the reward from this behaviour (Homans, 1958; Thibaut and Kelley, 1959). This cooperative relationship should include two-way benefit exchanges (Kaufmann et al., 2018). Therefore, reciprocity is the premise of the relationship (Altman, 1973). The importance of such a cooperative relationship in establishing SCRES was also emphasised by studies that use game theory (two studies including Butt, 2025; van Hoek, 2021) or transaction cost economics (two studies including (Bechtsis et al., 2022; Fan et al., 2024). They suggest that a cooperative relationship will encourage cost-sharing and risk-sharing among the supply network, thereby reducing transaction costs and helping establish SCRES (Bechtsis et al., 2022; Butt, 2025; Fan et al., 2024).

Theories including social exchange theory and relational view conceptualise SCRES as an outcome of relationship closeness (relational embeddedness), so actions that help build

relationship closeness could also help build SCRES. These actions include trust (Dubey et al., 2019, 2020; Kaufmann et al., 2018; Ul Akram et al., 2024), cooperation or coopetition (Butt, 2025; Dubey et al., 2019, 2020; Yilmaz Borekci et al., 2015), collaboration (Dubey et al., 2020; Jain et al., 2017; Münch and Hartmann, 2023; Ul Akram et al., 2024; van Hoek, 2021), social bonding (Durach et al., 2020), conflict avoidance (Faruquee et al., 2024), substantive responses (Kaufmann et al., 2018), and communication (Münch and Hartmann, 2023). These actions function not only at the organisational level but also on the individual level: theories such as leader-member exchange theory and boundary spanning theory suggest that relationship building at individual levels can foster the development of SCRES (Fan and Stevenson, 2019; Shin and Park, 2021). These individuals include SC leaders (who aim to improve the whole supply network) or boundary spanners (who represent the organisation involving external activities and process information from external) (Aldrich and Herker, 1977; Fan and Stevenson, 2019; Mokhtar et al., 2019; Shin and Park, 2021).

Structural Embeddedness

Similar to relational embeddedness, SCRES studies also developed divergent views on the impact of structural embeddedness on disruptions or SCRES, based on the theoretical lenses that were adopted. Three theories were used to explain how structural embeddedness becomes a source of disruption, including open systems theory (two studies), network theory (five studies), and graph theory (three studies), as point 1 in Figure 2.2 shows. Open systems theory considers a firm or a supply network as an energic input-output system, meaning that organisations can't avoid interactions with the environment. To ensure the organisation (system) maintains its existence, the size and complexity of the system will increase during the interaction between the system and the environment (Katz and Kahn, 1978). Structural embeddedness (or structural variety in the open system theory context) is an essential component of open systems like supply networks and contends that this complexity is a

crucial construct influencing the vulnerability to disruption, hence damaging the SCRES of the supply network (Blackhurst et al., 2011; Hosseini et al., 2022). On the other hand, network theory or graph theory abstracts firms and their relationship among firms as nodes and lines, models the SC as a graph and aims to optimise the resilience of the network purely based on that (Bier et al., 2020; Kim et al., 2015). Studies adopting network theory describe structural complexity as a crucial factor that escalates the impact of SC disruption (Galaskiewicz, 2011). Due to the increasing complexity of the supply network, which indicates a high level of structural embeddedness, managing the impact of disruptions becomes increasingly difficult (Bier et al., 2020). Based on such notions, SCRES studies adopting network theory or graph theory argue that network structure criteria that shows a high level of structural embeddedness, such as a high level of network connectivity (the number of links in supply network with a fixed number of firms) (Choudhary et al., 2024; Namdar et al., 2024), and a high level of geographical diversification (Choudhary et al., 2023), will prevent firms in the supply network from building SCRES. Consequently, the supply network structure that possesses a low level of structural embeddedness, including low density, average degree, or betweenness centrality, has a higher level of SCRES (Hearnshaw and Wilson, 2013; Kim et al., 2015).

In contrast, three theories, including resource dependence theory (six studies), portfolio theory (two studies) and social system theory (one study), were adopted by SCRES studies to explain why structural embeddedness improves SCRES, as point 3 in Figure 2.2 suggests. Portfolio theory addresses the benefit of diverse suppliers, customers, and geographic distribution (described as structural embeddedness) on SCRES building (Brandon-Jones et al., 2015; Wiedmer et al., 2021). Rooted in the finance field, it contends that although more diverse bundles of securities are more complex to manage, they can reduce the influence of volatility (Markowitz, 1991; Sealey and Lindley, 1977). In SCM studies, portfolio theory, as it relates to SC risk management (Schwieterman et al., 2017),

suggests that portfolios of diverse suppliers offer flexibility in sourcing and minimise the negative impact of disruption by helping firms build disruption recovery capabilities and improve SCRES (Brandon-Jones et al., 2015; Wiedmer et al., 2021). Social systems theory expresses a similar proposition as it addresses the importance of system complexity in coping with environmental change (Luhmann, 1995). Therefore, studies that use social systems theory suggest that firms in supply networks need to develop enough structural embeddedness (i.e. the number of suppliers or countries in their supply network) to prevent the impact of disruption (Wissuwa et al., 2022).

Regarding resource dependence theory (refer to 3.3.2.1), it mainly focuses on how the dependence aspect of relational embeddedness could develop as a source of disruption. On that basis, studies that adopt resource dependence theory (Chi et al., 2025; Park et al., 2024; Polyviou et al., 2023; Zhu et al., 2025) posit that a low level of structural embeddedness, which could present as supplier or customer concentration, is the main reason for firms' increasing dependency on other organisations, so improving structural embeddedness can offset the negative impacts of dependence. In general, these three theories contend that instead of initiating disruption or magnifying the impact of disruptions, increasing structural embeddedness could aid in the establishment of SCRES. This increase in structural embeddedness could be reflected by the growth of suppliers or customers (Gebhardt et al., 2022; Wiedmer et al., 2021; Wissuwa et al., 2022) or increasing supply base geographical dispersion (Xu et al., 2024).

Theories That Cover Both Dimensions of Structural Complexity

Besides the theories that cover only one dimension of structural complexity, there are two theories covering the impact of both dimensions of structural complexity, namely normal accident theory and social capital theory. Normal accident theory (Points 1 and 2 in Figure 2.2) recognises that both high structural embeddedness and high relational embeddedness

can incubate the disruption in a supply network and spread the impact of disruption. Based on normal accident theory, accidents are normal and inevitable in a system due to its complexity (relating to structural embeddedness) and tight coupling (relating to relational embeddedness) (Scheibe and Blackhurst, 2018; Scholten et al., 2023). The reason is that increased structural complexity makes the system operator lose control of certain aspects of the system and increases the difficulty of understanding the system's full scope (Rijpma, 2003). In four SCRES studies, normal accident theory was applied to address how high levels of structural embeddedness, including large network size and geographic spread of the network (Scholten et al., 2023; Wiedmer et al., 2021), and relational embeddedness, including the high level of dependence among supply network members (Scheibe and Blackhurst, 2018) incubate or extend the impact of disruption across the supply network. These complexities make disruption detection difficult and accelerate the spread of disruption, thus damaging the SCRES of the supply network during their readiness and response (Scheibe and Blackhurst, 2018; Scholten et al., 2023; Wiedmer et al., 2021).

Conversely, social capital theory explains why both structural embeddedness and relational embeddedness could help foster SCRES (Points 3 and 4 in Figure 2.2). Social capital theory focuses on the benefits that can accrue for an organisation by virtue of its social relationships (Carey et al., 2011). Six SCRES studies posit that SCRES is one type of benefit that social relationship networks offer (Ali et al., 2023; Daghar et al., 2022; Fan and Stevenson, 2019; Freitas et al., 2023; Johnson et al., 2013; Polyviou et al., 2019). Social capital includes three dimensions: structural capital, relational capital, and cognitive capital (Nahapiet and Ghoshal, 1998), and all dimensions of social capital could help SCRES improvement (Ali et al., 2023; Daghar et al., 2022; Fan and Stevenson, 2019; Freitas et al., 2023; Johnson et al., 2013; Polyviou et al., 2019). SCRES studies including Ali et al. (2023), Johnson et al. (2013), and Polyviou et al. (2019) adopt social capital theory to conceptualise structural embeddedness factors, including the number of network sizes or ties and network

configurations, as structural capital of the supply network. Meanwhile, relational embeddedness factors, including trust and commitment (Ali et al., 2023; Fan and Stevenson, 2019; Freitas et al., 2023; Johnson et al., 2013; Polyviou et al., 2019), were conceptualised as relational capital.

By analysing theories that were adopted in SCRES studies, this study detected divergent findings around the effect of structural complexity on SCRES or SC disruption and thus the following proposition is offered:

Proposition 3: Structural complexity (relational embeddedness and structural embeddedness) can positively affect the establishment of SCRES, while it is also one of the main sources of disruption.

Section 2.3.3.2 examines how theories adopted by SCRES studies address the constructs that influence the opposing relationship between SC disruption and SCRES building. A series of contradictions around this relationship has been identified from collected studies: structural complexity is considered one of the characteristics of supply networks. The contradiction under this context refers to the fact that although the current state of research claims both dimensions of structural complexity among supply networks can facilitate SCRES of firms and supply networks, it is also presented as a source of disruption or that it serves to exacerbate the impact of disruption. Studies that focus on environmental uncertainties derive similar conclusions, as environmental uncertainty could become the source of disruption from outside of the supply network or facilitate SCRES. However, there is some disagreement around the causality of the relationship between SCRES and environmental uncertainty.

2.3.4 The Role of Capabilities in SCRES

SCRES, as a type of SC capability, is tightly associated with other SC capabilities among

supply networks (Ekanayake et al., 2021; Yang et al., 2021), so it is important to understand the role of other SC capabilities in SCRES building. Based on the results of descriptive analysis from Table 2.5, Capability is the construct that received the most attention from SCRES studies.

Table 2.6 summarises the capabilities that were examined by the studies in this sample, emerging in the discussion and theory-building elements of the studies. It was observed that theories were not strictly bound to a particular SC capability, but three theories did explicitly address the importance of a particular capability. SC knowledge-related capability (such as knowledge management capability or knowledge ambidexterity) mostly appeared in studies that adopt the knowledge-based view (three studies). The knowledge-based view emphasises the importance of knowledge on firms' survivability and stability, hence helping the establishment of SCRES (Juan and Li, 2023; Pal et al., 2024; Sheng and Saide, 2021). All studies adopting paradox theory (2 studies) discuss the impact of ambidexterity as a capability on SCRES building (Aslam et al., 2024; Iftikhar et al., 2023). Paradox theory posits that firms and managers face a series of dilemmas when attempting to balance opposing demands (Aslam et al., 2024).

Given that SCRES is a multifaceted capability that sometimes presents opposing demands competing for the same resources, managers may find it difficult to build SCRES (Iftikhar et al., 2023). SC ambidexterity is a firm's or SC's capability to "manage and pursue trade-off activities at the same time" (Aslam et al., 2024, p.10573), and it could effectively address a set of paradoxical demands, such as exploitation-exploration and alignment-adaptability, to build resilience (Aslam et al., 2024; Iftikhar et al., 2023). Compared with the knowledge-based view and paradox theory, both of which focus on one SC capability, organisational information processing theory focuses on two capabilities, including SC information processing capability and SC visibility. Three studies adopting organisational

information processing theory consider SC visibility as the main component of SC information processing capability (Brandon-Jones et al., 2015; Galbraith, 1974; Jain et al., 2017; Yang et al., 2021). They posit that SC visibility or information processing capability decreases the gap between the amount of required and possessed information of firms, allowing firms to better proactively manage supply chain disruptions (Brandon-Jones et al., 2015; Yang et al., 2021). However, most of the capabilities appeared in a more generic manner, and they are not strictly bound to one particular theory.

Table 2.6: Capabilities count

SC Capability	Count	SC Capability	Count
visibility	24	knowledge-related capability	4
flexibility	24	absorptive	3
agility	15	efficiency	3
integration	7	information process capability	2
big (hybrid) data capability	6	readiness	3
response(responsiveness)	6	transparency	3
adaptability (adaptivity)	5	recovery	2
collaboration	5	velocity	2
redundancy	5	avoidance	1
ambidexterity	4	traceability	1
innovation	4	circularity	1

Among all capabilities examined, three receive significant attention: SC visibility, SC flexibility, and SC agility, as Table 2.6 suggests. SC visibility generally refers to how well information and materials flow among the entire supply network and how well it is captured, traced and monitored (Bag et al., 2022; Belhadi et al., 2022; Herburger et al., 2024). SC flexibility refers to the ability of organisations and supply networks to adapt to their environment's changing requirements by restructuring their SC assets and strategies with minimum time and effort (Erol et al., 2010; Tukamuhabwa et al., 2015). SC agility represents the ability to respond rapidly to unpredictable changes in the supply network (Christopher and Peck, 2004).

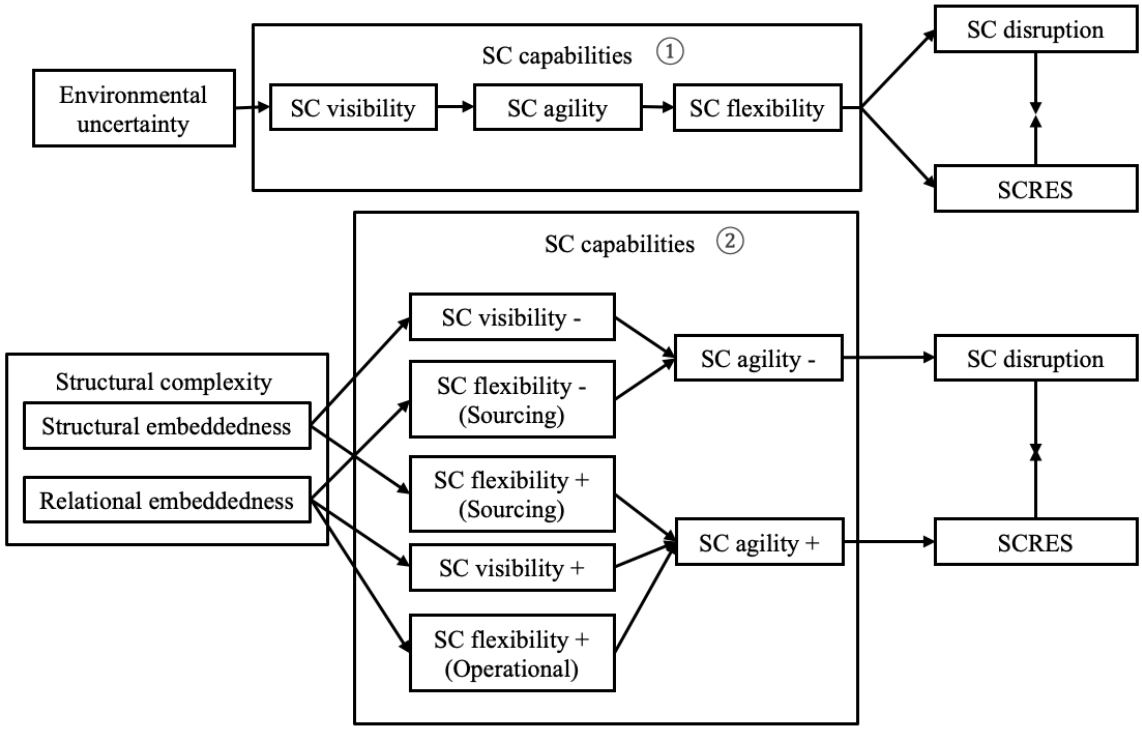


Figure 2.3: SC capabilities and SCRES

SCRES studies specify that SC visibility, SC flexibility, and SC agility play a vital role in explaining the opposing relationship between disruption and SCRES. From the collected studies, there are two conceptualisations that studies follow to systematically interpret the function of these three capabilities on SCRES, as Figure 2.3 states: the first (point 1 in Figure 2.3) is to use one proposition from dynamic capability, contending that these SC capabilities enhance SCRES through a sequence that starts with sensing, then seizing, and eventually transforming or reconfiguring (e.g. Belhadi et al., 2022; Juan and Li, 2023; Pattanayak et al., 2024). It explains how firms or supply networks could gain SCRES from environmental uncertainty by utilising different SC capabilities. The second approach (point 2 in Figure 2.3) is to connect these SC capabilities with structural complexity factors, including structural and relational embeddedness by describing how these structural complexity factors affect SC capability, hence impacting the establishment of SCRES (e.g. Brandon-Jones et al., 2015; Fan and Stevenson, 2019; Gebhardt et al., 2022; Wiedmer et al.,

2021). It provides a potential explanation for the existence of structural complexity's dual role on SC disruptions and SCRES. While both approaches conceptualise capability as the mechanism through which environmental uncertainty and structural complexity affect supply chain disruptions and resilience, they differ in how they sequence the roles of various supply chain capabilities. The following section explains how differences in theoretical lenses give rise to these variations in sequencing.

2.3.4.1 SC Capabilities and Environmental Uncertainty Under the Dynamic Capability Lens

In addition to interpreting the impact of environmental uncertainty on SCRES (see section 2.3.3.1), dynamic capability theory was also used by thirty-four studies to discuss the functions of specific SC capabilities in relation to SCRES. These SCRES studies posit that supply networks and firms that were exposed to a more uncertain or dynamic business environment have more opportunities to learn from this uncertainty and leverage dynamic capabilities like SCRES (Faruquee et al., 2024; Gupta et al., 2023; Laguir et al., 2024; Yu et al., 2019). One of the core propositions of this theory is that dynamic capabilities consist of three microfoundational capacities, named sensing, seizing, and reconfiguring (or transforming) (Teece, 2007). SCRES studies, by adopting dynamic capability theory, build connections between three micro foundations of dynamic capability and three SC capabilities that could benefit SCRES, to not only evidence that SCRES can be viewed as a dynamic capability, but also to explain how each SC capability improves SCRES. The main argument for such connections is that the sensing, seizing, and reconfiguring capacities of dynamic capabilities match the SC capabilities that are relevant to the phases of disruption (pre-disruption, during disruption, and post-disruption) (Betto and Garengo, 2023).

Using dynamic capability theory, some SCRES studies regard SC visibility as a "sensing" capacity (Bag et al., 2022; Belhadi et al., 2022; Herburger et al., 2024; Nikookar

et al., 2024, 2025; Nikookar and Yanadori, 2022; Pal et al., 2024; Pattanayak et al., 2024). Sensing is the first micro foundation of dynamic capability (Herburger et al., 2024). It requires firms to scan, create, learning and interpret opportunities and threats outside the firm before environmental changes take place (Teece, 2007). To gain sensing capacity, organisations must collect enough information about environmental change and uncertainty to establish a sensing capability and capture opportunities and threats before SC disruptions take place, and such demand for information could be fulfilled by increasing SC visibility (Nikookar and Yanadori, 2022).

"Seizing" refers to the capacity of firms or SC to make timely decisions and develop new opportunities in a highly uncertain business environment, and it is frequently connected with SC agility (Bag et al., 2022; Belhadi et al., 2022; Herburger et al., 2024; Nikookar et al., 2025; Pattanayak et al., 2024). The definition of SC agility includes terms such as "rapidly" and "respond", showing that time is the main measurement for SC agility (Christopher and Peck, 2004). During the SC disruption, firms or SCs with a higher level of SC agility will be able to better identify opportunities and threats to plan a swifter supply chain response during environmental uncertainty or SC disruptions and gain seizing capacity (Bag et al., 2022; Belhadi et al., 2022; Herburger et al., 2024; Nikookar et al., 2025; Pattanayak et al., 2024).

The term "adapts" in the SC flexibility definition emphasises that the application of SC flexibility takes place at the post-disruption stage and therefore shows the "reactive" feature of SC flexibility (Ali et al., 2017; Han et al., 2020). SC flexibility is connected with the reconfiguring/transformation capacity of dynamic capability. Reconfiguring capacity, the last component of dynamic capability, expects organisations to reallocate their resources to match the post-change environment and acquire long-time success (Kähkönen et al., 2023; Teece, 2007). The time scale of this definition (post-change) suggests reactive characteristics,

similar to SC flexibility. Because both reconfiguring capability and SC flexibility emphasise the importance of adapting to the uncertain, changeable environment after SC disruptions, SCRES studies build the alignment between them (Bag et al., 2022; Belhadi et al., 2022; Nikookar et al., 2024; Nikookar et al., 2025; Nikookar and Yanadori, 2022; Polyviou et al., 2019).

Based on these arguments, dynamic capability theory specifies that the three micro foundation capacities, namely sensing, seizing, and reconfiguring, possess a path-dependent nature, which means that these capacities come into effect to build dynamic capability with a fixed sequence, starting from sensing, to seizing, and eventually to reconfiguring (Kähkönen et al., 2023). SCRES studies utilise dynamic capability by building a connection between the three micro foundation capacities and (1) different phases of SC disruption (pre-, during-, and post-disruption; (2) different SC capabilities (SC visibility, SC agility, and SC flexibility). Hence, the following proposition was developed:

Proposition 4a: Environmental uncertainty influences supply chain disruptions SCRES by affecting supply chain capabilities that contribute to SCRES in a sequential manner.

2.3.4.2 SC Capability and Structural Complexity

The discussion in section 2.3.3.2 indicates that a significant body of work in SCRES literature aims to address the role of structural complexity in SC disruptions or SCRES. However, as proposition 3 stated, SCRES studies to date have derived contradictory conclusions regarding the impact of structural complexity. Observations on SCRES studies collected by this SLR show that one potential reason is that both dimensions of structural complexity are associated with multiple SC capabilities, hence making their impact on SC disruptions or SCRES unclear. SC visibility, SC flexibility, and SC agility are the three most common SC capabilities examined in the SCRES studies sampled, and these studies show how the three capabilities interact with each structural complexity dimension. Fourteen

studies have been identified as studies that explain how SC visibility, SC flexibility, and SC agility were used to facilitate the relationship between structural complexity and SCRES.

From the SC visibility perspective, SC visibility could be diminished by the increasing structural embeddedness. The scope of SC visibility is the entire supply network, which includes every node and link in this network (Tukamuhabwa et al., 2015). Therefore, a multiple-tier and geographically spread supply network will have a limited level of visibility (Gebhardt et al., 2022; Scheibe and Blackhurst, 2018; Scholten et al., 2023). Meanwhile, SC visibility could be enhanced by relational embeddedness. Visibility can be leveraged from relationship closeness based on relational theories such as social exchange theory, relational view, and social capital theory, as these theories suggest that trust, norms, collaboration, relational governance and commitment can create SC visibility by building confidence through the sharing of valuable information (Dubey et al., 2020; Freitas et al., 2023; Jain et al., 2017; Johnson et al., 2013; Nikookar and Yanadori, 2022).

Different from SC visibility, which has a relatively consistent definition in SCRES studies, SC flexibility was conceptualised in two ways. First, from an operations perspective, SC flexibility addresses the flexibility of products, processes, and transportation (Tang, 2006; Spiegler et al., 2012). Second, from a sourcing perspective, it represents the ability to establish backup contracts and suppliers and execute multiple sourcing (Tang, 2006; Roberta Pereira et al., 2014; Sawyerr and Harrison, 2019). SC flexibility is also bound by structural complexity. Structural embeddedness can benefit SC flexibility: portfolio theory and resource dependence theory posit that increasing structural complexity can help SCRES build because diverse suppliers provide sourcing flexibility and mitigate negative events' impacts (Brandon-Jones et al., 2015; Wiedmer et al., 2021; Xu et al., 2024).

Meanwhile, studies suggest that increasing relational embeddedness will lead to decreased SC flexibility of the supply network. This proposition was supported by studies

using resource dependence theory, which states that from the network design perspective, SC flexibility is a capability as opposed to dependency, because SC flexibility is constrained by organisations that control the resources that focal firms highly depend on (Gebhardt et al., 2022; Xu et al., 2024). Studies using social capital theory also claim that high levels of relational capital may lead to the inflexibility of the supply network (Fan and Stevenson, 2019). The reason might be that high dependency partnerships hinder potential innovative ideas from other organisations in the supply network, hence excluding the possibility of value-creation and information sharing across the supply network (Kim and Henderson, 2015).

However, several studies have opposite propositions, as they posit that the effect of relational embeddedness on SC flexibility is positive (Chowdhury et al., 2019; Johnson et al., 2013; Shin and Park, 2021). This argument comes from a difference in perspective: discussions about the negative impact of relational embeddedness on SC flexibility are from the sourcing flexibility perspective. While from the operational flexibility perspective, there is the suggestion that SC flexibility will likely be benefited by relational embeddedness. Based on social capital and social exchange theory, dependency and relationships built between organisations or individuals form a tie that creates an intimate atmosphere, increases the frequency of communication, mutual respect, and shared goals for both organisations (Fischer, 1982; Nikookar and Yanadori, 2022; Shin and Park, 2021). Therefore, organisations and individuals involved in an intimate dyadic relationship prefer to conduct timely knowledge exchanges and acquire immediate access to each other's resources during times of crisis (Johnson et al., 2013; Nikookar and Yanadori, 2022; Shin and Park, 2021). Compared with network-level studies, which mainly refer to SC flexibility as multiple choices of sourcing, dyad-level SC flexibility usually concerns operational flexibility. Ideal flexible suppliers could offer viable alternative practices, such as partners willing to offer extra help, permitting delivery schedule changes, and maintaining a continued relationship

during disruption (Johnson et al., 2013; Sheffi, 2007). Table 2.7 shows studies that discussed the relationship between structural complexity and visibility or flexibility.

Table 2.7: Structural and relational embeddedness and capabilities

Capability	Structural embeddedness	Relational embeddedness
Visibility	-	+
	Gebhardt et al., 2022	Dubey et al., 2020
	Scheibe and Blackhurst, 2018	Freitas et al., 2023
	Scholten et al., 2023	Jain et al., 2017
		Johnson et al., 2013
		Nikookar and Yanadori, 2022
		Fan and Stevenson, 2019
Flexibility (sourcing)	+	-
	Brandon-Jones et al., 2015	Gebhardt et al., 2022
	Wiedmer et al., 2021	Fan and Stevenson, 2019
	Xu et al., 2024	Xu et al., 2024
Flexibility (operational)		+
		Johnson et al., 2013
		Chowdhury et al., 2019
		Shin and Park, 2021

Several SCRES studies suggest that both SC visibility (Betto and Garengo, 2023; Dey et al., 2024; Jain et al., 2017; Sawyerr and Harrison, 2019; Wang and Zhao, 2023) and SC flexibility (Betto and Garengo, 2023; Dey et al., 2024; Dubey et al., 2023; Sawyerr and Harrison, 2019; Shin and Park, 2021) could enhance SC agility. To gain SC agility, firms should be able to identify risks and disruptions, and such ability relies on having enough knowledge about the uncertainties in the business environment (Betto and Garengo, 2023). SC visibility helps firms capture information and identify risks in the supply network or business environment (Brandon-Jones et al., 2014; Tukamuhabwa et al., 2015; Yang et al., 2021), hence fulfilling the requirement of SC agility. Meanwhile, firms also need to rapidly react to disruptions to exhibit a high level of SC agility (Christopher and Peck, 2004). The speed of reactions depends on how long it takes to gather the required resources that could help with disruption mitigation. Under this scenario, various sourcing and operations options and flexible operational processes offered by SC flexibility help firms respond to changes in their environment faster and gain SC agility (Sawyerr and Harrison, 2019).

Much of the discussion about SC agility is an extension of the relationship between structural complexity and SC visibility or flexibility. Despite the contradictions existing in SC flexibility and SC visibility studies, current SCRES studies state that from a network-level perspective, SC agility could be enhanced by increasing either relational embeddedness or structural embeddedness. The reason is that relational embeddedness benefits SC visibility (Dubey et al., 2020; Freitas et al., 2023; Jain et al., 2017; Johnson et al., 2013; Nikookar and Yanadori, 2022), structural embeddedness benefits SC flexibility (Brandon-Jones et al., 2015; Wiedmer et al., 2021; Xu et al., 2024), and both SC visibility and SC flexibility are antecedents of SC agility.

2.3.4.3 Conclusion

From a structural complexity perspective, the way these three SC capabilities interact with structural complexity and SCRES offers a possible explanation for why there is a theoretical contradiction around the role of structural complexity in SCRES building. How structural complexity influences SCRES building is not as straightforward as former studies suggest, as the change of any structural complexity construct will affect multiple capabilities differently. For example, this analysis shows that at the supply network level, SC visibility is improved from the development of relationships among organisations in a supply network and is negatively impacted by increasing structural embeddedness of the supply network, such as increasing suppliers and customers. Conversely, SC flexibility could be enhanced by structural embeddedness while damaged by relational embeddedness. Hence, the following proposition was developed:

Proposition 4b: The dual role of structural complexity exists because changes in any of its dimensions can influence SC capabilities that contribute to SCRES in different ways.

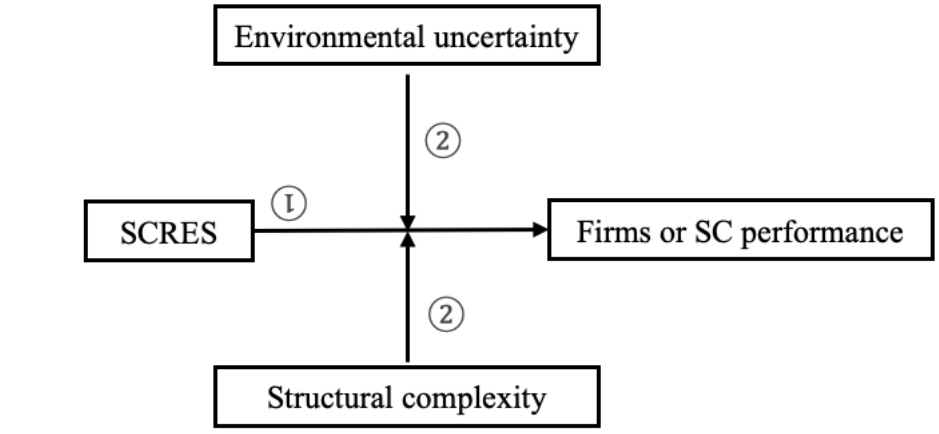
Overall, the examination of SC capabilities in SCRES literature shows that only through capability, constructs such as structural complexity and environmental uncertainty

can magnify the impact of disruption or help SCRES build. Hence, the following proposition was built:

Proposition 4: Environmental uncertainty and structural complexity build SCRES or trigger SC disruption through increasing or diminishing certain SC capabilities.

2.3.5 Performance - The Outcomes of SCRES

Performance is another construct widely discussed in SCRES literature based on the results of descriptive analysis. As the definition analysis illustrates (refer to section 2.3.1), organisations and supply networks have an expectation of an outcome when they devise strategies to build SCRES. Such expectation is measured or quantified by several performance metrics. These metrics are essential for organisations to evaluate their SCRES building practices systematically. Table 2.8 summarises the performance metrics that appear across the twenty-two studies examined. Although SCRES studies applied different theories to interpret the relationship between SCRES and performance, they all generally report that establishing SCRES can enhance the performance of organisations and their SC. However, these studies might diverge on the role of structural complexity and environmental uncertainty in the relationship between SCRES and performance. Figure 2.4 shows how different theories interpret the relationships between SCRES, performance outcomes, structural complexity, and environmental uncertainty.



① Resource-based view, Dynamic capability
② Organisational information process theory, Contingency theory

Figure 2.4: Outcomes of SCRES

Table 2.8: Performance criteria in SCRES studies

Performance categorisation	Criteria	Studies
Financial performance	Return on investment (ROI)	Ali et al., 2022; Iftikhar et al., 2021; Kumar and Raj, 2024; Yu et al., 2019; Zhao et al., 2023
	Return on assets (ROA)	Iftikhar et al., 2021; Parast,2020; Ruel and El Baz, 2021; Seif and Jafari, 2025; Wong et al., 2020; Yu et al., 2019
	Profit/profitability ratio	Chowdhury et al., 2019; Chowdhury and Quaddus, 2017; Iftikhar et al., 2021; Kumar and Raj, 2024; Ruel and El Baz, 2021; Stentoft et al., 2023; Yu et al., 2019; Wong et al., 2020
	Sales growth	Chowdhury et al., 2019; Chowdhury and Quaddus, 2017; Kumar and Raj, 2024; Stentoft et al., 2023; Yu et al., 2024
	Stock market value	Liu et al., 2023; Parast,2020
	Return on sales	Ruel and El Baz, 2021; Yu et al., 2019; Yu et al., 2024
	Sales over assets	Ruel and El Baz, 2021;
	Return on equity	Wong et al., 2020;
Operational performance	Cost	Birkie et al., 2017; Chowdhury et al., 2019; Chowdhury and Quaddus, 2017; Iftikhar et al., 2021; Stentoft et al., 2023; Zhao et al., 2023;
	Quality	Birkie et al., 2017; Chowdhury et al., 2019; Chowdhury and Quaddus, 2017; Iftikhar et al., 2021; Kumar and Raj, 2024; Parast,2020; Seif and Jafari, 2025;
	On-time delivery	Ali et al., 2022; Birkie et al., 2017; Chowdhury and Quaddus, 2017; Iftikhar et al., 2021; Kumar and Raj, 2024; Parast,2020; Queiroz et al., 2024;
	Logistics	Chatterjee et al., 2024;
	Efficiency	Queiroz et al., 2024;
	Products modification	Queiroz et al., 2024;
	Lead time	Chowdhury et al., 2019; Zhao et al., 2023
	Risk management performance	Wong et al., 2020;
	Growth productivity	Yu et al., 2024;
Competitiveness	Customer satisfaction	Ali et al., 2022; Chatterjee et al., 2024; Chowdhury and Quaddus, 2017; Queiroz et al., 2024; Parast,2020; Seif and Jafari, 2025; Wong et al., 2020; Zhao et al., 2023;
	Wastages reduction	Iftikhar et al., 2021;
	Market share	Ali et al., 2022; Kumar and Raj, 2024; Parast,2020; Seif and Jafari, 2025; Yu et al., 2019;
Disruption recovery	Time	Altay et al., 2018; Luqman et al., 2023;
	Cost	Altay et al., 2018;
	Continuity	Luqman et al., 2023; Parast,2020;
Sustainability	Sustainability	Ul Akram et al., 2024;

Competitive advantage is a term that appears in nearly every study that investigates the outcome of SCRES. It describes an attribute acquired by specific resources and attributes to allow organisations to perform better than others in the same industry or market (Porter, 2008; Chaharbaghi and Lynch, 1999). From a theoretical perspective, competitive advantage is fundamental to the resource-based view. Three studies use the resource-based view to emphasise the importance of SCRES on firms or supply chain performance. The resource-based view states the importance of a firm's strategic resources and capabilities as they determine the sustainable competitive advantage of a firm (Barney, 1991) (Point 1 in Figure 2.4). Although the resource-based view is one of the most applied theories in SCRES studies, it receives long-term criticism from OSCM scholars for several reasons. One criticism of the resource-based view is that it restricts the scope of SCM studies' discussion, as most studies adopting the resource-based view focus on the performance of supply networks or companies (Carter et al., 2017; Zimmermann and Foerstl, 2014). This SLR reports a similar result. Most SCRES studies use the resource-based view to conceptualise SCRES as a company's resource that could bring competitive advantages (Chatterjee et al., 2024; Iftikhar et al., 2021; Queiroz et al., 2024). Besides the interpretation of resource-performance relationships, the resource-based view did not make a significant further contribution to SCRES theory building.

Dynamic capability is usually considered an "extension" of resource-based view because dynamic capabilities can secure competitive advantages in an environment with unpredictable changes (Eisenhardt and Martin, 2000) (Point 1 in Figure 2.4). Moreover, it suits the nature of SCRES since SCRES functions against the impact of disruption, which partly results from the uncertain business environment. Twelve studies use dynamic capability theory to emphasise the importance of SCRES on firms or supply chain performance. (e.g. Ali et al., 2022; Altay et al., 2018; Chatterjee et al., 2024; Chowdhury

and Quaddus, 2017). Nevertheless, when it comes to empirical studies examining the outcome of SCRES, the application of these two theories is similar. Most studies employing the resource-based view and dynamic capability lenses operate under the assumption of the presence of disruption sources, and they posit that the magnitude of disruption sources is equivalent across all firms. (Altay et al., 2018; Luqman et al., 2023; Stentoft et al., 2023; Zhao et al., 2023). Consequently, these studies provide a simplistic and unconditional justification for the role of SCRES, asserting that increasing SCRES results in enhanced organisational performance without accounting for disruption-related variables in their research models. Only three studies using dynamic capability address the fact that orientation to SC disruption is a premise of the SCRES' positive impact on firms or SC performance (Ali et al., 2022; Parast,2020; Yu et al., 2019).

Unlike resource-based view and dynamic capability theory, contingency theory and organisational information processing theory empirically examine the effect of environmental uncertainty and structural complexity on the relationship between SCRES and organisational performance (Point 2 in Figure 2.4). Five studies used these two theories to discuss the impact of SCRES on firms or SC performance (Birkie et al., 2017; Chowdhury et al., 2019; Kumar and Raj, 2024; Wong et al., 2020; Yu et al., 2024). Contingency theory states that managers should find processes or capabilities that match the environment instead of finding the best way to design or govern an organisation (Kembro et al., 2014). Although both dynamic capability and contingency theory emphasise the importance of SCRES for sustained competitive advantage, studies that employed contingency theory include a comparison process to examine differences in SCRES effectiveness across scenarios, whereas most dynamic capability studies do not.

In SCRES studies, one of the main applications of contingency theory is embedding it with the resource-based view into the contingent resource-based view. The value of

resources under the resource-based view is not constant and universal but contingent, depending on the context (Aragón-Correa and Sharma, 2003). These studies prove that the function of SCRES on performance outcome is more significant in a highly uncertain business environment (Senna et al., 2024; Wong et al., 2020), or higher structural complexity or relationship closeness (Chowdhury et al., 2019), because these studies stated that the additional capacity that was set aside to gain SCRES can be fully utilised to enhance performance in the face of high-risk SC disruptions driven by increasing environmental uncertainty and structural complexity (Wong et al., 2020). However, they didn't deny the validity of SCRES in a safe business environment.

Organisational information processing theory is also a contingency theory (Kembro et al., 2014; Wong et al., 2020), which doesn't recognise SCRES as a one-size-fits-all construct. Instead, it posits the important moderating role of environmental uncertainties or structural complexity on the impact of SCRES on the firm or SC performance. Organisational information processing theory addresses the fit between the information brought by uncertainty (disruption severity) and information process capability (SCRES) (Tushman and Nadler, 1978). Therefore, SCRES will have a low or even no contribution to performance outcomes if the organisation is in a disruption-free business environment (Wong et al., 2020) or a low level of SC complexity (Birkie et al., 2017). Perspectives offered by contingent theory and organisational information processing theory show how existing SCRES studies interpret the relationship between SCRES building and the performance of firms or supply networks. Therefore, the following proposition was built:

Proposition 5: The establishment of SCRES could positively affect firm or supply network performance, but this effect would be more significant under high structural complexity or environmental uncertainty.

2.4 Implications and Limitations

The discussion will be divided into two sections. The first section presents the theoretical implications and future research, aiming to summarise the findings section and address the last research question: How to extend SCRES knowledge by theory building? The second section will discuss the limitations of this study.

2.4.1 Theoretical Implications and Future Research

To date, this study is the first to observe how SCRES was conceptualised and operationalised from a theoretical perspective in the operations and supply chain literature. By analysing theories used in SCRES studies, the findings section describes constructs that could affect or be affected by SCRES and explains how theories are adopted to interpret the relationship between SCRES and these constructs. A conceptual framework summarising relationships among different constructs is formulated as presented in Figure 2.5, based on propositions across the findings section. This framework offers a generalised answer to the question, "How do different theories interpret the relationship between SCRES and constructs that could affect or be affected by SCRES?" It shows which constructs affect the opposing relationship between SCRES and SC disruption (structural complexity and environmental uncertainty), the role of capabilities during this process (connecting structural complexity or environmental uncertainty with SCRES or SC disruption), and how different contingencies influence the outcome of SCRES. Several implications about SCRES building, supply network structural complexity, environmental uncertainty, and SC capabilities are derived based on this framework.

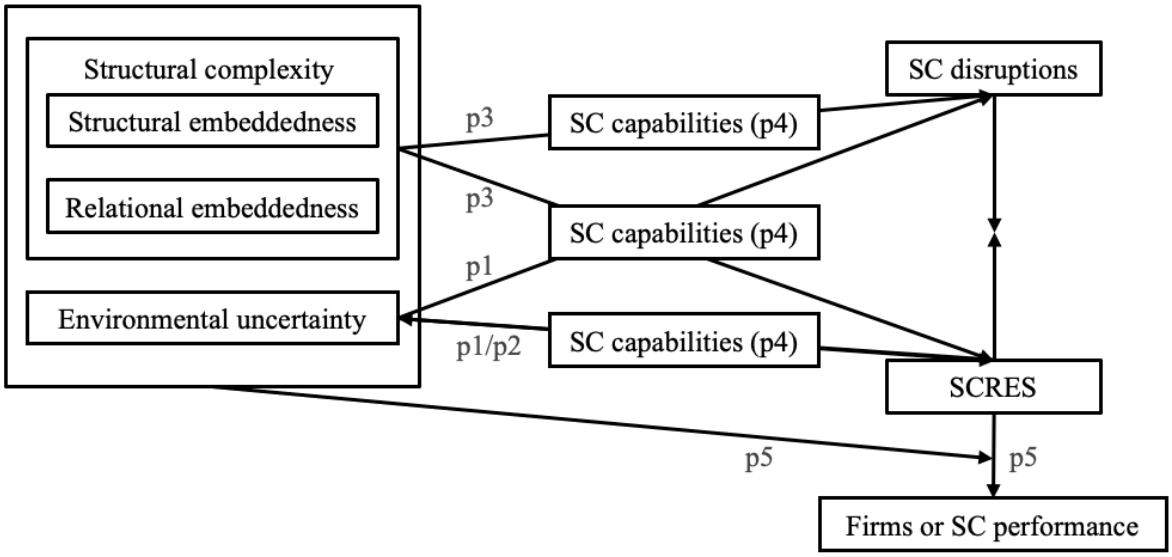


Figure 2.5: Current research state of SCRES studies from a theoretical perspective

Proposition 1 illustrates the dual role of environmental uncertainty on SCRES building and SC disruption. SCRES studies to date have mostly had either/or views on the impact of environmental uncertainty. This implies that environmental uncertainty could only be the source of SC disruption that firms and supply networks should be aware of (Yang et al., 2021), or an enabler of SCRES (Kähkönen et al., 2023; Yu et al., 2019). This paper contends that this either/or view is not the most suitable for discussing the role of environmental uncertainty for two reasons. First, this study shows that the pair of contradictory conclusions about the role of environmental uncertainty originates from using different theories. As these theories adopted by SCRES studies are widely justified and examined across different management disciplines, denying such theoretical lenses would be limiting. Second, environmental uncertainty is an objective construct, and firms and supply networks usually have no control over it, so it would be questionable to choose one side over another between building SCRES and triggering SC disruption. Hence, this study proposes that a dialectic perspective might be more suitable to understand the impact of environmental uncertainty on SC disruption or SCRES building. Dialectic is a method that "denotes an ongoing process of resolving tensions through integration" (Smith and Lewis,

2011, p.386). It requires future studies to admit the existence of the dual role of environmental uncertainty, but also to explore factors that potentially determine the evolving trend of this dual role. In other words, future studies could investigate which factors could shift the role of environmental uncertainty from the source of disruption to an enabler of SCRES.

Proposition 2 offers a unique perspective on the interaction between SCRES and environmental uncertainties. The majority of former studies focus on how environmental uncertainty affects SCRES (Kähkönen et al., 2023; Yu et al., 2019). By investigating existing literature, this study observed that establishing SCRES can affect environmental uncertainty (Tukamuhabwa et al., 2015; Wieland, 2021). Future research could extend the relationship between SCRES and environmental uncertainty in two ways. The first approach would be an empirical examination of the effect of SCRES on environmental uncertainty, as most current studies discuss this relationship at a conceptual level. The second approach would be extending the two-way perspectives on the relationship between SCRES and environmental uncertainty to the relationship between environmental uncertainty and SC disruption.

Proposition 3 reveals that just like environmental uncertainty, structural complexity can positively affect the establishment of SCRES, while it is also a primary source of disruption. This study finds that, unlike the dual role of environmental uncertainty, which has never been discussed in a single study, the dual role of structural complexity has been analysed and interpreted by numerous studies already, using different methods to disentangle this contradictory role. The first method is adopting a non-linear relationship perspective. For example, Kim et al. (2015), applying network theory to simulate a supply network, stated that either immoderate or inadequate structural embeddedness could benefit the network's resilience. Meanwhile, Fan and Stevenson (2019) suggested that relational capital, a part of

social capital theory and relational embeddedness, has a curvilinear effect on the resilience of entities in a supply network because excessive relationship closeness between two entities could trigger a counterfactual perspective. As a result, they could prohibit firms in this relationship from acquiring new knowledge or opportunities and hinder timely response to a disruption (Jüttner and Maklan, 2011).

The non-linear relationship could be an appropriate interpretation of the effect of each dimension of structural complexity on SCRES or SC disruption. However, studies to date are not able to ascertain an optimal level of structural complexity that could benefit SCRES building or confirm the factors that led to this non-linear relationship (Fan and Stevenson, 2019). Another method to unpack the dual role of structural complexity is to adopt multiple theoretical lenses to explain structural complexity's dual role, as demonstrated by Wiedmer et al. (2021) and Wissuwa et al. (2022). Most of these studies show that the dual role of structural embeddedness exists because each factor of structural embeddedness could function differently under a given scenario, but they focused on only structural embeddedness instead of relational embeddedness.

There are four takeaways for future research based on the conclusion of Proposition 3 and the drawbacks of contradiction-disentangling methods from past SCRES studies. First, future studies should hold a contingent view on structural complexity. The non-linear relationship between structural complexity and SCRES building shows that increasing or decreasing structural complexity is not a one-size-fits-all solution for SCRES building. Hence, the discussion under specific contexts, such as industry or network position, could be meaningful. For example, future studies could examine if there is any difference between the influence of the structural complexity of upstream and downstream on SCRES building. Second, there is scope to examine the theoretical lens that has the potential to address the dual role of relational embeddedness. Third, the adoption of a more rigorous and segmented

definition for structural complexity would enable a more nuanced understanding of its impact on establishing SCRES. Although there has been a relatively fixed definition for "structural complexity", it is always presented as a series of network characteristics in SCRES research. Since the findings of this SLR indicate that relationships between structural complexity, SC disruption, and SCRES building are more complex than studies infer, the current structural complexity definition and classification might be too vague. To formulate a more explicit or complete definition for structural complexity, future research could interrogate to a greater extent network characteristics such as institutional or technological distance in supply networks. At last, recent work suggests that the dual role could stem from different characteristics across supply chain tiers (see Kim et al., 2025). Since tier differences are not addressed in this study, future research needs to take this factor into consideration when investigating the relationship between structural complexity and SCRES.

Proposition 4 taps how supply network capabilities contribute to SCRES building and their connection with environmental uncertainty and structural complexity. As the change of structural complexity or environmental uncertainty could trigger SC disruption and build SCRES, the investigation on supply network capabilities shows that SC capabilities function differently depending on how these SC capabilities connect with environmental uncertainty or structural complexity dimensions. Besides that, this study finds two potential approaches that future studies could adopt. The first approach is to use SC capability to disentangle the contradiction between structural embeddedness and relational embeddedness. This SLR shows that there is a contradiction between two dimensions of structural complexity (structural embeddedness and relational embeddedness) as the increase of one will lead to the diminishment of another. For example, studies that applied portfolio theory and resource dependence theory are concerned that relational embeddedness (dependence mainly) among supply networks might cause disruption and exacerbate its impact on the network (Manhart et al., 2020; Wiedmer et al., 2021; Xiao et al., 2024). Therefore, these studies propose

strategies such as sourcing options diversification and secondary supplier relationship development to diminish the influence of relational embeddedness and build SCRES for the supply network because these strategies should increase structural embeddedness as they increase the number of entities in this supply network (Manhart et al., 2020; Wiedmer et al., 2021; Xiao et al., 2024).

Studies focusing on SC capabilities provide a potential explanation for this contradiction by clarifying that the change of any dimension of structural complexity will influence certain SC capabilities, then SCRES. However, because multiple capabilities are involved in this process, different conclusions could be derived depending on the focus of capability studies. It means that, although both structural embeddedness and relational embeddedness might help establish SCRES, the investment and decision-making that benefits one of them will diminish the capability established by the other. Hence, future SCRES studies should consider not only SC capabilities themselves but also regard them as connections with other characteristics of supply networks or strategies and practices. The second approach empirically examines the sequence and merit of different SC capabilities in the SCRES building. One of this study's findings is a sequence among SC capabilities during SCRES building (Hendry et al., 2019; Kähkönen et al., 2023). However, a significant gap is left for this proposition to be expanded and investigated. Dynamic capability theory is the only theory suggesting this proposition, and only three different SC capabilities could be involved in one study due to the three components of dynamic capability. Hence, future studies could explore more theories that could potentially connect different SC capabilities in a sequenced manner.

Compared with other propositions, proposition 5 generally overlaps with other studies that discussed the benefits of SCRES building on firm/supply network performance. Nevertheless, it is noticeable that this SLR finds performance is more isolated compared

with other constructs in the conceptual framework, as SCRES is the only construct directly interacting with performance based on different theoretical perspectives. Involving other constructs in the SCRES-performance relationship could elaborate on the understanding of SCRES's function. That requires SCRES studies to analyse "performance" more thoroughly. Although many performance metrics have appeared in SCRES studies, they were usually put together instead of explicitly distinguished in most empirical studies. Han et al. (2020) is the only study discussing several performance metrics individually and identifying matches between different performance metrics and SC capabilities that constitute SCRES. One of the possible future pathways is to investigate how each performance metric is affected by structural complexity or SC capabilities factors differently.

The above implications and future research directions were derived from each proposition in the conceptual frameworks developed. The conceptual framework based on multiple theoretical lenses shows that existing SCRES knowledge is more complicated than scholars' current understanding. Table 2.9 summarised research gaps and future research directions mentioned above.

Table 2.9: Findings summarise

Propositions	Research gaps	Future research directions
P1	SCRES studies mostly adopt either/or views on environmental uncertainty, without addressing the existance of environmental uncertainty's dual role on SC disruptions/SCRES.	Adopt a dialectic perspective and explore factors determining the evolving trend of the dual role, including shifts from disruption source to SCRES enabler.
P2	Majority of studies focus on how environmental uncertainty affects SCRES, while the effect of SCRES on environmental uncertainty is mainly discussed conceptually.	Empirically examine the effect of SCRES on environmental uncertainty and extend two-way perspectives to SCRES–environmental uncertainty relationships.
P3	Studies are unable to ascertain the optimal level of structural complexity or confirm factors leading to the non-linear relationship.	Hold a contingent view on structural complexity and examine context-specific differences such as upstream and downstream.
P3	Focus mainly on structural embeddedness rather than relational embeddedness.	Examine theoretical lenses that address the dual role of relational embeddedness.
P3	Structural complexity definition and classification may be too vague.	Develop more rigorous and segmented definitions of structural complexity and investigate additional network characteristics.
P3	Tier differences are not addressed.	Consider tier differences when investigating the relationship between structural complexity and SCRES.
P4	Contradictions exist between structural and relational embeddedness due to multiple SC capabilities leading to different conclusions.	Use SC capabilities to disentangle embeddedness contradictions, examine their connections with network characteristics and strategies.

P4	The sequence of SC capabilities is identified but not fully investigated.	Empirically investigate the sequence and merit of SC capabilities, and explore additional theoretical perspectives.
P5	Performance is treated as an isolated construct, with SCRES as the only direct link, and performance metrics are usually aggregated rather than individually analysed.	Involve other constructs in the SCRES–performance relationship, analyse performance more thoroughly, and investigate how individual performance metrics are affected by structural complexity or SC capabilities.

Besides implications from each proposition, the conceptual framework as a whole also shows future research how to expand SCRES knowledge from theoretical perspectives. Firstly, scholars should seek possibilities of applying multiple theories in one study. The opposing relationship between SCRES and SC disruption, along with other findings in the conceptual framework generated, is difficult to conclude through empirical studies because most empirical studies tend to apply only one theory in their studies. The finding of this study shows that no single theory can provide a full scope for SCRES knowledge. This proposition also matches with notions of some former theoretical lens SLR studies, such as Kembro et al. (2014), who state that a single theory is likely to have limited explanatory power and fail to address the full scope of a complex phenomenon. SCRES studies should keep applying multiple theories to find new contradictions existing in SCRES knowledge, as this SLR did, or find a theory that could explore SCRES from the contradiction perspective, such as paradox theory, to address or disentangle contrasts from the conceptual framework.

Secondly, regarding the varieties of theories, it is evident that theories outside the management disciplines contribute to SCRES knowledge. Whilst theories originating from management fields appear in the majority of collected studies, many also borrow theories from different fields, such as portfolio theory from finance, social system theory from sociology, panarchy theory from ecology and risk compensation theory or risk decision-making theory from psychology. Although based on the result of descriptive analysis, theories borrowed from other fields are less adopted by SCRES than some management theories, such as the resource-based view and dynamic capability; all these theories have the same relevance when it comes to the contribution to SCRES theory building. Hence, future studies should continue with the application of theories from other disciplines to expand the scope of SCRES.

Thirdly, future studies could explore and adopt theories that could interpret the individual behaviour's impact on SCRES. This construct appears in descriptive analysis, but the number of studies discussing it is not sufficient to conduct a systematic review. The current discussion about individual behaviour's impact on SCRES shows that the opposing relationship between SC disruption and SCRES could present at the individual level with a different formation. This relationship is embedded in the relationship between individual perception and decision-making by several cognitive and behavioural decision-making theories. In brief, these theories and studies show that increasing disruption risk perception will lead to the intention of applying SCRES strategies. Meanwhile, the increasing perception of resilience among supply networks and the environment led to a higher risk-taking intention during decision-making (Babich et al., 2007; Lorentz et al., 2021; Mena et al., 2020; Vanpoucke and Ellis, 2020). Therefore, future studies should find theories that explain how individual-level factors could moderate the impact of other constructs on SCRES.

Fourthly, future studies should seek the possibilities to fully utilise theoretical lenses that have already been used. Several studies discuss that when SCM studies adopt theories from other disciplines, they would always only use certain components of theories (Boer et al., 2015; Durach et al., 2017). For example, complex adaptive system is a theory that initially includes ten features that summarise the characteristics of a complex adaptive system (Choi et al., 2001; Tukamuhabwa et al., 2015), but this SLR observed a limited number of features appearing in SCRES studies, such as co-evolution (YaroSon et al., 2021) or self-organisation (Novak et al., 2021). Complex adaptive system features that have not been used in SCRES studies could be the key to disentangle the tension in existing knowledge. For example, one feature of the complex adaptive system, named “ability to learn” (Day, 2014; Tukamuhabwa et al., 2015), states that organisations in a complex adaptive system should be able to learn from the surrounding environment. As several

studies identify learning as one of the key abilities that aid in the establishment of SCRES (Chowdhury and Quaddus, 2016; Mubarik et al., 2021), ability to learn could be a very compromising explanation for the dual role of environmental uncertainty in SCRES building and SC disruption. For example, a supply network with high learning ability can learn from environmental uncertainty to gain SCRES (Holgado et al., 2024), while a supply network with low learning ability might find it difficult to recover from disruptions. Besides that, to fully utilise theoretical lenses that have already been used, future studies should also examine the theoretical development of SCRES research over time (Kim et al., 2018). As many theoretical lenses have been developed and expanded over time, their ability to explain SCRES knowledge could drastically change.

Finally, future studies should theorise SC disruptions and SCRES as a theory in its own right by developing a more supply chain-based theoretical foundation (Carter et al., 2015). As this study focuses on the theoretical lenses applied in SCRES research, its findings centre on the relationships between supply chain disruptions/SCRES and related constructs. One reason is that the main function of theory is to explain the interrelationship among different constructs (Carter, 2011). Intensively borrowing theory lenses from other disciplines leads to critical limitations to existing SCRES studies, as studies to date do not fully address the specific characteristics of SC disruptions or SCRES. Developing a more endogenous theoretical foundation would enable scholars to better differentiate between types of SC disruptions (e.g., known-knowns, known-unknowns, and unknown-unknowns) and to integrate multiple perspectives on SCRES (e.g., engineering and socio-ecological perspectives). More importantly, it would allow future research to examine how these elements interact, rather than treating disruption and resilience as static or isolated constructs. Such discussion can help SCRES studies form a more nuanced understanding of the relationship between the SC disruption and its impacts. Moreover, future studies will be able to explore the dynamics of SC disruptions and the SCRES relationship by doing so. Due to

the lack of SC disruptions and SCRES theorisation, most SCRES studies conceptualise SC disruptions and SCRES as a group of opposing forces. However, such a description oversimplifies their relationship. SC disruptions and SCRES should be understood as co-evolving phenomena, as SC disruptions can act as catalysts for the SCRES building, and SCRES can create new opportunities from SC disruptions (Tukamuhabwa et al., 2015). Future studies can explore how firms and supply chains can better understand and leverage the dynamic relationship between supply chain disruptions and supply chain resilience by identifying opportunities, fostering learning, and driving innovation in response to disruptions (Griffin and Grote, 2020).

2.4.2 Limitations

The primary limitations of this study coalesce around database selection. This review paper mainly includes two sections of journals based on the ABS journal list: journals above ABS 3 under the Operations and Technology Management category and journals above ABS 3 under the Ethics-CSR-Management category. The first rationale of this selection is that journals with a better ranking and higher quality have more opportunities to serve studies that propose unique theoretical frameworks or apply novel theories (Durach et al., 2015). Therefore, this review is not the most comprehensive one in SCRES studies. The second rationale is that SCRES studies are more likely to be found in journals under these two categories. However, this selection blocks cross-field studies published in journals from different fields, such as economics, political science, or psychology. Consequently, this study loses the opportunity to investigate how SCRES were interpreted or understood in these fields or what theories are adopted to contribute to SCRES knowledge.

Besides that, the findings section of this study presents a conceptual framework and several components of the framework that show which theories are based on to develop the

conceptual framework. Most of the theories applied by SCRES studies are embedded in this framework. It doesn't mean that the rest of the theories didn't make theoretical contributions, but rather that they are not under the narrative of this study. Future studies could further investigate theories that appeared in former SCRES studies but were not addressed by this SLR.

Chapter 3. A Dual Perspective on Slack: How Risk Perception and Slack Resources Shape Operational Resilience During COVID-19

3.1 Introduction

COVID-19 has been recognised as one of the most severe events worldwide since the Second World War (Jiang et al., 2023; Pantano et al., 2020). Beyond threatening lives and straining public health systems, COVID-19 triggered widespread operational and supply chain disruptions (Nikookar and Yanadori, 2022). These included factory shutdowns, material transport blockages, supply shortages, and volatile demand patterns (Munir et al., 2022). The experience of firms during COVID-19 underscores a crucial insight: traditional performance criteria, including low cost and high quality, are no longer sufficient for maintaining competitiveness in uncertain business environments (Carvalho et al., 2012). As a result, managers are actively seeking strategies to help their firms navigate future disruptive events such as COVID-19.

Due to the impacts of COVID-19, operational resilience as a concept is gaining attention from managers and scholars alike. Operational resilience is understood as the ability of a firm's operations system to absorb the negative impact of external adversity and to recover from such impacts (Essuman et al., 2020; Jiang et al., 2023). It enables firms to swiftly switch strategies in the face of disruption, thus increasing their adaptability to the changing business environment (Gu et al., 2025). As a firm's operation system has close ties with value-adding activities and revenue production, building operational resilience has been an area of focus for managers (Li et al., 2023), especially during, and following, COVID-19.

The development of slack resources is widely recognised as a key strategy used in the development of operational resilience (Holgado et al., 2024). Firms often build different

types of slack resources to build resilience in their operations and mitigate the impact of disruptions. For example, capacity slack minimises firms' need to acquire extra capacity during fluctuations in demand caused by disruptive events, when extra capacity is usually not available (Azadegan et al., 2013). Inventory slack refers to the excess inventory held by a firm beyond its actual operational requirements to buffer against disruptive events (Durach et al., 2024). It enables firms to eliminate the gap between the choice of customers and lead times that were used to produce required products during times of market instability (Brandon-Jones et al., 2014; Kovach et al., 2015). Meanwhile, financial slack refers to a firm's internal financial resources that are not committed to any specific purpose (John et al., 2017). It helps firms minimise the dependence on key resources during unprecedented disruptions (Chen et al., 2023; Oh and Oetzel, 2022).

OSCM studies to date have supported these practices, contending that slack resources are a form of operational flexibility, which enables firms to absorb shocks and adapt (Shi and Feng, 2024; Zhu et al., 2025). However, if building slack resources, as a strategy to leverage operational resilience, is indeed as effective and commonly deployed as studies suggest, firms should be able to evidence a higher level of operational resilience during COVID-19. Yet, many firms still struggled to maintain operational continuity. Based on a report from the Institute for Supply Management (2020), COVID-19 disrupted the supply network of 97% of firms worldwide. There are several limitations of previous studies that may have led them to underexplore or misinterpret the relationship between slack and resilience.

First, COVID-19, as a disruptive event, exhibits different characteristics compared with other disruptive events, and such differences could impact the effectiveness of traditional operational resilience strategies and practices (Sodhi and Tang, 2021). As distinct from other disruptions, COVID-19 was conceptualised as a type of "deep disruption" or

"unknown-unknowns disruption", which suggests that the appearance or the consequences of the disruptive event could not be predicted (Ge et al., 2023; Kauffman et al., 2018; Ivanov, 2021). Random disruptions, also known as known-knowns disruptions (e.g. annual flood in some Southeast Asia countries) or hazardous disruptions, also known as known-unknowns disruptions (e.g. continuously existing risk of earthquake in countries such as Türkiye and Japan), have anticipated appearance and/or consequences (Ivanov and Dolgui, 2022; Klibi et al., 2010), whilst deep disruptions like COVID-19 may indeed be more catastrophic in terms of their consequences but have received less attention in the literature (Ge et al., 2023). Compared with other disruptions, the impact of deep disruptions might not be mitigated, or even amplified, by traditional OSCM strategies, so these strategies need to be re-evaluated under the deep disruptions context like COVID-19 (Kauffman et al., 2018). Studies of slack and the associated resilience it brings also tend not to distinguish the nature of the disruption incurred (Essuman et al., 2022; Shi and Feng, 2024). However, compared with other disruptions, the impact of deep disruptions might not be mitigated, or even amplified, by traditional OSCM strategies, so firms need to either respond to such disruptions in an innovative way, or re-evaluate traditional strategies under the deep disruptions context (Kauffman et al., 2018; Sodhi and Tang, 2021). Therefore, this study seeks to investigate the impact of slack resources on firms' operational resilience during COVID-19 outbreak.

Second, resilience studies to date that investigate the impact of slack resources have omitted two important factors of slack resources, leaving the slack-resilience relationship underexplored. The first factor that has not been fully explored is the multidimensional nature of slack resources. Studies to date have posited the benefit of building slack resources on operational resilience without specifying which type of slack they refer to (Dimitriadis, 2021; Essuman et al., 2022; Manhart et al., 2020). Yet categorising different dimensions of slack has been common practice for scholars who explore the impact of slack resources on

other aspects of firm performance, such as occupational safety (Wiengarten et al., 2017), financial performance (Kovach et al., 2015), or R&D investment (Lee and Wu, 2016).

The second factor that has been overlooked is the agency-related issues of slack resources. Adopting an agency focus addresses the fact that slack resources can be misused by managers due to their conscious and subconscious misjudgements, or personal interests (Jensen, 1986; Zona, 2012). Multiple studies from the strategic management discipline have pointed out that due to such misjudgements or personal interests, slack resources could encourage managers or even CEO's risk-taking behaviour (Lim, 2017), hence negatively impact firms' performance regardless of whether these firms reside in a safe or a turbulent environment (De Carolis et al., 2009; Wan and Yiu, 2009). Potential negative impacts of slack resources due to their agency-related issues have also been investigated by several OSCM studies. These negative impacts include decreasing firms' operational efficiency under the impact of demand uncertainties and undermining firms' environmental performance (Liang et al., 2023; Modi and Canter, 2021). However, agency-related issues of slack resources have never been addressed in the resilience context in OSCM. It means that previous studies concluding a positive impact of slack resources on resilience may have overlooked the agency-related issues associated with slack resources, so it is necessary to re-evaluate this relationship. One determining factor of the significance of slack resources' agency-related issues is the type of slack (Lee and Wu, 2016; Steensma and Corley, 2001). Hence, this study examines how three types of slack resources, namely capacity, inventory, and financial slack, affect firms' operational resilience differentially, given their varying degrees of agency-related issues.

Third, discussions around the slack-resilience relationship assume that firms acknowledge the existence of disruptive events and pay attention to them. However, such an assumption ignores the heterogeneity of different attention levels of firms and might explain

why some firms recover from disruption quicker than others (Essuman et al., 2022). Such differences in how attentions are focused by firms could be reflected by differences among each firm's risk perception of disruptive events (Pinkse and Gasbarro, 2016). It is commonly agreed that disruptive events drive firms to adopt risk mitigation or resilience-building strategies to buffer against uncertainties (Bode et al., 2011). However, firms' risk perception of disruptive events could also affect firms' responses (Chen et al., 2024; Fan and Xiao, 2023), hence affecting firms' resource allocation to such events (Tuggle et al., 2024). This study aims to explore how firms' risk perception of COVID-19 affected their attitude towards slack resources. As COVID-19 has been perceived by many firms as a worldwide disruption (Choudhury et al., 2022), it is important to investigate how such a perception differentiation among firms regarding COVID-19 leads to their different behaviours and decision-making. To summarise, this study aims to answer two research questions:

RQ1: How did firms' risk perception towards COVID-19 affect their accumulation of slack resources, namely capacity slack, inventory slack, and financial slack during COVID-19?

RQ2: How did firms' slack resources, namely capacity slack, inventory slack, and financial slack, impact operational resilience during COVID-19?

To explore these research questions, the attention-based view (ABV) was adopted to examine the relationship between firms' risk perception towards COVID-19 and firms' slack resources accumulation, while both the attention-based view (ABV) and agency theory were applied to investigate the relationship between firms' different types of slack and firms' operational resilience. A panel dataset was built based on several databases, namely Orbis Bureau van Dijk, FactSet Revere Supply Chain Relationships database, and the Firm-Level Risk database. This panel dataset included US manufacturing firms with a time period spanning from the first quarter of 2020 to the first quarter of 2022, due to the consideration on COVID-19 impacts and data avaliability. This study applies two-way fixed-effect

analysis to verify all hypotheses, and findings reveal that during COVID-19, firms with a higher COVID-19 risk perception accumulate more capacity slack and financial slack. However, different types of slack exhibit different impacts on operational resilience during COVID-19, evidenced in the significant positive impact of capacity slack and a significant negative impact of financial slack on firms' operational resilience. Additionally, inventory slack is shown to have neither a significant impact on firms' operational resilience nor is it significantly influenced by firms' COVID-19 risk perception (Darby et al., 2020).

This study makes several contributions to the literature. First, it aligns with previous studies that emphasise the significance of firms' risk perception in decision-making (Chen et al., 2024; Fan and Xiao, 2023). The results indicate that in addition to disruptive events themselves (such as COVID-19), which objectively exist in the business environment and create challenges for firms in the same industry (Chen et al., 2024; Miller and Shamsie, 1999), firms' varied perceptions and sensitivities towards risk affect their implementation of resilience practices, including slack resources accumulation. The second contribution builds on the multidimensional nature of slack resources. Instead of generally positing that the accumulation of slack resources serves as an effective buffer strategy for enhancing firms' operational or supply chain resilience in the face of disruptive events (Bode et al., 2011; Chen et al., 2023), by adopting propositions from the ABV and agency theory, this study proposes a pair of competing hypotheses that focus on the differentiation of each type of slack and their impact on operational resilience. The findings in this study show that the impact of slack resources on operational resilience varies depending on the characteristics of slack, Specifically, certain types of slack, financial slack to be specific, can actually undermine a firm's ability to build operational resilience during COVID-19.

The remainder of the paper is structured as follows: Section 3.2 outlines the theoretical context of this study, with Section 3.3 developing the hypotheses examined.

Section 3.4 presents the data collection process, research design, and constructs operationalisation of the research. Section 3.5 describes the empirical results and robustness tests undertaken, whilst Section 3.6 addresses the implications and limitations of the study.

3.2 Theoretical Background

3.2.1 Slack Resources

Slack resources are defined as the buffer of actual or potential resources that enables an organisation to effectively respond to internal demands for adjustment, adapt to external pressures for policy change, and proactively implement strategic changes in relation to its external environment (Bourgeois, 1981; Sharfman et al., 1988). Slack resources has been extensively investigated in business literature, but current review studies have summarised that many of them theorise slack resources in a generic manner because they ignore the heterogeneity among different types of slack (Mount et al., 2024) - a phenomenon also observed in OSCM studies (Jia et al., 2025; Modi and Mishra, 2011; Zhu et al., 2025). Therefore, it is necessary to understand the characteristics exhibited by different types of slack resources and how these characteristics affect firms' operations.

The categorisation of slack resources tends to be based on the type or form that slack resources exist as in a firm (Depino-Besada et al., 2025) such as human resource, financial, relational, or operational (including capacity and inventory) slack (Depino-Besada et al., 2025; Mishina et al., 2004). Each type of slack resource exhibits distinct characteristics, thereby impacting firms' operations differently (Mount et al., 2024).

The first characteristic of slack is the level of its availability, which refers to how generic and commonly available a type of slack resource is (Voss et al., 2008). High availability slack resources can be accessed by a firm quickly, internally and independently

without seeking help from external forces, while low availability slack can only be accumulated with time, managerial effort, and a more complex process, and sometimes with the help of strategic partners (Mount et al., 2024). Therefore, as COVID-19 significantly disrupted firms' supply networks in a short period of time, firms are more likely to independently modify or build their slack resources with high availability. Among the four types of slack resources outlined, operational slack and financial slack are more generic and possess high availability, while human resource slack and relational slack exhibit high rarity and low availability (Aoki, 2025; Mount et al., 2024; Voss et al., 2008). Therefore, this study will only focus on operational slack and financial slack. Financial slack is defined as a firm's internal financial resources that are not committed to any specific purpose (John et al., 2017). Meanwhile, operational slack refers to the excess capacity, namely capacity slack, and excess inventory, namely inventory slack, that is unused or underutilised (Kovach et al., 2015).

The second characteristic of slack is the level of absorption (Bourgeois and Singh, 1983; Singh, 1986; Tan and Peng, 2003), which refers to how many tasks or activities a certain type of slack resource has been committed to (Voss et al., 2008). Based on the absorption level, different types of slack resources were divided into absorbed slack and unabsorbed slack (Tan and Peng, 2003; Titus et al., 2022). Absorbed slack refers to slack resources that have been absorbed into firms' operational system and committed to some specific purposes, while unabsorbed slack refers to slack resources that have not been committed to any specific purpose (Lai and Weng, 2014; Tan and Peng, 2003). Based on this notion, financial slack is defined as a type of unabsorbed slack, as it refers to a firm's internal financial resources that are not committed to any specific purpose (John et al., 2017; Natividad et al., 2013; Vanacker et al., 2017). Meanwhile, operational slack, which includes capacity slack and inventory slack, is commonly recognised as absorbed slack because it has

been embedded into and committed to the production process, so it is less likely to be used for other purposes (Azadegan et al., 2013; Love and Nohria, 2005).

Differences between absorbed and unabsorbed slack are determining factors of their impact on firms' operations. The first difference between absorbed and unabsorbed slack is the extent to which they are subject to managerial discretion (Sharfman et al., 1988). Unabsorbed slack such as financial slack, is more subject to managerial discretion, while absorbed slack, such as capacity slack and inventory slack, is less subject to managerial discretion (Tan and Peng, 2003; Zheng et al., 2022). The second difference between them is how easy they can be redeployed across different functions (Depino-Besada et al., 2025). There is a recognition that it is harder to redeploy absorbed slack but relatively easy to redeploy unabsorbed slack across different functions (Azadegan et al., 2013; Depino-Besada et al., 2025; Zheng et al., 2022). There is also evidence that absorbed and unabsorbed slack can have differential impacts on firms' operations, including firms' financial and market performance (Tan and Peng, 2003), firms' technological development (Lai and Weng, 2014), and the effectiveness of R&D expenses (Lee and Wu, 2016).

Similar findings have also been reported in an OSCM context. For example, Wiengarten et al. (2017) stated that absorbed and unabsorbed slack can impact firms' occupational safety differently, However, disruptions and resilience studies consistently view accumulating slack resources as a best practice for absorbing the negative impact of disruptive events and gaining resilience, and don't tend to acknowledge the heterogeneity between types of slack (Bode et al., 2011; Chen et al., 2023), leaving the slack-resilience relationship underexplored. One contention of this study is that due to the different characteristics of each type of slack, their impact on operational resilience during disruptive events may vary, especially for unanticipated events such as COVID-19. Hence, absorbed

slack, which includes capacity and inventory slack, and unabsorbed slack, including financial slack, would influence firms' operational resilience differently during COVID-19.

There are two contentions in this study related to slack resources. The first contention is that during COVID-19, the accumulation of slack resources is impacted by firms' risk perception of COVID-19. This argument is developed through the theoretical lenses of attention focus and situated attention from the attention-based view (ABV). The second contention is that during COVID-19, each type of slack will impact firms' operational resilience differently due to their unique characteristics. This argument is examined through the structural distribution of attention from ABV and agency theory.

3.2.2 The Attention-Based View

The attention-based view (ABV) investigated how firms' attention determines firms' actions and decision-making (Ocasio, 2011). Attention was defined by ABV as the process of noticing, encoding, interpreting, and allocating effort to "(a) issues: the available repertoire of categories for making sense of the environment, and (b) answers: the available repertoire of action alternatives" (Ocasio, 1997, p.189).

The ABV proposed three principles explaining this relationship between firms' attention and firms' actions or decision-making (Ocasio, 2011). The first principle, the focus of attention, posits that firms and their decision-makers have a limited amount of resources and time, and firms will not be able to pay attention to a diverse range of issues in the business environment, so firms would selectively pay attention to most strategic issues or issues that are most relevant with their operations while ignoring other issues (Ghobadian et al., 2022; Ocasio, 1997). Second, the situated attention, focuses on how a specific situation, context, or stimuli affect decision-makers and firms' attention allocation and efforts to address such situations (Li et al., 2022; Nadkarni and Barr, 2008). In this study, the focus of attention and the situated attention principle were used to explain the relationship between

firms' perception of COVID-19 and firms' slack resource accumulation. COVID-19, as a specific situation or stimulus, will attract decision-makers and firms' attention and impact firms' responses. As firms pay more attention to COVID-19, their decision-making will be more likely to focus on responding to and mitigating the impact of COVID-19 and gaining resilience by building slack resources (Nadkarni and Barr, 2008).

Third, the structural distribution of attention explains how firms' structures could govern, regulate, and distribute decision-makers or firms' attention allocation on different issues and determine firms' procedures' effectiveness in addressing these issues (Ocasio, 2011; Pinkse and Gasbarro, 2016). Such firms' structure, named "attention structure", includes firms' resources, key individuals, formal or informal rules, and social identification (Ocasio, 1997; Steven et al., 2015). Firms that lack such structures will limit their ability to correctly interpret or respond to any specific situations including COVID-19 (Galbreath, 2011). Since resources are one of the attention structures referred to by Ocasio (2011), it is argued that slack resources are an important attention structure that determines firms' ability to mitigate or absorb the impact of disruption and establish operational resilience. However, due to the characteristic differences between absorbed and unabsorbed slack, their impact on operational resilience during unexpected disruptive events, such as COVID-19, may be different.

3.2.3 Agency Theory

In contrast to the ABV, agency theory is a theoretical lens which explains how slack resources were misused by managers and hence negatively affect firms’ operations. Agency theory focuses on the impact of the agency relationship, where the principal, the first party, delegates decisions and work to the agent, the second party, on its behalf (Eisenhardt, 1989; Rungtusanatham et al., 2007; Zu and Kaynak, 2012). Most studies investigating agency theory and agency relationships regard agents as managers of firms and regard principals as

owners or stakeholders of firms (Guilding et al., 2005). Agency theory posits that certain key assumptions underpin the agency-principal relationship. At the individual level, both the principal and the agent will behave in their own interest, while at the organisational level, the information that the principal and the agent receive is not symmetrical (Rungtusanatham et al., 2007; Zu and Kaynak, 2012). Therefore, two types of problems could arise from an agency-principal relationship: the risk-sharing problem and the agency problem. The risk-sharing problem arises due to the differences in principals' and agents' attitudes towards environmental uncertainty and risks, which can lead to disagreement in firms' decision-making (Eisenhardt, 1989). The agency problem occurs when there is a goal conflict between the principal and the agent, and it is difficult for the principal to inspect the agent's behaviour, leading to the consequence that the principal cannot confirm whether the agent (managers) has behaved appropriately (Eisenhardt, 1989). As these two problems can damage firm performance across several dimensions, firm owners need to take control of managers to minimise these negative impacts (Tosi et al., 2003).

Agency theorists posit that slack resources mitigate the risk-sharing problem and the agency problem, as slack resources benefit only managers (the agent) but not firms (the principal) (Jensen and Meckling, 1976). Therefore, slack resources could exacerbate both agency problems and risk-sharing problems. From the agency problem perspective, managers are motivated to accumulate slack resources as these resources can offer an easier path to conducting self-serving projects (Jensen, 1986). It is also difficult for the principal to discipline and monitor the use of slack resources (Nohria and Gulati, 1996). From the risk-sharing perspective, a high level of slack resources creates a buffer against failure but makes managers underestimate the risk the firm is facing (Zona, 2012). This study posits that although slack resources have been considered a reliable response to the impact of disruptions (Holgado et al., 2024; Tomlin, 2006), due to the agency problem and risk-sharing problem, slack resources might negatively affect operational resilience instead. However,

due to differences between absorbed and unabsorbed slack, it is suggested that not all types of slack resources will be impacted by the agency and risk-sharing problem.

3.3 Hypothesis Development

3.3.1 Firms' Attention on COVID-19 and Slack Resources

ABV purports that firms have selective attention, in that they focus their attention on risks that are most relevant to their business operation while paying less attention to others (Ghobadian et al., 2022). This attention allocation has a determinant impact on the speed and effectiveness of firms' decision-making under the threat of external changes (Liu et al., 2024). The degree of attention firms allocate to a specific type of risk depends on their perception of such risk (Pinkse and Gasbarro, 2016). Firms' risk perception describes firms' managerial perceptions of the potential impacts that risk could bring to firms' operations (Charpin et al., 2021). It reflects the cognition and beliefs of the top management team, and it is the premise that firms give appropriate responses to risks (Fan and Xiao, 2023; Sharma, 2000). ABV-related studies also pointed out that attention to a certain type of risk would lead to a growing resource allocation to that risk (Tuggle et al., 2024).

A growing body of research has explored the relationship between firms' perception of certain types of risks and their operational strategy or response to those risks. For example, Shu and Fan (2024) stated that firms that possess a high level of perception of extreme weather risk in their supply bases will decrease their sourcing value from their suppliers, whilst Hajmohammad et al. (2024) report that firms with a high level of perception of sustainability risk for a supplier will shift their suppliers' management strategies from monitoring-based to collaborating-based. In the context of COVID-19, it is argued that a low level of firms' risk perception to COVID-19 infers that firms' top management team conceives that COVID-19 will have a low level of impact to their business (Ghobadian et

al., 2022), while a high level implies that top management teams' attention has been directed to COVID-19, so they will be more likely to take action to ensure mitigate the impact of the disruption caused by COVID-19 (Hajmohammad et al., 2024).

Evidence has shown that building slack resources is a commonly accepted practice for firms seeking to minimise the impact of disruptive events, such as COVID-19, as slack resources bring flexibility that helps build resilience (Tomlin, 2006; Holgado et al., 2024). Conversely, firms that eliminate slack resources are more vulnerable to disruption (Fogliatto et al., 2025). In an OSCM context, slack resources mostly refer to operational slack, including capacity slack and inventory slack. Bode et al. (2011) found that firms tend to build extra capacity slack to gain independence from suppliers after being impacted by disruptive events. Brandon-Jones et al. (2014) also noted that Japanese automotive manufacturers increased their inventory slack for sensitive components in response to the impact of the Japanese tsunami. Besides operational slack, financial slack can also be leveraged during disruptions such as COVID-19. Oh and Oetzel (2022) argued that under circumstances where global supply chains are disrupted by events such as COVID-19, it will be difficult for firms to replenish inventory or build inventory slack, and financial slack could be an appropriate alternative for mitigating disruptions.

Based on the arguments presented, it is posited that during COVID-19, firms pursued building slack resources as one practice to gain operational resilience. Firms that have a higher level of risk perception exhibited greater concern about COVID-19, and they would be more inclined to mitigate the impact of COVID-19 by building higher capacity, inventory, and financial slack:

Hypothesis 1: Firms' risk perception of COVID-19 is positively associated with their (a) capacity slack, (b) inventory slack, and (c) financial slack.

3.3.2 Firms' Slack Resources and Operational Resilience

Drawing on the ABV and agency theory arguments around absorbed and unabsorbed slack, the following competing hypotheses are proposed. H2 is based on the attention-based view premise that absorbed slack is less effective for unanticipated disruptions, while H3 draws on the proposition from agency theory, which posits that unabsorbed slack is less effective for enhancing operational resilience due to its agency-related issues.

ABV posits that slack resources allow managers to easily shift their focus of attention (Stevens et al., 2015), consequently impacting their response to risks and the impact of disruption. Firm resources, including slack resources, are important attention structures that can determine how firms regulate their attention and respond to environmental changes (Ocasio, 1997). Part of the reason that slack resources improve firms' operational resilience is that firms that have a high level of slack resources will pay more attention to long-term goals, such as increasing the stability and continuity of their operations (Essuman et al., 2022). During COVID-19, such attention to operational continuity will help them build operational resilience (Li et al., 2023).

Disruption and resilience studies to date argue that slack resources are important to firms at both pre-disruption and post-disruption stages (Chen et al., 2023; Manhart et al., 2020). At the pre-disruption stage, slack resources can serve as a buffer for firms to absorb the impact of disruption events internally (Manhart et al., 2020). At the post-disruption stage, slack resources offer operational flexibility to firms, helping them better respond to unexpected disruptive events as they allow firms to generate faster and more dynamic responses by providing more choices on response options (Chen et al., 2023). It is important however not to ignore the heterogeneity among different types of slack. As firms need to possess both operational stability and flexibility to achieve operational resilience (Aslam et al. 2024), the mechanisms by which absorbed slack and unabsorbed slack contribute to

operational resilience may differ. Although both absorbed slack and unabsorbed slack could benefit firms' resilience, their mechanisms are different: absorbed slack has been committed with a specific purpose of use, and difficult to be redeployed across different functions, but unabsorbed slack has not been committed with any particular purpose and easy redeployed across different functions (Azadegan et al., 2013; Depino-Besada et al., 2025; Zheng et al., 2022)., Therefore, absorbed slack exhibits a high level of stability that mainly mitigates the impact of anticipated disruption, while unabsorbed slack exhibits a high level of flexibility that mainly mitigates the impact of unforeseen disruption (Chen et al., 2023; Deng et al., 2024; Shi and Feng, 2024). Since slack resources are an important attention structure that can determine how firms regulate their attention and respond to environmental changes, it is postulated that if firms have a higher level of absorbed slack, they will have more resources to pay attention and respond to disruptive events that have anticipated occurrences or consequences. Whilst if firms have a higher level of unabsorbed slack, they will have more resources to pay attention to and respond to disruptive events that have unanticipated occurrences or consequences.

In OSCM literature, COVID-19 was considered a "deep disruption", which means that both the appearance and consequences of COVID-19 were not anticipated (Ge et al., 2023), so this study posits that firms' operational resilience during COVID-19 mainly depends on the level of their unabsorbed slack (financial slack). Therefore, firms that possess more financial slack will have a higher operational resilience during COVID-19. Conversely, firms that possess more absorbed slack (operational slack), including capacity slack and inventory slack, would have greater operational resilience during *anticipated* disruptions. However, since COVID-19's consequences are not anticipatable, firms with higher absorbed slack will be less effective in gaining operational resilience, because absorbed slack (operational slack) has already been committed to a certain purpose within a firm, and cannot be used based on multiple different scenarios (Voss et al., 2008). Therefore, firms with

higher operational slack will have more resources that could not be deployed for the disruptive impact of COVID-19, so they will have a lower level of operational resilience during COVID-19 compared with other firms.

Hypothesis 2(a): Firms' capacity slack negatively impacts operational resilience during COVID-19.

Hypothesis 2(b): Firms' inventory slack negatively impacts operational resilience during COVID-19.

Hypothesis 2(c): Firms' financial slack positively impacts operational resilience during COVID-19.

Agency theory concerns the potential negative effect of slack resources on firms' operations (Duan et al., 2020), but most studies mainly focus on the unabsorbed slack (financial slack). For example, De Carolis et al. (2009) and Latham and Braun (2008) respectively found that firms with high unabsorbed slack (financial slack) have diminished performance after adverse events or at the early stage of economic recession. Compared with unabsorbed slack, absorbed slack is subject to a lower level of managerial discretion (Lee and Wu, 2016), which agency theory considers a significant threat to firms' performance (Shen and Cho, 2005). In OSCM literature, although financial slack is an important component of slack resources and can build operational flexibility and resilience, there is also evidence of the negative impact of financial slack on firms' operations based on agency theory (De Carolis et al., 2009; Latham and Braun, 2008; Modi and Canter, 2021). These studies suggest that compared with capacity slack and inventory slack, financial slack is more likely to be associated with both the risk-sharing problem and the agency problem from agency theory. This study posits that under the circumstances that firms need slack resources to mitigate the impact of COVID-19, capacity slack and inventory slack will be more

efficient at achieved assigned purpose, which isbuilding operational resilience, as they are less influenced by the risk-sharing problem and the agency problem.

The risk-sharing problem occurs because of the differences between principals' and agents' attitudes toward environmental uncertainty and risks, and this difference could lead to disagreement in the decision-making of firms (Eisenhardt, 1989). The risk sharing problem with financial slack can mean that a high level of financial slack offers relaxation and comfort to managers (Liang et al., 2023). This has been associated with radical optimism and complacency (Zona, 2012), more risk-taking (Singh, 1986), misjudgement of the threat and potential impact of unexpected events or not performing to the best of their abilities (Liang et al., 2023). It follows then that risk-sharing problems brought by financial slack can undermine firms' ability to adapt to environmental changes and lead to a slower response to these changes (Cheng and Kesner, 1997). Conversely, absorbed slack (operational slack) deters the risk-taking intention of managers and leads to risk aversion (Steensma and Corley, 2001; Voss et al.,2008). Risk-aversion will reduce firms' tolerance for losses originating from disruptive events like COVID-19 and encourage managers to mitigate the impact of COVID-19 with such slack resources, hence enhancing operational resilience of the firm (Vanpoucke and Ellis, 2020).

The agency problem occurs when the principal cannot confirm whether the agent (managers) has behaved appropriately (Eisenhardt, 1989). From the agency problem perspective, unabsorbed slack (financial slack) is a resource that managers could misuse and discredit (Jensen, 1986). Agency theorists consider managerial discretion as an enhancer of the agency problem (Ponomareva et al., 2019). Even though building resilience is important during disruptive events such as COVID-19, managers might inappropriately invest financial slack resources into projects that are not helpful for resilience building (De Carolis et al., 2009). Besides that, the internal characteristics of financial slack resources make their

use more difficult to monitor (Liang et al., 2023). On the other hand, it is more difficult to redeploy absorbed slack to other uses, because moving absorbed slack from one area to another will involve cutting costs (Harrison and Coombs, 2012). Therefore, the absorbed slack (including capacity and inventory slack) is usually considered as low in managerial discretion (George, 2005; Sharfman et al., 1988), and it might be less of an agency problem than with financial slack. Hence, when firms possess absorbed slack during COVID-19, the absorbed slack will be more likely to be used to mitigate the impact of COVID-19 and build operational resilience.

On this basis, it is argued that as COVID-19 brought significant uncertainties and disruptive impacts, whilst firms with financial slack would have more resources to mitigate the impact of COVID-19, decision-making is often associated with greater managerial discretion, which could cause agency problems and risk-sharing problems. Therefore, firms with a higher level of financial slack would have greater difficulty coping with the changes caused by COVID-19 and hence lower operational resilience. While the decision-making of firms that have a higher level of operational slack, including capacity and inventory slack, is less associated with risk sharing problems, managerial discretion or agency problems, operational slack could be applied for the mitigation of COVID-19 impact to a greater extent, hence leading to a higher level of operational resilience.

Hypothesis 3(a): Firms' capacity slack positively impacts operational resilience during COVID-19.

Hypothesis 3(b): Firms' inventory slack positively impacts operational resilience during COVID-19.

Hypothesis 3(c): Firms' financial slack negatively impacts operational resilience during COVID-19.

3.4 Methodology

3.4.1 Data and Sample

To investigate the relationship between firms' perception of COVID-19 risk, slack resources, and operational resilience, a quarterly panel dataset, spanning from 2020Q1 to 2022Q1, based on several databases was developed. The rationale for the timeframe selection is that COVID-19 started in 2020Q1, and the Firm-Level Risk database was only updated until 2022Q1. Firms' operational resilience and slack resources (including capacity slack, inventory slack, and financial slack) data were collected from Orbis, firms' perception of COVID-19 risk from the Firm-Level Risk database, and firm-level and supply network-level control variables from Orbis and FactSet. Firstly, US firms that exist in all three databases were sampled based on firm unique ISIN identifiers, yielding 1852 firms. Only firms that belonged to the manufacturing industry based on the first two digits of the SIC industry code (from 20-39) were retained, leaving 678 firms. Finally, any samples that contained missing values in any variables were excluded, yielding the final data sample consisting of 472 firms with 3,568 observations.

3.4.2 Variables Construction

3.4.2.1 Operational Resilience

Operational resilience is the dependent variable for H2 and H3. Following Li et al. (2023), it is measured by calculating the change in operating revenue per unit production cost (ORPPC) before and after an external shock, which is COVID-19 in this study. Equation (1) is the original equation proposed by Li et al. (2023) and adopted by several operational resilience studies, including Liu et al. (2023), Gu et al. (2025), and Liu et al. (2025). The $ORPPC_i$ indicates the OPRRC after the external shock in year i. The average OPRRC from year i-1 to year i-3 is the benchmark before the external shock.

$$Operational\ resilience_i = \frac{ORPPC_i}{\Sigma_{i-3}^{i-1} ORPPC/3} \quad (1)$$

However, since the data structure of this study is quarterly panel data and operational resilience was calculated in each quarter, the original equation was modified into equation (2).

$$Operational\ resilience_q = \frac{ORPPC_q}{\Sigma_{i=2017}^{i=2019} ORPPC/3} \quad (2)$$

Where $ORPPC_i$ is replaced by $ORPPC_q$, and $ORPPC_q$ denotes firms' ORPPC in quarter q. Meanwhile, the ORPPC before external shock is calculated with the same method as the original study equation by calculating the average ORPPC from 2017 to 2019. A higher value of operational resilience suggests that firms exhibit better resilience during COVID-19.

3.4.2.2 Slack Resources

Three different types of slack are examined: Capacity, inventory, and financial slack.

Capacity slack is the dependent variable of H1(a) and the independent variable of H2(a) and H3(a). Firm's capacity slack in quarter q was calculated based on the ratio of production resources to sales in the same quarter, where production resources refer to property, plant, and equipment (PPE), as stated in equation (3) (Kovach et al., 2015).

$$Capacity\ slack_q = \frac{PPE_q}{Sales_q} \quad (3)$$

The high level of this ratio indicates firms have a higher capacity slack and have more excess production resources to respond to the change in demand, while the lower level of this ratio suggests firms efficiently utilise their production resources (Kovach et al., 2015; Kroes et al., 2022).

Inventory slack is the dependent variable of H1(b) and the independent variable of H2(b) and H3(b). Firm's inventory slack in quarter q was measured based on the ratio of the firm's average inventory to cost of goods sold (COGS) in the same quarter as equation (4) stated (Kovach et al., 2015; Kroes et al., 2022).

$$Inventory\ slack_q = \frac{Inventory_q}{COGS_q} \quad (4)$$

Similar to capacity slack, the high level of inventory slack ratio indicates firms have a better ability to respond to environmental changes by utilising finished goods inventory, while a low level of that suggests firms follow a lean strategy during inventory management quarter (Kovach et al., 2015; Kroes et al., 2022).

Financial slack is the dependent variable of H1(c) and the independent variable of H2(c) and H3(c). The financial slack of the firm in quarter q is measured by calculating the firm's quick ratio based on equation (5) (Palmer and Wiseman, 1999).

$$Financial\ slack_q = \frac{Total\ curent\ asset_q - Net\ inventory_q}{Current\ liability_q} \quad (5)$$

This measure shows the liquidity of a firm and the amount of redundant financial resources a firm owns (Liu et al., 2024). There are several methods to operationalise financial slack. The quick ratio was selected because it is not only a representative measurement for financial slack in OSCM literature (Modi and Cantor, 2021), but also a measurement that highlights the unabsorbed characteristics of financial slack (Lee and Wu, 2016; Singh, 1986). While other financial slack measurements, such as working capital/assets or debt/equity, do not fit the conceptualisation of financial slack in this study, because these equations were usually used to conceptualise financial slack as absorbed slack or potential slack (Lee, 2015).

3.4.2.3 Risk Perception of COVID-19

Firms' risk perception of COVID-19 is the independent variable for the hypothesis H1. A variable named **COVID_RISK** was adapted from the Firm-Level Risk database developed by the firm to measure the time-varying firm-level risk perception of COVID-19. A two-step methodology in developing this database was deployed (more details can be viewed in Hassan et al., 2023). First, a dictionary, which includes commonly used synonyms related to risk and exposure associated with a certain type of risk, was created based on online resources or newspaper articles (Haque and Varghese, 2023; Hassan et al., 2023). Second, a computational linguistics algorithm (Manning et al., 2008) was applied to identify and calculate the frequency of these synonyms' appearance during publicly listed firms' quarterly earnings calls (Hassan et al., 2023). This methodology was originally adopted to operationalise firms' risk perception to political risk (Hassan et al., 2019) and then extended to risk related to COVID-19. This risk measure captures the level of risk as perceived by firm managers (Hassan et al., 2019). While it differs from actual risk, it can still affect a firm's action even though it is biased (Hassan et al., 2019).

This database has been widely used by accounting and finance studies investigating COVID-19's impact on management guidance withdrawals (Hope et al., 2023) or rollover risk (Haque and Varghese, 2023). Another database that used the same methodology to measure firms' risk perception on political related risks has been used by operations management studies to examine its impact on firms' vertical integration or diversification strategies (Fan and Xiao, 2023), inventory strategies (Darby et al., 2020), and customer concentration (Leung and Sun, 2021). The measurement **COVID_RISK** was constructed based on the frequency of synonyms for terms such as "risk" or "uncertainty" used in firms' quarterly earnings conference call scripts within the context of COVID-19. This measure was operationalised as the ratio of the frequency of COVID-19-related risk or uncertainty

terms and synonyms to the overall length of the scripts (Hassan et al., 2023). Firms' managers will spend more time discussing COVID-19 if they feel firms are more significantly impacted by COVID-19 (Hope et al., 2023).

3.4.2.4 Control Variables

Several control variables were included in this study to exclude the potential confounding effects and increase the robustness of findings. Firm-level control variables were collected from the Orbis database, specifically firm size, measured by the log value of total assets, and firms' performance, measured by firms' return on assets (ROA), given that larger and more profitable firms have more resources to mitigate the impact of disruption (Liu et al., 2025; Zhu et al., 2025). From the firms' financial situation perspective, the leverage of the firm was controlled for, measured by the ratio of long-term debt to total assets. The asset tangibility of the firm, measured by the ratio of the tangible assets to total assets, was also controlled for, as firms with a higher level of leverage or a lower level of tangible assets will have more flexibility during COVID-19 (Jiang et al., 2023; Zhu et al., 2025). Lastly, R&D intensity was controlled for, measured by the ratio of R&D expenditures to total assets, as it is suggested that firms' innovation might impact their operational resilience because they could innovate and improve their processes or products to adapt to the post-COVID-19 business environment (Jiang et al., 2023; Liu et al., 2023). Following Jiang et al. (2023) and Chen and Ho (2019), zero was assigned to the missing value for R&D intensity.

For H2 and H3, one extra control variable was added, one-quarter lagged operational resilience, as firms' performance is historically dependent (Fan and Xiao, 2023). Network-level control variables were collected from the FactSet supply chain database. At the network level, the supply network and customer network degree centrality of firms was captured, measured by the number of suppliers and customers of firms, since a high level of degree

centrality at firms' suppliers and customers network will increase the difficulty of maintaining operational continuity and disruption recovery (Liu et al., 2025).

3.4.3 Endogeneity Concerns and Model Specification

Besides control variables, several practices were conducted to decrease the endogeneity concern of the study. First, to rule out the impact of potential industry factors and outliners on data analysis results, variables were standardised based on industry (first two digits of SIC industry code) means and standard deviations if they act as independent or dependent variables in any model (Modi and Mishra, 2011), and winsorise them at the 1st and 99th percentiles (or 0 and 99^{th} percentiles if the smallest value of an original variable is zero). Second, due to concerns over unobserved potential confounding variables, data analysis includes industry-quarterly fixed effects to exclude any unobservable time-invariant industry characteristics. Third, all control variables and independent variables in the main analysis are lagged by one quarter compared to the dependent variables, to rule out the possibility of reverse causality. One exception is that this study used unlagged data for risk perception of COVID-19, the independent variable in hypotheses H1a, H1b, and H1c. The reason is that whilst all other variables are collected at the last day of a quarter (as they come from financial report), risk perception of COVID-19 was collected at the beginning of the quarter, as based on Hassan et al. (2019, p.2143): "The majority of conference calls are held within 33 days of the new quarter", and these earnings calls are mainly presenting top management teams' "views on the company's state of affairs…over the past quarter". Therefore, compared with firms' COVID-19 risk perception in quarter q-1, firms' COVID-19 risk perception in quarter q is closer to other control variables in quarter q-1. Similar practice has been used by studies that apply the same dataset and variable from top-level finance journals (Haque and Varghese, 2023; Sihvonen and Kauppi, 2025).

It follows then that the model regression equation (6) is used to test H1:

$$Y_{i,t} = \beta_0 + \beta_1 Covid\ Risk\ Perception_{i,t} + \delta Controls_{i,t-1} + Quarter + Industry + \varepsilon \quad (6)$$

Where $Y_{i,t}$ is firm i's capacity slack, inventory slack, and financial slack in quarter t. $Covid\ Risk\ Perception_{i,t}$ is COVID-19 risk perception of firm i in quarter t. $Controls_{i,t-1}$ are all control variables in quarter t-1. $Quarter$ and $Industry$ are time fixed effects and industry fixed effects, respectively.

The model regression equation (7) is used to test H2 and H3:

$$Operational\ resilience_{i,t+1} = \beta_0 + \beta_1 Capacity\ Slack_{i,t} + \beta_2 Inventory\ Slack_{i,t} + \beta_3 Financial\ Slack_{i,t} + \beta_4 Operational\ resilience_{i,t} + \delta Controls_{i,t} + Quarter + Industry + \varepsilon \quad (7)$$

Where $Operational\ resilience_{i,t+1}$ and $Operational\ resilience_{i,t}$ indicate the operational resilience of firm i in quarter t+1 and quarter t. $Capacity\ Slack_{i,t}$, $Inventory\ Slack_{i,t}$, and $Financial\ Slack_{i,t}$ are firm i's capacity slack, inventory slack, and financial slack in quarter t. $Controls_{i,t}$ are all control variables in quarter t. $Quarter$ and $Industry$ are time fixed effects and industry fixed effects, respectively.

3.5 Analysis and Results

3.5.1 Main Results

Table 3.1 presents the mean, standard deviation, and correlations for all variables. The variance inflation factor analysis revealed that no variable has a VIF value exceeding 2.05, indicating that the likelihood of multicollinearity is low.

Table 3.1: Descriptive statistics

		Mean	SD	1	2	3	4	5	6	7	8	9	10	11
1	Operational resilience	0.00	0.68											
2	Capacity slack	-0.04	0.60	-0.23										
3	Financial slack	-0.21	0.63	-0.04	0.04									
4	Inventory slack	-0.03	0.56	-0.14	0.16	-0.01								
5	COVID-19 risk perception	-0.02	0.95	-0.06	0.05	0.05	0.02							
6	ROA	3.01	13.61	0.36	-0.10	-0.02	-0.08	-0.02						
7	R&D intensity	0.01	0.02	0.03	-0.07	0.11	0.01	-0.02	-0.26					
8	Asset tangibility	0.22	0.16	-0.07	0.34	-0.05	-0.05	-0.01	-0.03	-0.22				
9	Leverage	0.30	0.19	0.02	0.01	-0.18	-0.03	0.02	-0.08	0.04	-0.02			
10	Firms size	14.90	1.96	0.02	0.04	-0.23	-0.11	-0.02	0.27	-0.20	0.05	0.23		
11	Customer network centrality	17.06	27.15	0.01	-0.07	-0.09	0.00	-0.04	0.11	0.02	-0.13	0.05	0.44	
12	Supply network centrality	25.51	56.88	0.03	-0.03	-0.13	-0.11	-0.03	0.12	-0.04	0.01	0.06	0.57	0.62

Table 3.2 and Table 3.3 present models derived from the fixed-effects regression analysis. Models 1 to 3 in Table 3.2 include all control variables, the industry fixed effect, and the time fixed effect with capacity slack, inventory slack, and financial slack as dependent variables, respectively. Models 4 to 6 include COVID-19 risk perception as the independent variable, with Model 1 in Table 3.3 including all control variables, the industry fixed effect, and the time fixed effect with operational resilience as the dependent variable. Model 2 in Table 3.3 adds capacity slack, inventory slack and financial slack as independent variables.

Table 3.2 shows that the coefficient of COVID-19 risk perception is significantly positive in Model 4 ($\beta = 0.029$, $p = 0.005$) and Model 6 ($\beta = 0.028$, $p = 0.015$). Therefore, H1(a) and H1(c) are supported, indicating that firms' COVID-19 risk perception positively impacts the capacity slack and financial slack of firms. However, the coefficient of COVID-19 risk perception in Model 5 is insignificant ($\beta = 0.008$, $p = 0.467$), so H1(b) is not supported.

In Table 3.3, the coefficient of capacity slack is significantly positive ($\beta = 0.035$, $p = 0.032$). As H2(a) posits a negative association between firms' capacity slack and firms' operational resilience, and H3(a) posits a positive association, results support H3(a) but not H2(a). Meanwhile, the coefficient of financial slack is significantly negative ($\beta = -0.059$, $p = 0.000$). As H2(c) posits a positive association between firms' financial slack and firms' operational resilience, and H3(c) posits a negative association, the result supports H3(c) but not H2(c). However, the coefficient of inventory slack is insignificant ($\beta = 0.017$, $p = 0.271$), indicating that the result of the analysis supports neither H2(b) nor H3(b).

Table 3.2: Regression analysis for H1

Variables	Model 1 Capacity slack		Model 2 Inventory slack		Model 3 Financial slack		Model 4 Capacity slack		Model 5 Inventory slack		Model 6 Financial slack	
	β	p	β	p	β	p	β	p	β	p	β	p
	SE		SE		SE		SE		SE		SE	
Covid risk perception							0.029	0.005	0.008	0.467	0.028	0.015
							-0.011		-0.011		-0.012	
ROA	-0.005	0.000	-0.002	0.017	0.002	0.048	-0.005	0.000	-0.002	0.016	0.002	0.050
	-0.001		-0.001		-0.001		-0.001		-0.001		-0.001	
R&D intensity	-0.422	0.383	-0.855	0.093	3.248	0.000	-0.387	0.423	-0.845	0.097	3.281	0.000
	-0.484		-0.509		-0.542		-0.484		-0.509		-0.542	
Asset tangibility	1.829	0.000	-0.249	0.000	-0.463	0.000	1.836	0.000	-0.247	0.000	-0.457	0.000
	-0.066		-0.069		-0.074		-0.066		-0.069		-0.074	
Leverage	0.040	0.433	-0.151	0.004	-0.575	0.000	0.039	0.436	-0.151	0.004	-0.575	0.000
	-0.050		-0.053		-0.056		-0.050		-0.053		-0.056	
Firms size	0.051	0.000	-0.023	0.000	-0.071	0.000	0.051	0.000	-0.023	0.001	-0.071	0.000
	-0.006		-0.007		-0.007		-0.006		-0.007		-0.007	
Customer network centrality	-0.002	0.000	0.003	0.000	0.000	0.369	-0.002	0.000	0.003	0.000	0.000	0.335
	0.000		0.000		0.000		0.000		0.000		0.000	
Supply network centrality	0.000	0.140	-0.002	0.000	0.000	0.099	0.000	0.145	-0.002	0.000	0.000	0.102
	0.000		0.000		0.000		0.000		0.000		0.000	
Time/Industry-fixed effect	included		included		included		included		included		included	
Constant	-1.203	0.000	0.368	0.001	1.188	0.000	-1.198	0.000	0.370	0.000	1.193	0.000
	-0.101		-0.106		-0.113		-0.101		-0.106		-0.113	
Observations	3,568		3,568		3,568		3,568		3,568		3,568	
R-squared	0.250		0.055		0.147		0.251		0.055		0.149	

Table 3.3: Regression analysis for H2 & H3

Variables	Model 1 Operational resilience		Model 2 Operational resilience	
	β	p	β	p
	SE		SE	
Capacity slack			0.035	0.032
			-0.017	
Financial slack			-0.059	0.000
			-0.014	
Inventory slack			0.017	0.271
			-0.015	
Lagged operational resilience	0.544	0.000	0.547	0.000
	-0.013		-0.014	
COVID-19 risk perception	-0.007	0.454	-0.007	0.488
	-0.010		-0.010	
ROA	-0.002	0.001	-0.002	0.007
	-0.001		-0.001	
R&D intensity	0.643	0.211	0.928	0.072
	-0.513		-0.516	
Asset tangibility	-0.141	0.023	-0.231	0.001
	-0.062		-0.070	
Leverage	0.135	0.004	0.103	0.032
	-0.047		-0.048	
Firms size	0.001	0.851	-0.004	0.469
	-0.006		-0.006	
Customer network centrality	-0.001	0.047	-0.001	0.056
	0.000		0.000	
Supply network centrality	0.000	0.276	0.000	0.260
	0.000		0.000	
Time-fixed effect	included		included	
Industry-fixed effect	included		included	
Constant	-0.007	0.937	0.099	0.314
	-0.095		-0.099	
Observations	3,568		3,568	
R-squared	0.382		0.386	

3.5.2 Robustness Test

Additional measurements and tests were conducted to ensure the robustness of findings. First, industry-time fixed effect was replaced by state-time fixed effect, as former resilience studies focusing on COVID-19 suggest that firms located in different states might be impacted differently (Jiang et al., 2023). Appendix Table A1 presents the results, which are consistent with the baseline regression.

Second, two additional control variables, CEO tenure and CEO duality, were added to support the data analysis. These two variables were collected from the BoardEX database. CEO tenure is measured by the number of years since the CEO assumed office, and CEO duality is constructed as a dummy variable, where one represents that the CEO is the chairman of the board at the same time, while zero otherwise (Ghobadian et al., 2022). Although no study indicates that CEO characteristics could affect the operational resilience or accumulation of slack resources, the literature to date has posited that, based on ABV and agency theory, such CEO (individual) level indicators could affect attention or resource allocation (Lindlbauer et al., 2025). Appendix Table A2 presents the results, which are consistent with the baseline regression.

Last, an alternative measurement of resilience, named the production function developed by Dormady et al. (2019), was tested. This variable has been used in several resilience studies, such as Jiang et al. (2023) and Zhu et al. (2025), and this study followed their two-step construction. The first step is to calculate firms' total factor productivity (TFP) by using the production function, a measure that assesses firms' input-output relationship according to scale. This study adopted the classic Cobb–Douglas production function based on Giannetti et al. (2015), as equation (8) stated.

$$\ln(VA_{it}) = \alpha\ln(K_{it}) + \beta\ln(L_{it}) + \gamma\ln(M_{it}) + Quarter + Industry + \epsilon_{it} \quad (8)$$

Where VA_{it} denotes the total sales revenue of firm i in quarter t, K_{it} refers to the total assets of firm i in quarter t, L_{it} represents the total number of employees of firm i in a quarter t, and M_{it} refers to the expense for materials and other inputs of firm i in quarter t. The coefficients of each factor represent the firm's output elasticity with respect to that input, indicating the percentage change in VA_{it} output resulting from a 1% change in the input's value. This equation also includes quarter and industry dummy variables. ϵ_{it} is firm i's TFP in quarter t (Jiang et al., 2023; Zhu et al., 2025). The second step is using TFP to obtain firms' resilience by calculating the change between the current quarter's TFP and the previous quarter's TFP, as stated in equation (9).

$$Firm\ resilience_{it} = TFP_{it} - TFP_{it-1} \quad (9)$$

This variable was used as an alternative resilience measure for H2 and H3. Appendix Table A3 presents the results, which are consistent with the baseline regression.

3.6 Discussion

This study investigates how firms' risk perception of COVID-19 impacts their decision-making regarding three types of slack resources, capacity slack, inventory slack, and financial slack, and considers how these slack resources affect firms' operational resilience during COVID-19. Several valuable theoretical and practical implications are presented.

3.6.1 Theoretical Implications

First, this study contributes to the literature focusing on firms' attention mechanisms. ABV posits that firms' attention focus will enhance firms' perception of certain issues, and such attention will be transformed into operational practices that aim to address such issues (Essuman et al., 2022; Li et al., 2022; Ocasio, 1997). This study reinforces ABV by demonstrating that during COVID-19, firms that have a higher level of risk perception

related to COVID-19 will accumulate more capacity slack and financial slack during COVID-19. Such results support hypotheses 1(a) and 1(c), which are in line with tenets of ABV. During COVID-19, firms' risk perception, which has been suggested to be highly associated with firms' attention to risk (Fan and Xiao, 2023; Liu et al., 2025), impacts firms' resource allocation, alongside COVID-19 itself. To date, no OSCM study has investigated how firms' risk perception of certain disruptive events impacts their decision-making. There is a stream of work that has only focused on the impact of a disruptive event that objectively exists, such as Brexit (Hendry et al., 2019), the US-China trade war (Fan et al., 2024), COVID-19 (Chen et al., 2023) or the Russian invasion of Ukraine (Shu et al., 2025), but ignores the heterogeneity of firms' attention or perception of these events.

Another stream of work observes the impact of firms' perception of a general type of risk that subjectively and consistently exists, such as firms' perception of extreme weather risk (Shu and Fan, 2024), or political risk (Liu et al., 2025), but they are without a setting of actual events to eliminate the heterogeneity of the objective business environment. This study, which examines the impact of firms' risk perception of COVID-19, reveals that firms' risk perception of COVID-19, which reflects their attention to the disruption, still has a critical influence on firms' decision-making even if objectively existing disruptive events come into effect.

Secondly, this study contributes to the literature on operational resilience. It investigates the slack-resilience relationship during COVID-19 with two theoretical lenses, including ABV, which was used to build hypotheses 2 (a-c), and agency theory, which was used to build hypotheses 3 (a-c). This study finds that firms with more capacity slack during COVID-19 tend to have a higher level of operational resilience, whereas those with more financial slack tend to have a lower level of operational resilience. Such results provide empirical support to hypotheses 3(a) and 3(c), thus rejecting their opposing hypotheses 2(a)

and 2(c), providing empirical evidence that agency theory is the appropriate theory lens to explain the impact of different types of slack resources on firms' operational resilience.

This study illustrates that two agency-related issues determine the effectiveness of slack resources on firms' operational resilience, including how likely such slack resources are to be misused (agency problem), and how such slack resources affect managers' attitude towards risk (risk-sharing problem) (Eisenhardt, 1989). Therefore, capacity slack, as a type of absorbed slack that restricts managers' risk-taking intention and is less likely to be misused (Lai and Weng, 2014), is effective for firms' operational resilience during COVID-19. On the other hand, financial slack, as a type of unabsorbed slack that encourages managers' risk-taking intention and is more likely to be misused (Jensen, 1986; Singh, 1986), undermines firms' operational resilience during COVID-19. As most of the OSCM studies adopted agency theory to address supply chain relationship governance by conceptualising the buyer-supplier relationship as the principal-agency relationship (Matinheikki et al., 2022), this study extends the application of agency theory in the OSCM discipline. Through such extension, findings illustrate that agency theory can address not only dyad-level issues such as buyer-supplier relationship governance (Shou et al., 2022) or supplier quality management (Zu and Kaynak, 2012), but also organisational-level issues, including the impact of firms' decision making on resilience.

There is no evidence to support the contention that firms' inventory slack is impacted by firms' risk perception of COVID-19 or helps firms gain resilience during COVID-19. As such, hypotheses 1(b), 2(b), and 3 (b) are not supported. Even though many studies indicate that inventory slack is an effective method to mitigate the impact of risk, uncertainties, or disruptive events (Brandon-Jones et al., 2014; Kouvelis et al., 2018), this view has been challenged by recent studies. For example, Darby et al. (2020) did not find that the firms' perception towards policy risk has any impact on firms' inventory accumulation, and they

explain that the reason could be that the firms' perception towards policy risk is not apparent and salient enough for firms to respond with inventory accumulation. This study supports their examination of the risk perception-inventory accumulation relationship, but since this study focuses on this relationship in a COVID-19 context, it offers a different point of view on this phenomenon than Darby et al. (2020).

COVID-19, compared with other risk or disruptive events, has a much more severe impact on firms' operations (Jiang et al., 2023; Pantano et al., 2020). Hence, the fact that firms did not intend to build inventory slack to respond to events like COVID-19 shows that firms do not view building inventory slack as an effective resilience practice, regardless of the severity of disruptive events. This study validates such a view from firms, as the empirical result of this study shows that inventory slack does not help firms' operational resilience during COVID-19. A similar argument on inventory slack has also been suggested by Talluri et al. (2013), who pointed out that holding inventory slack does not help risk recovery of the firm.

3.6.2 Practical Implications

This study also provides several practical implications for managers regarding firms' operational strategies and risk management practices. First, the findings underscore the importance of being aware of and attentive to potential impacts of disruptive events. While the data analysis results indicate that awareness alone may not directly enhance operational resilience during disruptions, it serves as a critical foundation for implementing effective resilience strategies. Accordingly, firms should invest in robust risk detection systems and cultivate the ability to anticipate and assess the potential impacts of unexpected events.

Second, managers should carefully evaluate the effectiveness of the financial slack of their firms and the role that financial slack can play in mitigating disruptions – especially

those that are unanticipated. Risk management studies in the OSCM discipline posit that financial slack, as a type of unabsorbed slack, exhibits a high level of flexibility under the impact of unanticipated events (Chen et al., 2023). However, this study finds that a high level of financial slack can also be associated with agency problems and risk-sharing problems, both of which will interfere with managers' decision-making and negatively impact firms' operations. For example, Blau and Schoenherr (1971) considered that firms with a high level of financial slack are naturally bureaucratic, and Liang et al. (2023, p.10) suggested that managers who work in firms owning relatively long-term financial slack might be "incapable or too indolent to capitalise on changes and opportunities in an uncertain environment". To address these concerns, firms should consider mechanisms such as outcome-based contracts to align managerial incentives and mitigate the agency problem of financial slack.

Last, this study shows that building capacity slack, as a commonly accepted practice of managers to minimise the impact of disruptive events, exhibits a significant effect on firms' operational resilience during COVID-19. Such a result should bring confidence to managers when they consider building capacity slack for the potential disruptive events in the future, especially in the context of unstable business environments.

3.6.3 Limitations and Future Research

First, although inventory slack was conceptualised as an absorbed, low-discretion slack, as most other studies did (Wood et al., 2017; Zhang et al., 2022), there are studies pointing out that the categorisation of inventory slack is more contingent than that. Sharfman et al. (1988) and Latham and Braun (2008) argued that only inventory slack that is stored in a processed form (from process to finished good) could be categorised as low-discretion slack, while the inventories in raw material form should be considered as high-discretion and unabsorbed slack. It could potentially constitute one of the reasons that this study did not yield a

significant result on inventory slack. Therefore, future studies could have a more systematic investigation into the impact of each type of inventory slack on operational resilience.

Second, data and variables of this study come from several databases, including Factset, Orbis, and the Firm-Level Risk database. One common limitation of these databases is that they only include data from publicly traded firms, so the results of this study might not be applicable to private firms or small and medium enterprises (SME). Hence, future studies could use different sources of data to examine the relationship among firm-risk perception, slack resources, and a firm's operational resilience under an SME context.

Third, to exclude the heterogeneity among countries and industries, the data sample is from US manufacturing firms. However, such sample selection makes this study lose the opportunities to investigate the impact of policy dynamism and industrial dynamism on firms' decision-making and the effectiveness of firms' resilience strategies. Hence, future studies, by collecting data from different countries and industries, address the impact of macro factors on firms' operations during disruptive events.

Fourth, although the empirical design of this study attempts to limit endogeneity concerns, there is no direct endogeneity test conducted. Therefore, future studies could consider the potential endogeneity factor that could influence the results of this study.

Lastly, one of the important findings of this study is the negative impact of financial slack on operational resilience, due to its agency problems and risk-sharing problems. Nevertheless, the empirical result of this study indicates that some types of slack resources, such as capacity slack, indeed help firms' operational resilience when agency and risk-sharing problems are under control. Hence, one of the potential future research directions is to explore the contingent factors that could impact the relationship between financial slack and operational resilience, such as strategies, practices, or capabilities that can mitigate the

impact of financial slack's agency and risk-sharing problems and enable financial slack to enhance firms' operational resilience.

Chapter 4. Adapting Supply Networks to Achieve Resilience: The Impact of Geopolitical Disruption and Institutional Distance

4.1 Introduction

Geopolitical events, causing "tensions among states and political actors that affect the peaceful course of international relations" (Caldara and Iacoviello, 2022, p.4), are commonplace today, including examples such as Brexit (Dey et al., 2023; Jafari-Sadeghi et al., 2023), the US-China trade war (Fan et al., 2022), and the Russia-Ukraine conflict (Kim et al., 2025; Korosteleva, 2022). Such events encompass international conflicts, political instability, economic sanctions, and government policy shifts, often leading to severe disruptions that substantially influence global supply networks (Bednarski et al., 2025; Gray et al., 2013; Sodhi and Tang, 2021; Tukamuhabwa et al., 2015). For example, the first phase of the US-China trade war during Trump's first presidency (2018 to 2020), marked by the imposition of tariffs and export restrictions by the US and end with the "phase one agreement" between US and China (Fan et al., 2022), has prompted US firms to consider how to adapt their supply networks by diversifying sourcing locations to enhance resilience (Fan et al., 2022; Moradlou et al., 2025).

All international firms are exposed to geopolitical tensions, and geopolitical events have formed as a major concern for managers (Sinani and Zilja, 2025; Tippmann et al., 2023). For example, more than 90% of North American firms have reportedly already relocated some of their supply base to mitigate a myriad of risks associated with trade wars and geopolitical tensions (Van Wyck et al., 2023). Following the recent appointment of the new US administration in 2025, the Trade in Transition study which surveyed 3,500 global supply chain executives, reports that firms are continuing to adapt their supply networks to rising protectionism and shifting geopolitical alliances as "global trade may face its most

turbulent era since the 1930s" (Trade in Transition, Economist Impact, 2025, p.7). Indeed, the US-China trade war, which is the focus of this study, in particular, is often described as the "most serious disruption to global supply chains since their emergence" (Vortherms and Zhang, 2024, p.1815).

Trade wars, which are unpredictable, exogenous, slow-evolving and potentially long-term in nature (Grewal et al., 2007), require firms to understand points of vulnerability across their supply network, and proceed to make strategic adaptations to enhance supply network resilience (Blessley and Mudambi, 2022). In contrast to rapid onset events (such as natural disasters (e.g., Son et al., 2021), or factory fires (e.g., Chopra and Sodhi, 2014), slow-evolving events involve signals that may be visible to managers before a crisis, or only recognised in hindsight afterwards, and such signals could bring managers extra information re-evaluating the evolution of the crisis and its effects, influencing their decision making during the event, and affecting how supply network adapt to gain resilience (Grewal et al., 2007). However, as most of supply network resilience studies focus on rapid onset events, whether firms can make their supply networks resilient against the risk posed by slow-evolving, long-term disruptive events such as geopolitical events is less well-understood (Bednarski et al., 2025; Trade in Transition, Economist Impact, 2025).

Moreover, in operations and supply chain management (OSCM), resilience studies have predominantly adopted an engineering-oriented view of resilience (Wieland, 2021), focusing on how firms can prepare for and recover from disruptions to maintain the continuity of supply (e.g., Scheibe and Blackhurst, 2018; Scholten et al., 2014). Whilst these studies have led to an advanced understanding of how to better categorise (Azadegan and Dooley, 2021), develop (Kim et al., 2015), and leverage (Silva et al., 2023) supply network resilience, there is an opportunity to extend "resilience thinking" through consideration of the political contexts in which supply networks are embedded. To enable this extension, this

study adopts the social-ecological view of resilience, which is "characterised not by an organisation's attempts to conserve a supposedly optimal state of the supply chain but by renewal, reorganisation, development […]" (Wieland and Durach, 2021, p.318).

To complement this view, this study aligns with Wieland and Durach's (2021) definition of resilience: the capacity of a supply network to persist, adapt, or transform in the face of change, thereby capturing a multidimensional conceptualisation of resilience as *persistence, adaptation, and transformation*. 'Rethinking' resilience, beyond persistent engineering models, requires us to consider the broader systemic environment from which a supply network cannot be disentangled. By doing so, this study advances OSCM scholars' understanding of supply network resilience by emphasising resilience as *adaptation* and *transformation*, in the context of whether buying firms address potential disruptions arising from slow-evolving, long-term geopolitical disruptions (e.g., US-China trade war).

This study identifies two critical yet under-explored gaps in the extant literature on supply network resilience. The first gap that has not been addressed is whether, to be resilient in times of a slow-evolving, long-term geopolitical disruption, firms adapt and potentially transform their supply network in terms of institutional distance. In particular, this study focuses on regulatory distance, which derives from setting, monitoring, and enforcing rules through legal sanctioning, and is particularly relevant to this study on the US-China trade war, where regulatory strategies deployed "have expanded beyond tariffs to a wider set of policies aimed at strategic decoupling of the two economies" (Vortherms and Zhang, 2024, p.1816). Extant studies have shown that firms do actively manage geographic dispersion of their supply network during periods of geopolitical disruptions (Moradlou et al., 2025; Ren et al., 2024), but these findings do not shed light on whether firms consider the institutional distance with suppliers when making such crucial decisions. Given the volatile nature of the global trading environment and the role that legal sanctions and trade policy have had to date,

and will have in the future, it is necessary to better understand whether firms adapt the regulatory distance across their supply network to establish resilience.

The second gap is that if buying firms' perception of domestic and overseas political risk before the US-China trade war moderates the relationship between their exposure to the US-China trade war and the extent of adaptations made to their supply networks. Perception of political risk, which was defined as firms' "collective managerial perceptions of the likelihood and potential impact" of government intervention in the firm's affairs (Charpin et al., 2021, p.330), can determine how sensitive buying firms are in the environment (Fan and Xiao, 2023), and may thus impact decision-making in multiple aspects, including risk mitigation strategies they deploy during geopolitical disruptions such as the US-China trade war (Darby et al., 2020; Wulandhari et al., 2023). This study focuses on two dimensions of perceived political risk: political process risk and economic policy risk.

Political process risk refers to the uncertainty stemming from instability and lack of transparency around a government's decision-making processes (Hassan et al., 2019). The US-China trade war is said to have exposed firms to political processes more than ever before (Gammeltoft and Panibratov, 2024), but it is unclear how a firm's perceptions of these political processes affect mitigation strategies. Economic policy risk reflects the uncertainty in macroeconomic policy decisions related to fiscal, monetary, and tax policy (Al-Thaqeb et al., 2022). In a supply chain context, Leung and Sun (2021) show firms experiencing high economic policy risk will diversify their customer base, whilst Charoenwong et al. (2023) suggest firms will avoid suppliers that come from countries with high economic policy risk. This multidimensional approach to political risk allows us to capture both the unpredictability of policy changes (political process risk), and concerns around direct financial and operational impacts at the firm level (economic policy risk). Up until now, only a very limited number of studies (e.g., Zhu et al., 2025) have started to investigate the role

of political risk in shaping firms' responses to geopolitical disruptions. This study addresses these two vital gaps, by posing the following guiding research questions:

RQ1. Do buying firms adapt their supply networks, based on the regulatory distance with their suppliers, to maintain supply network resilience in the face of slow-evolving, long-term geopolitical disruptions?

RQ2. How does buying firms' perception of political risk (political process and economic policy risks) impact the adaptations made by buying firms to their supply network in response to slow-evolving, long-term geopolitical disruptions?

This study addresses these questions, building on the socio-ecological view of resilience and central tenets of institutional theory, using a series of databases including a firm-level risk database (Hassan et al., 2019), the World Governance Indicator database (WGI) (Kaufmann et al., 2011), the FactSet supply chain relationship database (Factset, 2024), and the Orbis database.

This study makes two distinct yet interconnected theoretical contributions to extant studies on supply network resilience. First, it shows that due to the US-China trade war, affected firms made adaptations to their supply networks. Specifically, the regulatory distance between affected buying firms and their supply networks significantly decreased. This signals that buying firms did indeed adapt their supply networks to leverage resilience and mitigate the disruption risks posed by the US-China trade war – a slow-evolving geopolitical event. Second, it is evident that other contextual factors influence whether buying firms respond to such slow-evolving, long-term disruptions. Specifically, the impact of the US-China trade war on regulatory distance across a supply network is influenced by the buying firm's perception of political risk. Taking a multidimensional approach to perceived political risk, this study examines the moderating effects of two dimensions -

political process and economic policy risks. The finding shows that buying firms' perception of political process and economic policy risks before the US-China trade war accentuates the reduction in supply network level regulatory distance during the time buying firms were exposed to the US-China trade war.

4.2 Theoretical Background

4.2.1 Rethinking Supply Network Resilience

The predominant view in OSCM on supply network resilience focuses on the ability of interconnected supply network actors to anticipate, prepare for, adapt to, and/or recover from disruptions while maintaining operational continuity and performance (e.g., Brandon-Jones et al., 2014; Ponomarov and Holcomb, 2009). The resilience of supply networks is a critical area of study in the field of OSCM given the interconnected nature of firms, combined with increasing uncertainties stemming from geopolitical events (Hendry et al., 2019), and natural disasters (Son et al., 2021), which collectively have elevated the importance of understanding how supply networks can withstand, respond to, and recover from disruptions (Tukamuhabwa et al., 2015). For example, Scheibe and Blackhurst (2018) investigate how the structure of a supply network impacts resilience and find that a complex network can hinder the establishment of resilience. Durach et al. (2020), on the other hand, explore the role of relationship closeness between supply network members and conclude that factors such as cooperation and social bonding can benefit resilience. To date, the conceptual foundations of supply network resilience have been centred on how robustness, stability, and adaptability mechanisms can enable a firm to recover to a desired level of operational performance (e.g., Yu et al., 2024), or restore pre-disruption performance levels (e.g., Sheffi and Rice, 2005), emphasising metrics such as time-to-recovery or time-to-survive (e.g., Simchi-Levi et al., 2014).

These foundations build on a classical engineering mindset, which considers the supply chain as a linear system that can be 'engineered' and controlled from end to end (e.g., Sheffi, 2005). For example, Sheffi and Rice (2005, p.41) define resilience as "the ability to bounce back from a disruption" to performance levels before disruption and investigate strategies and practices that build such engineering resilience. However, this conceptualisation of resilience is somewhat limiting, especially from a supply network perspective, when it comes to capturing some of the broader environmental factors - economic, political, cultural, or social - that firms within complex supply networks are exposed to (Wieland and Durach, 2021). In other words, supply networks need to evolve in response to the complex and multifaceted challenges that arise as a result of these factors rather than simply returning to pre-disruption states (Adobor and McMullen, 2018). This study aligns with Wieland and Durach's (2021) contention that supply networks should not be positioned purely as engineerable systems and that it is particularly appropriate, in this context, to consider supply network resilience from a more social-ecological perspective, a yet underexplored viewpoint, which is "complex, non-linear and self-organizing, permeated by uncertainty and discontinuities" (Berkes and Folke, 1998, p.12).

The social-ecological perspective of resilience underscores the importance of flexibility, diversity, and learning from disruptions to create more adaptive and sustainable systems. It moves beyond the *persistence* approach which is aligned with the engineering view of resilience (Holling, 1973), to capture adaptation (adjusting the system in response to a disruption, or fear thereof), and transformation (radically changing structures and processes in response to disruption) approaches (Lin et al., 2023; Wieland et al., 2023). Crucially, the socio-ecological perspective highlights that supply networks are interconnected with other socio-ecological systems (such as political-economic, or planetary, systems) that can dictate norms and ways of working (Flynn et al., 2021; Wieland, 2021), and that social actors (such as managers) may determine how the system responds

(Davoudi et al., 2013). This is especially pertinent when considering that a buying firm's supply networks may operate across many jurisdictions, with the political, cultural, and social institutions therein impacting how firms compete, operate, and coordinate with one another (Kauppi, 2013).

The US-China trade war illustrates how supply networks are intertwined with other systems - namely, in this case, political systems whereby the regulations around tariffs and levies imposed by the US political institution lead buying firms (based in the USA and other developed countries) to adapt their supply networks (Charoenwong et al., 2023; Zhang et al., 2025). Fan et al. (2022) note that the diversification of supply bases is used as an approach to cope with the US-China trade war, given the increased flexibility that such a strategy can afford. This is not an isolated case, as several studies have started to report on the adaptation, and transformation, of supply networks following disruptions driven by slow-evolving, long-term geopolitical disruptions (e.g., Handfield et al., 2020), examining 'how' firms realign their supply network structures (Moradlou et al., 2025; Roscoe et al. 2022), by focusing on 'where' they relocate supply (Chakkol et al., 2023). For example, Roscoe et al. (2022) investigate why managers redesign their supply networks during geopolitical disruptions and attribute institutional concerns, concerns about the mobility of supply chain assets, and potential disruption in the future as reasons for the adaptations made.

To restructure and realign the supply network seeking adaptability and resilience, one important factor that firms need to consider is the heterogeneity among the supply networks. Supply network heterogeneity represents the degree of difference between firms in the supply network (Liu et al., 2024). It could present in various forms, including product, technology, geographic, and industry (Deng et al., 2024; Gualandris et al., 2021). In a supply network, a high level of supply network heterogeneity hinders the positive collective outcomes of the supply network, such as innovation performance (Sharma et al., 2020) and

productivity (Serpa and Krishnan, 2018). The main reason is that the practices that were adopted for certain local institutions and operational settings are difficult to transfer to others (Gualandris et al., 2021).

From the resilience perspective, network analysis studies and disruption studies have suggested that high level of supply network heterogeneity will increase the difficulty of information process and supply network monitoring, hence increases the vulnerability of the supply network, accelerates risk propagation, increases the frequency of supply network disruption, and eventually undermines the resilience of the supply network (Bode and Wagner, 2015; Chen et al., 2025). However, the way previous OSCM studies supply network heterogeneity is limited to forms of heterogeneity such as geographical heterogeneity (Bode and Wagner, 2015) or industrial heterogeneity (Gualandris et al., 2021). One important form of heterogeneity that could impact firms' decision-making during geopolitical disruption might be ignored, namely institutional heterogeneity, which is commonly described as institutional distance. The following section will focus on the institutional distance between partners in supply networks to better understand a possible key driver of managers' decision-making.

4.2.2 Institutional Distance in Supply Networks

Institutional theory which examines how institutions shape the behaviour of individuals, firms, and nations (Scott, 2014), regards institutions as "humanly devised constraints that structure political, economic, and social interaction, and these can be formal, such as rules and laws or informal, such as norms of behaviour" (North, 1990, p.3). Institutional theory highlights how socially constructed systems of norms, values, and beliefs impact firms' behaviours and decision-making (e.g., Meyer and Rowan, 1977; Roscoe et al., 2022). One of the central tenets of institutional theory is that each country has its own institutions, where normative rules, heuristics, and values reside outside of its direct control and these

institutions define the perception of a country's uncertainty (Aguilera and Grøgaard, 2019). Institutional distance examines the extent of similarity or dissimilarity between domestic and foreign institutions and highlights how differences in regulatory systems, cultural norms, and societal expectations influence firms' decision-making (Collevecchio et al., 2024; Kostova, 1997).

Most prior studies investigating the impact of institutional distance stem from the field of international business (e.g., Kostova et al., 2020). Studies such as Gaur and Lu (2007) and Wu et al. (2022) suggest that the institutional distance between the home and host countries of a firm creates high uncertainty and costs for business activities, and it negatively affects financial performance and survival rates. It may also lead multinational firms to adopt entry modes with lower commitment when expanding into new markets (Kostova et al., 2020) or avoid entering certain countries altogether (Xu and Shenkar, 2002). The reason institutional distance can have a negative impact on firms' operations is that institutional distance reflects "the heterogeneity of cross-country variations at multiple levels", and host firms may be unfamiliar with such differences and unsure how to manage them (Depperu et al., 2024, p.1450). Studies in SCM have shown that high-level institutional distance between buyers and suppliers decreases operational performance for both (Batsakis et al.,2023).

In the supply network context, institutional distance constitutes an important source of uncertainty and nontransparency in global supply networks that rely on global sourcing (Bode and Wagner, 2015). Besides the common drawbacks across the different types of heterogeneity, there are unique characteristics of institutional distance that could undermine supply network resilience. Greater institutional distance between buying firms and suppliers creates a sense of insecurity, escalates any existing tensions, including geopolitical tensions, between buyers and suppliers, and hence incubates an environment that encourages opportunistic behaviours (Batsakis et al., 2023; Bhat et al., 2025). Such opportunisms drive

suppliers to prioritise their own interests, eventually undermining the buying firms' ability to adapt and recover from disruption (Wang et al., 2023). Conversely, if buying firms and suppliers have a low level of institutional distance, their comparable institutional quality will create compatible business procedures and develop trust (Bhat et al., 2025), which is critical for minimising the effect of opportunistic behaviours and improving supply network resilience (Ali et al., 2023; Dubey et al., 2019).

Institutional distance comprises five types of distance: regulatory, political, economic, cognitive, and cultural (Bae and Salomon, 2010; Wu and Salomon, 2016). Any country can enact and enforce regulations on the firms that operate within its boundaries and across its boundaries, and regulatory distance captures the differences across countries in this regard (Perkins, 2014). Political distance measures the differences in political stability and democracy of different countries (Salomon and Wu, 2012), whilst economic distance reflects country differences in economic structure and market stability (Bae and Salomon, 2010). Cognitive distance then addresses country-level differences in cognitive structures and routines, and how these factors impact judgment and problem-solving (Bae and Salomon, 2010). Lastly, cultural distance explains differences among countries' beliefs, values, and norms (Salomon and Wu, 2012).

This study focuses on regulatory distance as it is particularly relevant to the US-China trade war, where various tariff and non-tariff regulatory measures have been implemented to strategically decouple the two economies (Vortherms and Zhang, 2024). OSCM studies have started to highlight the negative impact of institutional distance on the supply network, citing role conflict and ambiguity among supply network members (e.g., Dong et al., 2016), the restriction of supplier knowledge acquisition across countries (e.g., Wang et al., 2023), and an increase in sustainability risks in supply networks (e.g., Busse et al., 2016). There is, however, a lack of attention paid to regulatory distance and its impact

on resilience, which may hinder buying firms' efforts to maintain and enhance supply network resilience. This study contends that when buying firms attempt to reconfigure their supply networks to maintain resilience against heightened disruption risk driven by slow-evolving, long-term geopolitical events, they may need to consider the extent of regulatory distance across their supply network.

4.3 Hypotheses Development

4.3.1 Geopolitical Disruptions and Regulatory Distance

Building a resilient supply network often requires network-wide coordination for preventive monitoring, ensuring early risk detection, and for collective sensemaking and resource mobilisation to respond effectively when risks escalate into actual disruptions (Lee et al., 2023; Scholten et al., 2014; Son et al., 2025). However, excessive regulatory distance across a supply network can hinder these efforts by buying firms. This is mainly because regulatory distance, driven by regulatory heterogeneity, can reduce visibility into supply networks, making it more difficult for buying firms to identify risks and vulnerabilities, especially those emerging from slow-evolving, long-term geopolitical disruptions (Chen and Lee, 2017). Moreover, when responding to disruptions, information asymmetry can create significant coordination challenges for a buying firm, hindering effective collective sensemaking and resource mobilisation with suppliers, hence making it more difficult for buying firms to mitigate the impact of geopolitical events and build supply network resilience (Choi and Krause, 2006; Lee et al., 2023; Vosooghidizaji, 2020).

Buying firms, that are more regulatorily distant from their suppliers, may also find themselves vulnerable to unilateral regulatory changes of the government under which their suppliers operate (Charpin et al., 2021; Henisz, 2000), given that governments determine "the rules of the game" of a country (North, 1990, p.3). It follows then that the greater the

regulatory distance between buying firms and their supply network, the greater the complexity in governing such interorganizational relationships (Wang et al., 2016). In response to these risks, firms may actively adapt their supply networks, modify their interfirm ties (Son et al., 2021), or even reshape their network nodes through strategic actions such as supplier switching, reshoring, or vertical integration (Hernandez and Menon, 2021). Geopolitical events like the US-China trade war create tensions between buying firms and suppliers, triggering disputes and disruptions in the supply network (Batsakis et al., 2023). To adapt to such changes and leverage resilience, buying firms may choose suppliers from countries with lower institutional distance from their home countries, because suppliers from countries that have great regulatory distance from the buying firms' home country will increase buying firms' insecurity and escalate the existing geopolitical tensions (Batsakis et al., 2023; Bhat et al., 2025). Meanwhile, relationships with suppliers from low regulatory distance with buying firms' home country are more trusted and less likely to be impacted by geopolitical events, thereby improving supply network resilience. Therefore, the following hypothesis is proposed:

H_1: An U.S. buying firm that was exposed to the US-China trade war in 2018 has a greater reduction in regulatory distance across its supply networks compared with those that were not exposed.

4.3.2 The Moderating Effect of Political Risk

Political risk captures the extent to which a buying firm perceives it is threatened by a country's policies and institutions (Darby et al., 2020; Hassan et al., 2019). Political risk plays a key role in determining how firms respond to slow-evolving, long-term geopolitical events such as the US-China trade war. It is acknowledged that firm-specific political risk is largely perceptual, and so buying firms that operate in similar locations will have divergent perceptions of the political risks they are exposed to (Charpin, 2021; Fan and Xiao, 2023).

Such perception reflects concerns over both home countries and overseas countries' political risk (Hassan et al., 2019; Hassan et al., 2024), and both parts of political risk perception could affect the extent of adaptation made to a firm's supply networks. From the home country perspective, policies and regulations should provide legal security and reduce uncertainty for firms, and such security can effectively reinforce relationships with suppliers located in countries with a high regulatory distance from buying firms (Alvarez et al., 2018). However, when regulations and policies of the home country become potentially harmful to firms, such legal security will be abolished, and firms will try to reduce their vulnerability to policy changes (Darby et al., 2020). One possible action is turning to suppliers who have less regulatory distance. Meanwhile, from an overseas country's perspective, if countries experience high political risk due to harmful policies, and buying firms perceive this as a source of risk, they are likely to shift to another country that is not affected (Fan and Xiao, 2023). This study contends that the extent of adaptation made to a firm's supply networks following the US-China trade war is contingently affected by the buyer's perception of political risk across two key dimensions (e.g., DuHadway et al., 2018; Mena et al., 2020).

First, political process risk refers to the uncertainty stemming from instability and lack of transparency around a government's decision-making processes when it comes to legislative, regulatory, and administrative actions (Hassan et al., 2019). It is manifest when institutional structures and political actors fail to provide a reliable framework for policy development and enforcement (North, 1990; Voshaar et al., 2025), leading to unpredictability in how and when decisions will be made and implemented. Political process risk and the uncertainty it fosters are associated with frequent policy reversals, fragmented governance, a lack of coordination among decision-making bodies, or a susceptibility to political deadlock and lobbying pressures (Adelino and Dinc, 2014; Henisz, 2000). This unpredictability affects a firm's confidence in the enforceability and durability of trade agreements, tax policies, and/or regulatory frameworks, thus shaping how firms pre-

emptively respond to disruption risks in their supply network (Hitt and Xu, 2016). This study contends that if buying firms perceive there to be a high level of political process risk in the business environment before the US-China trade war, they will take more conservative actions to hedge against potential disruption risk, with the onset of the US-China trade war. The US-China trade war could serve to validate further concerns related to regulatory instability, prompting more decisive actions to adapt supply networks for buying firms that already possess a high level of political process risk perception. This could see a shift for buyers towards suppliers in jurisdictions offering more predictable and stable regulatory frameworks. Therefore, buying firms that possess a higher level perception of political process risk will be more likely to adapt their supply network by searching for suppliers from low regulatory distance countries for supply network resilience.

Second, economic policy risk captures the uncertainty in macroeconomic policy decisions related to fiscal, monetary, and tax policies as well as currency and exchange rate management (Al-Thaqeb et al., 2022; Hassan et al., 2019). Associated with reduced firm investment and employment levels (Baker et al., 2016), economic policy risk can foster instability and uncertainty across supply networks via related key economic variables such as interest rates, exchange rates, inflation, and public spending. This uncertainty discourages buyers from relying on suppliers in jurisdictions where economic policy risk is high, as unpredictable fiscal and monetary decisions can disrupt production, financial flows, and trade financing arrangements (Pástor and Veronesi, 2013). Similarly, I argue that perceptions of economic policy risk before the US-China trade war may impact the effect that the US-China trade war has on a buyer's adaptations to its supply networks. Specifically, buyers with an elevated level perception of economic policy risk will re-evaluate their supply network composition, prioritising suppliers in economically stable regions with more predictable regulatory institutions. Therefore, these firms will adapt their supply networks more extensively in response to trade war exposure to avoid the potential disruptive impacts

from the US-China trade war by transforming their supplier network by reducing regulatory distance, as heightened policy risk intensifies concerns over regulatory divergence and macroeconomic instability. The following two moderating hypotheses are proposed:

H2a: An U.S. buying firm's perceived political process risk before the US-China trade war negatively moderates the exposure of the US-China trade war on the regulatory distance reduction between itself and its suppliers.

H2b: An U.S. buying firm's perceived economic policy risk before the US-China trade war negatively moderates the exposure of the US-China trade war on the regulatory distance reduction between itself and its suppliers.

4.4 Methodology

4.4.1 Data

Four databases were used to test the study's hypotheses. First, the Firm-Level Risk database developed by Hassan et al. (2019) was used to collect data on buying firms' perception of political risk prior to the US-China trade war (institutions & political process risk, and economic policy & budget risk). The Firm-Level Risk database compiles firm-level risk scores, which are calculated using Thomson Reuters' Street Events (Hassan et al., 2019). Next, the WGI was used to calculate the regulatory distance between buying firms' countries and those of their suppliers. The FactSet Supply Chain Relationships database was used to map supply networks. FactSet archives buyer-supplier ties of over 20,000 buying firms using corporate annual reports, press releases, and other announcements (e.g., investor presentations) (FactSet, 2024). Finally, the control variables data were extracted from the Orbis database.

4.4.2 Data Collection Processes

The data collection process was conducted in the context of the first phase of the US-China trade war, which broke out in 2018 and concluded in 2020. The two marking events for these two years are tariffs on US$50–60 billion worth of Chinese goods Phase One trade deal on January 15, 2020, an agreement that proposed a ceasefire, so in this study, 2017 is recognised as the last year before the US-China trade war (year -1) and 2019 as the first year after the US-China trade war commenced (year 1) (Fan et al., 2022).

Table 4.1 summarises the data collection process. It began from identifying the availability of firm-level data in FactSet and Firm-Level Risk, using ISIN numbers to match buying firms appearing in both, resulting in a final sample of 6,181 buying firms. Then, buying firms from certain countries were chosen from 6,181 buying firms derived from the last step.

Table 4.1: Data collection process

Sample selection steps	Firms excluded	Firms remaining	Firms left in treatment-group	Firms left in control-group	Database
1: Using ISIN number matching buying firms in FactSet and Firm Level Risk	-	6,181	-		FactSet; Firm Level Risk
2: Selecting buying firms based on their nationality for the control/treatment-group	1,914	4,267	3,161	1,106	FactSet, Worldwide Governance Indicators
3: Eliminating buying firms that have no data in Firm Level Risk in 2017	1,797	2,470	1,852	618	Firm Level Risk
4: Eliminating buying firms that belongs to finance, insurance, or real estate industries and the public administration industry	342	2,128	1,584	544	FactSet
5: Eliminating buying firms that does not have Chinese suppliers in 2017	1,740	388	226	162	FactSet
6: Eliminating buying firms that has missing value in matching/control variables	20	368	223	145	Orbis

Given that the US-China trade war is a geopolitical event, this study applied the difference-in-differences (DiD) analysis to examine the causal effect of the US-China trade war by controlling the pre-existing trend (Ren et al., 2023). To conduct the DiD analysis, a treatment-group and a control-group were established. The treatment-group consisted of US buying firms that had tier 1 suppliers in China. Accordingly, buying firms in the control-group came from countries that were not directly affected by the US-China trade war, and in this study, they were buying firms from other countries that had tier 1 suppliers in China. However, buying firms from the control-group should come from countries that have a similar institutional environment to the US before the US-China trade war. The rationale is to minimise the heterogeneity in the headquarters locations' institutional environment between the treatment-group and the control-group buying firms, as it could confound the effect of the US-China trade war (e.g., Fan et al., 2024). Such heterogeneity in headquarters locations' institutional environments might suggest that buying firms received different levels of government support from their countries or administrative regions (Hemmert et al., 2016), thereby impacting their decision-making during the US-China trade war.

As an initial step in choosing countries for the treatment-group and the control-group, the WGI database was used to calculate each country's or administrative region's institutional environment score before the US-China trade war broke out by averaging all six dimensions of WGI in 2017. These six dimensions include: (i) Voice and Accountability; (ii) Political Stability and Absence of Violence/Terrorism; (iii) Government Effectiveness; (iv) Regulatory Quality; (v) Rule of Law; and (vi) Control of Corruption. Then, I selected countries and administrative regions within 1.645 standard deviations in both directions from the institutional environment score of the US, since this suggests that their institutional environment is not significantly different from that of the US at a 0.100 significance level. As a result, the selected countries and administrative regions included Austria, Australia,

Belgium, the Czech Republic, Germany, France, the United Kingdom, Japan, Hong Kong (S.A.R), Taiwan, Ireland, and Portugal. Although more countries met this criterion, no buying firms were available in the databases from those countries. Through this process, a sample of 4,267 buying firms was obtained, including 3,161 treatment-group buying firms from the US, and 1,106 control-group buying firms from other selected countries.

Furthermore, buying firms that did not have any data in the Firm-Level Risk database in 2017 were eliminated, as this study aimed to measure the buying firms' perception of political risk before the US-China trade war broke out. Following this process, there were 2,470 buying firms remaining, 1,852 treatment-group buying firms, and 618 control-group buying firms. This was followed by the removal of buying firms from industries where physical products were not a major component of their supply networks. After excluding buying firms in the finance, insurance, or real estate industries and the public administration industry, 2,128 buying firms remained, including 1,584 treatment-group buying firms, and 544 control-group buying firms.

In the next step, buying firms without tier 1 Chinese suppliers in 2017 were removed from the data sample, as US buying firms with tier 1 Chinese suppliers are most likely to be directly affected by the US-China trade war (Fan et al., 2022). This means that to qualify for the treatment group, the headquarters location of a buying firm must be in the US and possess at least one Chinese supplier. To minimise heterogeneity between buying firms in the treatment-group and in the control-group, buying firms in the control-group were also required to have at least one tier 1 Chinese supplier. At this point, 388 buying firms in total, 226 treatment-group buying firms, and 162 control-group buying firms, remained.

As the final step, 20 buying firms were excluded due to the unavailability of financial data in Orbis, from which financial data was collected for the control variables and matching

covariates. As a result, the final sample consisted of 368 buying firms, 223 treatment-group buying firms, and 145 control-group buying firms.

4.4.3 Variables

4.4.3.1 Buying Firms' Perception of Political Risk Before the US-China Trade War

Firm-level Risk is a database which contains measures for the firm's perception of political risk across eight different topics (Hassan et al., 2019). This database uses textual analysis of transcripts from quarterly earnings conference calls from Thomson Reuters' Street Events, to calculate these measures (Hassan et al., 2019). The political risks that were mentioned during such conference calls include those from both domestic and overseas sources (Hassan et al., 2024). It has been widely used in studies across various disciplines, including finance (e.g., Huynh and Xia, 2021), economics (e.g., Caldara et al., 2020), as well as in OSCM (e.g., Darby et al., 2020; Fan and Xiao, 2023; Leung and Sun, 2021).

This study focuses specifically on two topics of political risk database, named institutions & political process risk, and economic policy & budget risk, as relevant to the constructs this study aims to investigate. Prior studies have pointed out that the US-China trade war has a deep association with the political process of governments and economic policy changes (Gammeltoft and Panibratov, 2024; Yu et al., 2021). The database was originally quarterly based. To measure the buying firms' perception of political process risk and economic policy risk before the US-China trade war, this study took the highest value from four quarters in 2017 of institutions & political process risk and economic policy & budget risk topics. The rationale of this operationalisation is based on the peak-end rule (Fredrickson, 2000; Kahneman et al., 1993), which states that subjective judgment or perception was based on the peak moment (i.e., the most intense moment), not an average feeling across a period (Yang et al., 2018). Therefore, the peak moment of the subjective perception has more explanatory power on decision making, and this statement has been

empirically verified under multiple experimental settings and supported by the psychological studies (Gregoriou et al., 2019). Hence, the highest quarter of the year is a better representation of a buying firm's perception of political risk rather than the arithmetic mean of four quarters.

4.4.3.2 Regulatory Distance Between Buying Firms and Suppliers

The dependent variable in this study was built upon the foundation of regulatory distance between two countries, even though regulatory distance itself was not a variable examined in the analysis. The WGI database was used to measure the regulatory distance between buying firms' and suppliers' headquarters locations. The WGI is updated annually, providing the data for six different pillars of the institutional environment (Kaufmann et al., 2011). Based on the definition of each term WGI offered (Kaufmann et al., 2011), these six pillars were categorised into two groups: (i) 'regulatory institutions', which was used to operationalise the dependent variable of the study; and (ii) 'political institutions', which was used to overseas network level political distance, a control variable of this study. The extant literature that investigates political distance and regulatory distance does not form a consistent view of operationalising these two variables and uses various databases and categorisation methods. However, they all follow the same notion that political distance focuses on the stability and democratic level of political systems among different countries, while regulatory distance focuses on the ability to monitor and enforce rules and laws among different countries (Lorenz et al., 2018; White et al., 2018). Table 4.2 states the categorisation of political and regulatory institutions based on definitions offered by Kaufmann et al. (2011) and notions from relevant studies such as Lorenz et al. (2018) and White et al. (2018). In this study, political distance measurement includes Voice and Accountability (e.g., Boateng et al., 2019), Political Stability and Absence of Violence/Terrorism (e.g., White et al., 2018), and Government Effectiveness (e.g., Lv et al., 2022), while regulatory distance measurement

includes Rule of Law (e.g., Kedia et al., 2015), Regulatory Quality (e.g., Nagaraj and Chao, 2021), and Control of Corruption (e.g., Lv et al., 2022).

Table 4.2: Categorization between political and regulatory institution

Institution pillars	WGI indicators	Interpretation (Kaufmann et al., 2011)
Political institution	Voice and Accountability	"Reflects perceptions of the extent to which a country's citizens are able to participate in selecting their government, as well as freedom of expression, freedom of association, and a free media."
Political institution	Political Stability and Absence of Violence/Terrorism	"Political Stability and Absence of Violence/Terrorism measures perceptions of the likelihood of political instability and/or politically motivated violence, including terrorism."
Political institution	Government Effectiveness	"Reflects perceptions of the quality of public services, the quality of the civil service and the degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies."
Regulatory institution	Regulatory Quality	"Reflects perceptions of the ability of the government to formulate and implement sound policies and regulations that permit and promote private sector development."
Regulatory institution	Rule of Law	"Reflects perceptions of the extent to which agents have confidence in and abide by the rules of society, and in particular the quality of contract enforcement, property rights, the police, and the courts, as well as the likelihood of crime and violence."
Regulatory institution	Control of Corruption	"Reflects perceptions of the extent to which public power is exercised for private gain, including both petty and grand forms of corruption, as well as "capture" of the state by elites and private interests."

Note: Three political institution indicators were applied as a control variable for the data analysis

The regulatory distance was calculated using the measurement created by Kogut and Singh (1988), as equation (10) shows

$$RD_i = \sum_{k=1}^{n} [(I_{ks} - I_{kh})^2 / V_k]/n \quad (10)$$

RD_i represents the regulatory distance between country h, where the buying firm comes from, and country s, where suppliers come from. I represents the regulatory institution score of the country s and h in the k criteria in the WGI database. n represents the number of measures that were applied to evaluate regulatory distance. In this study, n equals 3 as there are three factors from the database measuring the regulatory distance between any two countries. This equation was used to calculate the regulatory distance from 2015 to 2020. As 2017 and 2019 represent one year before and after the US-China trade war broke out, the regulatory distance from these two years was used to measure the change in the overseas network level regulatory distance during the US-China trade war. Meanwhile, regulatory distance in 2015, 2016, 2018, and 2020 was calculated for the parallel assumption analysis and the robustness check after the main analysis.

4.4.3.3 Overseas network level Regulatory Distance

The dependent variable was measured by calculating regulatory distance change at the overall supply network level using buyer-supplier relationship data from the FactSet Supply Chain Relationship database, which offers broader coverage and longer historical data than alternatives like Bloomberg SPLC or Compustat (Niu and Jiang, 2024; Son et al., 2021). FactSet offers the headquarters locations of buying firms and their tier 1 suppliers, both of which were used to assess changes in the overseas network level regulatory distance. The overseas network level regulatory distance was calculated based on the weighted average formula (equation (11)), modified from Chao and Kumar (2010).

$$NRD_f = \sum_{i=1}^{n} (RD_i * m_i)/m_n \quad (11)$$

NRD_f represents the overseas network level regulatory distance of the firm *f*, whose supply network consists of *m* suppliers from *n* overseas countries. m_i represents the number of suppliers from country *i,* while m_n represents the number of suppliers from all overseas countries. The dependent variable of this study is Δ post-trade war overseas network level regulatory distance (ΔNRD) = overseas network level regulatory distance 2019 (NRD 2019) – overseas network level regulatory distance 2017 (NRD 2017), as 2017 and 2019 remark one year before and one year after the US-China trade war broke out. Buying firms' overseas network level political distance in 2017 was calculated using this equation, but with three factors from the WGI database that were categorised as political institutions, as Table 2 states.

4.4.4 Control Variables/Matching Covariates

The control variables, which were used as matching covariates needed for the propensity score matching, consisted of several sections. The first control variable is the size of buying firms before the US-China trade war broke out, measured by their total assets in 2017, as firm size is the main reason for heterogeneity that confounds the result of DiD analysis (Fan et al., 2022). Then, the financial performance of the buying firms before the US-China trade war broke out was controlled, by measuring return on assets (Son et al., 2021), leverage (Lam et al., 2022), and liquidity (Lam et al., 2022) in 2017, because buying firms with better financial performance might have more resources dealing with the negative impact of slow-evolving geopolitical events (Shen et al., 2023). Another control variable is the number of buying firms' overseas suppliers before the US-China trade war broke out in 2017 (Kim et al., 2015), as it is an indicator of buying firms' ability to create ties and reconfigure supply networks during disruptive events (Son et al., 2021). At last, the overseas network level political and regulatory distance between buying firms and their overseas supply network before the US-China trade war were controlled because similar studies have suggested that

the treatment-group and the control-group buying firms should have similar network structures before the event (Son et al., 2021).

4.5 Analysis and Results

4.5.1 Propensity Score Matching

The final sample consisted of 368 buying firms. Of these, 223 US-based buying firms were designated as the treatment-group, while 145 buying firms from other countries were assigned to the control-group. To minimise the heterogeneity between two groups and avoid self-selection bias, this study applied propensity score matching (Lam et al., 2022; Levine and Toffel, 2010). A one-on-one propensity score matching was conducted, with a 0.1 caliper score based on the matching covariates (control variable) from section 4.4.4. Eventually, 234 buying firms were selected and matched into 117 pairs (Table 4.3). The result indicates that the *p*-value of each criterion is higher than 0.100, proving that there is no significant difference between the treatment-group and the control-group in these matching criteria.

4.5.2 DiD Analysis

Table 4.4 summarises the results of data analysis on the main effect, which examines the impact of the US-China trade war on the buying firms' overseas network level regulatory distance. Model 1 is the base model with only the control variable, while Model 2 is the model with independent variables. It follows then that the model regression equation (12) is used to test H1:

$$\Delta\, NRD \;=\; \beta_0 \;+\; \beta_1 * Trade\ war_i \;+\; \delta\, Controls + \; Industry \;+\; \varepsilon \qquad (12)$$

Where i indicates the buying firm, Trade war is a binary variable that equals one for the treatment group or zero for the control group. Controls are all control variables and Industy refers to industry fixed effect.

The negative coefficient for the US-China trade war in Model 2 (β = -0.251, p = 0.001) suggests that there is a statistically significant decrease in overseas network level regulatory distance between buying firms that were affected by the US-China trade war and their supply network. Therefore, Hypothesis 1 is statistically supported.

Table 4.3: PSM result

Variable	Group	Group means	Observations	% bias	p-value
Asset	Treatment-group	43,000,000	117	3	0.811
	Control-group	41,000,000	117		
Return-on-assets	Treatment-group	5.92	117	11.7	0.173
	Control-group	4.786	117		
Leverage	Treatment-group	0.784	117	7.4	0.609
	Control-group	0.687	117		
Liquidity ratio	Treatment-group	1.086	117	-2.9	0.323
	Control-group	1.215	117		
Oversea suppliers number	Treatment-group	40.197	117	9.5	0.450
	Control-group	35.128	117		
Overseas network level regulatory distance 2017	Treatment-group	1.104	117	0.8	0.951
	Control-group	1.098	117		
Overseas network level political distance 2017	Treatment-group	0.881	117	4.7	0.744
	Control-group	0.859	117		

Table 4.4: Results of DiD analysis

	Dependent Variable: *Δ NRD (NRD 2019 - NRD 2017)*			
	Model 1		Model 2	
Variable	β		β	
	SE	p	SE	p
Trade war			-0.251	0.001
			-0.071	
Asset	0	0.983	0	0.891
	0		0	
Return-on-assets	0.016	0.007	0.017	0.004
	-0.006		-0.006	
Leverage	0.027	0.281	0.034	0.156
	-0.025		-0.024	
Liquidity ratio	-0.022	0.579	-0.026	0.484
	-0.039		-0.038	
Oversea suppliers	0.001	0.654	0.001	0.579
	-0.001		-0.001	
Overseas network level regulatory distance 2017	-0.110	0.422	-0.170	0.206
	-0.137		-0.134	
Overseas network level political distance 2017	-0.555	0.005	-0.472	0.014
	-0.196		-0.190	
Political process risk perception			0.007	0.164
			-0.005	
Economic policy risk perception			0.005	0.336
			-0.005	
Industry fixed effect	Included		Included	
Constant	0.097	0.691	0.117	0.621
	-0.243		-0.236	
Observations	234		234	
R-squared	0.366		0.425	

Table 4.5: Results of moderation analysis

	Dependent Variable: *Δ NRD (NRD 2019 - NRD 2017)*			
	Model 1		Model 2	
Variable	β		β	
	SE	p	SE	p
Trade war	-0.139	0.097	-0.128	0.139
	-0.084		-0.086	
Asset	0	0.636	0	0.763
	0		0	
Return-on-assets	0.016	0.005	0.015	0.008
	-0.006		-0.006	
Leverage	0.034	0.153	0.032	0.178
	-0.024		-0.024	
Liquidity ratio	-0.027	0.465	-0.025	0.495
	-0.037		-0.037	
Oversea suppliers	0.001	0.485	0.001	0.488
	-0.001		-0.001	
Overseas network level regulatory distance 2017	-0.208	0.119	-0.196	0.140
	-0.133		-0.132	
Overseas network level political distance 2017	-0.447	0.018	-0.458	0.016
	-0.188		-0.188	
Political process risk perception	0.035	0.005	0.011	0.029
	-0.012		-0.005	
Economic policy risk perception	0	0.930	0.013	0.029
	-0.005		-0.006	
Political process risk perception * Trade war	-0.028	0.014		
	-0.011			
Economic policy risk perception * Trade war			-0.019	0.013
			-0.008	
Industry fixed effect	Included		Included	
Constant	-0.034	0.890	0.027	0.909
	-0.241		-0.236	
Observations	234		234	
R-squared	0.442		0.442	

Table 4.5 presents the results of data analysis on the moderation effect, which aims to investigate how buying firms' perception of political risk before the US-China trade war can affect the change of overseas network level regulatory distance between buying firms and their supply network before and after the US-China trade war. Model regression equation (13) is used to test H2:

$$\Delta\, NRD \;=\; \beta_0 \;+\; \beta_1 * Trade\ war_i * Political\ risk \;+\; \delta\, Controls + \; Industry \;+\; \varepsilon$$

(13)

In Model 13, political risk refers to firms' political risk perception (including political process risk and economic policy risk) before the trade war took place. In general, the result shows that buying firms' perception of political process risk (H2a) and economic policy risk (H2b) before the US-China trade war has a statistically significant moderation effect on the relationship between trade war and overseas network level regulatory distance changes (β = -0.028, p = 0.014 for political process risk; β = -0.019, p = 0.013 for economic policy risk). This result empirically proves that if buying firms had a higher perception of political process risk and economic policy risk before the US-China trade war broke out, it would strengthen the negative effect of the US-China trade war on the decreasing overseas network level regulatory distance.

4.5.3 Parallel Trend Assumption Analysis for DiD Analysis and Robustness Checks

One important premise of capturing the treatment effect with DiD analysis is the parallel assumption, so there should not be a pre-existing trend in the dependent variable between the treatment-group and the control-group before the US-China trade war broke out. Therefore, I collected supply network data of sample firms in 2015 and 2016 and calculated their network level regulatory distance in these two years with equation (11) to test whether there was any parallel trend between the two groups in 2015 and 2016. Meanwhile, to examine the time scale of the impact of the US-China trade war on overseas network level regulatory distance change, the time length of the main analysis was extended from 2019 to 2018, and 2020.

New dependent variables were collected by subtracting the overseas network level regulatory distance in 2017 (the baseline pre-treatment year) from the value of that in 2015, 2016, 2018, and 2020. Table 4.6 shows that there is no significant difference between the two groups before the US-China trade war (in 2015 or 2016), but a significant difference after the US-China trade war (in 2018 and 2020). The result of the analysis indicates that the two groups had a parallel trend before the US-China trade war broke out. Meanwhile, the exposure of the US-China trade war on the overseas network level regulatory distance is protracted, and the main effect of the study is robust. Figure 4.1 plots the estimated coefficients and confidence intervals from 2015 to 2020 based on the results from Table 4.6.

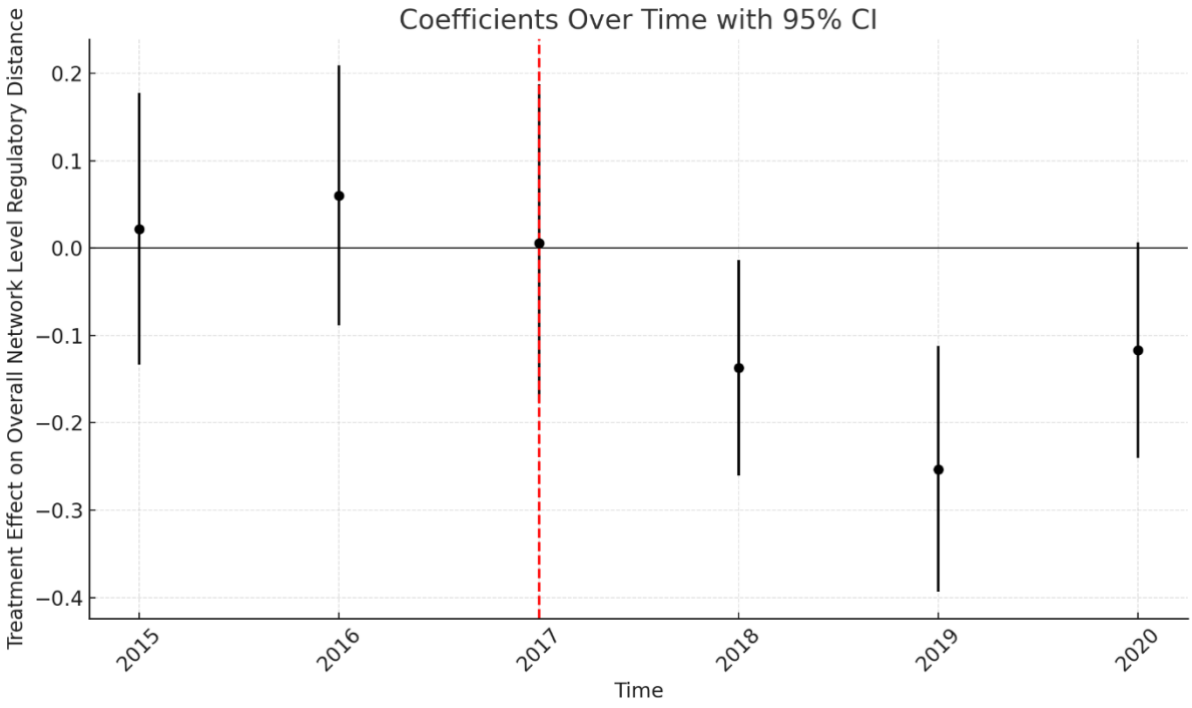


Figure 4.1: Plotted the estimated coefficients and confidence intervals

Table 4.6: Post analysis

	Dependent Variable: ΔNRD (NRD 2015 – NRD 2017)		Dependent Variable: ΔNRD (NRD 2016 – NRD 2017)		Dependent Variable: ΔNRD (NRD 2018 – NRD 2017)		Dependent Variable: ΔNRD (NRD 2019 – NRD 2017)		Dependent Variable: ΔNRD (NRD 2020 – NRD 2017)	
Variable	β		β		β		β		β	
	SE	p	SE	p	SE	p	SE	p	SE	p
Trade war	0.024	0.763	0.062	0.415	-0.137	0.028	-0.251	0.001	-0.119	0.057
	-0.079		-0.075		-0.062		-0.071		-0.062	
Constant	-0.172	0.505	-0.136	0.583	0.230	0.266	0.117	0.621	0.397	0.056
	-0.257		-0.248		-0.206		-0.236		-0.207	
Observations	226		232		234		234		234	
R-squared	0.533		0.384		0.371		0.425		0.656	

All control variables were included

4.6 Discussion

4.6.1 Theoretical Contribution

Trade wars, which are unpredictable, exogenous, slow-evolving and potentially long-term in nature (Grewal et al., 2007), require firms to identify vulnerabilities in their supply networks, and subsequently make strategic adaptations to enhance supply network resilience (Blessley and Mudambi, 2022). This study makes two distinct, yet interrelated, theoretical contributions. First, it provides critical insights into whether buying firms seek to achieve a resilient supply network in the face of increased risk of disruption from slow-evolving, long-term geopolitical events (e.g., Bednarski et al., 2025). While some geopolitical events, such as the US-China trade war, unfold over an extended time period, the vast majority of previous studies have investigated the relationship between physical supply network characteristics and supply network resilience to an acute supply network disruption event such as the Japanese earthquake (e.g., Son et al., 2021). This study builds on the socio-ecological view of resilience (Wieland and Durach, 2021) and shed light on the role of the broader systemic environment, emphasising resilience as adaptation and transformation, in the context of how buying firms address potential disruptions arising from slow-evolving, long-term geopolitical disruptions.

This study offers a novel theoretical lens through which to observe whether networks adapt and transform during disruption, furthering current understanding of resilience beyond the traditional engineering perspective of 'returning to normal' (Scholten et al., 2020). A growing number of supply network resilience studies adopt system social network theory (Kim et al. 2015; Son et al., 2021), which focuses on the effect of different network structural factors on supply network resilience. Although such perspectives are appropriate and contribute to knowledge, they have not traditionally enabled a granular assessment of

whether the institutional features of a network, and political context, matter in terms of resilience.

Whilst previous studies investigated how firms seek to reduce their supply network presence in regions affected by geopolitical events (Moradlou et al., 2025; Ren et al., 2024), this study provides empirical evidence that buying firms' supply network geographic adjustments to mitigate the risk of disruption also result in a significant reduction in institutional heterogeneity (i.e., regulatory distance). The empirical results support the assertion that the US-China trade war, and the increased disruption risk and regulatory uncertainty it presents, see firms adapting their supply networks to reduce regulatory distance and enhance supply network resilience. In other words, buying firms that are exposed to the US-China trade war, an example of a slow-evolving, long-term geopolitical disruption, are more focused on building a network of suppliers from similar institutional environments to ensure supply network resilience.

Second, this study shows that buying firms' perceived political risk prior to geopolitical events plays a key role in determining their responses to slow-evolving, long-term geopolitical disruptions such as the US-China trade war. It is evident that the extent of adaptation made to a firm's supply networks following the US-China trade war is contingently affected by the buying firm's perception of political risk prior to the event across two dimensions, including political process risks, and economic policy risks (Hassan et al., 2019). The US-China trade war is said to have exposed firms to political risk more than ever before (Gammeltoft and Panibratov, 2024). Prior studies have investigated the effect of a firm's perception of political risk on buying firms' strategies, such as inventory (e.g., Darby et al., 2020) and vertical integration (e.g, Fan and Xiao, 2023). Until now, very few studies (e.g., Zhu et al., 2025) have started to investigate the role of political risk in shaping firms' responses to geopolitical disruptions. Given the increasing frequency of

geopolitical events, it is important to better understand the factors that impact firm decision-making (such as their perceived risk) when it comes to making adaptations in their supply networks to leverage resilience.

It is observed that buyers made shifts towards suppliers in jurisdictions offering more predictable, stable, regulatory frameworks and certainty in macroeconomic policy decisions. More specifically, it is evident that the importance of other contextual factors in influencing whether buying firms respond to such slow-evolving, long-term geopolitical disruptions. It is found that the impact of the US-China trade war on regulatory distance across a supply network is influenced by the buying firm's perception of political risk. Taking a multidimensional approach to perceived political risk, this study examines the moderating effects of two dimensions - political process and economic policy risks. It is evident that buying firms' perception of political process and economic policy risks before the US-China trade war accentuates the reduction in the supply network level regulatory distance during the time buying firms were exposed to the US-China trade war.

4.6.2 Managerial and Societal Implications

This research also offers several practical implications for firms and managers grappling with slow-evolving, long-term geopolitical disruptions and their impact on firms' supply networks. Based on the findings of this study, firms do consider the regulatory distance of their supply network, and thus they might want to consider embedding regulatory distance considerations into their supplier selection process and supply base monitoring programs. A more granular tracking of regulatory distance across their supply network would allow firms to continuously track any changes in the regulatory environment that could impact their suppliers, or their own operations. In the event of disruption, including geopolitical or other, firms will have this information at their disposal and be able to make balanced risk assessments.

This study shows that perceptions of risk influence decision-making in the context of supply network redesign following a geopolitical disruption. By understanding their own firm's risk perception, managers can more effectively design strategies to mitigate the negative impacts of geopolitical disruptions. For instance, firms that perceive a low level of political risk may overlook potential vulnerabilities within their supply networks. On the other hand, firms with an overly cautious view of political risk may adopt overly conservative strategies, which could hinder growth or lead to inefficient resource allocation.

Extant literature predominantly focuses on the economic impact of supply network adaptation, but such an adaptation can also influence societal value. Institutional distance within supply networks is known to exacerbate ESG challenges, such as supplier-induced ESG controversies, by increasing information asymmetry and coordination difficulties with suppliers (Li and Cuervo-Cazurra, 2024). The supply network adaptations for resilience discussed in this paper may inadvertently reduce such asymmetry, leading to improved ESG performance at the network level in the long term. Buying firms should be aware of this and capitalise on it. However, such adaptation efforts, particularly when buying firms withdraw operations from institutionally distant countries, can have unintended socio-economic consequences for the countries where the suppliers are located, especially in socio-economically disadvantaged areas. Such shifts may lead to job losses, poverty, and exacerbate inequalities. Decision-makers in buying firms should be aware of these potential societal implications and consider mitigation strategies when implementing such decisions.

4.6.3 Boundary Conditions and Future Research

This research has several boundary conditions that provide opportunities for future study. First, although this study focused on the US-China trade war and regulatory distance, the insights it offers are also relevant to other types of settings with slow-evolving, long-term geopolitical events such as Brexit and the Ukraine-Russia or Israel-Gaza conflicts. However,

as these geopolitical events have different triggers and contextual backgrounds when compared to the US-China trade war, they could have differential impacts across other dimensions of institutional distance. Future studies could investigate the link between the nature of geopolitical events and different types of institutional distance with suppliers.

Second, this study investigated the impact of slow-evolving, long-term geopolitical events, but "slow evolving" here is a general description compared with rapid-onset events, and this study did not quantify the speed of the US-China trade war impact. Future studies could use a database such as the Economic Policy Uncertainty Index (Baker et al., 2016) to conduct time series analysis to investigate the relationship between the speed of geopolitical events and the supply network changes. There are potential insights that could be gained by measuring how quickly firms respond to slow-evolving, long-term geopolitical disruptions in their supply networks by tracking changes in supply network decisions over time, lag effects, or contingent factors that impact the speed of reaction to such associated uncertainties.

Third, future studies drawing more on (scenario-based, or field) experiments could inform extant literature on supply network resilience and meaningfully extend research insights from this study. For example, future research efforts might focus on investigating who, at what level (subsidiary, business, and corporate), and in what job role (e.g., engineering, legal, and purchasing) makes decisions regarding supply network adaptation. Such decisions may include a host of performance measures beyond purely economic ones, including, for example, social value (Helper et al., 2021) and environmental factors (Dahlmann et al., 2023). Identifying the interplay of various factors, including political uncertainty, may further scholars' understanding of how and by whom supply networks are adapted.

Geopolitical events lead to volatile and uncertain operating environments for global supply networks, and firms often respond by adapting their networks to ensure resilience. Ideally, this study will provide a rich future research ground for future research on the impact of slow-evolving, long-term geopolitical disruptions on supply networks and their resilience.

Chapter 5. Conclusion

5.1 Integration and Summary of the Studies

The aim of this thesis is to investigate: **How to achieve operational and supply chain resilience under the impact of geopolitical disruptive events?** To answer this question, it explored operational and supply chain resilience from three different perspectives - the theoretical, engineering, and the social-ecological perspective of resilience, with three research papers presented in Chapters 2 to 4.

Chapter 2 presents a systematic literature review examining the theoretical lenses employed in studies of supply chain resilience and how these theoretical lenses have been used to explain and develop SCRES knowledge. This chapter does not focus specifically on either the engineering or the social-ecological perspective of resilience, but instead provides a comprehensive overview of SCRES knowledge by identifying which theories have been applied in SCRES studies and how they contribute to explaining SCRES-related phenomena. Building on the findings from this review, the second and third studies apply three theoretical lenses, including institutional theory, the attention-based view, and agency theory, all of which have been underutilised and insufficiently explored in past SCRES research, to examine both the engineering and social-ecological views of resilience in the context of geopolitical disruptions.

Chapter 3 of the thesis, titled “A dual perspective on slack: How risk perception and slack resources shape operational resilience during COVID-19”, addresses the engineering perspective of resilience by revisiting a commonly accepted notion that firms can enhance operational resilience using slack resources. Focusing on the context of COVID-19 and

adopting the attention-based view and agency theory, this study investigates how firms' perceptions of COVID-19-related risk influence the accumulation of different types of slack resources, and how these slack resources, in turn, affect operational resilience during COVID-19. The findings reveal that firms with higher perceived COVID-19 risk tend to accumulate higher levels of capacity slack and financial slack. However, it is found that capacity slack, as a type of absorbed slack that restricts managers' risk-taking intention and is less likely to be misused (Lai and Weng, 2014), was effective for firms' operational resilience during COVID-19. On the other hand, financial slack, as a type of unabsorbed slack that encourages managers' risk-taking intention and is more likely to be misused (Jensen, 1986; Singh, 1986), negatively impacted operational resilience during COVID-19. These results indicate that firms' attention to disruptive geopolitical events shapes their resource allocation decisions, and that the impact of slack resources on operational resilience varies depending on the unique characteristics of each type of slack resource. As such, this study provides valuable insights for firms seeking to achieve engineering resilience in the face of geopolitical disruptions.

Chapter 4 of the thesis, titled "Adapting supply networks to achieve resilience: The impact of geopolitical disruption and institutional distance", examines how firms adapt their supply networks in response to geopolitical disruptions to gain the social-ecological perspective of supply chain resilience with the institutional theory lens. Using the 2018 US–China trade war as the research context, this study investigates whether firms adapt their supply networks based on the regulatory distance between them and their overseas suppliers to enhance supply network resilience during geopolitical disruptive events. Additionally, it explores how firms' perceptions of political risk influence their adaptation decisions. Whereas previous research has focused on how firms reduce their supply network presence in regions affected by geopolitical events (e.g., Moradlou et al., 2025; Ren et al., 2024), this study provides empirical evidence that network adjustments to mitigate the risk of disruption

also result in a significant reduction in institutional distance (i.e., regulatory distance). Moreover, firms' perception of political risk is shown to negatively moderate the relationship between their exposure to the US-China trade war and the extent of regulatory distance reduction. Overall, this study contributes to the literature by providing new insights into how firms can achieve social-ecological resilience in the face of geopolitical disruptions.

Together, the three studies constitute this thesis that examines how to achieve operational and supply chain resilience under the impact of geopolitical disruptive events from a theoretical, engineering, and social-ecological perspective, with several theoretical contributions and managerial contributions to resilience literature.

5.2 Theoretical Implications of the Studies

Several theoretical implications can be derived from the studies conducted. The systematic literature review, Chapter 2 of the thesis, is the first study to examine how SCRES has been conceptualised and interpreted through various theoretical perspectives. By analysing the theories employed in existing supply chain resilience research, the study identifies key constructs that influence or are influenced by SCRES and explains how different theories have been used to interpret the relationships between supply resilience and these constructs. Based on these findings, a conceptual framework is developed to summarise the associations among these constructs. This study illustrates which constructs shape the inverse relationship between supply chain resilience (SCRES) and supply chain disruption, namely structural complexity and environmental uncertainty, the role of capabilities in linking these factors to SCRES or disruption, and how different contingencies influence resilience outcomes. Based on this conceptual framework, several theoretical implications for each proposition in the framework were proposed. Besides that, four directions for future research regarding theory application are proposed, including (1) applying multiple theories in one study, (2) adopting theories outside the management discipline, (3) adopting theories that explain the impact of

individual behaviour, and (4) fully utilising theories that have been used. This study contribute to the thesis research question by identifying key constructs that influence or are influenced by SCRES and explaining how different theories have been used to interpret the relationships between supply resilience and these constructs.

The remaining two studies aim to address the research question: "**How to achieve operational and supply chain resilience under the impact of geopolitical disruptive events?"** from two different perspectives of resilience, namely the engineering perspective and the social-ecological perspective of resilience. However, regardless of the perspective that was used, both studies found that the firms' risk perception plays an important role in building operational and supply chain resilience. Such a risk perception may refer to the perception of a specific disruptive event, such as the perception of COVID-19-related risk. The second study illustrates that during COVID-19, firms with higher perceived COVID-19-related risks tend to accumulate higher levels of both capacity slack and financial slack, both of which are viewed as traditional resilience-building practices. Besides that, risk perception could also refer to the perception of a particular pillar of the business environment, such as political risk. The third study shows that firms' perceptions of political risk prior to the US-China trade war determined the extent of firms' adaptive responses and resilience strategies to geopolitical disruptions such as the US–China trade war. As previous research suggests that firms' risk perception is closely linked to their attention to risk (Fan and Xiao, 2023; Liu et al., 2025), the findings of these two studies reflect the proposition from the attention-based view, which posits that firms' attention focus will enhance firms' perception of certain issues, and such attention will be transformed into operational practices that aim to address such issues (Essuman et al., 2022; Li et al., 2022; Ocasio, 1997).

Following the critical role of firms' risk perception on resilience building, the second study contributes to the resilience literature by investigating the engineering perspective of

operational resilience in the context of COVID-19. This study examines the relationship between slack and resilience during COVID-19 through two theoretical lenses: the attention-based view and agency theory. The results of this study show that firms with greater capacity slack during COVID-19 tended to have higher operational resilience, whereas those with greater financial slack tended to have lower operational resilience. Such findings suggest that agency theory is better at interpreting the slack-resilience relationship. Agency theory posits that two agency-related issues determine the effectiveness of slack resources on firms' operations, including how likely such slack resources are to be misused (agency problem), and how such slack resources affect managers' attitude towards risk (risk-sharing problem) (Eisenhardt, 1989). As most of the OSCM studies to date adopted agency theory to address supply chain relationship governance by conceptualising the buyer-supplier relationship as the principal-agency relationship (Matinheikki et al., 2022), this study extends the application of agency theory in the OSCM discipline. Through such an extension, the findings illustrate that agency theory can address not only dyad-level issues such as buyer-supplier relationship governance (Shou et al., 2022) or supplier quality management (Zu and Kaynak, 2012), but also organisational-level issues, including impacts of firms' operational strategic decision making on resilience.

The motivation for the second study is to revisit strategies and practices used to enhance engineering resilience. The engineering perspective or resilience expects firms to achieve an optimal equilibrium state without considering the fact that firms and their supply chains interact with the external environment (Borgatti and Li, 2009). Therefore, it is unclear how effective engineering resilience strategies and practices will be under the impact of geopolitical disruptive events like COVID-19, which originate from the external environment and have unanticipated appearances and consequences (Ge et al., 2023). Based on agency theory, this study concludes that the negative impact of financial slack on operational resilience is due to managers' misuse. It is not correct to claim managers will

not misuse financial slack without disturbance from the external environment, because managers might behave in their own interest (Rungtusanatham et al., 2007; Zu and Kaynak, 2012). However, geopolitical disruptive events indeed bring challenges to managers in their decision-making, as such events require more information to be analysed and processed (Galbraith, 1974), hence increasing the possibility of slack resources being misused. To conclude, the finding of this study illustrates that the effectiveness of resilience strategies and practices that were developed based on engineering resilience ideology can be undermined by geopolitical disruptive events and need to be reassessed.

The third study contributes to the resilience literature by exploring the social-ecological perspective of supply chain resilience in the context of the US-China trade war. This study examines whether and how firms adjust their supply network to achieve social-ecological supply network resilience in response to geopolitical events. By applying institutional theory, this study examines how institutional features of a supply network shape resilience. The findings support the argument that the US-China trade war forced firms to adapt their supply networks by reducing regulatory distance to enhance overall supply network resilience. This study expands the application of institutional theory and the concepts of institutional distance from the organisational level or dyad level to the supply network level by showing that the consideration of risk from institutional distance will affect not only organisational-level decision-making (Xu and Shenkar, 2002) but also supply network evolution.

The motivation of the third study is to explore how the supply network could achieve social-ecological resilience under the impact of geopolitical events. Many prior studies on supply network resilience have employed theories such as social network theory or resource dependence theory (e.g., Son et al., 2021; Zhu et al., 2025) to assess how different supply network structural factors change after disruptive events. Although such narratives are

appropriate and contribute to resilience knowledge, supply network structural factors addressed by these studies are mostly physical supply network characteristics such as network centrality or supply network concentration (Son et al., 2021; Zhu et al., 2025). Hence, the social-political nature of geopolitical events is ignored. By using institutional theory, this study illustrates that geopolitical events can trigger supply network changes from the social-political aspect, which had not been addressed by previous OSCM studies. Such an observation not only can be used as an evidence to distinguish geopolitical disruptions from other type of disruptions, but also offers an example of how supply networks transform into a "desired state" (e.g. low regulatory heterogeneity supply network) that adapt to the "new normal" (e.g. business environment with ongoing geopolitical disruptions) (Wieland and Durach, 2021; Wieland et al., 2023).

Table 5.1 summarises the what key implications have been derieved from Chapter 2 to Chapter 4 and how they can address the research question of the thesis: "**How to achieve operational and supply chain resilience under the impact of geopolitical disruptive events?"**

Table 5.1: Findings summarise

Chapter	Perspective of resilience	The implication of the chapter	How it answer the question: How to achieve operational and supply chain resilience under the impact of geopolitical disruptive events?
2	Theoretical	Identifies key constructs that influence or are influenced by SCRES and explains how different theories have been used to interpret the relationships between supply resilience and these constructs.	To answer this question, future studies should seek possibilities of applying multiple theories in one study, and detect new contradictions existing in resilience knowledge. They also should utilise theoretical lenses that have already been used.
3	Engineering	Two agency-related issues determine the effectiveness of slack resources on firms' operational resilience during COVID-19.	The effectiveness of resilience strategies and practices that were developed based on engineering resilience ideology can be undermined by geopolitical disruptive events and needs to be reassessed to ensure firms and supply network main resilience during geopolitical events
4	Social-ecological	Buying firms' supply network geographic adjustments to mitigate the risk of disruption result in a significant reduction in institutional heterogeneity to gain social-ecological resilience.	Geopolitical events can trigger supply network changes from the social-political aspect. It is evidence to distinguish geopolitical disruptions from other types of disruptions, and an example of how supply networks transform into a "desired state" that adapts to the "new normal".
3&4	Engineering/Social-ecological	Both before and during geopolitical disruptive events, firms' risk perception, which has been suggested to be highly associated with firms' attention to risk, can affect firms' resource allocation or supply network adjustment during geopolitical events.	Firms' risk perception of geopolitical events or the political environment plays a critical role in building operational and supply chain resilience during geopolitical events.

5.3 Practical Implications of the Studies

The practical implications of this thesis primarily stem from the second and third studies. The second study emphasises that managers should critically assess both the effectiveness and the necessity of maintaining financial slack within their firms. While risk management research in the OSCM suggests that financial slack provides flexibility in responding to unforeseen events (Chen et al., 2023), this study shows that excessive financial slack can also lead to agency and risk-sharing problems, ultimately undermining firm performance, including operational resilience during COVID-19. For instance, Blau and Schoenherr (1971) argued that firms with substantial financial slack tend to become bureaucratic, while Liang et al. (2023, p.10) observed that managers in firms with long-standing financial slack may become "incapable or too indolent to capitalise on changes and opportunities in an uncertain environment." To address these issues, firms should implement governance mechanisms (e.g. outcome-based contracts) to better align managerial incentives and mitigate agency problems associated with financial slack. Besides that, this study finds that capacity slack, a widely recognised managerial practice for reducing the impact of disruptions, significantly enhances operational resilience during COVID-19. This finding should give managers confidence in considering the accumulation of capacity slack as a resilience strategy for future disruptions, particularly in today's uncertain business environment.

The third study suggests firms take into account the regulatory distance within their supply networks when responding to disruptions. Firms should consider integrating regulatory distance assessments into their supplier selection and supply base monitoring processes. By systematically tracking regulatory distance across their supply networks, they may be able to better identify and monitor changes in the regulatory environments that may affect their suppliers or their own operations. Maintaining such visibility across the supply network would enable firms to make more informed and balanced risk assessments in the

face of disruptions, whether geopolitical or otherwise, and to respond more effectively to emerging regulatory challenges.

Many firms have adapted their supply networks to mitigate the disruption risks associated with the US-China trade war and to strengthen resilience. However, the medium- to long-term implications of these adjustments remain uncertain because supply network adaptation is a complex, time-consuming, and resource-intensive process (Lin et al., 2023). Over time, such adaptations may lead to challenges, including persistent shortages of critical components and increased vulnerability to disruptions due to a high level of dependency on a small number of key suppliers. Therefore, these strategic changes should be evaluated with careful consideration of their medium- and long-term consequences and supported by appropriate mitigation strategies to minimise potential risks and unintended outcomes.

From a risk perception perspective, both the second and third studies demonstrate that firms' perceptions of risk significantly shape decision-making in relation to operational strategies and supply network redesign following geopolitical disruptions. The second study conceptualises firms' risk perception of geopolitical disruptive events as a proxy for their attention to such events, emphasising the importance of awareness and vigilance toward potential disruptions. Although the findings indicate that such awareness alone may not directly strengthen operational resilience during disruptions, it provides an essential foundation for designing and executing effective resilience strategies. Consequently, firms should invest in comprehensive risk detection and monitoring systems and develop the capability to anticipate, assess, and respond to the potential impacts of unexpected events in a timely and informed manner.

Meanwhile, the third study highlights the contingent role of perceived political risk (comprised of political process risk and economic policy risk). By understanding their own firms' risk perceptions, managers can develop more balanced and effective strategies to

mitigate the adverse impacts of geopolitical disruptions. For example, firms with low perceived political risk may underestimate vulnerabilities within their supply networks. In contrast, firms with high perceived political risk may adopt overly cautious approaches that constrain growth or lead to inefficient resource allocation.

5.4 Limitations and Future Research

This thesis has two major limitations. The first limitation of this thesis coalesces around the data samples and databases used. This limitation has different impacts across the three studies. In the first study, data were collected from journals listed in two categories of the ABS journal list: journals rated above ABS 3 in the *Operations and Technology Management* category and those rated above ABS 3 in the *Ethics–CSR–Management* category. This selection was based on two main rationales. As a result, this review focuses on theoretically rigorous contributions but is not the most comprehensive in covering the full range of supply chain resilience research. Second, supply chain resilience studies are most commonly found in journals within these two categories. However, this selection criterion excludes cross-disciplinary studies published in other domains, such as economics, political science, or psychology. Consequently, the study misses the opportunity to explore how supply chain resilience is conceptualised or interpreted in these fields and what theoretical perspectives they may contribute to the broader understanding of supply chain resilience.

For the second and third studies of this thesis, the data were collected from several secondary databases. One limitation of these databases is that they only include data from publicly traded firms, so the results of these studies might not be applicable to private firms or small and medium enterprises. Hence, future studies could use different sources of data to examine relationships addressed by these two studies under an SME context. Meanwhile, from a data sample perspective, both studies mainly focus on US firms, with the exclusion of several industries to control for heterogeneity across countries and industries and enhance

the reliability of empirical results. However, such a practice limits the potential of exploring how macro-level factors, such as policy dynamism and industrial dynamism, affect firms' or supply networks' resilience-building practices or strategies. Therefore, future research could address this limitation by collecting data from firms across multiple countries and industries.

The second limitation of the thesis is the separation of the two resilience perspectives. Both the second and the third study only address one perspective of operational and supply chain resilience (the second study for the engineering perspective and the third one for the social-ecological perspective). Empirically investigating one perspective of resilience is a common practice for resilience studies, but such a practice hinders resilience studies from exploring the relationship between the engineering perspective and the social-ecological perspective of resilience. In the last few years, conceptual studies focusing on resilience promoted the social-ecological perspective of resilience and posited that the engineering perspective is outdated (Wieland and Durach, 2021). However, many resilience measurements commonly used by OSCM studies align with the engineering perspective of resilience. These measurements were formulated by comparing firms' or supply chains' financial or operational performance before and after disruption and are easy to draw managers' and shareholders' attention (e.g., the operational resilience measurement in the second study). Meanwhile, building social-ecological resilience can be complex, time-consuming, and resource-intensive (Lin et al., 2023). Under such circumstances, it is questionable how appealing the social-ecological perspective of resilience will be to firms, especially when firms might face a survival situation under the impact of geopolitical disruption. Therefore, it would be interesting to investigate the interaction between two perspectives of resilience in future studies. For example, can engineering resilience and social-ecological resilience be co-developed, or are they mutually exclusive? Or how do strategies and practices for building engineering resilience and social-ecological resilience mutually influence one another in firms or supply networks?

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Appendix

Table A1: Robust analysis with State-fixed effect

Variables	Model 1 Capacity slack		Model 2 Financial slack		Model 3 Inventory slack		Model 4 Operational resilience	
	β SE	p	β SE	p	β SE	p	β SE	p
Capacity slack							0.029 -0.016	0.063
Financial slack							-0.053 -0.014	0.000
Inventory slack							0.016 -0.016	0.307
Lagged operational resilience							0.539 -0.014	0.000
COVID-19 risk perception	0.033 -0.011	0.003	0.024 -0.012	0.048	0.012 -0.011	0.257	-0.008 -0.009	0.394
ROA	-0.004 -0.001	0.000	0.000 -0.001	0.586	-0.002 -0.001	0.003	-0.002 -0.001	0.001
R&D intensity	-0.006 -0.517	0.991	1.022 -0.563	0.070	-0.153 -0.506	0.762	0.422 -0.527	0.423
Asset tangibility	1.306 -0.064	0.000	-0.089 -0.070	0.202	-0.117 -0.063	0.064	-0.177 -0.062	0.004
Leverage	-0.022	0.675	-0.489	0.000	-0.093	0.075	0.115	0.016

	-0.053		-0.058		-0.052		-0.048	
Firms size	0.028	0.000	-0.051	0.000	-0.019	0.003	0.001	0.878
	-0.007		-0.007		-0.006		-0.006	
Customer network centrality	-0.001	0.187	0.000	0.890	0.002	0.000	-0.001	0.016
	0.000		0.000		0.000		0.000	
Supply network centrality	-0.001	0.025	0.000	0.071	-0.001	0.000	0.000	0.244
	0.000		0.000		0.000		0.000	
Time/State-fixed effect	included		included		included		included	
Constant	-1.396	0.000	0.554	0.016	-0.201	0.330	0.099	0.604
	-0.211		-0.230		-0.207		-0.190	
Observations	3,564		3,564		3,564		3,564	
R-squared	0.196		0.138		0.125		0.392	

Table A2: Robust analysis with CEO variables

Variables	Model 1 Capacity slack		Model 2 Financial slack		Model 3 Inventory slack		Model 4 Operational resilience	
	β	p	β	p	β	p	β	p
	SE		SE		SE		SE	
Capacity slack							0.028	0.090
							-0.016	
Financial slack							-0.052	0.000
							-0.014	
Inventory slack							0.011	0.471
							-0.015	
Lagged operational resilience							0.562	0.000
							-0.014	
COVID-19 risk perception	0.028	0.008	0.025	0.033	0.005	0.628	-0.003	-0.703
	-0.011		-0.012		-0.011		-0.009	
ROA	-0.006	0.000	0.002	0.055	-0.002	0.002	-0.002	0.025
	-0.001		-0.001		-0.001		-0.001	
R&D intensity	-0.358	0.461	3.255	0.000	-0.789	0.123	0.855	0.092
	-0.485		-0.543		-0.511		-0.508	
Asset tangibility	1.848	0.000	-0.513	0.000	-0.224	0.001	-0.200	0.004
	-0.066		-0.074		-0.070		-0.070	
Leverage	0.059	0.252	-0.532	0.000	-0.096	0.078	0.100	0.036
	-0.052		-0.058		-0.055		-0.048	
Firms size	0.055	0.000	-0.060	0.000	-0.023	0.001	-0.002	0.724
	-0.006		-0.007		-0.007		-0.006	

Customer network centrality	-0.002	0.001	0.000	0.324	0.003	0.000	-0.001	0.079
	0.000		0.000		0.000		0.000	
Supply network centrality	0.000	0.080	0.000	0.072	-0.002	0.000	0.000	0.359
	0.000		0.000		0.000		0.000	
CEO tenure	0.006	0.000	0.012	0.000	0.008	0.000	0.000	0.919
	-0.002		-0.002		-0.002		-0.002	
CEO duality	-0.092	0.000	-0.207	0.000	0.070	0.001	-0.005	0.785
	-0.020		-0.022		-0.021		-0.018	
Time/Industry-fixed effect	included		included		included		included	
Constant	-1.220	0.000	1.065	0.000	0.323	-0.003	0.067	-0.503
	-0.104		-0.117		-0.110		-0.099	
Observations	3,467		3,467		3,467		3,467	
R-squared	0.267		0.173		0.069		0.392	

Table A3: Robust analysis with alternative operational resilience

Variables	Model 1 Operational resilience	
	β SE	p
Capacity slack	0.039 -0.006	0.000
Financial slack	-0.014 -0.005	0.007
Inventory slack	0.025 -0.006	0.000
Lagged operational resilience	-0.014 -0.010	0.186
COVID-19 risk perception	-0.002 -0.003	0.604
ROA	-0.002 0.000	0.000
R&D intensity	-0.163 -0.238	0.492
Asset tangibility	-0.045 -0.026	0.083
Leverage	0.015 -0.018	0.411
Firms size	0.002 -0.002	0.490
Customer network centrality	0.000 0.000	0.500
Supply network centrality	0.000 0.000	0.433
Time/Industry-fixed effect	included	
Constant	-0.084 -0.037	0.022
Observations	3,516	
R-squared	0.123	