Firms' strategic responses to rising uncertainty amid ongoing geopolitical tensions: The synergistic mediating role of network capability and innovation ambidexterity

Abstract

With our study, we aimed to enrich the discourse on supply chain disruptions by exploring the strategic responses of firms to supply chain uncertainty (SCUn) that enhance supply chain resilience (SCRes). Drawing on the dynamic capabilities view (DCV), we investigated whether and how firms utilise uncertainty amid geopolitical turmoil as a catalyst to enhance SCRes. This contrasts with the predominant focus found in the existing literature on the detrimental impacts of uncertainty amid rising geopolitical tensions. Using survey data drawn from 242 firms across multiple industries in Pakistan, we employed structural equation modelling (SEM) to test our proposed model, introducing network capabilities (NCs) and innovation ambidexterity (IA) as mediators to elucidate their differential roles in the SCUn-SCRes relationship. Our findings reveal that SCUn triggers strategic responses aimed at building SCRes, with NCs emerging as a significant mediator that enhances SCRes. However, IA has an insignificant mediating effect. Notably, our study uncovers a sequential mediation pathway from NCs to IA, highlighting the dynamic interplay between these capabilities in translating SCUn into enhanced SCRes amid global crises. Our study provides actionable insights for logistics and supply chain managers who navigate uncertain environments amid geopolitical tensions, emphasizing the importance of NCs in driving IA towards achieving SCRes. Our research, which makes a novel contribution by going beyond the conventional perspectives on SCUn and SCRes, advances a new stream of literature on how SCUn influences SCRes through the mediating roles of NCs and IA.

***Keywords*:** Supply chain uncertainty; resilience; network capability; innovation ambidexterity.

1. Introduction

The increasing interconnectedness of global markets, compounded by persistent geopolitical tensions such as the Russia-Ukraine conflict, China-USA trade disputes, and unrest in the Middle East has significantly increased the complexity of supply chain and logistics networks. In this rapidly changing business environment, heightened levels of uncertainty expose supply chains to potential disruptions (Ali et al., 2024; Lu et al., 2025). These challenges threaten the stability and reliability of global supply networks, necessitating firms to enhance their supply chain resilience (SCRes) to maintain continuity amid an increasingly volatile global landscape. SCRes enables firms to prepare for, resist, and recover from disruptions, returning to normal or an even better post-disruptive state (Ambulkar et al., 2015; Giannoccaro & Iftikhar, 2022; Wieland et al., 2023). For example, in response to the trade restrictions imposed by the US government, Huawei diversified its supply chains and invested intensely in local research and development to reduce its dependency on foreign technology. In 2023, Huawei announced that it had exited 'crisis status' and aimed to return to normal operations despite ongoing trade restrictions (Lee-Makiyama & Baker, 2024). Likewise, amid the escalating US-China trade tensions related to tariffs and supply chain dependencies, Apple is diversifying its supply chain to the Southeast Asian region, e.g., Vietnam, Malaysia, and the Philippines, to reduce its reliance on Chinese suppliers (Jung & Park, 2024). These examples demonstrate how urgent it is for firms to build resilience as a strategic response to the uncertainties arising from trade restrictions.

The aforementioned examples also highlight how the cultivation of SCRes in uncertain business landscapes requires multifaceted strategic approaches, at the heart of which lies the development of network capabilities (NCs) and innovation ambidexterity (IA) (O'Reilly & Tushman, 2013; Polyviou et al., 2019). NCs refer to a firm's ability to effectively manage and utilise its relationships and interactions within its supply network, enhancing flexibility, information flow, and collaborative innovation (Partanen et al., 2020; Villena et al., 2011). Simultaneously, IA, the capability to concurrently explore new opportunities while exploiting existing competencies enables firms to dynamically adjust and innovate in response to environmental changes (Charpin et al., 2021; O'Reilly & Tushman, 2013). While NCs and IA are established in the existing literature as dynamic capabilities that enhance firm performance (Partanen et al., 2020), foster creativity and cognitive processes (De Carolis et al., 2009), provide a competitive advantage (Lavie et al., 2010), and facilitate knowledge creation (Ardito et al., 2020), little research has hitherto addressed their roles as response mechanisms to supply

chain uncertainty (SCUn) and their contributions to enhancing SCRes, especially in unpredictable environments caused by trade conflicts and geopolitical tensions (Fan et al., 2022; Zahoor et al., 2024).

A review of the literature on relational, collaborative, and network capabilities reveals that nurturing trust and cultivating relationships to achieve organisational outcomes in highly turbulent and uncertain environments is challenging (Capaldo & Giannoccaro, 2015; Giannoccaro & Iftikhar, 2022). However, earlier research in this domain has been rather analytical and has taken a simplified approach; e.g., using intra-firm level relational capabilities to understand network-level relationships (Bonatto et al., 2020; Zahoor et al., 2024). This has led to an incomplete understanding of NCs, which may have overlooked the impact of their complex nature (Partanen et al., 2020). Further, by utilising their NCs, firms can enhance the flow of information and resources needed for both exploratory and exploitative innovations—referred to as IA (Blome et al., 2013). In extending the discussion on SCUn, the extant literature has mainly examined its contingent role as a moderator in the relationship between different organisational capabilities and firm performance (Ahammad et al., 2021; Ojha et al., 2018) and resilience (Gölgeci & Ponomarov, 2015; Tiwari et al., 2024). Additionally, the study of SCUn has hitherto been focussed on its role as a driver of supply chain risks and complexity (Chand et al., 2022; Sreedevi & Saranga, 2017), which is considered detrimental to firm performance (Brandon-Jones et al., 2015; Hoffmann et al., 2013). However, the empirical body of work on the direct influence of SCUn on firms' strategic decisions pertaining to the development of NCs and IA as mechanisms for enhancing SCRes, particularly amid the current geopolitical tensions, is still underdeveloped.

Given the unpredictable nature of the SCUn induced by ongoing geopolitical instability, firms may be driven to invest in capabilities that enable them to adapt and respond promptly to ensure operational continuity. By examining the role played by SCUn as a driver of the adoption of NCs and IA for SCRes enhancement, we can gain deeper insights into firms' strategic responses to uncertainty and their efforts to build adaptive capacity. Also, studies have linked NCs with IA (Al-Tabbaa & Zahoor, 2024; De Silva et al., 2022), and relational and collaborative capabilities with SCRes (Polyviou et al., 2019; Saglam et al., 2022); however, it remains poorly understood how the combined effect of NCs and IA translates into SCRes (Nikookar et al., 2024; Oyedijo et al., 2022). As NCs involve complex sets of collaborative practices and strategic partnerships (Walter et al., 2006), their interaction with IA represents a rich area for exploration, particularly in resource-constrained settings.

To address these gaps, we developed the following research questions: i) *Does supply chain uncertainty (SCUn) motivate firms to enhance their supply chain resilience (SCRes)?* and, ii) *Do network capabilities (NCs) and innovation ambidexterity (IA) mediate the relationship between SCUn and SCRes?*

To answer these questions, we developed a conceptual framework built upon the dynamic capability view (DCV), and the SCUn, NC, IA, and SCRes literature. Our study offers a unique perspective on the interplay between NCs and IA within the context of supply chain management. The DCV posits that a firm's sustained competitive advantage is derived from its proficiency in integrating, developing, and reconfiguring both internal and external competencies to adeptly navigate the rapidly evolving business landscape (Eisenhardt & Martin, 2000; Teece, 2014). Although the DCV has been widely applied in strategic management research, our goal is to empirically investigate how NCs and IA synergise to bolster SCRes in an environment marked by SCUn, particularly amid ongoing geopolitical tensions. This represents a critical area of inquiry given the increasingly complex and volatile nature of global supply chains.

Our research advances the application of the DCV by investigating how NCs and IA, as representatives of dynamic capabilities, equip firms with the agility and innovative capacity necessary to confront SCUn. NCs, as dynamic capabilities, enable firms to build, reconfigure, and optimise external relationships, ensuring access to critical resources and strengthening resilience against disruptions (Dubey et al., 2024). Another area of focus in building dynamic capabilities is IA, which involves the routines and processes that enable ambidextrous organisations to effectively allocate, mobilise, coordinate, and integrate diverse and often conflicting innovative efforts (Božič & Dimovski, 2019). The innovation literature has considered IA to be a complex dynamic capability that enables the development of new competencies and the reconfiguration of resources, serving as an additional driver of sustained competitive advantage (Smith et al., 2005). We, therefore, argue that, together, NCs and IA represent complementary dimensions of dynamic capabilities that enable firms not only to respond effectively to SCUn but also to proactively shape resilience strategies. Through this theoretical lens, we also contribute to the existing body of knowledge that investigates how firms utilise dynamic capabilities to secure a competitive edge in the face of uncertainty. This exploration is particularly important as businesses worldwide deal with unprecedented SC challenges driven by geopolitical tensions and global market volatility, highlighting the significance of these dynamic capabilities in sustaining operational continuity and performance.

While exploring the mediation mechanisms, we find that SCUn influences SCRes through the sequential mediation of NCs and IA. Interestingly, our analysis indicates that, when tested alone, IA does not mediate the relationship, while NCs do. This suggests a synergistic relationship between NCs and IA, in which NCs serve as a foundational element necessary to exploit the potential of IA for enhanced SCRes. Finally, the goal of our research was to kickstart a discourse and advance theory towards a more comprehensive understanding of the dynamic capabilities developed by firms exposed to SCUn.

We studied these relationships from a developing economy perspective by collecting data from Pakistan, the fifth most populated country in the world. Beyond the aforementioned empirical gap, we also identify a significant contextual gap. That is, Pakistan's unique geopolitical position, bordering regions with significant political instability and economic fluctuations, presents challenges such as disrupted supply chains and uncertain market conditions, making it an ideal context to explore firms' strategic adaptations to rising uncertainty (Asif et al., 2019). Although developing economies comprise more than three-quarters of the world's population, the vast majority of research is disproportionately focussed on developed economies (Iftikhar et al., 2021; Tukamuhabwa et al., 2017). Yet developing economies often face heightened levels of SCUn due to political uncertainty, market fluctuations, and infrastructural challenges (Mohandas & Gautam, 2024). We, therefore, aimed to understand how, within these challenging contexts, supply chains respond to SCUn and develop dynamic capabilities, such as NCs and IA, to enhance SCRes. In the global marketplace, firms from developing economies often face stiff competition from established players, therefore demonstrating how strong SCRes, supported by NCs and IA, could serve as a strategic pathway for these firms is crucial.

We have organised this research paper in the following manner. The theoretical background on the key constructs is discussed in Section 2. Section 3 discusses the conceptual model and presents the proposed research hypotheses. Section 4 explains the methodology of the study, followed by the data analysis and results in Section 5. Finally, Section 6 presents a discussion of the results, along with the theoretical and practical implications, limitations, and future research directions.

2. Theoretical Background

2.1 Supply chain uncertainty

Contemporary supply chains are increasingly exposed to various uncertainties, such as fluctuating demand, disruptions in logistics, geopolitical tensions, and unexpected events like

pandemics (Ali et al., 2024; Roscoe et al., 2022). Geopolitical disruptions, such as trade wars, sanctions, and regional conflicts, can further complicate these uncertainties by affecting trade regulations, causing supply interruptions and disrupting market stability (Roscoe et al., 2020). These factors significantly impact the efficiency and continuity of supply chain and logistic networks, making it essential for businesses to develop more resilient strategies.

SCUn refers to a situation whereby firms lack the information or knowledge necessary to make both internal and external decisions about the supply chain or its environment, consequently leading to turbulence (Van Der Vorst & Beulens, 2002). SCUn can arise not only from within a firm's boundaries—as a result of production inconsistencies—but also from external factors such as geopolitical shifts disturbing market stability, supplier reliability, and customer demand (Flynn et al., 2016; Gereffi et al., 2021; Roscoe et al., 2020). Geopolitical shifts causing political instability, regulatory changes, and trade barriers can significantly change supply chain dynamics, forcing firms to continuously adapt to environmental unpredictability (Charpin et al., 2021). As such, research on SCUn is more crucial than ever. In recent times, growing SCUn caused by geopolitical shifts has attracted research attention, with scholars studying its impact on SC operations (representative studies and their findings are discussed in Appendix 1). For example, (Charpin et al., 2021) highlighted that foreign subunit managers' perceptions of political risks shape their legitimacy goals, leading them to adapt strategies for supplier relationships. (Ren et al., 2024) developed a geopolitical disruption diffusion model to analyse disruption propagation in single-region and inter-region blockades, expanding electric vehicle lithium-Ion battery SC network research from a macro- to a meso-level analysis. (Moradlou et al., 2021) found that geopolitical disruptions have driven firms to relocate production and distribution based on market-seeking and efficiency-seeking advantages, while ownership/internalization advantages had no impact. (Roscoe et al., 2020) observed that multinational enterprises (MNEs) use worst-case scenarios while SMEs and large firms adopt "wait-and-see" approaches, implementing reactive and proactive strategies to handle supply chain uncertainty caused by geopolitical events.

The extant literature on SCUn is divided into two streams. The first emphasises its far-reaching implications beyond operational complexities, highlighting its influence on strategic decision-making, risk mitigation and business survival (Kwak et al., 2018; Sreedevi & Saranga, 2017), the alternate perspective has a narrower scope, emphasising how uncertainties cause firms to deploy heightened resources to effectively address and manage SCUn (Rehman & Jajja, 2023). The latter perspective is centred on the reactionary aspect, acknowledging that

SCUn acts as a catalyst, compelling firms to adopt adaptive strategies to ensure operational continuity.

To date, there is a notable gap in our understanding of the mechanism through which firms affected by SCUn utilise superior resources and competencies to achieve SCRes (Wegner, Foguesatto, et al., 2023; Zahoor et al., 2024), particularly amid geopolitical tensions. An understanding of these impacts can not only enable firms to not only confront but also effectively overcome these uncertainties.

2.2 Supply chain resilience

SCRes refers to a firm's ability to resist and recover from disruptions by maintaining operational continuity (Giannoccaro & Iftikhar, 2022; Wieland et al., 2023). This concept underscores the two core facets that are significant for SCRes: resistance to and recovery from disruptions. The resistance component characterises a firm's ability to persist by maintaining control and stability amid adversity (Farjoun, 2010; Hamel & Välikangas, 2003), whereas the recovery component involves the adoption of certain measures through the development of robust strategies aimed at maintaining a continuous flow of goods and services (Ambulkar et al., 2015). In this study, SCRes is conceptualised as being dynamic in nature, where a firm reconfigures and reorganises its resource base in an uncertain environment. This illustrates the multifaceted nature of the SCRes concept and shows how achieving it may require the development of specific supply chain capabilities. The literature discusses the beneficial effects of various supply chain capabilities for SCRes, such as risk management strategies, flexible operational structures, diversified sourcing, information transparency, and collaborative relationships (Ali et al., 2017; Iftikhar et al., 2021; Manhart et al., 2020; Tukamuhabwa et al., 2015). However, whether exposure to SCUn significantly pushes firms to achieve SCRes is less well understood. An examination of this relationship not only widens the scholarly discussion, it also holds practical implications suited to guide firms in the development of adaptive strategies aimed at addressing uncertainties and strengthening supply chains against disruptions.

2.3 Network capabilities and innovation ambidexterity as dynamic capabilities

The current research aims to understand whether firms exposed to SCUn develop NCs and IA to further drive SCRes. Considering the impact of SCUn on NCs and IA and that of NCs and IA on SCRes, the current conceptual model is grounded in the DCV, which is based on the notion that firms integrate, build, and reconfigure their internal and external competencies in

response to uncertain and dynamic environments (Teece et al., 1997) driven by market uncertainties, technological advancements, and the evolving market player landscape (Eisenhardt & Martin, 2000). It emphasises the building of rare and superior competencies suited to make firms unique and better than their competitors (O'Reilly & Tushman, 2013). We contend that NCs and IA are dynamic capabilities that lead to SCRes in the face of SCUn.

Within the context of SCUn, the examination of NCs holds significant importance in contemporary business landscapes. The networks in which firms operate represent their intricate webs of relationships, coordination, and interaction with supply chain actors (Partanen et al., 2020). Understanding how the firms within these networks adapt, reconfigure, and utilise the resources and capabilities drawn from their wider networks when faced with SCUn is significant to ensure resiliency. Grounded in the DCV, we argue that the dynamic nature of NCs acts as a capacity to evolve, reshape, and adapt to changing market demands and technological advancements (Forkmann et al., 2018; Mitrega et al., 2017). NCs enable firms to establish and adapt their external network connections, reallocate key resources among partnerships, and effectively manage a diverse array of relationships with different network partners (Faroque et al., 2022). Firms recognise that the ability to build, exploit, and nurture networks is a dynamic force that fosters innovation, facilitates resource reconfiguration, and ultimately enables the sustainment of competitive advantage (Polyviou et al., 2019; Sarwar et al., 2021). NCs mobilise firms by enabling them to change their circumstances and strike a balance between the benefits and risks inherent in the SC network (Yang et al., 2018). NCs are complex organisational capabilities for managing SC network relationships but are also considered an important part of doing business nowadays (Wegner, Foguesatto, et al., 2023). The literature, by and large, expresses the view that NCs offer performance benefits for firms (Bhatti et al., 2022; Semrau & Sigmund, 2012); however, studies have focused on exploring the effectiveness of NCs in stable business environments, leaving a gap in our understanding concerning the complexities of network relationships during crisis situations like geopolitical events or pandemics (see for review Wegner, Santini, et al. (2023) and Al-Tabbaa and Zahoor (2024). Additionally, some studies have yielded inconclusive results (Durach & Machuca, 2018; Iftikhar et al., 2021). This underscores the need to examine the complex dynamics of NCs. Thus, we aimed to investigate the effectiveness of NCs for SCRes when faced with SCUn.

Earlier research has highlighted that to sustain success over long periods, it is important to simultaneously balance exploratory and exploitative innovation, which is referred to as IA (Blome et al., 2013; Lin et al., 2013). Exploratory innovation, which is geared towards creating novel products and new markets, targets new customers; conversely, exploitative innovation

operates incrementally and focusses on existing customers or market needs (Benner & Tushman, 2003; Iftikhar et al., 2023). Further, exploitative innovation relies on existing knowledge, resources, and competencies to refine existing products and their supply chains (Kristal et al., 2010). IA is not only about initiating novel practices, it entails an equilibrium between exploring new opportunities and leveraging existing resources (Blome et al., 2013). This strategic alignment is embedded within the DCV framework (O'Reilly & Tushman, 2008), which involves sensing external conditions, seizing opportunities, and reconfiguring resources accordingly (Aslam et al., 2022; Božič & Dimovski, 2019). Therefore, IA, as a dynamic capability, fosters sustaining innovation, extending firm abilities beyond mere adaptability and enabling them to thrive in dynamic and uncertain environments. In this context, our study was aimed at investigating the effectiveness of IA for SCRes under SCUn.

3. Conceptual model and research hypotheses

3.1 Supply chain uncertainty and resilience

In the complex scope of supply chain management, where uncertainties abound, firms are confronted with multifaceted challenges that demand strategic responses aligned with the DCV presented by Teece et al. (1997). The DCV framework can define the pivotal role of a firm's ability to integrate, build, and reconfigure both its internal and external competencies in navigating the uncertainties inherent in supply chains, thereby maintaining a competitive advantage (Teece et al., 1997). Grounded in this perspective, the following discussion delves into how the presence of SCUn propels SCRes, a dynamic capability, enabling firms to maintain a competitive edge in the ever-evolving business landscape.

The concept of uncertainty is centred on a lack of accurate information or knowledge for decision-making, both within an organisation and in its external environment (Van Der Vorst & Beulens, 2002). Such a situation may hinder a firm's ability to understand supplier adherence to specifications and quality standards (Hoffmann et al., 2013; Sreedevi & Saranga, 2017). Consequently, firms are driven to adeptly integrate, build, and reconfigure their competencies, transforming the challenge into an opportunity, in line with DCV assumptions (Teece et al., 2007). In other words, firms develop SCRes—a robust system capable of weathering uncertainties through swift response and adaptability while addressing the financial implications that may arise from potential supply disruptions (Ali & Golgeci, 2019).

The level of uncertainty also reflects any demand fluctuations and unexpected competitor actions that hamper informed decision-making (Hoffmann et al., 2013). The possible consequences of such uncertainty include the risk of supply-demand disruptions and

a compromised competitive edge within the industry. In navigating these challenges, enterprises strategically engage in collaborative approaches with their partners, emphasising open communication and information sharing (Ali et al., 2023). Collaborative initiatives, intertwined with effective decision-making processes, contribute to the cultivation of SCRes (Pettit et al., 2010), which empowers firms to promptly respond to shifts in demand patterns and adapt to any unexpected actions of competitors (Ambulkar et al., 2015; Golgeci & Kuivalainen, 2020). As such, it involves not only reacting to disruptions but also proactively building a system capable of dynamically adjusting to changing circumstances (Golgeci and Kuivalainen, 2020). For example, after the 2011 earthquake and tsunami in Japan, Toyota developed robust systems and processes by adopting a dual-supply system and increasing its inventory buffers. This marked a substantial departure from its traditional Just-In-Time (JIT) inventory system, aimed at enhancing resilience (Shih, 2022). These strategic adjustments enabled the firm to effectively manage SCUn.

Moving forward, uncertainty may also undermine a firm's ability to accurately evaluate major suppliers (Hoffmann et al., 2013). Resilient supply chains, aligned with the DCV, utilise internal capabilities to navigate upstream uncertainties without compromising overall supply chain stability. The subsequent exploration extends into the dimension of thoroughly monitoring the performance of key suppliers, revealing a seamless alignment with the DCV in an effort to promptly respond to supply chain disruptions (Ali et al., 2023). Thus, in response to any uncertainties inherent in their supply chains, firms engage in the deliberate integration, building, and reconfiguration of resources, leading to the development of SCRes as a dynamic capability. This discussion led us to formulate the following hypothesis:

H1. Supply chain uncertainty positively influences supply chain resilience.

3.2 The mediating effects of innovation ambidexterity and network capabilities

Today's business environment is characterised by rapid technological advancements, market fluctuations, and unforeseen events (Syed et al., 2020); therefore, achieving SCRes has become a non-negotiable element for firms. The high levels of SCUn challenge firms' abilities to maintain operational continuity, requiring resilient strategies to mitigate its potentially negative impact (Rehman & Jajja, 2023). We proposed that the positive impact of SCUn on SCRes is channelled through the intermediary role of innovation ambidexterity. As SCUn introduces challenges, such as a lack of information, supplier evaluation complexities, unexpected competitor actions, and fluctuating demand, it serves as a trigger to adopt innovation

ambidexterity as a dynamic response mechanism. Innovation ambidexterity involves the pursuit of exploratory and exploitative innovation strategies, presenting organisations with a framework suited to navigate the complexities of their supply chains (Benner & Tushman, 2003; Blome et al., 2013). In response to SCUn, exploratory innovation entails the exploration of novel ideas, technologies, and approaches (Iftikhar et al., 2023). This allows one to venture into unchartered territories, exploring alternative methods for monitoring, evaluation, and response (Blome al., 2013) to address challenges such as a lack of information and unexpected competitor actions. Simultaneously, exploitative innovation focusses on refining and organising existing processes and utilising known resources and competencies (Lin et al., 2013). This dimension strategically addresses challenges like supplier evaluation complexities and fluctuating demand, ensuring the efficient use of existing capabilities to adapt and respond to uncertainties and maintain operational continuity (Herold et al., 2024). This duality in innovation ambidexterity is relevant to SCRes as it requires both stability to prevent disruptions and flexibility to restore normalcy after disruptions (Annarelli & Nonino, 2016; Holgado et al., 2024; Shi et al., 2025). Achieving this balance requires an ambidextrous capability in order to address competing demands effectively (Aslam et al., 2022).

With the lens of DCV, the integration of both exploratory and exploitative innovation enables organisations to position innovation ambidexterity as the transformative force that translates the challenges posed by SCUn into opportunities for building resilience. Given this discussion, we found it plausible to propose the following hypothesis:

H2. Innovation ambidexterity mediates the relationship between supply chain uncertainty and supply chain resilience.

The intricate relationship between SCUn and SCRes prompts an exploration of the mediating role played by network capabilities. In this regard, we posited that internal communication, coordination, relationship skills, and partner knowledge are integral components of network capabilities that act as mediators, influencing how organisations respond to uncertainties within their supply chains. Network capabilities, which encompass effective internal communication denoted by regular project meetings and informal contacts among employees (Partanen et al., 2020), can lay the groundwork for SCRes. In the context of uncertainty, this communication becomes a dynamic capability, ensuring that information flows seamlessly and enabling an organisation to collectively comprehend and respond to the

challenges posed by the unpredictable nature of its supply chain (Semrau & Sigmund, 2012; Walter et al., 2006). In addition, coordination within network capabilities involves developing relations with partners based on contributions, regular discussions about mutual support, and proactive partner selection (Ali et al., 2022; Sarwar et al., 2021). These coordination efforts become a manifestation of dynamic capabilities, enabling organisations to swiftly adapt and reconfigure their collaborative networks (Partanen et al., 2020; Walter et al., 2006). By pooling resources, sharing insights, and collectively addressing uncertainties, organisations strengthen the resilience of their supply chains, aligning with the DCV of strategic adaptability to changing environments.

The emphasis on relationship skills within network capabilities which encompass the ability to build personal relationships, flexibility in dealing with partners, and constructive problem-solving (Partanen et al., 2020), aligns with the DCV. These skills cultivate a resilient organisational culture capable of navigating uncertainties. Trust and collaborative problem-solving, inherent in relationship skills, become crucial elements in adapting dynamically to unforeseen disruptions, aligning with the DCV's concept of building external competencies for competitive advantage (Teece et al., 1997). Moreover, a comprehensive partner knowledge that covers markets, products, procedures, strengths, and weaknesses represents a strategic capability. In the DCV, this knowledge corresponds to the ability to integrate external competencies, enabling organisations to make informed decisions, rapidly adjust, and navigate challenges collaboratively, showcasing the dynamic capability of reconfiguring competencies for sustained competitiveness (Ali et al., 2022). Based on this discussion, we advanced the following hypothesis:

H3. Network capabilities mediate the relationship between supply chain uncertainty and supply chain resilience.

The consequentiality that leads from SCUn to network capability, to innovation ambidexterity, and, ultimately, to SCRes can form a strategic progression, aligning with the DCV. The recognition of uncertainty, for instance, can propel firms to invest in and enhance network capabilities such as internal communication, coordination with partners, strong relationship skills, and comprehensive partner knowledge (Partanen et al., 2020; Qu & Yang, 2015). Network capabilities create a fertile ground for the cultivation of innovation ambidexterity in order to not only explore new and innovative possibilities but also to optimise and refine existing processes (O'Reilly & Tushman, 2008; Yang et al., 2019), which is crucial

for navigating uncertainties and maintaining resilience in the face of dynamic challenges. Effective NCs are also useful for assessing internal communication and knowledge regarding supply chain partners, which are essential for pursuing IA and managing tensions within supply chain relationships (Andriopoulos & Lewis, 2009). A comprehensive knowledge of the partners within a network provides valuable insights for informed decision-making in innovation pursuits (O'Reilly & Tushman, 2008). Understanding their partners' strengths, weaknesses, markets, and products enables organisations to make strategic decisions on where to focus their innovative efforts (Luzzini et al., 2015). This knowledge not only minimises any risks associated with innovation but also maximises the potential for successful outcomes (Donmez & Norheim-Hansen, 2024). Moreover, relationship skills and interfirm coordination enable open communication and information sharing among supply chain partners (Bordonaba-Juste & Cambra-Fierro, 2009). This reduces friction and resistance to the implementation of innovative solutions (Gerges-Yammine & Ter Wal, 2023). These important traits of NCs establish open dialogues and develop trust among supply chain partners (Alghababsheh & Gallear, 2020), which are crucial for managing the dual demands of IA within supply networks (Zahoor et al., 2024). Similarly, internal communication is also significant for the achievement of IA, particularly due to the distinct and conflicting objectives of exploitation and exploration (Andriopoulos & Lewis, 2009; Wenke et al., 2021). Internal communication enables the dissemination of knowledge about new market trends, technological advancements and potential disruptions across departments, fostering a culture of collaborative learning. This supports managing the contradictory knowledge processes to attain ambidextrous orientation (Lubatkin et al., 2006; Mei et al., 2023). In times of SCUn, effective internal communication decreases the likelihood of goal conflict, ensuring shared visions and goals to achieve IA (Aslam et al., 2022).

This aligns with the DCV, in which the integration and reconfiguration of network capabilities and innovation ambidexterity lead to the dynamic capability of SCRes in response to uncertain and changing environments. Based on this discussion, we posited the following:

H4. Network capabilities and innovation ambidexterity sequentially mediate the relationship between supply chain uncertainty and supply chain resilience.

Our proposed research hypotheses are shown in Figure 1.

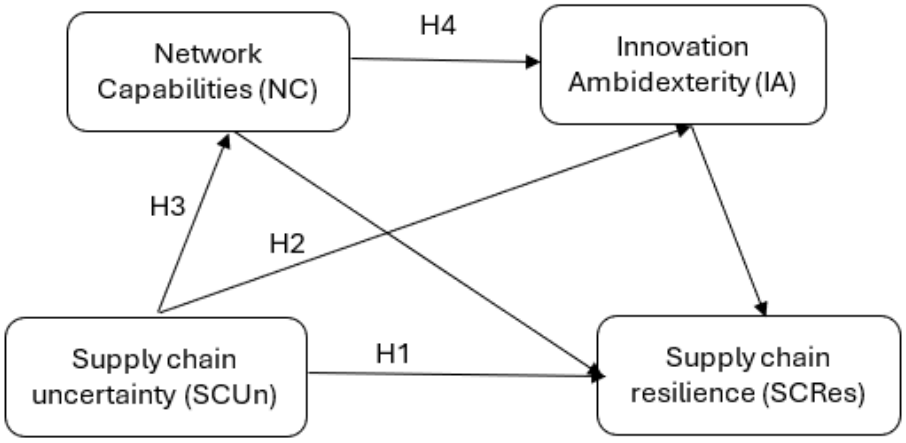

Figure 1: Research framework

4. Research Methodology

In our research, to validate the research framework and proposed hypotheses (see Figure 1), we took a quantitative approach and made use of a positivist paradigm, which relies on observable and quantifiable measures (Zikmund et al., 2013). By following deductive reasoning, we employed a survey instrument as our primary data collection method, aligned with established procedures for questionnaire structuring and sampling techniques (Dillman, 2011). We used a simple random sampling method, ensuring that all survey participants would have an equal chance of being selected and that the selected sample would be representative of the whole population. This reduced any selection bias risk in our employment of the survey methodology. Our study's unit of analysis was at the firm level in Pakistan, representing an emerging and developing economic context. Given Pakistan's strategic geopolitical location and exposure to regional political instability and economic fluctuations, it provides a relevant setting to explore firms' strategic adaptations to rising uncertainty.

4.1 Data collection

We collected the data for our study from senior Pakistani firm managers operating in multiple industries, with experience in supply chain, purchasing/procurement, production, logistics, and warehousing functions. We developed a structured questionnaire on Google Forms and distributed it to 1,200 firms through email, collecting the data between November 2021 and March 2022. To ensure unbiased participant selection, we referred to the Securities and Exchange Commission of Pakistan (SECP) database. As the primary regulatory authority for

the corporate sector in Pakistan, the SECP maintains extensive records of the firms operating in the country. Thus, by using this database, we ensured that our sample would be representative of the formal business sector. We received a total of 275 responses; however, after removing 33 missing and incomplete observations, were retained only 242 useful ones. We collected these data after two email reminders, with a response rate of 20.2%, which is deemed adequate to conduct statistical analysis (Gölgeci & Kuivalainen, 2020; Iftikhar et al., 2024). Table 1 showcases the heterogeneity of our sample.

Further, to enhance our study's robustness, we sought feedback on our questionnaire from industry and academic professionals. We also pre-tested our questionnaire on 50 industry professionals to evaluate the clarity and effectiveness of the scale items. These industry professionals were contacted through the professional networking website, LinkedIn, between August and September 2021. The feedback we obtained from this pre-testing helped us to refine the wording of the scale items to ensure they were easily understood by the respondents. The pre-test participants were excluded from our main survey.

Table 1: Demographic profile of the respondents

Dimension	Category	Number	Percentage
Age	25 - 34	65	27%
	35 - 44	108	45%
	45 - 54	42	17%
	Over 55	27	11%
Work Experience (years)	Less than 11 years	115	48%
	More than 11 years	127	52%
Firm size	Below 500 employees	98	40%
	500 - 1000 employees	66	27%
	More than 1000 employees	78	32%
Annual Sales (Million PKR)	0 - 1000	59	24%
	1001 - 2000	41	17%
	2001 - 3000	53	22%
	> 3001	89	37%
Managerial Designation	Assistant Manager	11	5%
	Manager/Senior Manager	163	67%
	General Manager	28	12%
	Director	20	8%
	CEO/Owner	20	8%
Industry	Consumer Goods	68	28%
	Apparel and textile	40	17%

Automotive	31	13%
Pharmaceuticals	30	12%
Consumer Electronics	19	8%
Others	15	6%
Energy and Utility	14	6%
Banking, Hospitality and Consulting	12	5%
Construction	8	3%
Shipping and Logistics	5	2%

4.2 Measurement

We drew our study's research framework from the existing literature and used validated scale items. In this paragraph, we provide details of the empirical constructs we used in our study.

We measured the *supply chain uncertainty* construct as a first-order reflective construct consisting of five scale items adapted from Hoffmann et al. (2013) and Sreedevi and Saranga (2017), with additional insights into geopolitical disruptions drawn from (Roscoe et al., 2020). While asking the respondents about the supply chain uncertainty items we stated that please consider your responses in the context of geopolitical factors such as trade restrictions, political instability, regulatory changes and international conflicts. We measured the items of this construct on a scale of 1 (not at all) to 5 (to a great extent). The developed construct, as the single independent variable, was operationalised in terms of supply, demand, and market uncertainty resulting from geopolitical disruptions.

We adapted the first mediating variable, *network capabilities,* from the work of (Partanen et al., 2020); Walter et al. (2006), and measured it as a second-order formative construct (Zacca et al., 2015). Within this construct, we used internal communication, inter-firm coordination, relationship skills, and partner knowledge as its first-order constructs, with each consisting of three scale items. We measured the items of the first-order constructs on a scale of 1 (strongly disagree) to 5 (strongly agree). We adapted the second mediating variable, *innovation ambidexterity*, from the work of He and Wong (2004) and Blome et al. (2013). The IA measures this construct as a joint pursuit of exploitative and explorative innovation. In line with Aslam et al. (2020) and Tamayo-Torres et al. (2017), we measured IA as a second-order formative construct suited to represent the simultaneous adoption of contrasting activities. We measured the items pertaining to exploitative and explorative innovation as first-order reflective constructs on a scale of 1 (strongly disagree) to 5 (strongly agree).

We measured the dependent variable, *supply chain resilience,* by adapting five items from Ambulkar et al. (2015) and Golgeci and Kuivalainen (2020), which we graded on a scale of 1 (not at all) to 5 (to a great extent).

4.3 Non-response and common method bias

We tested for non-response bias by following the guidelines of Armstrong and Overton (1977). Their method views late respondents as a proxy for non-respondents and compares early and late respondents by using an independent sample t-test. This method has also been adopted by survey-based studies in the SCM domain (Ali et al., 2023; Chowdhury et al., 2019). We found no significant difference in the t-tests based on firm size, number of employees, or employee experience. The independent sample t-test between early and late respondents yielded a p-value greater than 0.05, signalling the absence of any significant differences. This suggested that non-response bias was not a concern in our study.

As we conducted an online self-respondent survey, we faced the possible risk of common method bias (Podsakoff et al., 2003). We thus adopted some procedural remedies for this before proceeding to test our hypotheses. We drew the measurement items in our study from established scales; we divided the questionnaire into various sections and separated the independent and dependent variables (Fawcett et al., 2014). Moreover, the constructs we used consisted of varying items, from 3 to 5, exhibiting different scales of comparison (MacKenzie & Podsakoff, 2012; Zhao et al., 2011). At the same time, we ensured our respondents of their anonymity thus encouraging them to complete the questionnaire objectively and promoting unbiased responses (Demeter et al., 2017). Finally, we also used the marker variable technique, considering our respondents' experience as a method variance marker variable (Lindell & Whitney, 2001). The number of years of respondent experience was not theoretically related to any other constructs used in our study. We compared the correlation of this marker variable with other constructs in our empirical model, and found a non-significant correlation that highlighted how common method bias was not a concern in our study (Podsakoff et al., 2003).

5. Data Analysis and Findings

We tested our hypotheses by employing partial least squares structural equation modelling (PLS-SEM) through the SmartPLS (v. 4.1.0.6) software, which is prevalent in SCM research (Saglam et al., 2022). We chose PLS-SEM for several reasons. First, it offers advantages when dealing with complex models that involve multiple mediation analyses (Chand et al., 2022; Saglam et al., 2022; Sarstedt et al., 2014; Stekelorum et al., 2021). Second, PLS-SEM is well

suited for testing models with second-order formative constructs, such as NCs and IA, allowing for the assessment of complex relationships where indicators form the construct (Sarstedt et al., 2014; Wang et al., 2024). Third, PLS-SEM imposes fewer restrictions on distributional assumptions but has the ability to obtain robust model estimates (Hair et al., 2011; Hair et al., 2019).

We performed our data analysis in two stages. First, we assessed our measurement model by evaluating its reliability, convergent validity, and discriminant validity. Second, we evaluated our structural model by means of the PLS-SEM technique (Hair et al., 2019).

5.1 Measurement model

We performed reliability and validity tests following the work of Chand et al. (2022). The composite reliability (CR) and average variance extracted were found to fall above their respective minimum threshold values of 0.7 and 0.5 (Hair et al., 2011; Nunnally, 1978). Moreover, we used the Fornell-Larcker criterion (Fornell & Larcker, 1981) to establish convergent and discriminant validity. The factor loadings of all items were found to range between 0.611 and 0.898 (>0.5), indicating that each item was strongly associated with its respective latent variables, thus confirming convergent validity (see Table 2). To assess discriminant validity, we compared the square root of the AVE for each construct with the correlation of all other constructs. We found the square root of the AVE to be higher than its correlations with all other constructs (see Table 3). We also evaluated the Heterotrait-monotrait (HTMT) values to confirm discriminant validity, as suggested by (Henseler et al., 2015). To discriminate between the two variables, the HTMT values needs to fall well below the 0.9 maximum threshold value. The HTMT values (Table 3) were found to support discriminant validity in our study.

Table 2: Construct and item reliability

Constructs	Indicators	VIF	Loading	CR	AVE
Supply Chain Uncertainty	We frequently encounter unexpected actions from our competitors.	1.604	0.746	*0.847*	*0.525*
	Our product/service demand fluctuates from week to week.	1.638	0.743		
	Monitoring supplier adherence to specifications and quality standards demands considerable effort.	1.352	0.685		
	Accurately evaluating our major suppliers requires substantial effort.	1.509	0.733		
	Thoroughly monitoring key suppliers' performance demands significant time and effort.	1.589	0.706		
Internal Communication	In our company, we have regular meetings for every project.	1.047	0.729	*0.802*	*0.576*
	In our company, employees develop informal contacts among themselves.	1.052	0.731		
	In our company, managers and employees often give feedback to each other.	1.083	0.810		
Interfirm Coordination	In our company, we develop relations with each partner based on what they can contribute.	2.532	0.916	*0.858*	*0.674*
	In our company, we discuss regularly with our partners how we can support each other.	2.437	0.898		
	We judge in advance which possible partners to talk to about building up relationships.	1.106	0.611		
Relationship Skills	In our company, we have the ability to build good personal relationships with our business partners.	1.197	0.803	*0.866*	*0.683*
	In our company, we can deal flexibly with our partners.	1.553	0.857		
	In our company, we almost always solve problems constructively with our partners.	1.327	0.814		
Partner Knowledge	In our company, we know our partners' markets.	2.013	0.884	*0.904*	*0.758*
	In our company, we know our partners' products/procedures/services.	1.293	0.848		
	In our company, we know our partners' strengths and weaknesses.	2.100	0.878		
Exploitative Innovation	To stay competitive, our firm continuously refines existing products and services, driving innovation in processes.	1.104	0.756	*0.721*	*0.514*

	Our firm leverages current technologies and makes small adaptations for incremental innovation.	1.390	0.676		
	Our firm introduces improved, but existing products and services for our local market.	1.222	0.722		
	We focus on developing stronger competencies in existing processes, driving innovation throughout the organization.	1.549	0.712		
Explorative Innovation	Our firm proactively pursues innovative approaches.	1.704	0.734	*0.830*	*0.551*
	Our firm continuously experiments to discover novel solutions that revolutionize our processes.	1.794	0.732		
	Our firm constantly explores new opportunities to innovate and embrace cutting-edge practices for sustainable growth.	1.533	0.808		
	Our firm invents new products and services.	1.347	0.686		
Supply Chain Resilience	Our supply chain demonstrates swift response capabilities, efficiently restoring product flow in the face of unexpected disruptions.	2.020	0.807	*0.903*	*0.651*
	Our firm possesses effective strategies to address the financial implications resulting from potential supply chain disruptions.	2.038	0.809		
	Our firm can promptly respond to supply chain disruptions, ensuring minimal disruption to our operations.	2.582	0.867		
	Our supply chain exhibits easy adaptability to disruptions, enabling rapid recovery and resumption of normal operations.	2.090	0.818		
	Our firm has the capacity to successfully cope with changes induced by supply chain disruptions, facilitating efficient recovery and restoration of stability.	1.582	0.720		

Table 3: Fornell-Larcker criterion

Constructs	1	2	3	4	5	6	7	8
1. Exploit Innov	***0.716***	0.507	0.42	0.515	0.275	0.406	0.435	0.492
2. Explor Innov	0.403	***0.742***	0.566	0.658	0.451	0.548	0.355	0.246
3. INCMN	0.325	0.439	***0.758***	0.642	0.503	0.516	0.298	0.072
4. INCOOD	0.406	0.579	0.593	***0.821***	0.534	0.632	0.267	0.136
5. PKNOW	0.22	0.366	0.407	0.43	***0.871***	0.552	0.273	0.319
6. Relationship skills	0.328	0.441	0.388	0.513	0.485	***0.824***	0.276	0.188
7. Resilience	0.353	0.28	0.222	0.225	0.221	0.213	***0.805***	0.29
8. Uncertainty	0.386	0.176	0.037	0.106	0.258	0.137	0.263	***0.725***

Diagonal values are the square root of AVE values; below the diagonal are the inter-construct correlations; above the diagonal values are HTMT values.

In our study, we considered NCs and IA as second-order formative constructs. To operationalise their measurements, we applied a two-step process, as suggested by (Ringle et al., 2012). First, we applied the repeated indicator method to obtain our first-order constructs' latent variables scores, which we subsequently utilised to establish the second-order measurement. Finally, to validate the measurement fit for formative constructs, we examined the multicollinearity and internal validity of the higher component model. To check for multicollinearity, we tested the variance inflation factor (VIF) values, all of which were below the recommended threshold of 5, with none exceeding the cut-off limit of 10 (Benitez et al., 2018), indicating no multicollinearity concerns in our study. Table 4 shows the outer weights, the outer loadings which were found to fall above the 0.5 threshold and the VIF values of NCs and IA (Sarstedt et al., 2014).

Table 4: Second-order formative construct assessment

Second-order constructs	First-order constructs	VIF	Outer weight	Outer loading
Network capabilities	Internal Communication	3.067	0.443	0.919
	Interfirm Coordination	2.823	0.256	0.862
	Relationship Skills	2.773	0.283	0.868
	Partner Knowledge	2.250	0.179	0.794

Innovation ambidexterity	Exploitative innovation	1.296	0.452	0.831
	Explorative innovation	1.296	0.702	0.884

5.2 Hypotheses testing: structural model analysis

The summarised results of our structural equation model analysis are presented in Table 5. We utilised the Smart PLS 4.0 software to test our hypotheses (direct and indirect) through PLS-SEM. We estimated the path coefficient and the significance of our hypothesised relationships (H1 – H4) by employing the bootstrapping technique with 5,000 subsamples. Our results were found to reveal a significant positive relationship between SCUn and SCRes (H1- β = 0.317, p < 0.000). Therefore, H1 was found to be supported.

We also assessed the mediation hypotheses (H2 – H5). In H2, we found an insignificant effect of IA on the relationship between SCUn and SCRes (β = 0.048, p>0.10). Therefore, H2 was not found to be supported, and no evidence of mediation was found. In H3, the mediation effect of NCs between SCUn and SCRes was found to be positive and significant (β = 0.057, p < 0.05). Both the direct effect of SCUn and SCRes and the indirect effect with NCs were found to be positive and significant; therefore, providing evidence of a partial mediation effect and supporting H3. In H4, the sequential mediation effect from NCs to IA between SCUn and SCRes (β = 0.083, p < 0.05) was found to be positive and significant. As the direct effects of SCUn and NCs (β = 0.157, p < 0.000), SCUn and IA (β = 0.397, p < 0.000) and SCUn and SCRes (β = 0.317, p < 0.000) were found to be positive and significant, H4 was found to be supported by evidence of a partial mediation effect. We also tested the sequential mediation from IA to NCs between SCUn and SCRes, however it was found to be insignificant (β = 0.033, p>0.10). We also tested industry type as a control variable, but its effect on the main relationships was found to be statistically insignificant (p=0.210), indicating industry type does not introduce a confounding effect.

Table 5: Hypothesis and structural model statistics

Hypothesis	Path Coefficient	t-statistics	p-values	95% Confidence Interval	Decision
H1 - Supply chain uncertainty -> Supply chain resilience	0.317	4.871	0.000	0.186 - 0.436	Supported

H2 - Supply chain uncertainty -> Innovation Ambidexterity -> Supply chain resilience	0.048	1.488	0.137	- 0.009 - 0.119	Rejected
H3 - Supply chain uncertainty -> Network capabilities -> Supply chain resilience	0.057	2.235	0.025	0.015 - 0.104	Supported
H4 - Supply chain uncertainty -> Network capabilities -> Innovation ambidexterity -> Supply chain resilience	0.083	2.886	0.004	0.036 - 0.148	Supported

5.3 Robustness test

To ensure the robustness of our findings, we conducted tests for endogeneity. In particular, we used the Gaussian Copula (GC) test within Smart-PLS v. 4.1.0.6, as recommended by Hult et al. (2018). Before conducting this test, we verified that the variables potentially affected by endogeneity were not normally distributed. Therefore, we first performed the Kolmogorov-Smirnov test with Lilliefors correction on our empirical constructs. We obtained p-values lower than 0.05, indicating a non-normal distribution (Sarstedt & Mooi, 2014). We then performed the GC test by creating various model combinations (Table 6). Across all combinations, the GCs were found to produce non-significant p-values (greater than 0.05), suggesting no evidence of endogeneity and thereby reinforcing the robustness of our model. However, endogeneity issues can also arise from reverse causality, whereby the dependent variable influences the independent one (Damali et al., 2016). Our study was grounded in the DCV, which mitigates reverse causality, meaning that SCRes does not cause SCUn. We adopted maximum measures to minimise any potential endogeneity issues.

Table 6: Endogeneity test results

Variable	Model 1 (endogenous variable: SCUn)		Model 2 (endogenous variable: NC)		Model 3 (endogenous variable: IA		Model 4 (endogenous variable: SCUn, NC)	
	Coeff.	p-value	Coeff.	p-value	Coeff.	p-value	Coeff.	p-value
SCUn	0.231	0.007	0.319	0.000	0.328	0.000	0.225	0.012
NC	0.304	0.000	0.243	0.056	0.329	0.000	0.279	0.030
IA	0.183	0.010	0.167	0.020	-0.001	0.951	0.185	0.009
Cscun	0.043	0.841					0.049	0.785
Cnc			0.072	0.245			0.024	0.617
Cia					0.153	0.155		

Variable	Model 5 (endogenous variable: SCUn, IA)		Model 6 (endogenous variable: NC, IA)		Model 7 (endogenous variable : SCUn, NC, IA)	
	Coeff.	p-value	Coeff.	p-value	Coeff.	p-value
SCUn	0.215	0.011	0.324	0.000	0.215	0.011
NC	0.313	0.000	0.285	0.025	0.313	0.000
IA	0.063	0.696	0.018	0.902	0.063	0.696
Cscun	0.066	0.716			0.065	0.701
Cnc			0.040	0.455	0.017	0.836
Cia	0.112	0.291	0.138	0.227	0.113	0.325

Cnc: Gaussian Copula term for NC; Cscun: Gaussian Copula term for SCUn; Cia: Gaussian Copula term for IA.

6. Discussion and conclusions

6.1 Main findings

By adopting the DCV as our theoretical lens, we examined how SCUn acts as a driver, leading to SCRes through IA and NCs. In the face of uncertainty, firms strive to remain competitive by adapting to complex and unpredictable environments (Sreedevi & Saranga, 2017), thus enabling their survival and resilience. The prevailing SCUn is exemplified by recent global events, such as tensions between Russia and NATO and the war in the Middle East. These events have exerted a substantial impact on supply chain operations, especially in developing economies, in which significant logistical activities take place (Van Barneveld et al., 2020), rendering them vulnerable. Therefore, it is important to understand how, under the influence of SCUn, firms manage and adapt to disruptive events.

We examined the complex relationship between SCUn and SCRes by drawing data from multiple industries of a developing economy. We empirically validated that SCUn positively influences firms to improve SCRes (H1). This implies that, in response to both internal and external uncertainties, firms proactively develop courses of action suited to address these uncertainties and to ensure business continuity. Along a similar line of argument, Brown and Eisenhardt (1995) and Ali et al. (2024) argued that, under higher levels of uncertainty, firms face immense pressure from their stakeholders to adapt and change their actions. This positive association also suggests that firms develop different mechanisms—like internal integrative practices and external ones within their larger networks, with key suppliers and customers—to cope with supply chain risks and disruptions and therefore enhance their SCRes. In line with this argument, Gereffi et al. (2021) highlighted how, when firms are faced with trade restrictions, they respond by switching supply chain partners and pursuing diverse strategies. These strategies leverage the shifting geographies associated with new trade rules to

support their longevity. Our findings also complement earlier research on the beneficial effects of supply chain diversification and integrative practices under conditions of SCUn and risk (Jajja et al., 2018; Tang & Tomlin, 2008; Wong & Boon-Itt, 2008).

We also explored the mechanism underpinning the relationship between SCUn and SCRes (H1) through IA (H2) and NCs (H3). Despite the positive association between SCUn and SCRes, we found that the introduction of IA as a mediating variable does not yield a significant relationship. This is an unexpected finding, despite the limited research hitherto conducted on the nexus of SCUn, IA, and SCRes (Saleh et al., 2023). One possible explanation for this finding is that, within resource-constrained environments, firms find it challenging to strike a balance between the opposing strategies of exploitative and explorative innovation (Andriopoulos & Lewis, 2010). At the same time, the complexity involved in striking this balance is compounded when firms are striving for survival and responding to disruptions. Additionally, firms require swift responses to achieve resilience, whereas the beneficial effects of IA may not be immediately realised and require more complex skill sets to be distributed consistently across an organisation, particularly to facilitate both exploitative and explorative innovation. Therefore, the delayed impact of IA limits its short-term effectiveness in enabling SCRes. The outcome of our non-significant result also points towards a potential variation in the roles of exploitative and explorative innovation. Rather than examining them simultaneously as higher-order constructs of IA, it could be useful to study their individual roles and their sequential impacts. This also provides an important avenue for conducting further research in this domain.

The testing of H3 was found to suggest that firms develop NCs in response to the need to manage uncertainties and enhance their SCRes. Further, to cope with supply, market, and demand uncertainties and to ensure operational continuity, firms improve their internal communication, interfirm coordination, and develop relationship skills and partner knowledge, which represent NCs. Prior research on the effects of relational capabilities and NCs within the disruption management and SCRes domains has yielded conflicting results and is lacking in empirical validation (Capaldo & Giannoccaro, 2015; Daghar et al., 2021). Our finding that firms under uncertain and turbulent environments redesign their structures and relationship routines and can outperform their competitors is congruent with Wegner, Foguesatto, et al. (2023) and Rehman and Jajja (2023). This strategic adaptation enables firms to effectively collaborate with supply chain partners and overcome difficulties. Drawing from the DCV, we argue that SCUn is an inevitable reality, and firms need to proactively embrace it by developing safeguard mechanisms such as NCs to enhance SCRes.

We also analysed the sequential mediation, from NCs to IA, on the relationship between SCUn and SCRes (H4). The evidence we found for a sequential mediation provides the exciting insight that, in isolation, IA may not be a primary driver for SCRes; rather, it takes on a more impactful role when embedded with the NC framework. In this sequential mediation, NCs emerge as a foundational bedrock upon which IA thrives. This finding implies that innovative practices are fostered by the establishment of strong collaborative infrastructure, information-sharing mechanisms, and trust through NCs. Therefore, NCs serve as facilitators, enabling the creation of a suitable environment in which diverse ideas and resources converge, stimulating a culture of continuous innovation and adaptability and enhancing decision-making processes (Sarwar et al., 2021). Our finding is in line with Giotopoulos et al. (2017) and Chang and Hughes (2012), who found that enhanced communication systems and trustful social relations support the occurrence of exploratory and exploitative innovation.

6.2 Theoretical implications

This research builds upon prior SCUn research (Haarhaus & Liening, 2020; Roscoe et al., 2020; Sreedevi & Saranga, 2017), which has primarily examined its influences on firm performance and inter-organisational relationships (Rehman & Jajja, 2023; Wegner, Foguesatto, et al., 2023). Conversely, in the context of SCRes, scholars have predominantly explored the moderating role of SCUn, emphasising its adverse effect on various organisational capabilities and resilience (Aslam et al., 2020; Gölgeci & Ponomarov, 2015). In contrast to this prevailing view, we have taken a novel perspective by arguing that SCUn can serve as an opportunity or catalyst for firms to develop strategic capabilities (aka IA and NC), thereby enhancing SCRes. Specifically, we find that SCUn positively influences SCRes through sequential mediation of NCs and IA. This indicates that NCs, such as internal communication, coordination, relationship skills, and partner knowledge, play crucial roles in supporting IA, including exploitative and explorative innovation, amid rising uncertainty; thus, enabling firms to cultivate SCRes.

The extant literature on the effectiveness of inter-organisational relationships and NCs within a turbulent and uncertain environment has presented conflicting results (Capaldo & Giannoccaro, 2015; Wegner, Foguesatto, et al., 2023) and has predominantly been studied within a developed country context (Daghar et al., 2021). In contrast, we examined the role of NCs from a developing country perspective. Our research suggests that developing NCs is essential for firms operating within these contexts to utilise network resources and reconfigure their operations when exposed to uncertainty. We, therefore, contribute to the existing NC

literature (Hendry et al., 2019; Mitrega et al., 2017; Partanen et al., 2020) and the results advocate the importance of studying developing country contexts. Further, our results align with Aman and Seuring (2021) and Wegner, Foguesatto, et al. (2023) that, during uncertain times, firms develop strong relationships with their network partners to navigate crises, enabling them to adapt and strategically pivot. Geopolitical events can disrupt traditional supply chains (Roscoe et al., 2022), forcing firms to explore alternative sourcing and distribution channels and requiring strong relationships with stakeholders to ensure business continuity and resilience. Our findings complement and align with Charpin et al. (2021), who emphasized how perceptions of political risk influence supplier strategies in achieving legitimacy goals. Our mediation results highlight the importance of utilising NCs not just for legitimacy but for resilience under geopolitical risks. This advances the theoretical understanding of how firms navigate SCUn caused by political risks through strategic SC capabilities. Furthermore, our research extends the findings of Handfield et al. (2020) by demonstrating that NCs enable firms to adapt SC relationships dynamically, facilitating SCRes amid geopolitical shocks.

Our study also extends the literature on IA (Blome et al., 2013; Božič & Dimovski, 2019) and aligns with research conducted in the context of a resource-constrained developing country (Partanen et al., 2020; Wenke et al., 2021). The findings show that IA does not directly influence SCRes when firms are exposed to SCUn. We argue that, within this context, firms operating under uncertain and volatile conditions often face resource constraints and prioritisation dilemmas (Park et al., 2002; Tukamuhabwa et al., 2017). Therefore, allocating or gaining access to resources for effective exploitation and exploration may lead to suboptimal outcomes under uncertainty, without a clear guarantee of success (Osiyevskyy et al., 2020). Although IA does not yield a significant mediating relationship, our study revealed a sequential mediation effect from NCs to IA. That is, in isolation, IA may not be a primary driver for SCRes, but when embedded within the NC framework, it becomes more impactful. This insight complements earlier research by Rothaermel and Alexandre (2009), suggesting that to manage the tension inherent in ambidexterity, firms must develop a knowledge sharing mechanism among their network partners. This highlights that firms dynamically build resilience through layered responses (Singh, 2024). Further, this enables firms to effectively balance exploitation and exploration activities (Aslam et al., 2022). With this, we also respond to the call by Wenke et al. (2021) to investigate how firms mitigate the impact of uncertain environments by utilising cross-industry collaboration and strategic alliances to support ambidexterity efforts. Theoretically, this study informs the dynamic capabilities literature by explaining how

uncertainties trigger firms to develop and deploy combinations of mechanisms to achieve SCRes.

6.3 Practical implications

Many of today's global supply chains are characterised by high uncertainty, exacerbated by the effects of major geopolitical events. The findings of this research are of particular importance to firms operating in such highly uncertain environments. They demonstrate how, under the influence of SCUn, logistics and supply chain managers can manage and adapt to disruptive events. This provides logistics and supply chain managers with an insight into how they can proactively develop courses of action that address uncertainties and ensure business continuity.

More specifically, logistics and supply chain managers may wish to adopt a sequential approach to developing their capabilities, beginning with network capabilities as innovation ambidexterity on its own does not enhance SCRes in the presence of SCUn. Network capabilities may be developed, for example, by enhancing internal communication mechanisms, such as via regular project meetings and informal contacts among employees, and by improving coordination within the wider (external) network, such as by developing relationships with supply chain partners based on mutual trust, support, and proactive partner selection. This ensures information flows seamlessly, enabling the organisation to collectively comprehend and respond to the challenges posed by SCUn, laying the foundations for SCRes. Once firms have enhanced their network capabilities, they can turn to innovation ambidexterity to obtain the synergistic effects available from combining the two dynamic capabilities together. While exploitative innovation may be leveraged to provide incremental gains for existing customers or markets, exploratory innovation can create radically novel products and establish new markets. Further, the experiences of global giants like Huawei and Apple underscore the practical relevance of our study's findings. Huawei's intense investment in R&D in response to US trade restrictions, leading to their recovery, mirrors the importance of fostering IA in navigating SCUn. Similarly, Apple's strategic shift towards diversifying its supply base in Southeast Asia highlights the significant role of NC in mitigating risks arising from geopolitical tensions. Furthermore, our study's findings also hold crucial importance for the recent trade dispute between the USA – Mexico – Canada, as it provides actionable insights to firms. The imposed and threatened tariffs represent a significant increase in SCUn for firms operating in these countries. Firms relying heavily on imports from one of the affected countries might explore alternative suppliers from other regions, and domestic sourcing options, and enhance collaboration and communication with existing partners to navigate the

complexities of the new trade environment. Similarly, firms may need to invest in R&D to find alternate materials, optimise existing operations and find ways to absorb some of the tariff cost.

6.4 Limitations and future research suggestions

Despite the study's theoretical and practical implications, it has some limitations that present opportunities for future research. The data in this study was collected from Pakistan's main urban cities which could limit the geographic implications. Additionally, the participating firms were mainly from the manufacturing sector, which may restrict the applicability of the results to non-manufacturing sectors with different operational dynamics. Furthermore, our study focuses on geopolitical uncertainty in Pakistan, limiting the direct applicability of findings to other geopolitical contexts. Future research could conduct comparative analyses by expanding the geographic scope of data collection, including by studying more countries from developing regions and by including diverse sectors to develop a more comprehensive understanding of uncertainty and SCRes. Since our study uses PLS-SEM due to the formative constructs (NCs and IA), assessing validity and collinearity is crucial. Future studies could refine construct operationalisation using alternate approaches such as higher order modelling or latent variable modelling (Wang et al., 2024). We also used self-reported surveys, which runs the risk of common method bias. Although we applied procedural remedies, future research could incorporate multi-source or objective data to strengthen the validity of findings.

From a theoretical perspective, the DCV suggests that firms reconfigure their capabilities over time, however our study did not capture temporal evolution. Future research could examine longitudinally how NCs and IA evolve over time in response to geopolitical uncertainty/disruptions instead of assuming a static relationship. Meanwhile, although we assessed the influence of SCUn on resilience measures, future studies could explore its impact on broader dimensions such as social-ecological resilience or sustainability performance. Finally, this study considers IA as a higher-order formative construct. However, future research could also adopt the balanced (subtractive) and combined (multiplicative) dimensions of ambidexterity (Cao et al., 2009) and explore its impact on SCRes under different levels of SCUn.

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Appendix 1: Representative studies on the impact of geopolitical shifts in supply chain management.

Author	Research Question(s)	Findings	Methodology
(Charpin et al., 2021)	To what extent do foreign subunit managers' perceptions of political risk influence their strategic practices with host country suppliers to mitigate that risk?	The research shows that varying perceptions of political risk influence the legitimacy goals that subunits aim to achieve. To meet these goals, subunits adapt their strategies for building and enhancing relationships with suppliers.	Case study (Qualitative)
(Ren et al., 2024)	How can focal firms in the global electric vehicle Lithium-Ion Battery supply chain network identify the potential geopolitical disruption risks they face and how the impact propagates dynamically?	A geopolitical disruption diffusion model is created to simulate the spread of disruptions in two specific scenarios: a single-region blockade and an inter-region blockade. This research expands the scope of EV LIB SCN studies, transitioning from macro-level to meso-level analyses.	Secondary data (Quantitative)
(Handfield et al., 2020)	How do disruptive events like COVID-19 and other trade disruptions (e.g., Brexit, tariffs) influence the design and flow of global supply chains, and what lessons can be drawn for future supply chain resilience and risk management?	The research highlights that Brexit and trade wars impact supply costs gradually, while COVID-19 caused rapid, global supply and demand disruptions. Using Bejan's constructal law, supply chains are expected to shift from cost-focused designs to prioritizing sustainability, low emissions, and resilient risk-recovery strategies to better handle future disruptions.	Case study (Qualitative)
(Moradlou et al., 2021)	How do geopolitical disruptions influence the manufacturing supply chain location decisions of multinational firms, and what key drivers shape these decisions?	The research highlights that companies have relocated production from the UK to the EU and distribution centers from the EU to the UK. These moves were driven by market-seeking (proximity to demand, market access) and efficiency-seeking (port delays, tariff barriers) advantages, with ownership and internalization advantages not playing a role.	Interviews (Qualitative)
(Roscoe et al., 2020)	How do firms formulate and implement strategies to manage supply chain uncertainty caused by geopolitical disruptions, and how does firm size influence their ability to align with a disrupted external business environment?	The research finds that multinational enterprises used worst-case assumptions to formulate strategies, while large firms and SMEs adopted a "wait-and-see" approach to reduce supply chain uncertainty. Firms implemented both reactive and proactive strategies to mitigate risks.	Interviews (Qualitative)

(Roscoe et al., 2022)	What drives managers to restructure global supply chains in specific ways when faced with overlapping geopolitical disruptions?	The research shows that managers redesign global supply chains based on three key factors: (1) perceived intensity of institutional pressures, (2) mobility of suppliers and assets, and (3) severity of potential disruption risk.	Interviews (Qualitative)
(Belhadi et al., 2024)	How can digital dynamic capabilities support agri-food supply chain resilience strategies, and under what conditions can African agri-food supply chains leverage these capabilities to develop effective and efficient resilience strategies?	The research finds that downstream firms in African agri-food supply chains use advanced digital tools like blockchain to make worst-case assumptions and take proactive actions during geopolitical disruptions. Upstream partners rely on simpler technologies, adopting a "wait-and-see" approach with reactive strategies to manage uncertainty.	Case study (Qualitative)