THE ROLE OF ENVIRONMENTAL UNCERTAINTY IN THE RELATIONSHIP BETWEEN SUPPLY CHAIN RESILIENCE AND SUPPLY CHAIN PERFORMANCE

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Abstract: ***This study explores how supply chain resilience and environmental uncertainty influence supply chain performance in Vietnamese manufacturing firms. The study is grounded in dynamic capability theory and contingency theory. Data were collected from 379 managers. Results show both factors positively affect supply chain performance. Furthermore, the study confirms the moderating effect of environmental uncertainty.***

• Keywords: *environmental uncertainty, supply chain resilience, supply chain performance.*

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1. Introduction

In today's business environment, modern supply chains are increasingly exposed to unexpected and unpredictable shocks, ranging from pandemics and geopolitical conflicts to climate change, market demand fluctuations, and shifting trade policies. These disruptions pose significant challenges for managers in sustaining supply chain performance. In response to such volatility, supply chain resilience has emerged as a critical strategic capability, enabling firms not only to mitigate the adverse effects of disruptions but also to recover rapidly and, in some cases, leverage crises as opportunities to enhance operational efficiency (Ivanov & Dolgui, 2021; Ponomarov & Holcomb, 2009).

Supply chain resilience is considered a dynamic capability that helps firms recover from disruptions, restructure operations, and adapt to external changes (Belhadi et al., 2021; Li et al., 2023). Resilient firms maintain customer service, reduce losses, recover faster, and improve supply chain reliability (Chowdhury & Quaddus, 2017; Riaz et al., 2025; Teece, 2007, 2014; Teece et al., 1997). However, the effect of supply chain resilience may vary with the volatility and complexity of the environment, highlighting environmental uncertainty as an important contextual factor.

Environmental uncertainty refers to the difficulty of predicting markets, customers, competitors, technology, or policy (Jaworski & Kohli, 1993; Miller & Dröge, 1986). High uncertainty can raise safety stock costs, cause inventory imbalance, price volatility, and delivery delays, harming supply chain performance (James & George, 2018; Linn & Maenhout, 2019). Yet, agile firms may turn uncertainty into opportunities to innovate, share information, and use technology to enhance responsiveness and strengthen performance (Dağdeviren & Mirza, 2024).

According to Contingency Theory, performance improves when internal capabilities align with external conditions. Under high environmental uncertainty, firms with strong supply chain resilience can anticipate risks, adjust production, diversify suppliers, and coordinate with partners to maintain flows, creating a competitive advantage. When uncertainty is low, the performance gap between highly resilient and less resilient firms narrows. This view aligns with Dynamic Capabilities Theory, emphasizing sensing, seizing, and reconfiguring resources (Teece et al., 1997).

Although many studies confirm the positive effect of supply chain resilience on performance, evidence on the moderating role of environmental uncertainty is still limited, particularly in emerging economies like Vietnam, where supply chain digitalization is accelerating amid market and policy volatility. This study, therefore aims to (i) test the direct effect of

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supply chain resilience on performance, (ii) examine the direct impact of environmental uncertainty and (iii) explore its moderating effect on the relationship between supply chain resilience and supply chain performance.

The remainder of this paper is organized as follows. Section 2 reviews the key concepts, presents the theoretical foundations, and develops the research hypotheses. Section 3 describes the research methodology, including data collection procedures and analytical techniques. Section 4 reports the empirical findings on both the direct and moderating effects among the variables. Finally, Section 5 summarizes the main conclusions, discusses theoretical and managerial implications, acknowledges the study's limitations, and offers directions for future research.

2. Theoretical background and research hypotheses

2.1. Theoretical background

In today's business environment, enterprises operate under conditions of volatility, where economic, political, technological, and social factors change rapidly and are often difficult to predict. This volatility poses a strategic challenge to maintaining supply chain continuity and efficiency. To explain how organizations respond to such complexity and uncertainty, two major theoretical perspectives are frequently employed: Contingency Theory and Dynamic Capabilities Theory.

According to Contingency Theory, there is no single governance model or organizational structure that is optimal in all circumstances. Instead, organizational effectiveness depends on the degree of alignment between strategy, structure, and the external environment (Burns & Stalker, 1994; Lawrence & Lorsch, 1967). In stable environments, firms can emphasize cost optimization and standardized processes to achieve high levels of efficiency. By contrast, in volatile environments, firms must adopt more flexible structures, responsive information systems, and effective coordination mechanisms to adapt quickly to change. Within the supply chain context, Contingency Theory implies that capabilities such as supply chain resilience become particularly critical under conditions of risk and uncertainty. Supply chain resilience can thus be viewed as a mechanism that enables firms to achieve a dynamic fit with the environment, allowing them to adjust and reconfigure supply chain operations in a timely manner to sustain performance.

In parallel with Contingency Theory, Dynamic Capabilities Theory offers a complementary lens for understanding how firms build, integrate, and reconfigure resources to sustain competitive advantage in rapidly changing environments (Teece et al., 1997). This theory highlights three core competencies: sensing, seizing, and reconfiguring, which enable organizations to adapt effectively to environmental turbulence. Within the supply chain context, supply chain resilience can be viewed as a concrete manifestation of dynamic capabilities. A resilient supply chain with strong sensing capabilities proactively gathers information, monitors market trends, and anticipates potential disruptions. Seizing capabilities are reflected in the firm's ability to rapidly implement response measures, adjust supply allocations, and modify production and distribution plans. Finally, reconfiguring capabilities enables firms to redesign supply chain networks, establish new partnerships, and optimize resource allocation to align with evolving environmental conditions.

When examining the relationship between supply chain resilience and supply chain performance, both Contingency Theory and Dynamic Capabilities Theory offer a robust theoretical foundation. Supply chain resilience enables firms to mitigate the negative effects of disruptions, sustain material flows, shorten recovery times, and enhance delivery reliability, ultimately improving key performance dimensions such as cost efficiency, quality, flexibility, and customer satisfaction. Beyond resilience, environmental uncertainty represents an important contextual variable that has been widely examined in supply chain management research. Environmental uncertainty reflects the degree of unpredictability and the lack of reliable information regarding external factors that influence business operations, including demand fluctuations, supply network complexity, policy shifts, and competitive pressures. From a contingency perspective, high levels of environmental uncertainty expose firms to greater risk and decision-making pressure, thereby necessitating stronger coordination mechanisms, information sharing, and adaptive capabilities. Consequently, environmental uncertainty not only directly influences supply chain efficiency by increasing costs, lengthening delivery times, or creating supply-demand imbalances but also shapes the extent to which supply chain resilience contributes to superior performance outcomes.

2.2. Research hypotheses

Grounded in Dynamic Capabilities Theory, supply chain resilience is regarded as a higher-order dynamic capability, reflected in a firm's ability to reconfigure resources and processes in response to fluctuations in the external environment, thereby safeguarding operational outcomes. Empirical studies have shown that supply chain resilience reduces disruption duration, enhances reliability and flexibility, and ultimately improves supply chain performance (Chowdhury & Quaddus, 2017; Riaz et al., 2025; Teece, 2007, 2014; Teece et al., 1997). Accordingly, supply chain resilience is expected to directly enhance supply chain performance by maintaining continuity and operational efficiency. Based on this reasoning, the following hypothesis is proposed:

H1: Supply chain resilience has a positive effect on supply chain performance.

In addition to the effect of supply chain resilience, environmental uncertainty is a critical contextual factor that directly influences supply chain performance. Environmental uncertainty captures the degree of unpredictability associated with market demand, raw material availability, policy fluctuations, and macroeconomic risks (Miller, 1987). According to Contingency Theory, the more complex and volatile the external environment becomes, the greater the pressure on organizations to enhance adaptability in order to sustain operational efficiency. While earlier studies suggested that environmental uncertainty can hinder performance by increasing inventory costs and the risk of disruptions (Duncan, 1972), more recent research highlights that volatile environments can also present opportunities for dynamic firms to exploit market gaps, enhance flexibility, and strengthen their competitive position (Dağdeviren & Mirza, 2024). Building on this perspective, this study anticipates a positive relationship between environmental uncertainty and supply chain performance in contexts where firms actively adapt and innovate.

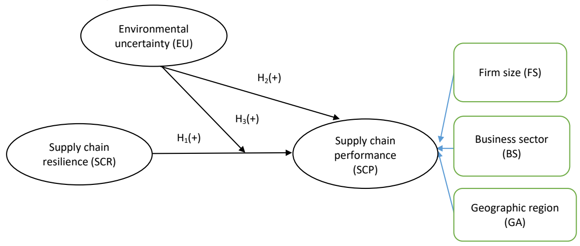
H2: Environmental uncertainty has a positive effect on supply chain performance.

In addition to its direct influence, environmental uncertainty may moderate the relationship between supply chain resilience and supply chain performance. Under conditions of high environmental uncertainty, firms with strong supply chain resilience are likely to outperform those with lower resilience, as they are better equipped to maintain material flows, adjust production plans rapidly, and collaborate flexibly with partners to mitigate risks. This reasoning aligns with Contingency Theory, which posits that organizational effectiveness depends on the fit between internal capabilities and the external environment. Similarly, from the perspective of Dynamic Capabilities Theory, environmental uncertainty serves as a catalyst that compels firms to activate and leverage their dynamic capabilities, thereby amplifying the positive effect of supply chain resilience on performance outcomes.

H3: Environmental uncertainty positively moderates the relationship between supply chain resilience and supply chain performance, such that the effect of supply chain resilience on supply chain performance is stronger under high environmental uncertainty.

The study also incorporates three control variables in the statistical analyses. The first control variable is firm size, measured using annual revenue (Dubey et al., 2020; Wamba et al., 2020). The second is the business sector, which accounts for potential differences across sectors (Dubey et al., 2020). The third control variable is geographical area, to capture possible regional variations in supply chain performance.

Figure 1: Proposed Research Model



Source(s): Proposed by the Authors

3. Research methodology

3.1. Measurement scales of variables

The authors developed a structured questionnaire in which all items were measured on a five-point Likert scale ranging from (1) = Strongly disagree to (5) = Strongly agree. The measurement scale for supply chain resilience (five items) was adapted from Belhadi et al. (2021), while the scale for supply chain performance (four items) was adapted from Zhao et al. (2023). The scale for environmental uncertainty (five items) was adapted from Inman and Green (2021).

To ensure linguistic and conceptual equivalence, all items were translated into Vietnamese and then back-translated into English. And the finalized questionnaire was then distributed to managers of manufacturing enterprises operating in industrial parks across Vietnam.

3.2. Data Collection

An online survey was conducted using a combination of convenience sampling and purposive sampling to ensure that respondents possessed relevant experience and knowledge of their enterprises' supply chain operations. The survey link was distributed to managers of manufacturing enterprises operating in industrial zones across Vietnam. After an eight-month data collection period, a total of 379 valid responses were obtained.

According to Hair (2009), a minimum sample size of approximately 100-150 is sufficient to estimate structural equation models with five or fewer constructs. As the present research model includes only three constructs, the achieved sample size of 379 comfortably exceeds this threshold and is therefore adequate for partial least squares structural equation modeling (PLS-SEM) analysis.

Following data collection, the measurement model and structural model were assessed using SmartPLS 4 software.

4. Findings

4.1. Measurement models

The evaluation of the measurement model focused on assessing the reliability and validity of the constructs.

Table 1. Assessment of Reliability and Convergent Validity

Indicator	Outer Loading	CA	CR	AVE
SCR	0.797-0.844	0.888	0.918	0.691
EU	0.757-0.860	0.859	0.899	0.640
SCP	0.774-0.881	0.836	0.891	0.672

Source(s): Created by the Authors

The results indicate that all observed variables have outer loadings greater than 0.70, confirming their statistical significance in the model. The composite reliability (CR) values for all constructs exceed the recommended threshold of 0.70, ranging from 0.891 to 0.918. Similarly, Cronbach's alpha (CA) coefficients are above the minimum requirement of 0.70, with values ranging from 0.836 to 0.888, demonstrating that the measurement scales possess high internal consistency. In addition, the outer loadings range from 0.757 to 0.881, further supporting indicator reliability, and the average variance extracted (AVE) values exceed the recommended threshold of 0.50, ranging from 0.640 to 0.691. These results collectively confirm that the measurement scales achieve both reliability and convergent validity.

Discriminant validity was subsequently assessed using the Fornell-Larcker criterion. The square root of the AVE for each construct was found to be ≥ 0.80 and higher than the inter-construct correlation coefficients, thereby satisfying the Fornell-Larcker criterion and confirming discriminant validity.

Table 2. Discriminant validity assessment using the Fornell-Larcker criterion

	EU	SCP	SCR
EU	**0.800**		
SCP	0.417	**0.820**	
SCR	-0.043	0.539	**0.831**

Source(s): Created by the Authors

In summary, all observed variables are statistically meaningful, and the measurement scales demonstrate high reliability, as well as both convergent and discriminant validity. Therefore, the collected data are appropriate for testing the proposed research hypotheses.

4.2. Structural model assessment

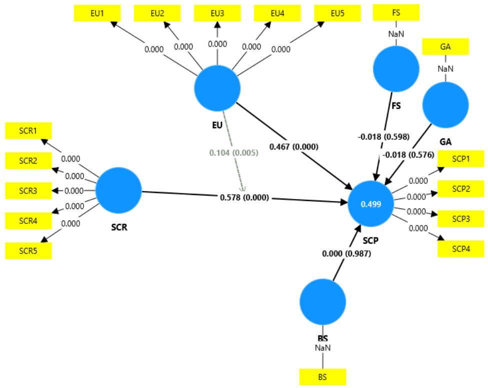
The structural model was evaluated following several steps: assessment of multicollinearity, examination of the adjusted coefficient of determination (R^2), evaluation of path coefficients, statistical significance testing of the structural paths, and assessment of overall model fit.

First, variance inflation factors (VIF) were calculated to examine multicollinearity among the independent variables. The results show that the maximum VIF value is 2.485, which is below the threshold of 5. Therefore, the research model is not affected by multicollinearity issues among the independent variables.

The adjusted R^2 value represents the proportion of variance in the dependent variable explained by the independent variables in the model. The adjusted R^2 value for SCP is 0.491, indicating that the independent variables account for 49.1% of the variance in SCP.

Next, the hypotheses were tested by identifying both direct and indirect effects. The results, presented in Figure 2 and Table 5, illustrate the structural model and the direct relationships between the constructs.

Figure 2: The Structural Model



Source(s): Created by the Authors

Table 3: Results of hypotheses testing in the structural model

Paths(hypotheses)	β	p-value	t-value
BS -> SCP	0.000	0.987	0.016
EU -> SCP	0.467	0.000	11.203
FS -> SCP	-0.018	0.598	0.527
GA -> SCP	-0.018	0.576	0.559
SCR -> SCP	0.578	0.000	17.031
EU x SCR -> SCP	0.104	0.005	2.801

Source(s): Created by the Authors

First, the results indicate that supply chain resilience has a direct and strong positive effect on supply chain performance ($\beta = 0.578$, $p < 0.001$, $t = 17.031$). This finding suggests that higher levels of supply chain resilience lead to significant improvements in supply chain performance, thereby supporting Hypothesis H1.

Next, environmental uncertainty was found to have a direct and positive effect on SCP ($\beta = 0.467$, $p < 0.01$, $t = 11.203$). This result implies that under conditions of greater environmental uncertainty, firms enhance their flexibility and responsiveness, which in turn improves performance. Thus, Hypothesis H2 is supported.

Furthermore, the moderation analysis shows that the interaction term (EU × SCR) has a positive and significant effect on supply chain performance ($\beta = 0.104$, $p < 0.01$, $t = 2.801$). This indicates that environmental uncertainty positively moderates the relationship between supply chain resilience and supply chain performance, such that the effect of supply chain resilience on supply chain performance becomes stronger when environmental uncertainty is higher. Accordingly, Hypothesis H3 is supported.

Finally, the results indicate that none of the three control variables firm size (FS), business sector (BS), and geographic area (GA) exert a statistically significant influence on supply chain performance, as all p-values exceed 0.01. Therefore, potential confounding effects from these variables can be ruled out in the assessment of the main structural relationships.

In addition, the SRMR value was 0.049, which is below the recommended threshold of 0.08, indicating a good model fit.

Taken together, these results confirm that the structural model is appropriate, all research hypotheses are supported with high statistical significance, and the model demonstrates good explanatory power for the relationships under investigation.

5. Discussion and implications

5.1 Discussions

The study results reveal that supply chain resilience exerts a strong, direct, and statistically significant effect on supply chain performance ($\beta = 0.578$; $p < 0.01$). This finding aligns with the core proposition of Dynamic Capabilities Theory, which argues that firms must develop dynamic capabilities to sense opportunities, seize them, and continuously reconfigure resources to sustain competitive advantage in turbulent environments (Teece, 2007; Teece et al., 1997). As a critical dynamic capability, supply chain resilience enables firms to detect early warning signals of risk, mobilize and reallocate resources, and rapidly recover from disruptions. These results contribute further empirical evidence that SCR is a key driver of operational efficiency, helping firms maintain service quality, minimize disruption-related costs, and enhance overall supply chain flexibility (Belhadi et al., 2021; Chowdhury & Quaddus, 2017; Zhao et al., 2023).

Moreover, environmental uncertainty was also found to have a direct positive effect on supply chain performance. This finding is consistent with the results of many previous studies (Dağdeviren & Mirza, 2024; Inman & Green, 2022; James & George, 2018). In addition, environmental uncertainty positively moderates the relationship between supply chain resilience and supply chain performance ($\beta = 0.104$; $p < 0.01$). This result aligns with Contingency Theory, which asserts that organizational performance depends on the fit between internal capabilities and external environmental conditions (Donaldson, 2001). When environmental uncertainty increases, firms with higher levels of supply chain resilience are more effective in maintaining supply chain performance. This may be explained by the fact that, under volatile conditions, firms must continuously activate resilience mechanisms, strengthen collaboration with suppliers, restructure processes, and leverage resources to mitigate negative impacts, thereby amplifying the effect of supply chain resilience on supply chain performance.

Finally, the fact that other variables such as business sector, firm size, and geographic area are not statistically significant suggests that, within the context of this study, these characteristics are not major drivers of supply chain performance, or that Vietnamese enterprises have not yet effectively leveraged these resources. This further underscores the importance of developing supply chain resilience as a strategic priority, particularly in the face of increasingly uncertain global supply chains.

5.2. Theoretical implications

The study reveals that supply chain resilience is the strongest driver of supply chain performance. Managers should view supply chain resilience as a strategic dynamic capability that requires continuous investment and development. Following Dynamic Capabilities Theory, firms should simultaneously build three capability groups: (i) sensing - early detection of risks and market changes, (ii) seizing - mobilizing resources and making timely decisions and (iii) reconfiguring - restructuring networks and processes when conditions shift.

Results further indicate that under high environmental uncertainty, the positive effect of supply chain resilience on supply chain performance becomes stronger. Firms should proactively develop disruption scenarios (e.g., raw material shortages, exchange rate volatility, policy changes) and accelerate digital transformation to enhance visibility and enable real-time data sharing with partners. This enables not only effective responses but also continuous learning and sustainable growth.

Finally, business sector, firm size, and geographic location show no significant effects, suggesting that resources should be reallocated toward resilience-building and responsiveness initiatives rather than dispersed across less impactful factors.

5.3. Limitations and future research directions

Although this study offers important theoretical and practical contributions, several limitations should be acknowledged, paving the way for future research.

First, the survey data were collected from manufacturing firms in selected regions, which may limit the generalizability of the findings. Future research could broaden the sample to include more industries and compare results across sectors or countries with varying development levels to validate the model's robustness.

Second, the cross-sectional research design does not capture the evolution of supply chain resilience over time. As Dynamic Capabilities Theory emphasizes, dynamic capabilities reveal their value through continuous resource reconfiguration. Longitudinal studies or multi-stage case research could provide deeper insights into how resilience develops in response to environmental fluctuations.

Third, environmental uncertainty was measured at a general level without distinguishing between its sub-dimensions. According to Contingency Theory, each type of uncertainty may exert different pressures and require distinct responses. Future work should disaggregate uncertainty types to provide more precise managerial recommendations.

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