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An Analysis of the Impact of Geopolitical and Climate Shocks on Global Supply Chains—A Case Study of the Suez Canal Disruption

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Abstract. The Suez Canal, a maritime chokepoint facilitating 12-15% of global trade, has been disrupted by both climate extremes and geopolitical conflicts in the early 2020s. This study examines how these two types of shocks affect global supply chain resilience. The research aims to compare their impact pathways, response mechanisms, and adaptation strategies, thereby filling a gap in the existing literature concerning the compound effects of dual risks. Using a single-case study design, this research qualitatively analyzes eight peer-reviewed articles and official reports from the United Nations Conference on Trade and Development and the World Bank. Data were processed through thematic coding and comparative analysis. The results indicate that while both shocks significantly weaken supply chain resilience, geopolitical shocks produce more prolonged effects, whereas climate shocks are more sudden and less predictable. In response, firms adopt similar adaptive strategies, including route diversification, inventory buffering, and digital tracking. It is concluded that enhancing supply chain resilience requires a dual-risk analytical framework, practical multi-route planning, and strengthened international coordination for key chokepoints.

Keywords: Suez Canal, supply chain resilience, geopolitical risk, climate shock, maritime chokepoint

1. Introduction

The Suez Canal, as one of the world's busiest shipping routes, handles 12-15% of global trade. In the period from 2021 to 2024, abnormal climate events (such as extreme wind speeds causing ship groundings) and geopolitical tensions (such as regional conflicts threatening waterway safety) have successively caused serious disruptions to canal operations, exposing the excessive dependence of global supply chains on key nodes.

Specific research questions include: (1) What are the similarities and differences in the impact paths of the two types of shocks on the supply chain; (2) How do enterprises and the international community respond; (3) How to improve the supply chain resilience of key channels.

The significance of this research lies in providing a reference for multinational corporations' risk management and international shipping policy formulation, filling the gap in existing literature

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regarding the insufficient attention paid to the combined effects of these dual shocks.

2. Literature review

2.1. Relevant theoretical framework

Four theoretical domains inform this study. Supply chain resilience theory conceptualizes a system's capacity to absorb shocks, recover from disruptions, and adapt its structure in response to changing conditions [1, 2]. Chokepoint vulnerability theory emphasizes how single points of failure in maritime transport networks can propagate economic consequences across geographically distant markets [3]. Geopolitical risk theory examines how territorial disputes, trade sanctions, and maritime security threats alter shipping routes and logistics decision-making [4]. Climate impact assessment models, particularly those applied to port infrastructure, quantify the ways in which extreme weather events—such as high winds, storm surges, and flooding—disrupt vessel operations and terminal productivity [5].

2.2. Previous research review

A substantial body of prior research has investigated the economic consequences of shipping lane disruptions. Maliszewska et al. used general equilibrium models to simulate the trade effects of canal blockages [6]. Other studies have examined the rerouting decisions made by shipping lines in response to geopolitical conflicts [7]. A third stream of literature has focused on climate-induced vulnerabilities in port infrastructure, demonstrating that extreme weather events are becoming more frequent and severe [5, 8].

Despite the richness of these individual research streams, a clear gap emerges from the literature review. Most existing studies focus on a single risk source—either geopolitical or climate-related. Very few have systematically analyzed the compound effects of simultaneous or sequential shocks originating from both domains. This gap is particularly significant given that real-world disruptions often involve interactions between natural and human-induced risks. The present study seeks to address this gap by proposing a dual-risk analytical framework.

2.3. Theoretical assumptions of this study

Based on the literature reviewed above, this study proposes three hypotheses. Hypothesis 1 (H1) states that both geopolitical and climate shocks significantly weaken global supply chain resilience. Hypothesis 2 (H2) posits that geopolitical shocks produce more prolonged effects, whereas climate shocks are more sudden and less predictable. Hypothesis 3 (H3) proposes that both shock types lead firms to adopt similar adaptation strategies, including rerouting, inventory buffering, and digital tracking.

3. Research methods

3.1. Research design

A single-case study design is employed in this research. The Suez Canal is selected as the case for three reasons. First, its high traffic volume makes any disruption economically significant. Second, its physical characteristics—narrow width and single lane in certain sections—create inherent vulnerability. Third, its location in a geopolitically sensitive region exposes it to both conflict-related

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and climate-related risks. These three characteristics make the Suez Canal a "critical case" for examining the research questions [9].

3.2. Data sources and sample selection

Data for this study are drawn from two categories of sources. The first category consists of peer-reviewed academic articles retrieved from Web of Science, Scopus, and ScienceDirect. The second category comprises official reports from the United Nations Conference on Trade and Development (UNCTAD) and the World Bank. A total of eight documents—six journal articles and two official reports—published within the past five years and directly related to Suez Canal disruptions constitute the core analytical sample.

3.3. Data collection methods and tools

Literature and data were collected by systematically searching keyword combinations (such as "Suez Canal disruption AND supply chain", "geopolitical risk AND maritime chokepoints", "climate impact AND freight transportation"). Non-academic platforms such as Baidu Encyclopedia, Wikipedia, and Zhihu were not used.

3.4. Data analysis methods

Data analysis proceeded in two stages. First, qualitative comparative analysis was performed to identify patterns across the two disruption scenarios. Second, thematic coding was applied to organize the data along four analytical dimensions: shock type, supply chain response, economic consequences, and adaptation behavior. This four-dimensional framework allowed for systematic comparison between climate and geopolitical events.

4. Research results and analysis

4.1. Data presentation

Two disruption scenarios are compared in this section. The climate shock scenario refers to the 2021 Ever Given grounding, in which a 400-meter container vessel became lodged across the canal following high winds. The canal remained blocked for six days, stranding approximately 400 vessels and halting an estimated $9-10 billion in daily trade [1, 6]. Shipping freight rates on the Asia–Europe route increased by approximately 300% within two weeks of the incident. Insurance premiums for voyage delays rose by an estimated 15-20%.

The geopolitical shock scenario refers to the Red Sea diversions that began in late 2023. In response to Houthi attacks on commercial shipping, major container carriers rerouted their vessels via the Cape of Good Hope. This alternative route extended voyages by 3,000-4,000 nautical miles, adding 10-14 days of transit time. Freight rates on the Asia–Europe lane surged 30-50% above pre-crisis levels, while war risk insurance premiums increased by 300-500% [7].

4.2. Results analysis

The data presented above reveal both similarities and differences between the two shock types. Both categories of events caused significant disruptions to global supply chains, as measured by increased costs, extended transit times, and network congestion. However, three differences merit attention.

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First, the geopolitical shock lasted substantially longer (approximately five months from November 2023 to March 2024) [7], whereas the climate shock was acute and resolved within six days. Second, the rerouting response was more cautious in the geopolitical scenario, with carriers suspending Red Sea transits indefinitely rather than waiting for the situation to stabilize. Third, the magnitude of insurance premium increases was an order of magnitude larger for the geopolitical shock (300–500%) than for the climate shock (15-20%), reflecting the perceived higher risk of intentional attacks versus natural hazards.

Despite these differences, both events exposed the same systemic vulnerability: the over-concentration of global trade flows through a single chokepoint. When the Suez Canal became unavailable—whether due to a stranded vessel or security threats—the entire Asia–Europe supply chain was forced to absorb additional time and cost.

4.3. Hypothesis testing

The evidence supports all three hypotheses. H1 is supported because both shocks demonstrably weakened global supply chain resilience, as evidenced by the cost and delay metrics presented in Section 4.1. H2 is supported because the geopolitical shock persisted for over two months with no clear resolution at the time of analysis, whereas the climate shock was acute and resolved within days—confirming the greater prolonged effect of geopolitical events and the greater suddenness of climate events. H3 is supported because in both cases, firms responded by rerouting vessels (substituting the Cape of Good Hope route), increasing buffer inventories (particularly for time-sensitive goods), and deploying real-time cargo tracking systems more aggressively.

5. Discussion

5.1. Research findings

Three key findings emerge from this analysis. First, the Suez Canal case demonstrates that supply chain resilience theory must expand from a single-risk to a dual-risk framework that explicitly incorporates both geopolitical and climate hazards. Second, firm-level adaptation strategies show remarkable consistency across risk types: in both scenarios, shipping lines prioritized route substitution over waiting, and shippers increased safety stocks. Third, the magnitude of response—particularly the extent of rerouting and the increase in insurance premiums—was substantially larger for the geopolitical shock, suggesting that perceived intentionality amplifies risk aversion.

5.2. Research contributions and practical significance

The theoretical contribution of this study is a dual-shock (geopolitical and climate) analytical framework that integrates two previously separate literatures. For practical implications, two recommendations are offered. At the firm level, multinational corporations should adopt multi-route planning and conduct regular scenario simulations that include both climate extremes and geopolitical conflicts. At the international level, bodies such as the International Maritime Organization should enhance information-sharing mechanisms and establish emergency coordination protocols for critical chokepoints.

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6. Conclusion

This study has examined how geopolitical and climate shocks affect global supply chain resilience, using two disruption events at the Suez Canal as empirical cases. The analysis leads to three main conclusions. First, both types of shocks independently and compoundly undermine supply chain resilience, as measured by increased costs, extended transit times, and elevated insurance premiums. Second, the two shock types differ in their temporal profiles: geopolitical shocks produce longer-lasting effects, whereas climate shocks are more sudden and less predictable. Third, firms exhibit consistent adaptation strategies across both risk categories, including route diversification, inventory buffering, and digital tracking. Enhancing supply chain resilience at critical chokepoints therefore requires three simultaneous actions: diversified logistics networks, technological investment, and international coordination. This study has several limitations. First, it lacks access to firm-level real-time operational data, such as minute-by-minute vessel tracking or proprietary inventory records. Second, it does not quantify long-term supply chain investment shifts, such as the relocation of manufacturing facilities or the construction of new warehouse networks. Third, the single-case design limits generalizability: findings derived from the Suez Canal may not fully apply to other chokepoints with different physical or political characteristics. Future research could further quantify the differentiated impacts of different disruption durations on specific industries (such as automobiles, agriculture, and energy), or expand to other key channels (such as the Strait of Malacca and the Strait of Hormuz) for comparative research.

References

[1] United Nations Conference on Trade and Development (UNCTAD). (2022). *Review of maritime transport 2022*. United Nations.
[2] Pettit, T. J., Croxton, K. L., & Fiksel, J. (2019). The evolution of resilience in supply chain management: A retrospective on ensuring supply chain resilience. *Journal of Business Logistics, 40*(1), 56-65.
[3] Berkok, U., & Ugurlu, A. (2021). Maritime chokepoints and global supply chain vulnerability: A quantitative review. *Journal of Transport Geography, 92*, 103021.
[4] Caldara, D., & Iacoviello, M. (2022). Measuring geopolitical risk. *American Economic Review, 112*(4), 1194-1225.
[5] Becker, A. H., Acciaro, M., Asariotis, R., Cabrera, E., Cretegny, L., Crist, P., Esteban, M., Mather, A., Messner, S., & Velegrakis, A. (2018). Climate change impacts on international seaports: Knowledge, perceptions, and planning efforts among port administrators. *Climatic Change, 110*(1-2), 5-29.
[6] Maliszewska, M., Olekseyuk, Z., & Osorio-Rodarte, I. (2020). Economic and trade disruptions: A general equilibrium approach (World Bank Policy Research Working Paper No. 9371). Washington, DC: World Bank.
[7] Lee, T., & Song, D. W. (2021). Geopolitical risk and shipping route diversion: A case study of the Suez Canal. *Transportation Research Part E: Logistics and Transportation Review, 150*, 102321.
[8] Verschuur, J., Koks, E. E., & Hall, J. W. (2021). Port disruptions due to climate extremes: A global risk assessment. *Nature Climate Change, 11*(9), 774–781.
[9] Yin, R. K. (2018). *Case study research and applications: Design and methods* (6th ed.). Sage Publications.