



Navigating Uncertainty: Geopolitical Tensions and Their Impact on Global Maritime Supply Chain

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ABSTRACT

Global maritime logistics play an essential role in interconnecting the world, given that it ensures over 80% of world trade. However, in recent years, the global supply chain is undergoing an era of significant geopolitical uncertainty and increased disruptions. Regional disputes, conflicts, rivalries, and power shifts are diverse risks occurring in supply chains, that leads to delays in delivery schedules, important impacts on market stability, and wider economic resilience. This research analyzes the interaction between the geopolitical situation and maritime transport, the influence of geopolitical tensions on maritime connectivity, and examines the ability of existing international legal frameworks to tackle these risks. The interpretation of freedom of navigation, carrier liability, and jurisdictional ambiguities is illustrated in this study using a legal and case-based study. The research evaluates the effectiveness of dispute settlement mechanisms to address the interplay of strategic and commercial interests. The need to reinforce cooperative governance, enhance legal predictability, and incorporate resilience-oriented norms into maritime law is also emphasized in this study by combining legal analysis with insights from recent maritime incidents. Reinforcing these frameworks is essential in this era of increased geopolitical volatility, to ensure the stability, reliability and continuity of global supply chains.

1. Introduction.

Maritime transport constitutes the backbone of globalization, functioning under presumptions of free trade regimes, secure sea lanes, and predictable routing. These presumptions justified decades of efficiency-driven logistics optimization, symbolized by lean stocks, just-in-time delivery, and the concentration of flows through a small number of highly efficient routes and hub ports. In recent years, this system's geopolitical foundations have become more unstable. Global maritime supply chains have become vulnerable due to armed conflict, sanctions regimes, geopolitical rivalry among great powers, and increasing insecurity in key maritime corridors (Stehle and Huchzermeier, 2025; Rasshyvalova et al., 2024). Overlapping crises

have caused persistent disruptions to shipping routes, port operations, and freight markets, especially since 2020 (Yap et al., 2025; Smyrnov et al., 2025). These events signal a shift toward an era of chronic geopolitical uncertainty impacting maritime transport systems worldwide. Strategic chokepoint disruptions force rerouting and congestion spillovers, change insurance terms, and cause freight market volatility, affecting far-off economies unrelated to the conflict (Verschuur et al., 2025; Meza et al., 2022). As a result, geopolitical risk can be considered as a force impacting trade flows, market behavior, and network design (Dawar and Bai, 2024; Incekara and Incekara, 2024).

Existing scholarship has advanced significantly in documenting qualitative topics of geopolitical disruption, including chokepoint vulnerability, maritime security risks, and freight market volatility. However, a large portion of this literature is scattered across disciplinary boundaries, often examining operational, economic, or security aspects separately. This fragmen-

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tation restricts our understanding of how geopolitical tensions transform maritime supply chains as interconnected systems in which physical infrastructure, markets, institutions, and governance dynamically collaborate.

This paper aims to fill this gap by establishing an integrated analytical study of how geopolitical tensions impact global maritime supply chains via interacting processes of disruption and adjustment. The research analyses chokepoint vulnerability, freight market stress, security-related costs, and the spread of uncertainty throughout maritime networks; building on recent conceptual contributions and empirical findings from maritime economics, supply chain management, and geopolitical risk analysis. Rather than considering geopolitical events as external factors, the study visualizes maritime supply chains as adaptive systems where political risk is ingrained in chokepoint dependence, governance arrangements, and network structure. Based on current maritime disruptions, this study uses a conceptual and literature-based analytical approach. The paper shows recurrent patterns of exposure and adjustment that distinguish maritime supply chains in times of increased geopolitical tension, by combining insights from a wide variety of recent studies.

The main argument advanced in this paper is that resilience-oriented logistics is replacing efficiency-driven globalization in global maritime supply chains. Rerouting, network reconfiguration, and diversification are examples of adaptive responses that can improve short-term continuity, but they can also create new inefficiencies, redistribute vulnerability, and lead to trade-offs related to cost, sustainability, and governance. To understand these dynamics, it is necessary to move from event-based analysis to an integrated framework that illustrates how geopolitical uncertainty spreads across maritime systems and reconfigures long-term supply chain organization.

The paper is structured as follows. The literature review examines existing studies on geopolitical disruption, chokepoint vulnerability, freight market dynamics, and maritime security. The conceptual and analytical approach used in the study is described in the methodology section. Key findings about disruption and risk transfer in maritime supply chains are presented in the results section. In order to analyze resilience methods, network reconfiguration and governance implications, the discussion interprets the key findings. The findings' wider implications for understanding global maritime supply chains in an era of constant geopolitical uncertainty are discussed in the conclusion.

2. Literature Review.

Early supply chain research mainly assumed a stable geopolitical context, in which disruptions were exogenous and momentary, to keep the analytical focus on efficiency, just-in-time logistics, and cost minimization. Meanwhile, recent scholarship shows a prevalent increase in geopolitical instability caused by armed conflict, international economic governance fragmentation, strategic rivalry, and sanctions regimes, which significantly changes the risk context in which the global supply chain

functions (Rasshyvalova et al., 2024; Stehle and Huchzermeier, 2025; Aropelto, 2025).

Within this changing environment, maritime transport appears to be especially vulnerable to geopolitical tensions, because disruptions spread quickly across sectors and regions. Maritime shipping bears the larger part of global merchandise trade, which depends on highly interconnected networks. According to empirical and analytical research analyzing late crises, e.g., the Russo–Ukrainian war, South China Sea tensions, and security threats in the Red Sea, geopolitical events have a direct effect on shipping routes, port accessibility, insurance availability, and regulatory compliance obligations. These effects hardly remain localized; instead, they create domino effects that change network configuration, freight cost, and vessel deployment globally (Atacan and Aık, 2023; Mykyta, 2025; Oikonomou, 2023).

Literature indicates the crucial role of strategic maritime chokepoints in intensifying these mechanisms. Quantitative evaluations and modeling approaches demonstrate that a small number of passages—such as the Suez Canal and Bab el-Mandeb, the Strait of Malacca, the Strait of Hormuz, and the Panama Canal—account for a considerable share of global trade flows (Verschuur et al., 2025; Meza et al., 2022). Under stable circumstances, this concentration increases efficiency, but chokepoint disruptions lessen effective shipping capacity through delays and rerouting, raising transport freight and uncertainty for far-off economies.

Insights from the literature on maritime security also reinforce this systemic perspective. Modern assessments increasingly consider maritime insecurity as a structural situation resulting from the interplay of geopolitical rivalry, governance deficiencies, cyber threats, piracy, militarism, and legal ambiguity, rather than a collection of separated incidents (Tsailas, 2025). Security risks are embedded in maritime space in a geopolitically contested region, influencing route choices, insurance markets, and regulatory reactions.

Recent research also focuses on another important area: -freight market behavior. Fuel cost and demand cycles were frequently highlighted in explanations of freight rate volatility. However, studies conducted during times of crisis contest this belief, showing that geopolitical risk has an independent and eventually dominant impact on freight markets (Chi et al., 2025; Iliopoulos, 2025; Zhao et al., 2023). Empirical assessments of tanker and container shipping demonstrate that periods of increased geopolitical tension are linked to increases in freight rate volatility, even when energy costs are relatively stable. These findings demonstrate how geopolitical risk is transmitted into market outcomes through insurance premiums, security surcharges, financing restrictions, and expectation-driven behavior.

Network-based indicators like global supply chain stress indices conceive container shipping as functioning around a steady state and quantify deviations caused by excess delays and congestion (Arvis et al., 2024). These methods offer quantitative proof that maritime disruptions spread globally instead of staying confined to certain areas or routes. Additionally, they also show a strong correlation between freight rate spikes and

capacity loss caused by delays, reinforcing the claim that network stress is a major factor in market volatility rather than isolated cost shocks. The literature also indicates an increasing tendency toward network fragmentation and reconfiguration as businesses adjust to geopolitical risk. In order to maintain continuity during unstable times, strategies including rerouting, diversifying suppliers and ports, and redesigning service networks are being used more frequently (Koray et al., 2025; Yap et al., 2025). Although these adjustments improve short-term resilience, they frequently result in increasing emissions, longer travel times, and inefficiencies. A variety of studies recognize that such solutions reallocate vulnerability across regions rather than eradicating it, modifying the geography of risk and creating new bottlenecks elsewhere in the system.

Finally, a growing corpus of research places these changes in the context of a larger shift in globalization. Recent approaches recognize geopolitical tensions as structural forces changing trade patterns, logistics governance, and market behavior, rather than perceiving them as temporary deviations from efficiency-driven integration. Global supply chains are gradually shifting toward resilience-oriented configurations marked by redundancy, diversification, and a stronger focus on institutional coordination, according to reports from international organizations and scholarship (Uthpala and Kavirathna, 2025; Stehle and Huchzermeier, 2025). Longer routes, higher freight, and an increasing dependence on governance systems to maintain expectations under geopolitical uncertainty are all indicators of this change in the maritime industry.

Therefore, the literature exposes a fragmented but convergent knowledge of how geopolitical conflicts change global maritime supply chains. There's still a need for comprehensive analytical frameworks that link these components into a coherent explanation of systemic transformation, even if current research offers insightful information about particular mechanisms — such as chokepoint vulnerability, freight market volatility, and maritime security issues. It is imperative that this gap be filled in order to comprehend maritime supply chains as adaptive geopolitical structures ingrained within an increasingly uncertain global order.

3. Methodology.

This study adopts a conceptual and literature-based methodological approach to examine the effects of geopolitical tensions on global maritime supply chains. Such an approach is particularly appropriate for analyzing phenomena characterized by systemic complexity, multi-jurisdictional interaction, and high levels of uncertainty, where access to consistent micro-level operational data is limited and where disruptions evolve rapidly across interconnected networks. Rather than seeking causal estimation through econometric modeling, the methodology emphasizes analytical integration and theoretical synthesis to capture structural patterns observed across recent geopolitical disruptions.

The analysis draws on an extensive review of peer-reviewed academic literature, international reports, and policy-oriented

studies addressing maritime logistics, geopolitical risk, maritime security, freight markets, and global supply chain resilience (Stehle and Huchzermeier, 2025; Uthpala and Kavirathna, 2025; Rasshyvalova et al., 2024; Aropelto, 2025). The selected literature spans conceptual contributions, empirical assessments, and modeling approaches, enabling triangulation across methods and disciplinary traditions.

A central methodological pillar of the study is the use of uncertainty propagation as an analytical lens (Mykyta, 2025). In the maritime context, this diffusion occurs through regulatory ambiguity, security-related cost adjustments, insurance availability, behavioral responses by shipping actors, and capacity constraints linked to chokepoint dependence. This perspective allows the analysis to move beyond event-based disruption narratives toward a systemic understanding of how instability reshapes maritime logistics over time.

To operationalize this framework, the study integrates evidence from network-based stress indicators and risk indices widely used in recent scholarship. In particular, global supply chain stress measures conceptualize container shipping as operating around a steady state and quantify statistically significant deviations caused by excess delays and congestion (Arvis et al., 2024). These indicators provide a methodological bridge between abstract geopolitical risk and observable market outcomes, such as freight rate volatility and capacity loss, without requiring firm-level data that may be unavailable or confidential.

The methodology further incorporates comparative analytical reasoning across strategic maritime chokepoints. Rather than conducting case studies of individual passages, the study synthesizes findings related to multiple chokepoints, e.g., Suez–Bab el-Mandeb, Hormuz, Malacca, and Panama, to identify common vulnerability patterns and amplification mechanisms. This comparative logic is consistent with recent modeling and scenario-based approaches that demonstrate how chokepoint disruptions generate systemic rather than localized effects within global shipping networks. It also avoids overgeneralization from single-event analysis while preserving analytical relevance.

Freight market dynamics are examined through secondary empirical findings reported in the literature, particularly studies linking geopolitical risk indicators to freight rate behavior in tanker and container shipping markets (Chi et al., 2025; Iliopoulos, 2025). These studies inform the methodological interpretation of freight markets as transmission channels through which geopolitical uncertainty is rapidly internalized and priced.

The methodological approach also accounts for institutional and governance dimensions of maritime supply chains (Tsailas, 2025; Ali, 2025). Legal uncertainty, sanctions compliance, insurance regulation, and security governance are treated as integral components of risk transmission rather than external constraints. This aligns the methodology with interdisciplinary maritime scholarship that emphasizes the co-evolution of logistics systems, legal frameworks, and geopolitical power structures.

Finally, the study adopts a framework-building methodology as its principal output. Drawing on synthesized evidence from the reviewed literature, it develops a geopolitical maritime

supply chain structural resilience framework that links geopolitical drivers, maritime security disruptions, transmission mechanisms, vulnerability moderators, and adaptation strategies. The resulting framework provides an integrative analytical tool that can guide future empirical research and policy analysis without claiming predictive precision beyond the scope of the underlying literature.

4. Results.

The results of this study reveal that geopolitical tensions exert a systematic and multi-dimensional impact on global maritime supply chains, transforming localized political events into network-wide disruptions. Across the reviewed literature, a consistent finding is that geopolitical shocks rarely remain confined to their geographic point of origin. Instead, they propagate through maritime transport systems via chokepoints, market mechanisms, and institutional constraints, producing cumulative effects on connectivity, capacity, and reliability.

The first key result concerns the structural vulnerability of strategic maritime chokepoints. Disruptions at chokepoints such as the Suez–Bab el-Mandeb corridor, the Strait of Hormuz, and the Strait of Malacca reduce effective global shipping capacity by forcing rerouting, increasing transit times, and generating congestion spillovers across alternative routes (Verschuur et al., 2025; Meza et al., 2022). The literature demonstrates that these impacts are systemic rather than local, with trade delays and cost increases affecting economies far removed from the initial disruption site.

The second result relates to the transmission of geopolitical risk into freight markets. Multiple studies document a strong association between heightened geopolitical tension and increased freight rate volatility, particularly in tanker and container shipping markets (Chi et al., 2025; Iliopoulos, 2025). Importantly, this relationship persists even in periods when traditional drivers such as fuel prices or demand fluctuations do not fully account for observed market behavior. The evidence indicates that war-risk premiums, insurance availability, sanctions compliance costs, and expectations of future disruption play a decisive role in shaping freight market dynamics during geopolitical crises (Tsailas, 2025; Mykyta, 2025).

Security risk, e.g., militarization, contested sea lanes, and governance breakdown, alter routing decisions, port accessibility, and insurance conditions, thereby translating political instability into operational disruption. Rather than acting as isolated threats, these security conditions are embedded within maritime spaces and interact with regulatory and market responses, amplifying uncertainty and reducing predictability across supply chains.

Another significant result concerns the uncertainty generated by geopolitical events, which diffuses through supply chains via behavioral and institutional responses. In maritime logistics, long planning horizons, capital-intensive assets, and reliance on fixed routes intensify these propagation effects. Firms frequently respond to uncertainty through precautionary strategies—such as rerouting, capacity hoarding, or renegotiation of contracts—that, while rational at the firm level, collectively

exacerbate congestion and volatility at the system level. This dynamic explains why supply chain stress often escalates even in the absence of physical disruption.

Evidence from network-based stress indicators reinforces these findings (Arvis et al., 2024). These indicators show that stress diffuses globally rather than remaining localized, and that delay-induced capacity loss is closely associated with sharp increases in freight rates. The results thus confirm that geopolitical disruptions affect both physical flows and market conditions simultaneously.

Rerouting, diversification of ports and suppliers, and service network redesign are widely documented strategies employed by carriers and shippers to maintain continuity under conditions of instability (Koray et al., 2025; Yap et al., 2025). However, the results indicate that these adaptations introduce trade-offs. While they reduce exposure to specific risks, they increase transit distances, operational costs, and emissions, and often redistribute vulnerability rather than eliminating it.

Finally, the results point to a broader structural transformation in global maritime supply chains. Across academic studies and international reports, there is convergence on the finding that geopolitical tensions are accelerating a shift away from efficiency-driven logistics toward resilience-oriented configurations (Uthpala and Kavirathna, 2025; Stehle and Huchzermeier, 2025). This transformation is reflected in longer routes, higher buffer costs, greater emphasis on redundancy, and increasing reliance on institutional coordination to stabilize expectations.

5. Discussion.

This section discusses the findings by integrating risk transmission dynamics, network reconfiguration processes, and the broader structural implications for maritime logistics. A first critical insight emerging from the results concerns the multi-channel transmission of geopolitical risk (Yap et al., 2025; Chi et al., 2025). The literature consistently shows that geopolitical tensions translate into maritime supply chain disruption through a combination of physical constraints, economic amplification, regulatory fragmentation, operational disequilibrium, and informational uncertainty. These channels do not operate independently; rather, they interact in ways that intensify systemic vulnerability. For example, physical insecurity at strategic corridors alters routing decisions, which in turn triggers insurance repricing and regulatory compliance uncertainty, reinforcing freight market volatility and capacity loss. This interdependence explains why maritime supply chain stress often escalates even when physical disruptions remain limited in scope.

This interpretation is reinforced by empirical studies suggesting that freight markets act as amplifiers rather than passive reflectors of geopolitical instability.

Another key dimension highlighted by the discussion is the role of maritime security as a mediating condition between geopolitical tensions and supply chain performance (Tsailas, 2025; Zhao et al., 2023). Contemporary maritime security scholarship emphasizes that insecurity is increasingly embedded within contested maritime spaces rather than arising from isolated incidents. Security disruptions thus operate as structural constraints

that translate geopolitical rivalry into persistent uncertainty affecting connectivity, reliability, and cost structures in maritime logistics.

The findings also shed light on the systemic consequences of uncertainty propagation. Rather than responding solely to realized disruptions, shipping actors frequently adjust behavior in anticipation of potential escalation, engaging in precautionary strategies such as rerouting, capacity hoarding, or contractual renegotiation (Mykyta, 2025; Koray et al., 2025). While rational at the firm level, these responses collectively intensify congestion, reduce effective capacity, and exacerbate volatility at the system level. This dynamic confirms theoretical arguments that uncertainty itself constitutes a form of disruption, capable of reshaping supply chain outcomes even in the absence of physical damage.

In response to these pressures, network reconfiguration emerges as a dominant adaptive strategy (Yap et al., 2025; Koray et al., 2025). The literature documents widespread rerouting, diversification of ports and suppliers, and service network redesign aimed at preserving continuity under geopolitical stress. However, the discussion of these adaptations reveals important trade-offs. While reconfiguration can reduce exposure to specific risks, it often leads to longer routes, higher operational costs, increased emissions, and the redistribution rather than elimination of vulnerability. As a result, resilience-oriented adaptation may generate new forms of systemic fragility, particularly when multiple actors pursue similar strategies simultaneously.

These dynamics point toward a broader structural transformation of global maritime supply chains. Across academic studies and international reports, there is growing consensus that geopolitical tensions are accelerating a shift away from efficiency-driven globalization toward resilience-oriented logistics configurations. Importantly, the results suggest that this transformation is not temporary but reflects a reconfiguration of maritime supply chains as adaptive systems embedded within an increasingly fragmented geopolitical environment.

The integrative framework developed in this study provides a conceptual lens through which these developments can be understood. By linking geopolitical drivers, maritime security disruptions, risk transmission mechanisms, vulnerability moderators, and adaptation strategies, the framework synthesizes fragmented strands of the literature into a coherent analytical structure. Unlike approaches that treat geopolitical events as exogenous shocks, this framework conceptualizes geopolitical risk as endogenous to maritime network design, chokepoint dependence, and governance arrangements. In doing so, it offers a basis for interpreting the observed shift from efficiency-oriented optimization toward resilience-oriented logistics as a structural rather than cyclical phenomenon (Uthpala and Kavirathna, 2025; Stehle and Huchzermeier, 2025).

From a governance perspective, the discussion emphasizes the limits of purely market-based adaptation. While firms and carriers can reconfigure networks in response to geopolitical risk, the literature suggests that long-run stabilization requires institutional coordination to reduce regulatory uncertainty, harmonize security responses, and stabilize expectations. The ab-

sence of such coordination risks reinforcing fragmentation and undermining both economic efficiency and sustainability objectives, particularly as rerouting and redundancy increase environmental footprints.

Overall, the discussion confirms that global maritime supply chains are best understood not as neutral transport infrastructures but as adaptive geopolitical systems, in which connectivity, cost, and reliability are shaped by the interaction of politics, security, markets, and governance (Rasshyvalova et al., 2024; Smyrnov et al., 2025; Oikonomou, 2023). This interpretation examines how resilience can be enhanced without exacerbating fragmentation in an era of persistent geopolitical uncertainty.

Conclusions.

In an era of increased uncertainty and persistent disruption, this study set out to examine how geopolitical tensions reshape global maritime supply chains. The research has demonstrated, building on a conceptual and literature-based analytical approach, that maritime logistics systems are increasingly subject to geopolitical forces that transform localized political events into systemic supply chain stress. Global maritime supply chains no longer operate in a stable and politically neutral environment; instead, they are embedded in a context marked by contested maritime spaces, armed conflicts, sanctions, and strategic rivalry.

Strategic maritime chokepoints play a crucial role in this transformation, as the analysis shows. Disruptions at these passages lead to delays, rerouting, and congestion spillovers, which can reduce effective capacity and create economic impacts that reach areas far beyond the disruption area. These findings demonstrate that chokepoints don't function as neutral transport infrastructure but rather as risk amplification points.

The results also show that increased geopolitical tension is linked to higher freight rate volatility, which is exacerbated by insurance limitations, security-related costs, regulatory compliance uncertainty, and expectation-driven behavior in addition to physical disruption. In this context, uncertainty itself emerges as a powerful driver of disruption, capable of reshaping supply chain outcomes even in the absence of direct physical damage.

The study also emphasizes the mediating role of maritime security conditions in translating geopolitical tensions into operational and market-level impacts.

Adaptive responses by shipping actors, particularly network reconfiguration through rerouting and diversification, illustrate the growing emphasis on resilience-oriented strategies. While such adaptations enhance short-term continuity, they introduce important trade-offs in the form of higher costs, longer routes, increased emissions, and the redistribution rather than elimination of vulnerability. The analysis suggests that these responses reflect a broader structural shift away from efficiency-driven globalization toward resilience-oriented maritime logistics, rather than temporary adjustments to exceptional events.

By integrating insights from geopolitical risk analysis, maritime security studies, and supply chain literature, this paper

advances an analytical framework that conceptualizes global maritime supply chains as adaptive geopolitical systems. The study advances a more cohesive understanding of the systemic changes caused by geopolitical uncertainty in maritime logistics.

From a governance perspective, the results highlight the limitations of solely market-based adaptation in managing geopolitical risk. Even though firms can adjust networks in response to instability, long-term resilience and predictability depend on institutional coordination that can reduce regulatory fragmentation, stabilize expectations, and address security risks in strategically sensitive corridors. In the absence of such coordination, adaptive strategies run the risk of strengthening fragmentation and undermining both economic efficiency and sustainability objectives.

Overall, this study demonstrates that the structure, performance, and governance of international maritime supply chains are shaped by geopolitical tensions.

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