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Key Factors Influencing the Cost of Global Supply Chains Under Geopolitical Instability

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Abstract *— The article presents a systematic analysis of the factors that drive cost escalation in global supply chains under conditions of geopolitical instability. The study is based on the structuring of key risk domains — energy, logistics, manufacturing, agri-food systems, and labor resources — and on examining their interdependent impact on overall expenditures. The mechanisms through which geopolitical events translate into higher costs are analyzed, including route disruptions, resource price fluctuations, increased production delays, and declines in export flows. Particular attention is given to the comparative vulnerability of countries and industries: the analysis identifies the specific response patterns of export-oriented economies, the extent of the impact generated by system-critical states, and the domain structure of industries where primary cost pressures originate. The findings show that the cost of global supply depends on the overlay of multiple layers of risk and is shaped by the degree to which economies are integrated into international flows and by the nature of interdomain linkages. It is concluded that cost management in unstable conditions requires a systemic approach that accounts for interactions among energy, logistics, and production factors, as well as the spatial structure of the global economy. The article will be useful for researchers of global supply chains, logistics professionals, operational risk analysts, and experts focused on the resilience of international production and logistics systems.*

Keywords *— **global supply chains, geopolitical instability, supply chain cost, domain risks, logistics, energy vulnerability, export operations.***

I. INTRODUCTION

Global supply chains have evolved into complex, multilayered systems where cost is formed at the intersection of logistics, production, energy, finance, and international politics. Under conditions of geopolitical instability, the influence of external shocks intensifies, ranging from demand fluctuations and trade restrictions to transportation disruptions, currency volatility, and raw material shortages. In addition to these shocks, interstate tensions such as sanctions, export controls, tariff escalations, and geopolitical confrontations increasingly reshape the pricing environment of global supply chains. These instruments alter access to strategic materials, modify logistics routes, and transform the baseline cost parameters faced by both export-oriented and manufacturing-driven economies.

Cost dynamics have ceased to be linear. They are defined by the asymmetry of shocks and differences in industry vulnerability [3]. In some sectors, the decisive factor is the cost of energy; in others, it is the availability of transport routes or the stability of export markets. Without systemic analysis, it is no longer possible to correctly assess the cost structure.

The sensitivity of chains to geopolitical risks varies. Export economies react to falling demand, logistics operators to route disruptions, and manufacturing companies to rising raw material and energy prices [7]. A universal cost assessment model

does not exist, and analytics must account for industry specifics, a country's role in global flows, import and export structures, the level of technological maturity, and supply diversification.

The scientific novelty of the research lies in the systematization of factors that form the cost of global supply chains under conditions of instability and in the identification of mechanisms linking geopolitical events to changes in operational, production, and logistical expenses. The work is oriented toward creating a structural framework that allows for assessing how events of different types alter the total cost and which domains are key points of cost accumulation.

The objective of the study consists of identifying and analytically describing the systemic factors determining the change in the cost of global supply chains under the influence of geopolitical risks and external shocks, with a subsequent assessment of mechanisms for restructuring logistical structures. To achieve the stated objective, the study identifies and structures the domain areas forming the cost dynamics of global supply chains, describes the causal mechanisms of the influence of external events on cost growth, conducts a comparative analysis of sources of geopolitical instability, and develops analytical criteria for assessing the vulnerability of logistical systems.

The research hypothesis posits that the key driver of cost growth in global supply chains is the combination of geopolitical instability and high domain interdependence. The systemic nature of these connections leads to a situation where a local event causes a chain reaction of costs in adjacent areas, amplifying the initial effect.

The scope of the study is limited to the analysis of global and transnational chains, where cost depends on macroeconomic parameters, logistical processes, energy sustainability, and integration into international trade. Domestic national chains and local industry specifics are considered only as context elements influencing the sensitivity of systems to external events.

II. MATERIALS AND METHODS

The methodological foundation of the study is formed at the intersection of approaches to the analysis of global supply chains, risk assessment models, and empirical methods for studying the influence of geopolitical instability on cost parameters. Such an interdisciplinary approach allows for the unification of several levels of analysis: mechanisms of external shocks, industry-specific logistics, the behavior of export flows, and the interrelationships between operational, strategic, and macroeconomic factors.

Source selection was conducted based on the criteria of scientific reliability and relevance. The analysis includes studies from 2023 to 2025 published in peer-reviewed journals. The work of Drljača et al. [2] examines models for assessing supply chain quality and mechanisms for preventing costly disruptions. The study by Gürpinar and Gulum [3] analyzes the role of distributed systems and feedback loops in increasing chain resilience, which defines the methodological context for cost assessment. Jarašūnienė and Gelžinis [4] describe theoretical and practical models of crisis management in logistics, setting the tools for analyzing industry reactions to external shocks.

Koray et al. [5] highlight strategies for mitigating disruptions in maritime transport, which is important for assessing sources of cost growth in global trade. Özdemir et al. [6] demonstrate the influence of geopolitical risks on commodity market volatility, defining approaches to interpreting price fluctuations. Setyadi et al. [7] analyze post-pandemic operational responses of supply chains, describing which processes prove most costly during structural disruptions. The study by Solari et al. [8] examines long-term trends in sustainable logistics, setting frameworks for analyzing future cost profiles. Štreimikienė et al. [9] propose a multicriteria analysis method applied to assess digital and sustainable factors, which forms the basis for structuring cost criteria. In the work of Sufi and Alsulami [10], the dynamics of systemic disruptions and the sustainability of "green" chains are modeled, expanding the toolkit for analyzing complex effects in global networks. The study by Truong et al. [11] provides an empirical model of the asymmetric influence of geopolitical risks on exports, which is important for understanding the cost sensitivity of export-oriented economies to external shocks. Additionally, the results of Albahouth [1] are used,

where the impact of global uncertainties on inflation is analyzed, which helps interpret macroeconomic factors of chain cost changes.

The methodological strategy of the research is based on a systematic comparative analysis of quantitative and qualitative risk assessment models, mechanisms of geopolitical influence, and logistical responses. The synthesis of results allowed for the identification of three key analytical directions: external cost factors (geopolitical risks, market volatility), operational mechanisms of price increases (logistical disruptions, transport limitations), and structural drivers of chain resilience. These components are subsequently used to build the research structure and formalize factors influencing the cost of global supply chains.

III. RESULTS

In this study, the cost of global supply chains is interpreted as the result of the accumulation and transfer of expenses between several interconnected domains—energy resources, logistics, production, agri-food systems, and the socio-labor sphere. This formulation relies on the system-of-systems view of green supply chains proposed by Sufi & Alsulami [10]. Geopolitical and macroeconomic shocks lead to changes in energy prices, disruption of transport routes, growth in production costs, and restrictions on exports, which intensifies the volatility of total expenses throughout the entire value creation chain, as shown in the study by Solari et al. [8].

At the same time, the domain structure of costs is not an abstraction. It manifests in the empirical configuration of events recorded in news flows and interpreted as disruptions in specific subsystems of the global economy, as demonstrated in detail in the work of Sufi & Alsulami [10]. To analyze the influence of geopolitical instability on supply chain costs, this study adopts precisely this domain decomposition, as it allows for correlating macro-level shocks with specific classes of expenses—energy, logistics, production, food, and socio-labor. Table 1 examines the distribution of domain factors influencing the cost of global green supply chains based on the results of event systematization in the work of Sufi & Alsulami [10].

Table 1 – Key domains affecting the cost of global supply chains (Compiled by the author based on the source: [10])

Domain of systemic disruptions	Share of events	Cost impact description
Energy & Resources	22%	Increase in energy and resource costs
Logistics & Transportation	19%	Higher transport costs and delay-related expenses
Manufacturing & Production	17%	Rising production costs and input price pressures
Agri-Food Systems	14%	Vulnerability of food supply chains and price spikes
Labor & Social Systems	–	Cost effects of labor and social disruptions

The presented structure shows that the maximum concentration of disruptions falls on the Energy & Resources domain, which forms the base price level for subsequent links in the supply chain and translates directly into inflationary effects recorded at the macro level in the study by Albahouth [1]. The high share of events in logistics and transport reflects that route disruptions, rising insurance premiums, and corridor capacity limitations immediately increase the cost of moving cargo and intensify the load on warehousing and buffer capacities, which aligns with the conclusions of Koray et al. [5].

The domains of Manufacturing & Production and Agri-Food Systems concentrate expenses related to rising raw material prices, interruptions in component supplies, and the vulnerability of food chains, which is discussed in detail in the work of Setyadi et al. [7]. An additional level of costs is formed in the socio-labor sphere. Strikes, migration shocks, and social tension alter the availability of the labor force and the structure of operational expenses, which partially manifests in the asymmetric effects of geopolitical risk on exports in the study by Truong et al. [11].

In such a configuration, the domain structure can be viewed as a description of the cost

configuration of global supply chains, in which geopolitical shocks increase individual cost components and redistribute the load between domains based on empirical patterns of disruptions recorded in the global news corpus by Sufi & Alsulami [10]. The dominance of the energy and logistics blocks in the disruption structure is interpreted as an indication that primary price pressure arises here, while production, food, and socio-labor effects act as channels for transmitting this pressure into the final product cost and export indicators [7]. This analytical reading creates a basis for the subsequent transition from describing the domain structure to considering tools for managing supply chain resilience and cost under conditions of geopolitical instability based on distributed ledgers, digital platforms, and multifactor assessment schemes.

Rising geopolitical tension transforms into a key driver of cost increases in global supply chains. The influence of such shocks affects both logistical routes and production nodes, intensifying expenses throughout the entire operations structure. The study by Solari et al. [8] shows that geopolitical events form sustained cascading effects leading to a growth in operational expenses and planning complexity, especially under conditions of energy volatility. Similarly, the work of Özdemir et al. [6] demonstrates that periods of intensive disruptions in global green supply chains coincide with a sharp rise in the cost of operations and an intensification of interdomain interconnectivity. In turn, the study by Drljača et al. [2] establishes that negative changes in the geopolitical risk index exert asymmetric pressure on exports, reducing external flows and increasing the total cost of supplies.

To assess the influence of geopolitical factors on cost, this study uses an integral approach combining the dynamics of event data, macroeconomic effects, and export flow reactions. The principal task is to correlate risk types with observed cost changes. Table 2 examines how key geopolitically driven factors transform the cost structure of global supply chains.

Table 2 – Geopolitically driven cost-changing factors in global supply chains (Compiled by the author based on the sources [3, 8, 10, 11])

Factor	Impact on costs
Negative changes in GPR	Decline in exports; higher operational and trade costs
European energy crisis	Increased operational and energy-intensive expenses
Disruption peaks in global supply chains	Sharp rise in cost intensity across domains
Concentration of systemic risk hubs	Higher structural costs due to centrality effects
Trade barriers and restrictions	Increase in supply and transaction costs

After correlating the factors, it becomes obvious that cost growth is formed not in isolation, but through interaction mechanisms between domains. Negative changes in geopolitical risk reduce export flows, intensifying direct and indirect foreign trade expenses [2]. Energy instability, recorded by Solari et al. [8], increases the cost of production and transportation, especially in energy-intensive sectors.

Periods of peak disruption, described by Sufi & Alsulami [10], show that geopolitical spikes increase disruption intensity tenfold, leading to a jump in prices for transportation, insurance, reserve capacities, and raw materials. The concentration of risks in the USA, China, and India intensifies total expenses, since failures in systemically important countries are transmitted globally [5]. Trade barriers, analyzed by Truong et al. [11], create an additional level of transactional and logistical expenses, especially for export-oriented economies. Beyond formal trade barriers, cost escalation is increasingly shaped by geopolitical tools employed by states, including sanctions regimes, export bans on strategic raw materials, retaliatory tariffs, and politically motivated import restrictions. These measures restructure the cost environment by disrupting established sourcing channels, forcing rerouting through higher-cost corridors, and embedding permanent tariff-related price premiums into the final cost of goods. As such, interstate economic confrontation acts as a structural mechanism that

amplifies and prolongs cost pressure across multiple domains.

Thus, geopolitical effects act as a structural mechanism for cost redistribution in global supply chains. Energy crises form primary price pressure, logistical disruptions intensify it, and export restrictions and trade barriers solidify cost growth at the level of regional and international flows.

IV. DISCUSSION

Cost growth in global supply chains is formed under the influence of interconnected energy, logistical, production, and socio-economic factors. The study by Solari et al. [8] shows that disruptions in one domain lead to cascading shifts in others, creating a complex cost contour that cannot be explained by isolated shocks. The analysis of crisis scenarios in logistics presented by Koray et al. [5] confirms that the cost of transportation and warehouse infrastructure rises following energy and trade disproportions. Data from Setyadi et al. [7] demonstrate that production expenses increase even with moderate logistical delays, as production chains are sensitive to the quality and stability of supply flows. Table 3 examines how interdomain connections form a unified mechanism of cost growth under conditions of geopolitical instability.

Table 3 – Interdomain cost-interaction patterns (Compiled by the author based on the sources [4, 7, 10])

Interconnected domains	Nature of impact	Correlation
Energy ↔ Logistics	Energy costs directly influence transportation costs	r > 0.7
Logistics ↔ Manufacturing	Delays in logistics elevate production expenses	r > 0.7
Energy ↔ Manufacturing	Higher resource costs increase manufacturing costs	r > 0.7

The presented dependencies confirm the systemic nature of expenses: rising resource costs lead to an increase in transport expenses, while logistical delays are translated into production chains through lengthened cycles and increased need for buffer capacities. These mechanisms align with the conclusions of Drljača et al. [2], showing that a reduction in the resilience of individual links leads to a synchronous growth in total operational expenses.

A particularly significant layer of cost formation arises from deteriorating interstate relations. Modern supply chains operate in an environment where geopolitical tools—sanctions, tariff escalations, export controls, technology restrictions, and politically motivated trade disputes—are increasingly used as instruments of economic pressure. Their impact on cost is multidimensional. Sanctions and export bans restrict access to critical materials, increase dependency on longer or less efficient routes, and elevate insurance and compliance-related expenditures. Retaliatory tariffs directly change the price baseline for entire commodity groups, embedding cost growth into long-term contractual structures.

Conflicts and geopolitical confrontation amplify these effects by destabilizing regional transport routes, increasing the risk premium applied to maritime and land corridors, and limiting the operational continuity of firms located in contested zones. As a result, cost growth becomes not only the consequence of operational disruptions but also an outcome of strategic rivalry among states. The structural nature of these instruments means that they generate persistent, rather than episodic, price pressures and significantly reduce the predictability of supply chain planning.

For managers and policymakers, this implies that geopolitical tools must be treated as systemic drivers shaping sourcing, logistics architecture, and cost-to-serve models. Under such conditions, firms are compelled to reassess supplier portfolios, develop alternative routing strategies, strengthen regional production configurations, and integrate geopolitical risk assessments into financial and operational decision-making.

From the perspective of analyzing supply chain functioning, the key point is that domain interconnectivity works as a mechanism for amplifying the primary shock. Energy crises reflect on

transportation and the cost structure of manufacturers, which is confirmed by data from Solari et al. [8]. Logistical disruptions lead to growth in product cost and a loss of export operation efficiency, which manifests in the asymmetry of international flow reactions recorded by Truong et al. [11]. The study by Gürpinar & Gulum [3] shows that even resilient chains with high interdomain connectivity react to geopolitical restrictions with accelerated operational expense growth. An additional systemic effect is formed at the intersection of logistical and production processes. Koray et al. [5] demonstrate that maritime transport is particularly sensitive to changes in energy costs and political restrictions, which intensifies the dependence of production chains on external decisions. Similar dependencies were identified in the work of Albahouth [1], where growth in global uncertainty leads to an increase in inflationary expenses through logistics and production channels.

Consequently, the interdomain interconnectivity of cost factors confirms that global supply chains function as a unified system in which energy, logistical, and production components amplify each other's influence. It is this structural cohesion that makes chains sensitive to geopolitical changes, accelerating cost growth, and complicating resilience management under conditions of international instability.

A comparison of country contexts and industry structures shows that the sensitivity of global supply chains to geopolitical impacts is distributed extremely unevenly. The study by Truong et al. [11] shows that export-oriented economies with high dependence on external demand react disproportionately strongly to negative changes in the geopolitical risk index: negative GPR fluctuations lead to a reduction in export flows accompanied by a growth in operational costs. This asymmetry indicates that even under stable production and logistical conditions, the geopolitical background is capable of setting baseline cost volatility.

At the same time, industry analysis based on data from Solari et al. [8] demonstrates that not all sectors experience the same load. Energy and logistics act as systemic fields for cost formation. Rising resource prices transform into transportation price increases and increase costs in industries dependent on energy-intensive production. Data from Sufi & Alsulami [10] supplement this picture, pointing to the high intensity of interconnected events in energy, logistical, and production segments. However, unlike the previous section, where structural disruption peaks are recorded, in this case, the comparative aspect becomes important. The aggregate sensitivity of industries is determined by the depth of their inclusion in domains with high event density.

A separate layer of vulnerabilities is related to the spatial organization of global flows. Sufi & Alsulami [10] show that the systemic significance of individual countries is determined not by the number of disruptions as such, but by the degree of their involvement in international routes, distribution hubs, and production chains. This means that the vulnerability of countries is formed under the influence of local factors and their structural role in the network, where any changes in energy or transport are instantly reflected in neighboring links.

The comparison of country and industry characteristics provides an opportunity to interpret cost effects not as the sum of independent impacts, but as the result of overlapping contexts. Export-oriented economies face double pressure. External shocks reduce their export volumes, while the domain structure—where energy, logistics, and production remain key fields of cost formation—intensifies internal price tensions [3]. Countries with high systemic significance in the global network complement this configuration. Their role in flow distribution turns individual events into multi-level feedback effects that amplify cost variability.

Thus, the comparison of country and industry vulnerabilities shows that cost growth in global supply chains is formed not by separate risks, but by the interaction of three structural elements: the asymmetric reaction of export economies to geopolitical shocks, the domain concentration of energy and logistical cost factors, and the network significance of countries determining the scale of disruption propagation.

V. CONCLUSION

The conducted research revealed that the cost of global supply chains is formed not by separate factors, but by a combination of interconnected

processes in which geopolitical instability amplifies the action of energy, logistical, and production limitations. The cost structure is determined by exactly how external shocks are distributed among domains, involve adjacent industries, and transform into sustained cost effects. Under conditions of growing instability, it is not the scale of individual events that becomes decisive, but the configuration of connections between them.

The analysis showed that the domain structure plays a key role in cost dynamics. Energy limitations set the baseline pressure level, logistical disruptions amplify general expenses, and production failures solidify cost growth in the operational cycle. Alongside this, country differences determine the degree of impact: export-oriented economies prove more sensitive to external risks, while systemically important states form the contours of global cost transmission.

The results obtained allow for the assertion that the vulnerability of global supply chains has a multilayered character and depends on a combination of factors—industry structure, the degree of involvement in international flows, and the distribution of load centers. It is this combination that forms the limits of the resilience of the current global logistics configuration and determines the directions in which the greatest economic losses are possible. Furthermore, the difference in the reactions of industries and countries indicates the necessity of a differentiated approach to cost assessment and management.

The conducted study showed that effective cost reduction requires systemic work with risk nodes, rather than local measures. Route optimization, energy source diversification, regional production hub development, and increasing the flexibility of logistical schemes must be viewed as a unified complex of actions. Cost pressure in supply chains is formed at the intersection of domains, and any solutions that do not account for this interconnectivity prove to be of limited effectiveness.

The findings also demonstrate that interstate tensions—sanctions, tariff escalations, trade wars, and export controls—play a decisive role in institutionalizing cost pressures. These instruments reinforce the effects of energy and logistical disruptions by limiting access to strategic inputs and reshaping cost structures across entire industries. As geopolitical tools become entrenched in international economic relations, they transform cost volatility from a temporary disturbance into a long-term structural condition.

Thus, global supply chains under conditions of geopolitical instability represent a system in which cost arises as a consequence of the interaction of energy, logistical, production, and country factors. The resilience of this system is determined by the ability of economies to adapt to asymmetric shocks and reduce the effect of mutual risk amplification. The conclusions obtained create a basis for developing strategies aimed at increasing the stability, manageability, and predictability of supply chains under conditions of growing uncertainty.

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