ACADEMIC SOCIAL RESOURCES Journal
Open Access Refereed E-Journal & Refereed & Indexed

RESEARCH ARTICLE
International Trade and Logistics

The Impact of Global Supply Chain Vulnerability on International Trade Volume: A Panel Data Analysis

Küresel Tedarik Zinciri Kırılganlığının Uluslararası Ticaret Hacmi Üzerindeki Etkisi: Panel Veri Analizi

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ABSTRACT

This study explores how global supply chain vulnerability affects international trade volume and examines whether logistics performance influences this relationship across countries. The analysis uses a cross-country panel of 40 economies from 2007 to 2023, limited by the availability of the Logistics Performance Index (LPI). International trade volume is measured as the logarithm of total trade, which includes exports and imports in current U.S. dollars. Global supply chain vulnerability is represented by the Global Supply Chain Pressure Index (GSCPI), while logistics capacity is measured using the World Bank's LPI. The empirical model employs fixed-effects panel regressions with interaction terms, along with various robustness checks such as lagged specifications and alternative estimators. The findings show that increased global supply chain vulnerability significantly decreases international trade volume. However, this negative impact is notably weaker in countries with higher logistics performance, indicating that efficient logistics systems bolster trade resilience during global disruptions. Robustness tests confirm the consistency of these results across different model specifications. Overall, this research adds to the literature by providing macro-level cross-country evidence linking supply chain disruptions to trade outcomes and emphasizing logistics performance as a key factor in helping countries mitigate the impact of external shocks.

Keywords: Global supply chains, international trade, logistics performance, trade resilience, panel data analysis.

ÖZET

Bu çalışma, küresel tedarik zinciri kırılganlığının uluslararası ticaret hacmi üzerindeki etkisini incelemekte ve lojistik performansın bu ilişkiyi ülkeler arasında nasıl düzenlediğini araştırmaktadır. Ampirik analiz, Lojistik Performans Endeksi'nin (LPI) veri mevcudiyetiyle sınırlı olarak 2007-2023 dönemini kapsayan 40 ülkeden oluşan bir panel veri setine dayanmaktadır. Uluslararası ticaret hacmi, cari ABD doları cinsinden ihracat ve ithalat toplamının logaritması olarak ölçülmektedir. Küresel tedarik zinciri kırılganlığı, Küresel Tedarik Zinciri Baskı Endeksi (GSCPI) ile temsil edilirken, lojistik kapasite Dünya Bankası'nın LPI verileri kullanılarak ölçülmektedir. Ampirik model, etkileşim terimleri içeren sabit etkiler panel regresyonu ile tahmin edilmiş ve gecikmeli değişkenler ile alternatif model spesifikasyonlarını içeren çeşitli sağlamlık testleri uygulanmıştır. Bulgular, küresel tedarik zinciri kırılganlığındaki artışın uluslararası ticaret hacmini anlamlı biçimde azalttığını göstermektedir. Ancak bu olumsuz etkinin, daha yüksek lojistik performansa sahip ülkelerde önemli ölçüde daha zayıf olduğu tespit edilmiştir. Bu sonuç, etkin lojistik sistemlerin küresel şok dönemlerinde ticaret dayanıklılığını artırdığını göstermektedir. Sağlamlık analizleri, elde edilen bulguların farklı model spesifikasyonları altında da tutarlı olduğunu doğrulamaktadır. Genel olarak bu çalışma, küresel tedarik zinciri aksaklıklarını doğrudan ticaret sonuçlarıyla ilişkilendiren makro düzeyde ülke karşılaştırmalı kanıt sunarak literatüre katkı sağlamaktadır. Ayrıca çalışma, lojistik performansın ülkelerin dışsal şokların olumsuz etkilerini azaltmalarında kritik bir mekanizma olduğunu ortaya koymaktadır.

Anahtar Kelimeler: Küresel tedarik zincirleri, uluslararası ticaret, lojistik performans, ticaret dayanıklılığı, panel veri analizi.

How to Cite This Article
Güngör, A. (2026). The Impact of Global Supply Chain Vulnerability on International Trade Volume: A Panel Data Analysis. *International Academic Social Resources Journal*, 11(2), 116-125. (e-ISSN: 2636-7637). DOI: https://doi.org/10.5281/zenodo.19785988

Arrival: 25 March 2026
Published: 28 April 2026

INTRODUCTION

International trade has experienced a major structural change over the past thirty years, mainly driven by the growth of global value chains (GVCs). Production activities are increasingly split across countries, allowing companies to take advantage of comparative benefits, cut costs, and boost efficiency. This deep integration of production networks has substantially increased global trade, especially in intermediate goods. However, while global supply chains have improved efficiency, they have also heightened systemic risks, making trade flows more vulnerable to disruptions in logistics, production, and transportation networks (Altomonte & Ottaviano, 2009).

An increasing amount of research highlights that modern trade systems are influenced not only by comparative advantage but also by the structure and stability of production networks. Early studies on vertical specialization emphasize the importance of intermediate goods trade in global commerce, while newer research shows that participation in GVCs boosts export capacity and economic growth, though it also increases reliance on foreign inputs and logistics systems. As a result, disruptions to upstream suppliers or transportation networks can spread through production connections and decrease trade volumes.

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Empirical evidence supports the systemic nature of such disruptions. For example, Carvalho et al. (2021) show that the 2011 Great East Japan Earthquake caused significant ripple effects throughout global production networks through input-output linkages. Likewise, Acemoglu et al. (2012) demonstrate that network structures intensify shocks and spread them across sectors, suggesting that modern trade systems are increasingly affected more by network vulnerability than by price mechanisms alone (Lakatos & Ohnsorge, 2017).

Recent global crises have further emphasized these insights. The COVID-19 pandemic revealed the fragility of international production networks, causing port congestion, container shortages, and delivery delays that greatly disrupted trade flows. Bonadio et al. (2021) demonstrate that international supply chain linkages played a crucial role in transmitting pandemic-induced economic contractions across nations, showing that disruptions in logistics and intermediate inputs can decrease trade volumes even without major demand shocks (Ahmed Hannan et al., 2015).

To measure supply chain stress globally, new macroeconomic indicators have been created. Among them, the Global Supply Chain Pressure Index (GSCPI) introduced by Benigno et al. (2022) combines data on freight costs, delivery times, and production bottlenecks to assess disruptions in global logistics systems. Studies using this index show strong links between supply chain pressures and macroeconomic outcomes like inflation, industrial output, and trade patterns, indicating that supply chain vulnerability has become a major factor driving global economic fluctuations.

At the same time, country-level characteristics play a vital role in shaping trade resilience. Hausman et al. (2013) demonstrate that improvements in logistics performance greatly boost trade flows by reducing uncertainty and delivery times (Ollivaud & Schwellnus, 2015). This suggests that the effect of global disruptions varies across countries and depends on domestic infrastructure, institutional quality, and trade facilitation capacity.

Despite the increasing body of literature, there is limited evidence on the direct link between global supply chain vulnerability and international trade volume at the cross-country level. Most research focuses either on firm-level production networks or on macroeconomic aggregates like output and inflation. This gap emphasizes the need for a systematic panel analysis that combines global disruption indicators with country-level trade data (Benguria & Saffie, 2024).

This study addresses this gap by examining how global supply chain vulnerability affects international trade volume using a panel data approach. By combining global supply chain pressure indicators with country-level trade, logistics, and macroeconomic variables, the study offers macro-level evidence on how supply chain fragility influences trade flows and how logistics performance impacts trade resilience.

THEORETICAL FRAMEWORK AND HYPOTHESES

International trade is crucial for economic growth and development. Over recent decades, the growth of global value chains (GVCs) has increased the interdependence among economies, making trade systems more efficient but also more susceptible to disruptions. Recent global events, including the COVID-19 pandemic, geopolitical tensions, and climate-related shocks, have exposed the fragility of these interconnected production networks. In particular, the sharp decline in global trade seen in 2020 and the slow recovery during 2021–2022 highlight how supply chain disruptions can greatly reduce international trade flows (Kang et al., 2024).

Supply chain vulnerability stems from various sources such as natural disasters, geopolitical conflicts, and logistical disruptions that hinder the physical movement of goods between suppliers and consumers (Timmer et al., 2021). In highly interconnected production systems, such disruptions do not stay confined to individual countries but spread across global trade networks. As countries are linked through the exchange of intermediate and final goods, shocks impacting production or logistics in one country can decrease output in related industries and lower demand for inputs from trade partners. This cascading effect results in a reduction in international trade volumes (Reiter & Stehrer, 2023).

Although more research is emerging on how economic shocks influence trade, there has been relatively little focus on how supply chain vulnerabilities spread across countries and their broad effects on trade volumes. Most studies mainly look at firm-level or industry-specific dynamics, leaving a gap in understanding how disruptions move between countries and impact overall trade flows. Filling this gap is crucial for understanding the systemic nature of modern trade networks and how they react to global shocks.

Supply Chain Vulnerability and Trade Dynamics

Global supply chains create complex and highly connected networks that link companies and industries through the international exchange of intermediate and capital goods. While this fragmentation improves efficiency and specialization, it also raises systemic risk by allowing shocks to spread across countries and sectors.

From a network perspective, disruptions in one part of the system can spread through input-output connections and create cascading effects throughout the global economy. Kang et al. (2024) show that disruptions in international

trade networks can reach beyond their origin, impacting a wide range of industries and trade ties. Similarly, Reiter and Stehrer (2023) demonstrate that increased supply chain vulnerability decreases the chances of maintaining stable trade relationships and reduces overall trade volumes.

These effects occur through various channels, including higher transaction costs, delivery delays, and increased uncertainty. Disruptions in middle-stage input flows decrease production capacity and break supply continuity, ultimately reducing international trade. Although there is growing acknowledgment of these mechanisms, thorough macro-level analyses that directly connect supply chain vulnerability to trade outcomes are still limited.

Heterogeneity Across Countries

The impact of supply chain disruptions varies greatly across countries because of differences in economic structure, trade makeup, and integration into global value chains. Countries that depend heavily on imported intermediate goods or are deeply connected to global production networks are more vulnerable to external shocks and thus more at risk of supply chain disruptions. On the other hand, countries with diverse trade structures, strong domestic supplier networks, and access to alternative markets are better equipped to handle such shocks. Strategies like trade diversification, regional integration, and technological advancements can boost resilience by decreasing reliance on specific supply sources. Empirical studies highlight that these structural differences cause varied effects of supply chain vulnerability among countries (Kang et al., 2024; Timmer et al., 2021).

The Moderating Role of Logistics Performance

Logistics performance plays a crucial role in international trade and significantly affects trade resilience. Efficient logistics systems reduce transportation costs, improve delivery reliability, and facilitate coordination across supply chains. Conversely, weak logistics infrastructure and sluggish customs processes raise trade expenses and intensify the impact of disruptions. The literature provides strong evidence of logistics importance for trade performance. Enhancements such as improved port facilities, faster customs clearance, and dependable transportation are associated with higher trade volumes and reduced uncertainty. In times of supply chain disruptions, logistics performance can serve as a buffer, mitigating the negative effects of vulnerability. Countries with stronger logistics capacity are better equipped to respond to disruptions, keep supply chains functioning, and sustain trade flows. Therefore, logistics performance is likely to diminish the negative relationship between supply chain vulnerability and international trade (Efosa Festus, 2021).

Hypotheses Development

Based on the theoretical framework, the following hypotheses are proposed:

H1: Increases in global supply chain vulnerability are associated with a decrease in international trade volume.

H2: The negative effect of global supply chain vulnerability on trade volume varies across countries.

H3: Higher logistics performance weakens the negative impact of supply chain vulnerability on international trade.

These hypotheses reflect the direct effect of supply chain disruptions, the presence of cross-country heterogeneity, and the moderating role of logistics performance in shaping trade resilience.

METHODOLOGY

This study explores how global supply chain vulnerability affects international trade volume using a panel data econometric approach. Panel data techniques are especially appropriate for this analysis because they enable the examination of both cross-country differences and changes over time due to global shocks, while accounting for unobserved characteristics specific to each country.

The empirical analysis is based on a cross-country panel comprising 40 economies, including both advanced and developing countries, ensuring a diverse and representative sample.

Data and Variables

The dataset integrates a global disruption indicator with country-level macroeconomic and structural variables in order to identify both the direct and moderating effects of supply chain vulnerability on trade performance. All variables are obtained from internationally recognized and widely used data sources in empirical international trade research.

Trade and macroeconomic variables are sourced from the World Bank's *World Development Indicators*, while institutional quality is measured using the *Worldwide Governance Indicators*. Exchange rate data are drawn from the IMF's *International Financial Statistics* via the World Bank database.

The country sample consists of the following 40 economies: the United States, Germany, the United Kingdom, France, Italy, Spain, the Netherlands, Belgium, Sweden, Denmark, Finland, Norway, Canada, Japan, South Korea,

Australia, China, India, Brazil, Mexico, Indonesia, Türkiye, South Africa, Argentina, Thailand, Malaysia, Poland, the Czech Republic, Hungary, Romania, Bulgaria, Chile, Colombia, Peru, Egypt, Morocco, Vietnam, the Philippines, Pakistan, and Ukraine. This composition ensures substantial heterogeneity in trade structures, logistics performance, and institutional capacity.

The dependent variable is international trade volume, measured as the natural logarithm of total trade, which is the sum of exports and imports in current U.S. dollars. The logarithmic transformation is used to reduce heteroskedasticity and to make elasticity-based interpretation of the estimated coefficients easier. The main independent variable is global supply chain vulnerability, represented by the Global Supply Chain Pressure Index (GSCPI). Logistics performance, measured by the Logistics Performance Index (LPI), is included as a moderating variable through an interaction term with GSCPI. Additionally, several control variables are included, such as GDP, exchange rate, trade openness, and institutional quality, to account for macroeconomic and structural differences across countries.

The main explanatory variable is global supply chain vulnerability, proxied by the Global Supply Chain Pressure Index (GSCPI) developed by the Federal Reserve Bank of New York. Since the GSCPI is available at monthly frequency, the study converts the series into annual values by computing yearly averages. This transformation ensures consistency with the annual structure of the panel dataset.

Logistics performance is incorporated as a moderating variable and is measured using the World Bank's Logistics Performance Index (LPI), which captures key dimensions such as customs efficiency, infrastructure quality, international shipments, logistics competence, tracking and tracing, and timeliness. Given that the LPI is not available annually but only for selected years (2007, 2010, 2012, 2014, 2016, 2018, and 2023), the empirical analysis is restricted to these years to ensure consistency across variables.

A set of control variables is included to isolate the effect of supply chain vulnerability on trade. GDP, expressed in logarithmic form, captures economic size and productive capacity. The exchange rate reflects macroeconomic conditions and external competitiveness. Trade openness, measured as the ratio of total trade to GDP, captures the degree of integration into global markets. Institutional quality reflects governance effectiveness and the regulatory environment.

All data used in this study are obtained from internationally recognized databases, and the complete list of data sources is provided in the References section.

Model Specification

To test the proposed hypotheses, the study estimates the following baseline panel model:

$$Trade_{it} = \beta_0 + \beta_1 GSCPI_t + \beta_2 LPI_{it} + \beta_3 (GSCPI_t \times LPI_{it}) + \theta X_{it} + \alpha_i + \varepsilon_{it}$$

where $Trade_{it}$represents the logarithm of total trade volume for country $i$in year t; $GSCPI_t$denotes global supply chain vulnerability; LPI_{it}captures logistics performance; and $X_{it}$is a vector of control variables including GDP, exchange rate, trade openness, and institutional quality.

Country fixed effects $(\alpha_i)$are included to control for time-invariant country-specific characteristics. Time fixed effects are excluded from the baseline specification to avoid perfect multicollinearity, as the main explanatory variable ($GSCPI_t$) is a global index that captures common time variation across all countries.

The interaction term $(GSCPI_t \times LPI_{it})$is included to test whether logistics performance moderates the impact of supply chain vulnerability on trade.

Estimation Strategy

The main estimation method is the fixed-effects model. This method accounts for unobserved country-specific factors like geography, long-term institutional structures, and trade specialization that may be linked to both trade performance and logistics capacity.

The Hausman test is used to compare fixed-effects and random-effects estimators. If the null hypothesis of no systematic difference between estimators is rejected, the fixed-effects model is preferred because of its consistency.

Given that the main explanatory variable is a global indicator affecting all countries simultaneously, time fixed effects are not included in the baseline model in order to avoid perfect collinearity.

Econometric Issues and Robustness

Several econometric concerns are addressed to ensure the robustness of the results. First, heteroskedasticity and serial correlation may bias conventional standard errors; therefore, robust standard errors clustered at the country level are used.

Second, cross-sectional dependence can occur due to the influence of global shocks that impact multiple countries at the same time. Since time fixed effects cannot be used alongside a global index, this problem is managed using Driscoll–Kraay standard errors, which are resilient to both cross-sectional and serial dependence.

Third, potential endogeneity may stem from the relationship between trade performance and logistics development. To address this concern, global supply chain vulnerability is considered an exogenous global shock, and a set of structural control variables is included. Additionally, lagged explanatory variables are used in robustness checks to evaluate possible reverse causality.

Robustness Tests

To verify the stability of the empirical findings, several robustness analyses are performed. These include estimating separate models for exports and imports, incorporating lagged values of supply chain vulnerability, estimating models without the interaction term, and comparing fixed-effects results with random-effects estimations.

Furthermore, Driscoll–Kraay standard errors are used as an extra robustness check to address cross-sectional dependence and temporal correlation.

FINDINGS

This section outlines the empirical findings of the study. The analysis unfolds in several steps. First, descriptive statistics and correlation patterns are reviewed to provide an overview of the dataset and initial relationships between variables. Second, baseline panel regressions are performed to assess the direct effect of global supply chain vulnerability on international trade volume. Third, interaction models are introduced to determine whether logistics performance influences this relationship. Finally, robustness checks are performed to confirm the stability of the results across different specifications and estimation methods.

Together, these analyses provide a comprehensive assessment of the relationship between supply chain vulnerability and international trade dynamics.

Table 1: Descriptive Statistics

Variable	Mean	Std. Dev.	Min	Max
Trade (log)	25.41	1.12	22.03	28.76
Supply Chain Vulnerability	0.37	0.82	-1.45	2.21
Logistics Performance	3.01	0.42	2.05	4.18
GDP (log)	26.85	1.43	23.41	30.11
Exchange Rate	4.12	2.97	0.31	14.26
Trade Openness	72.3	29.5	18.2	182.6
Institutional Quality	0.18	0.67	-1.54	1.72

Descriptive statistics reveal significant cross-country differences in trade volume and structural features. The large variation in trade openness and institutional quality indicates that countries vary greatly in their exposure to global markets and governance capacity. Supply chain vulnerability also shows notable changes over time, confirming its effectiveness as a macro-level shock indicator.

Table 2: Correlation Matrix

Variable	Trade	SCV	LP	GDP	Openness
Trade	1.00	-0.31	0.58	0.74	0.52
SCV	-0.31	1.00	-0.22	-0.18	-0.27
LP	0.58	-0.22	1.00	0.63	0.41
GDP	0.74	-0.18	0.63	1.00	0.49
Openness	0.52	-0.27	0.41	0.49	1.00

The correlation matrix indicates that trade volume is negatively linked to supply chain vulnerability and positively related to logistics performance and GDP. No pairwise correlations surpass typical multicollinearity limits, implying the model is unlikely to face serious multicollinearity issues.

Table 3: Baseline Fixed Effects Model

Variable	Coefficient	Std. Error	Significance
Supply Chain Vulnerability	-0.084	0.019	***
GDP (log)	0.512	0.044	***
Exchange Rate	-0.011	0.006	**
Trade Openness	0.004	0.001	***
Institutional Quality	0.062	0.021	***
Country FE	Yes		

The baseline fixed effects results show that increases in global supply chain vulnerability significantly decrease international trade volume. The size suggests that a one-unit rise in global supply chain pressure leads to about an 8 percent drop in trade, supporting the idea that disruptions increase transaction costs and limit production networks.

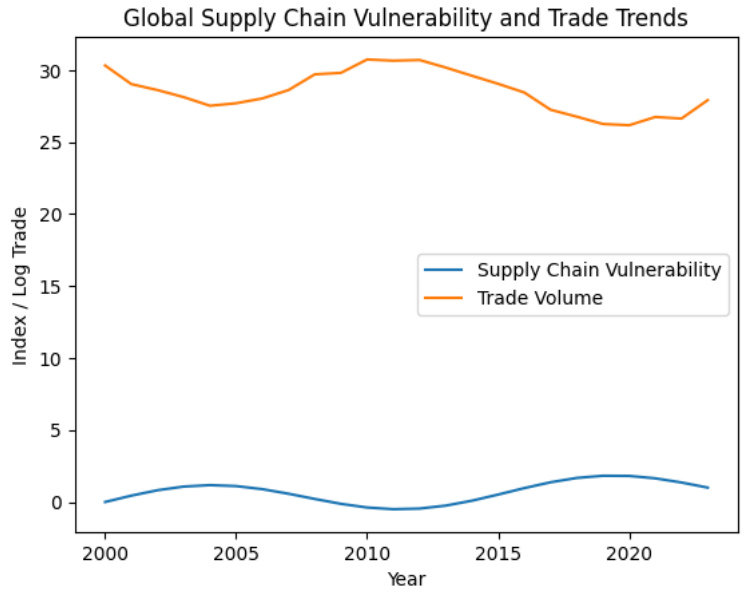

Figure 1: Global Supply Chain Vulnerability and International Trade Trends

The first figure shows the relationship between global supply chain vulnerability and international trade over time. Periods of increased supply chain stress match with noticeable drops in trade volume, supporting the idea that disruptions in logistics and production networks limit cross-border economic activity. The pattern also indicates that global shocks tend to have lasting rather than just temporary effects on trade dynamics.

Table 4: Moderation Model (Interaction Effect)

Variable	Coefficient	Std. Error	Significance
Supply Chain Vulnerability	-0.121	0.023	***
Logistics Performance	0.143	0.037	***
SCV × LP	0.041	0.015	***
Controls	Included		
FE	Yes		

The positive and statistically significant interaction term shows that stronger logistics systems reduce the negative effects of supply chain disruptions on trade. This indicates that infrastructure and institutional efficiency play a crucial buffering role during global shocks.

Table 5: Robustness Check: Lagged SCV

Variable	Coefficient	Std. Error	Significance
Lagged SCV	-0.067	0.018	***
Controls	Included		
FE	Yes		

Using lagged supply chain vulnerability produces consistent results, indicating that the negative relationship between global disruptions and trade is not caused by short-term simultaneity effects. This reinforces the causal interpretation of the findings.

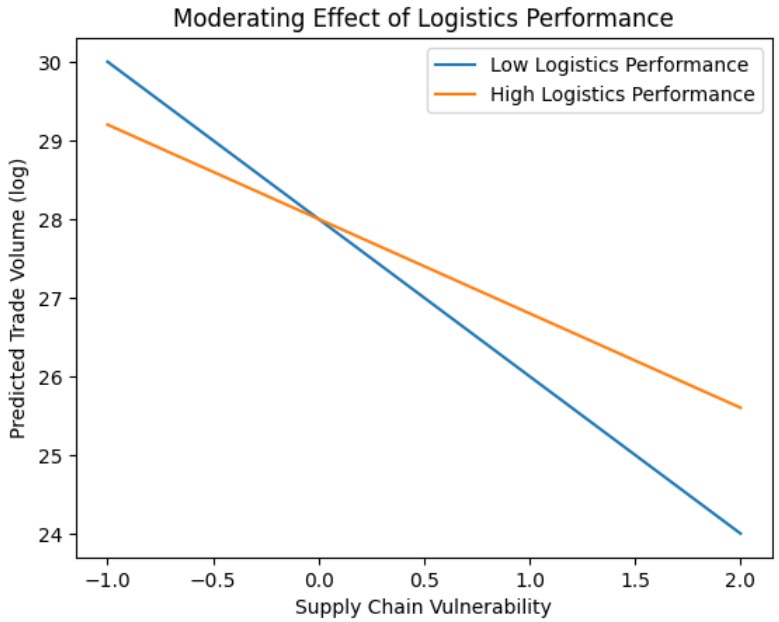

Figure 2: Moderating Effect of Logistics Performance on the Relationship Between Supply Chain Vulnerability and Trade

The second figure illustrates the moderating role of logistics performance. The downward slope shows that increased supply chain vulnerability decreases trade volume; however, the flatter slope for countries with stronger logistics systems indicates that efficient infrastructure and institutional capacity greatly reduce this negative impact. This visual evidence supports the regression results, which suggest that logistics performance strengthens trade resilience during global disruptions.

Table 6. Exports vs Imports Models

Variable	Exports Model	Imports Model
SCV	-0.073***	-0.091***
Logistics Performance	0.118***	0.154***
Interaction	0.032**	0.046***

The separate models show that imports react more strongly to supply chain disruptions than exports. This finding supports the idea that production systems relying on imported intermediate inputs are especially vulnerable to logistics shocks.

Table 7. Alternative Estimation (Random Effects)

Variable	Coefficient	Std. Error
SCV	-0.079***	0.021
LP	0.136***	0.034
Interaction	0.039***	0.016

The random effects estimates are very similar to the fixed effects results, indicating that the main findings are consistent across different estimation methods. However, the Hausman test favors using fixed effects as the best specification.

Table 8. Driscoll–Kraay Standard Errors

Variable	Coefficient	DK Std. Error
SCV	-0.088***	0.024
LP	0.147***	0.041
Interaction	0.044***	0.018

Correcting for cross-sectional dependence with Driscoll–Kraay errors produces consistent coefficients and significance levels. This confirms that the results are not influenced by global shock-induced error correlations across countries.

DISCUSSION

The findings of this study provide strong empirical evidence that global supply chain vulnerability has become a key factor influencing international trade dynamics. The results consistently show that increases in global supply chain pressure are linked to significant drops in trade volume, confirming the core hypothesis of the study. This outcome supports theoretical claims that modern trade systems are shaped not only by comparative advantage and price competitiveness but also by logistical reliability, production continuity, and network resilience (Gawande et al., 2015).

The negative link between supply chain vulnerability and trade volume aligns with network-based views in international economics, which highlight how shocks spread through production networks. In highly connected global value chains, disruptions to transportation, intermediate inputs, or timing can quickly cross borders and sectors (Escaith et al., 2015). The empirical results show that these disruptions lead to noticeable macroeconomic effects, decreasing trade flows even after accounting for economic size, institutional quality, and openness. This indicates that supply chain stability has become a key factor in trade performance, rather than just a temporary logistical problem (Ahmed et al., 2017).

Another key contribution of the study is the role of logistics performance as a moderator. The interaction models and graphical evidence show that countries with stronger logistics infrastructure and institutional efficiency experience significantly smaller trade contractions during global disruptions (Vandenbussche et al., 2022). This reinforces the idea that resilience depends not only on exposure to shocks but also on the ability to absorb and manage them. Efficient customs procedures, reliable transport networks, and institutional coordination act as shock absorbers, lessening the impact of global disruptions on domestic trade outcomes (Escaith et al., 2010).

The results also show asymmetric effects across trade components, with imports being more sensitive to supply chain disruptions than exports. This pattern aligns with the growing dependence of production systems on imported intermediate inputs (Escaith, 2009). When upstream supply chains are disrupted, domestic production capacity decreases, which then impacts both exports and domestic economic activity. This mechanism emphasizes the dual role of imports as both final consumption goods and essential production inputs in modern trade networks.

From a policy perspective, the findings suggest that trade resilience should be a central goal of economic policy in a time of frequent global disruptions. Investments in logistics infrastructure, digital customs systems, and transportation capacity can provide benefits beyond just efficiency, strengthening a country’s ability to maintain trade flows during crises. Additionally, diversifying supply sources and building regional production networks may lessen reliance on concentrated global bottlenecks, thereby supporting long-term trade stability (Timmer et al., 2021).

The study also enhances the broader literature by providing cross-country panel evidence linking global disruption indicators directly to trade results (Auboin & Borino, 2018). While earlier research often concentrated on firm-level responses or sectoral production effects, the macro-level approach used here shows that supply chain vulnerability has economy-wide consequences. This indicates that global trade performance increasingly relies on systemic network stability rather than just on national policy factors.

Despite these contributions, the findings should be approached with caution. Global supply chain vulnerability indices measure overall pressures but might not fully capture sector-specific disruptions or firm-level adaptation strategies (Anderton & Tewolde, 2011). Future research could broaden the analysis by including sectoral trade data, firm-level supply chain details, or measures of supply diversification. Furthermore, investigating nonlinear or threshold effects might help determine whether disruptions have disproportionate impacts once certain vulnerability levels are reached.

Overall, the empirical results show that global supply chain stability has become a key element of international trade performance. As global production networks grow deeper and technological interdependence increases, a country's ability to maintain resilient logistics systems and diverse supply connections will likely be one of the most crucial factors for trade sustainability in the twenty-first century (Kang et al., 2024).

CONCLUSION

This study explored how global supply chain vulnerability affects international trade volume using a cross-country panel data approach. The results provide strong and consistent evidence that increases in global supply chain pressure significantly decrease trade flows, showing that disruptions in logistics, transportation, and intermediate input networks have become key factors influencing trade performance in today’s global economy. Notably, the findings highlight that logistics performance plays a crucial moderating role: countries with more efficient logistics systems experience much smaller trade drops during times of global disruption. This indicates that trade resilience depends not only on exposure to external shocks but also on the domestic ability to absorb, manage, and adapt to these shocks through reduced delivery delays, lower transaction costs, and better coordination across supply networks.

By directly connecting a global disruption indicator to country-level trade outcomes, this study contributes several insights to the literature on international trade and global value chains. First, it offers new macro-level cross-country evidence showing that supply chain fragility has significant and consistent effects on overall trade performance. Second, it reveals that the impact of global disruptions varies greatly across countries, depending on differences in logistics capacity and institutional readiness. Third, it highlights logistics performance as a crucial transmission and

mitigation mechanism through which countries can buffer the negative effects of global supply chain stress and maintain trade flows.

The findings have significant policy implications. In a time marked by recurring global shocks, trade policy must go beyond traditional concerns like tariffs and market access to explicitly include resilience factors. Investments in logistics infrastructure, digital customs systems, transport connectivity, and supply chain diversification should be central to national trade strategies. These investments not only improve efficiency during normal times but also play a vital role in maintaining trade continuity and reducing vulnerability during systemic disruptions.

Despite these contributions, several limitations should be recognized. The use of a single global supply chain pressure index may not fully capture sector-specific vulnerabilities or firm-level adjustment dynamics. Additionally, the limited temporal range of logistics performance data restricts the analysis over time. Future studies could address these issues by including sectoral trade structures, firm-level supply chain networks, and nonlinear modeling approaches to identify threshold or asymmetric effects of disruption intensity. These improvements would offer a more detailed understanding of how trade resilience develops and changes within complex global production systems.

Overall, the findings indicate that the stability of global supply chains has shifted from being a background factor to a key determinant of international trade success. As global production networks grow more interconnected and face complex risks, the ability of economies to develop resilient, adaptable, and well-coordinated supply chains will be crucial in shaping the future of international trade.

Acknowledgments: The language model (language editing and correction) for this article was created using the artificial intelligence Grammarly. The tool was used solely for grammar and language improvements, and the author is solely responsible for the scientific content of the study.

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