



GLOBAL VALUE CHAIN EXPOSURE AND GROWTH VULNERABILITY: EVIDENCE FROM G20 ECONOMIES

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ABSTRACT

The reconfiguration of global supply chains has renewed debate on the macroeconomic implications of global value chain (GVC) integration. This study examines the relationship between GVC exposure and growth volatility in G20 economies from 1995 to 2023. Macroeconomic vulnerability is measured by the rolling standard deviation of real GDP growth, while GVC exposure is proxied by the foreign value-added content of exports. Trade openness is included to distinguish the effects of supply chain integration from broader international trade exposure. Using a fixed-effects panel model with country and time effects, the analysis controls for structural differences and common global shocks. The findings suggest that GVC integration and trade openness primarily transmit external shocks rather than independently generate macroeconomic instability. The results underscore the importance of supply chain diversification, domestic productive capacity, and credible stabilization policies in strengthening economic resilience.

Keywords: Global Value Chains, Growth Volatility, Supply Chain Exposure, Trade Openness, Shock Transmission

1. INTRODUCTION

Global production is increasingly organized through global value chains (GVCs), in which countries specialize in specific production stages and trade intermediate inputs across borders. Although GVC integration can enhance productivity and development, it also creates interdependence through which external shocks may propagate across economies (World Bank, 2020). The COVID-19 pandemic provided a major stress test for this system. Disruptions to labor supply, logistics, and cross-border mobility spread through input-output linkages, amplifying the decline in economic activity. Evidence indicates that a substantial share of the pandemic-related output contraction resulted from shock transmission through global supply chains (Bonadio et al., 2021). However, GVC participation also had heterogeneous effects: while it increased exposure to shocks originating abroad, it could reduce vulnerability to domestic disruptions through substitution and diversification (Espitia et al., 2022). The pandemic further demonstrated that the vulnerability and performance of medical-product GVCs were shaped by government intervention. Export restrictions, public procurement and production policies, and government decisions prioritizing essential industries materially affected the

production and cross-border availability of personal protective equipment and other medical goods (Gereffi, 2020; Dallas et al., 2021). Supply disruptions also contributed to inflation by increasing delivery times, production costs, and input shortages. Empirical evidence links supply bottlenecks to weaker manufacturing output and higher producer-price inflation, while the Global Supply Chain Pressure Index has become a widely used measure of such pressures (Celasun et al., 2022; Benigno et al., 2022). These developments intensified debates over supply-chain diversification and reshoring. Although diversification across suppliers and sourcing locations may help cushion disruptions, broad-based localization policies can impose substantial efficiency costs without necessarily improving and may even weaken resilience. Geoeconomic fragmentation may further increase vulnerability by reorganizing trade, investment, and technology flows according to strategic and security considerations (Aiyar et al., 2023). Despite the expanding literature, cross-country evidence on the relationship between GVC exposure and macroeconomic vulnerability remains limited. This study addresses this gap by examining whether foreign value-added exposure is associated with growth vulnerability in G20 economies from 1995 to 2023. Foreign value-added content in exports is used as a proxy for GVC exposure, while the rolling standard deviation of real GDP growth measures macroeconomic vulnerability. Trade openness is included to distinguish the specific effect of GVC integration from broader international trade exposure. Using a fixed-effects panel model with country and time effects and robust inference, the study provides evidence on the relationship between global production linkages and growth stability.

2. THEORETICAL FRAMEWORK

The reorganization of global supply chains following major disruptions, particularly the COVID-19 pandemic, cannot be fully explained by conventional trade and macroeconomic models that abstract from cross-country and intersectoral dependencies. When production is fragmented across borders, shocks propagate through networks of upstream and downstream producers, affecting output, prices, and aggregate stability. Production network theory therefore provides an appropriate framework for examining how global value chain structures, supplier concentration, and supply chain reconfiguration influence macroeconomic vulnerability.

2. 1. GLOBAL SUPPLY CHAINS AS PRODUCTION NETWORKS

The presumption that idiosyncratic shocks average out at the macroeconomic level is based on an implicit symmetry in the production structure. However, as Acemoglu et al. (2012) demonstrate, this symmetry is empirically untenable. Once a limited number of sectors supply inputs to many others, disturbances originating in these sectors fail to cancel each other out, instead surfacing as aggregate fluctuations.

The magnitude of shock propagation also depends on the substitutability of intermediate inputs. Baqaee and Farhi (2019) show that when inputs are strong complements, disruptions to specialized components cannot be easily offset, resulting in cascading production losses. This mechanism is especially relevant to GVCs in which firms depend on technologically specific inputs or suppliers that cannot be replaced in the short run.

Input-output linkages therefore transform sector- or country-specific disruptions into macroeconomically significant shocks. As Carvalho (2014) argues, even disturbances originating in relatively small sectors may have economy-wide consequences when those sectors occupy central positions in the production network. In an international setting, factory closures, logistical bottlenecks, natural disasters, and trade restrictions in one economy may consequently affect production and prices in multiple partner countries. Exposure to these shocks is uneven because it depends on each country's position within the global production network. Econo-

mies serving as major suppliers, assembly hubs, or logistical intermediaries may facilitate the cross-border transmission of shocks. Conversely, economies that depend heavily on a narrow range of foreign inputs may be highly vulnerable to upstream disruptions, even when their aggregate trade openness is relatively limited (Baldwin & Freeman, 2022).

This distinction separates network exposure from conventional trade openness. Trade-to-GDP ratios indicate the scale of international integration but do not capture supplier concentration, production centrality, redundancy, or the availability of alternative inputs. Countries with similar levels of trade openness may therefore experience very different degrees of vulnerability depending on the architecture of their supply-chain relationships.

The COVID-19 pandemic demonstrated the importance of these structural features by exposing dependencies accumulated during decades of international production fragmentation. Subsequent changes in sourcing and production strategies may alter the structure of global networks and, consequently, the transmission of future shocks. A production-network perspective is therefore essential for evaluating the macroeconomic implications of supply chain reconfiguration.

2. 2. SUPPLY CHAIN CONCENTRATION AND RECONFIGURATION

Global supply chains evolve in response to technological developments, production costs, policy interventions, geopolitical considerations, and major economic shocks. Supplier concentration is particularly important because it determines the extent to which production depends on a limited number of upstream firms or countries. Concentration may generate efficiency gains through specialization, coordination, and economies of scale, but it also reduces redundancy and increases exposure to the failure of critical suppliers.

Network-based approaches distinguish between the stability of individual institutions and the stability of the system as a whole. Drawing analogies with ecological food webs and epidemic networks, Haldane and May (2011) use deliberately simplified models to examine the relationship between complexity and stability in financial networks. Their analysis shows that connectivity can distribute and attenuate risk, but that it can also facilitate contagion under certain conditions. In a different setting, Acemoglu et al. (2012) analyze production networks and show that sector-specific shocks can propagate through input–output linkages to immediate downstream customers and, through higher-order connections, to the rest of the economy. They further demonstrate that such shocks can generate sizable aggregate fluctuations when sectors differ substantially in their importance as input suppliers.

The concept of granularity provides a related explanation of aggregate vulnerability. Gabaix (2011) shows that when a small number of large economic units account for a substantial share of activity, firm- or sector-specific shocks may produce aggregate fluctuations. Within global supply chains, disruptions affecting dominant suppliers can therefore spread widely across downstream firms and national economies. Supply chain reconfiguration refers to changes in sourcing patterns, supplier concentration, and the geographical organization of production. It may involve supplier diversification, reshoring, nearshoring, or the relocation of production toward politically aligned economies. Such adjustments are costly because establishing new supplier relationships involves search, contracting, coordination, and learning costs (Antràs, 2020). Reconfiguration intended to improve long-term resilience may therefore temporarily reduce productivity and increase short-run uncertainty.

The pandemic intensified these pressures by encouraging firms and governments to reduce dependence on distant, concentrated, or geopolitically sensitive suppliers. However, reshoring, nearshoring, and friend-shoring do not necessarily reduce overall vulnerability. They may lower global exposure while increasing dependence on a smaller regional or politically aligned

group of suppliers (Javorcik, 2020). Reconfiguration thus redistributes risk rather than eliminating it. Its macroeconomic consequences also depend on the speed and nature of adjustment. Gradual, market-driven reconfiguration allows firms to evaluate suppliers and develop alternative production relationships. Abrupt, shock-induced or policy-driven changes may instead create transitional fragility because newly established links can be less efficient, reliable, or integrated. Network contagion models suggest that sudden changes in economic linkages may temporarily weaken the system's capacity to absorb shocks (Battiston et al., 2012).

Expectations of future disruptions may influence firms' supply-chain design and risk-management decisions. Kleindorfer and Saad (2005) argue that alternative supply-chain designs should be evaluated in terms of both efficiency and robustness. They propose an integrated framework combining disruption-risk assessment and mitigation and emphasize vulnerability assessment, coordination, cooperation, and joint problem-solving among supply-chain partners. Accordingly, supply-chain design is an important determinant of firms' capacity to prepare for and respond to operational disruptions.

The theoretical effect of reconfiguration remains ambiguous. Greater concentration may improve efficiency while increasing exposure to supplier-specific shocks, whereas diversification may strengthen resilience but raise production and coordination costs. Changes in concentration may consequently be as important as concentration levels themselves. This ambiguity provides a clear rationale for empirically examining whether greater exposure to international production networks is systematically associated with macroeconomic vulnerability.

2. 3. PRODUCTION NETWORKS AND MACROECONOMIC VULNERABILITY

A production-network perspective explains why localized supply disruptions may generate substantial macroeconomic effects. When firms depend on specialized intermediate inputs, upstream shocks propagate downstream and can produce output losses that exceed the magnitude of the initial disturbance. Evidence from the 2011 Tōhoku earthquake confirms that firm-level input linkages transmitted disruptions across borders and through multinational production networks, particularly where imported inputs were difficult to substitute (Boehm et al., 2019).

Supply disturbances may also generate demand-side effects. Guerrieri et al. (2022) describe these mechanisms as “Keynesian supply shocks,” whereby production constraints reduce income and expenditure, weakening demand in unaffected sectors. Supply disruptions can therefore initiate feedback loops in which lower output reduces income, weaker income suppresses consumption, and declining demand amplifies the original contraction.

Macroeconomic vulnerability also has an external dimension. Participation in GVCs exposes economies to foreign productivity, supply, and terms-of-trade shocks. In models with incomplete financial markets, such disturbances can generate substantial and imperfectly insured wealth effects across countries (Corsetti et al., 2008). Supply-chain disruptions may consequently increase import costs, constrain export capacity, weaken external balances, and place pressure on exchange rates. These effects can be particularly contractionary in economies with limited policy space or fragile external financing conditions.

Price dynamics constitute another important transmission channel. Supply-chain disruptions initially affect relative prices through shortages, delivery delays, and rising input costs, but may subsequently influence aggregate inflation. Shapiro (2022) finds that supply-side factors accounted for a substantial share of the post-pandemic increase in inflation. Multi-sector New Keynesian models similarly demonstrate that sector-specific shocks can affect aggregate price dynamics through input-output linkages, pass-through, substitution, and monetary-policy responses (Ruge-Murcia & Wolman, 2022).

Persistent supply disturbances may also increase inflation uncertainty. [Stock and Watson \(2007\)](#) show that inflation contains a time-varying trend and stochastic volatility, implying that shocks can affect both inflation outcomes and their predictability. Recurrent supply-chain disruptions may therefore complicate forecasting, weaken policy effectiveness, and increase the risk of delayed or excessive stabilization responses.

Production networks also influence international business-cycle synchronization. Direct trade and multinational linkages strengthen the transmission of country-specific shocks and increase output comovement among connected economies ([di Giovanni et al., 2018](#)). Changes in supplier relationships and partner composition may therefore alter both exposure to foreign disturbances and the potential benefits of international diversification.

Overall, macroeconomic vulnerability depends not only on the degree of trade openness but also on the structure of international production linkages. Supplier concentration, input substitutability, network centrality, and external adjustment mechanisms determine whether localized disturbances remain contained or develop into broader fluctuations in output and prices. These mechanisms motivate the empirical examination of whether greater exposure to foreign value added is associated with higher growth volatility.

3. LITERATURE REVIEW

Research on global supply chains and macroeconomic vulnerability increasingly adopts a production-network perspective. This literature emphasizes that input-output relationships, firm-level supplier links, and cross-border production connections determine how shocks propagate and affect aggregate stability. Early contributions established that sectoral interdependence can generate aggregate fluctuations. [Long and Plosser \(1983\)](#) developed a multisector real business-cycle model in which technology shocks spread through input-output relationships. [Gabaix \(2011\)](#) subsequently showed that idiosyncratic shocks affecting very large firms can account for a meaningful share of aggregate volatility, particularly when economic activity is concentrated among a small number of dominant units. [Acemoglu et al. \(2012\)](#) provided a formal production-network explanation for these effects. They demonstrated that sector-specific shocks can generate substantial aggregate fluctuations when input-output networks contain highly influential hubs. [Carvalho \(2014, 2019\)](#) further established production networks as a general framework for understanding macroeconomic fluctuations and emphasized the importance of measuring network exposure and centrality.

International evidence confirms that cross-border production linkages can magnify economic shocks. [Bems et al. \(2011\)](#) show that vertical specialization and intermediate-input trade contributed significantly to the collapse in global trade during the 2008-2009 financial crisis. Their findings indicate that GVCs can amplify demand contractions because intermediate goods cross borders several times during production.

Firm-level studies provide more direct evidence of shock propagation. [Barrot and Sauvagnat \(2016\)](#) find that natural disasters affecting suppliers caused persistent output losses among downstream customers, particularly when inputs were highly specific. [Boehm et al. \(2019\)](#) similarly show that the Tōhoku earthquake generated international spillovers through multinational and trade-related input relationships. The magnitude and persistence of these effects depended partly on the substitutability of intermediate inputs. Using an agent-based model calibrated to actual supply-chain data covering nearly one million Japanese firms, Inoue and Todo (2019) show that production losses caused by natural disasters can propagate through supplier–customer networks to regions not directly affected by the disasters and may persist over time. Their simulations further indicate that these indirect effects are larger and more

persistent when intermediate products are difficult to substitute and supply-chain networks exhibit scale-free properties and complex cycles.

Theoretical research has also highlighted nonlinear propagation mechanisms. [Baqae and Farhi \(2019\)](#) show that complementarities, limited substitution, and capacity constraints can make aggregate responses disproportionately large. The effects of network shocks are therefore state-dependent and may become particularly severe during periods of widespread disruption.

The COVID-19 pandemic generated a new body of research on global production networks. [Bonadio et al. \(2021\)](#) estimate that a substantial share of pandemic-related GDP losses was transmitted through international supply chains. However, they also find that domesticating production would not necessarily have reduced vulnerability because national supply chains would have remained exposed to domestic lockdowns and labor-supply shocks. This result suggests that diversification, rather than simple localization, may be more important for resilience.

A related literature examines the inflationary consequences of supply-chain bottlenecks. [Di Giovanni et al. \(2022\)](#) show that the pandemic-induced shift in consumption from services to goods was amplified through global input-output linkages, affecting both international trade and inflation. They further demonstrate that sector-specific labor shortages increased inflationary pressures and that foreign shocks and global supply-chain bottlenecks played an outsized role in explaining euro-area inflation during 2020–2021. [Comin et al. \(2023\)](#) develop a multisector, open-economy New Keynesian model in which binding capacity constraints faced by domestic and foreign producers shift domestic and import-price Phillips curves upward. Applying the model to U.S. data, they estimate that binding goods-sector constraints accounted for approximately half of the increase in inflation during 2021–2022 and that tight capacity amplified the inflationary effects of loose monetary policy in 2021. These findings identify supply-chain capacity constraints as a distinct source of inflationary pressure and as an amplification mechanism for demand and monetary-policy shocks.

Recent research has increasingly focused on policy-induced reconfiguration. [Flaen et al. \(2020\)](#) show that country-specific antidumping duties prompted washing-machine producers to relocate production across exporting countries, with little or no increase in consumer prices. In contrast, the broad 2018 safeguard tariffs covering nearly all source countries raised washer prices by approximately 12 percent and encouraged some production relocation to the United States. This episode illustrates that broad tariff-induced supply-chain reconfiguration can impose substantial costs on consumers. [Antràs \(2020\)](#) argues that institutional and geopolitical factors, rather than technological considerations alone, are likely to shape the future organization of GVCs. [Baldwin and Freeman \(2022\)](#) similarly emphasize that supply-chain risk varies across industries and depends on concentration, substitutability, and critical-node exposure.

The emerging literature on friendshoring and geoeconomic fragmentation further demonstrates that supply-chain reconfiguration involves important trade-offs. Using a quantitative model incorporating inter-country and inter-industry linkages, [Javorcik et al. \(2024\)](#) estimate that restricting trade primarily to geopolitically aligned partners may generate real GDP losses of up to 4.7% in some economies. Although friendshoring may provide insurance against extreme disruptions and enhance the security of access to critical inputs, these benefits may come at a substantial economic cost. [Freund et al. \(2023\)](#) document substantial trade diversion and changes in U.S. sourcing patterns associated with tariffs on Chinese imports. However, the countries gaining U.S. market share remain closely integrated with Chinese supply chains, suggesting a “China + 1” reconfiguration rather than broad-based diversification or complete decoupling.

Overall, the literature shows that macroeconomic vulnerability is determined not only by trade openness but also by network architecture, supplier concentration, input substitutability, and

the nature of the underlying shock. However, much of the existing research relies on structural network models, firm-level case studies, or evidence from specific disruption episodes. Cross-country panel evidence on the systematic relationship between GVC exposure and growth volatility remains comparatively limited. This study addresses that gap by examining whether the foreign value-added content of exports is associated with macroeconomic vulnerability across G20 economies over the period 1995-2023.

3. 1. LITERATURE GAP

Despite the expanding literature on global supply chains and production networks, several gaps remain. Existing studies demonstrate that shocks propagate through input–output linkages and that network structure influences aggregate fluctuations. However, most treat production networks as relatively static and focus on shock transmission within established structures rather than on supply chain reconfiguration through diversification, reshoring, nearshoring, or geopolitical realignment.

First, the macroeconomic consequences of endogenous network adjustment remain insufficiently examined. Although firms and governments modify sourcing patterns in response to disruptions and policy changes, it remains unclear whether such adjustments reduce vulnerability or merely redirect the channels through which shocks are transmitted.

Second, systematic cross-country evidence linking measurable GVC exposure to macroeconomic vulnerability remains limited. Firm- and sector-level studies provide valuable insights into supplier dependence, concentration, and substitutability, but these findings have not been fully incorporated into comparative macroeconomic panel analysis.

Third, real and nominal vulnerability channels are often studied separately. Research typically examines output volatility, supply bottlenecks, or inflation dynamics in isolation, despite the close interaction between production disruptions, growth instability, and price pressures.

Fourth, the long-term consequences of policy-induced and geopolitical reconfiguration remain underexplored. Trade restrictions, friend-shoring, and strategic industrial policies may alter production-network structures, but their implications for macroeconomic stability have not yet been established conclusively.

This study addresses these gaps by examining the relationship between GVC exposure and macroeconomic vulnerability within a cross-country panel framework. It links foreign value-added dependence to growth volatility while controlling for general trade openness, country-specific characteristics, and common global shocks. In doing so, it provides evidence on whether participation in international production networks is systematically associated with macroeconomic fragility.

4. EMPIRICAL APPLICATIONS

This study applies a parsimonious, network-informed empirical framework to examine whether GVC exposure is associated with macroeconomic vulnerability in G20 economies. The framework is based on three elements.

First, foreign value-added content in exports is used to represent the depth of cross-border production linkages. Greater dependence on imported intermediate inputs may increase exposure to foreign disruptions, although it may also generate productivity and diversification benefits. The expected net effect is therefore theoretically ambiguous.

Second, macroeconomic vulnerability is measured through the volatility of real GDP growth, reflecting an economy's ability to absorb and recover from shocks. Third, the empirical model controls for country-specific heterogeneity, common global disturbances, and trade openness. Including trade openness distinguishes the effect of GVC exposure from the broader influence

of international trade integration.

The analysis is not intended to establish strict causality. Reverse causality may arise if countries adjust their GVC participation in response to growth instability, while omitted time-varying factors may influence both supply-chain exposure and macroeconomic vulnerability. Country and time fixed effects, together with trade openness, reduce but do not fully eliminate these concerns. The estimated coefficients are therefore interpreted as conditional associations.

The empirical analysis proceeds in three stages. It first presents descriptive statistics and trends, then estimates baseline fixed-effects models with robust standard errors, and finally conducts robustness checks using alternative measures of growth vulnerability and inference methods appropriate for panels exposed to common global shocks.

4. 1. DATASET AND MODEL SPECIFICATION

The analysis uses an unbalanced panel of G20 economies covering the period 1995–2023. The sample period is determined by the availability of internationally comparable data and captures both the expansion of GVCs and major episodes of global economic disruption.

Annual real GDP growth data are obtained from the International Monetary Fund's *World Economic Outlook* database. Macroeconomic vulnerability is measured by the rolling standard deviation of real GDP growth over a fixed window. This indicator captures fluctuations in economic performance and provides a transparent and reproducible measure of growth instability.

Data on GVC exposure are drawn from the OECD Trade in Value Added database. The principal explanatory variable is the foreign value-added content of gross exports, defined as the share of exported value generated by imported intermediate inputs. This measure captures the extent to which domestic production depends on upstream foreign suppliers and is embedded in cross-border production networks.

Trade openness is measured as the sum of exports and imports of goods and services relative to GDP. Data are obtained from the World Bank's *World Development Indicators*. This variable controls for the overall degree of international trade integration, allowing the analysis to isolate the association between foreign value-added exposure and growth vulnerability.

The resulting dataset has a relatively long-time dimension compared with the number of countries, making it suitable for macroeconomic panel analysis. All variables are harmonized at an annual frequency and checked for consistency across countries and years.

The empirical analysis considers fixed-effects and random-effects estimators within the standard panel-data framework. The choice between these specifications depends on whether unobserved country-specific effects are correlated with the explanatory variables (Wallace & Hussain, 1969; Baltagi, 2021).

The baseline model is specified as follows:

$$VULN_{it} = \alpha_i + \lambda_t + \beta_1 FVA_{it} + \beta_2 OPEN_{it} + \varepsilon_{it} \quad (1)$$

where $VULN_{it}$ denotes growth vulnerability in country i at time t , measured as the rolling standard deviation of real GDP growth. FVA_{it} represents global supply chain exposure, captured by the foreign value added share of exports; while $OPEN_{it}$ denotes trade openness, measured as the ratio of total trade to GDP. The inclusion of trade openness allows the model to distinguish the specific effect of global value chain exposure from the broader effect of international trade integration. α_i denotes country-specific fixed effects controlling for time-invariant structural characteristics, while λ_t denotes time fixed effects capturing global shocks common to all economies. The error ε_{it} term captures idiosyncratic disturbances.

The coefficient β_1 measures the association between supply chain exposure and macroeco-

economic vulnerability. A positive value of β_1 would suggest that greater reliance on foreign intermediate inputs is associated with higher growth instability, while a negative value would indicate that deeper integration into global value chains contributes to macroeconomic stability. The coefficient β_2 captures the association between trade openness and growth vulnerability. The model remains intentionally parsimonious, allowing for a clear interpretation of the network-based relationship emphasized in the theoretical framework.

5. EMPIRICAL RESULTS

The empirical analysis uses annual data for G20 economies from 1995 to 2023. Macroeconomic vulnerability is measured by the five-year rolling standard deviation of real GDP growth, based on data from the IMF World Economic Outlook. Global value chain exposure is proxied by the foreign value-added content of exports obtained from the OECD Trade in Value Added database. Trade openness is included as a control variable to distinguish the effect of GVC exposure from broader international trade integration.

The baseline model relates growth vulnerability to foreign value-added exposure and trade openness while controlling for country-specific heterogeneity and common global shocks through country and time fixed effects. Given the presence of cross-sectional dependence, heteroskedasticity, and serial correlation, statistical inference is based on Driscoll–Kraay standard errors.

5.1. DESCRIPTIVE STATISTICS

Table 1 reports descriptive statistics for the variables used in the analysis, providing an overview of their central tendencies, dispersion, and overall distribution before the econometric estimation.

Table 1. Panel Descriptive Statistics

Variables	Mean	Overall Std. Dev.	Between Std. Dev.	Within Std. Dev.	Min	Max
Growth vulnerability (VULN)	2.10	0.90	0.55	0.72	0.70	5.60
Foreign value added in exports (FVA)	22.8	8.4	6.8	4.9	8.5	42.0
Trade openness (OPEN, % of GDP)	55.4	21.7	18.5	10.8	18.2	110.6

Notes: The overall standard deviation measures total variation in the pooled panel. The between standard deviation captures variation across countries, while the within standard deviation reflects changes over time within countries. VULN denotes growth vulnerability, measured as the five-year rolling standard deviation of real GDP growth. FVA denotes the foreign value-added share of exports, and OPEN denotes trade openness, measured as exports plus imports of goods and services as a percentage of GDP.

Source: The Authors

Table 1 shows sufficient variation in all variables across G20 economies during 1995–2023. Growth vulnerability has a mean of 2.10 and a standard deviation of 0.90, indicating meaningful differences in macroeconomic instability across countries and over time.

The foreign value-added share of exports averages 22.8 percent and ranges from 8.5 to 42.0 percent. This dispersion reflects substantial heterogeneity in GVC participation and dependence on imported intermediate inputs.

Trade openness has a mean of 55.4 percent and a standard deviation of 21.7, with values ranging from 18.2 to 110.6 percent. These figures are consistent with the structural diversity of the G20, which includes both large, relatively closed economies and highly trade-oriented countries. Including OPEN allows the empirical analysis to separate the broader effects of trade integration from the specific association between foreign value-added exposure and growth vulnerability.

5.2. CROSS-SECTIONAL DEPENDENCE TEST

Given the strong economic interdependence among G20 economies and the global nature of production networks, cross-sectional dependence is likely to be present. Ignoring this dependence may produce inconsistent standard errors and misleading statistical inference. To evaluate this issue, the Pesaran (2004) cross-sectional dependence test is applied. The results are reported in Table 2.

Table 2. Cross-Sectional Dependence Test

Variables	CD statistic	p-value
VULN	6.84	0.000***
FVA	9.27	0.000***
OPEN	7.56	0.000***

Notes: *** denotes statistical significance at the 1% level; ** at the 5% level; * at the 10% level.

Source: The Authors

The Pesaran (2004) CD test results are reported in Table 2. The CD statistics are 6.84 for VULN, 9.27 for FVA, and 7.56 for OPEN, with p-values of 0.000 in all cases. The null hypothesis of cross-sectional independence is therefore rejected at the 1% significance level for each variable.

These findings confirm the presence of cross-sectional dependence in the panel. Accordingly, Driscoll-Kraay standard errors are used in the fixed-effects estimations to obtain inference robust to cross-sectional dependence, heteroskedasticity, and serial correlation.

5. 3. HAUSMAN SPECIFICATION TEST

The Hausman specification test is used to determine whether the fixed-effects or random-effects estimator is more appropriate. The test examines whether unobserved country-specific effects are correlated with the explanatory variables. Under the null hypothesis, the random-effects estimator is consistent and efficient, whereas rejection of the null supports the fixed-effects specification.

The results are presented in Table 3.

Table 3. Hausman Specification Test

Variables	Fixed Effects Coefficient	Random Effects Coefficient	Difference	Std. Error
FVA	0.021	0.016	0.005	0.003
OPEN	0.006	0.003	0.003	0.002
Chi-square statistic	8.74			
p-value	0.0126**			
Preferred estimator	Fixed effects			

Notes: ** denotes statistical significance at the 5% level. The null hypothesis of the Hausman test is that the random-effects estimator is consistent. Rejection of the null hypothesis supports the use of the fixed-effects estimator.

Source: The Authors

The Hausman test statistic is 8.74, with a p-value of 0.0126. Since the p-value is below the 5% significance threshold, the null hypothesis is rejected. This indicates that the random-effects estimator is inconsistent because unobserved country-specific effects are correlated with the explanatory variables. The fixed-effects estimator is therefore retained as the preferred specification.

5. 4. BASELINE FIXED-EFFECTS RESULTS

Following the evidence of cross-sectional dependence reported in Table 2, the baseline relationship between global supply chain exposure and macroeconomic vulnerability is estimated using a fixed-effects panel model with time effects. This specification controls for unobserved, time-invariant country characteristics and common global shocks.

Statistical inference is based on Driscoll-Kraay standard errors, which are robust to heteroskedastici-

ty, serial correlation, and cross-sectional dependence. The estimation results are presented in Table 4.

Table 4. Baseline Fixed-Effects Estimation

Dependent variable: VULN	Coefficient	Std. Error	T-stat
FVA	0.021	0.010	2.10**
OPEN	0.006	0.003	2.00**
Country fixed effects	Yes		
Time fixed effects	Yes		
Observations	480		
Countries	20		
Within R-squared	0.184		
Between R-squared	0.231		
Overall R-squared	0.207		
F statistic	4.42**		

Notes: ** denotes statistical significance at the 5% level; * at the 10% level. Standard errors are Driscoll-Kraay standard errors robust to cross-sectional dependence, heteroskedasticity, and serial correlation. The effective sample size is reduced due to the construction of rolling-window volatility measures and missing observations in value-added trade data.

Source: The Authors

Table 4 presents the baseline fixed-effects estimates. The coefficient on FVA is positive and statistically significant at the 5% level ($\beta = 0.021$; $SE = 0.010$; $t = 2.10$), indicating that greater foreign value-added exposure is associated with higher growth vulnerability. OPEN also has a positive and statistically significant coefficient ($\beta = 0.006$), suggesting that broader trade integration is associated with greater growth volatility in the baseline specification.

The model explains a modest share of the variation in growth vulnerability. The within R-squared of 0.184 indicates that 18.4% of the within-country variation is explained by the model. The between and overall R-squared values are 0.231 and 0.207, respectively, indicating a moderate fit for a parsimonious macro-panel specification.

5. 5. ROBUSTNESS CHECK TEST

To assess whether the baseline findings are sensitive to the specific construction of the growth vulnerability measure, a robustness check is conducted using an alternative rolling window. Instead of the five-year window employed in the baseline specification, growth vulnerability is redefined as the three-year rolling standard deviation of real GDP growth. This alternative measure places greater weight on short-term fluctuations and allows for a check of stability across definitions.

The findings are reported in Table 5.

Table 5. Robustness Check Test: Alternative Vulnerability Measure

Dependent variable: VULN	Coefficient	Std. Error	T-stat
FVA	0.018	0.010	1.78*
OPEN	0.005	0.003	1.67*
Country fixed effects	Yes		
Time fixed effects	Yes		
Observations	480		
Countries	20		
Within R-squared	0.162		
Between R-squared	0.205		
Overall R-squared	0.181		
F statistic	3.21**		

Notes: * denotes statistical significance at the 10% level; ** at the 5% level; *** at the 1% level. Standard errors are Driscoll-Kraay standard errors robust to cross-sectional dependence, heteroskedasticity, and serial correlation. The effective sample size is reduced due to the construction of rolling-window volatility measures and missing observations in value-added trade data. For comparability with the baseline model, the robustness

specification is estimated using the same effective sample.

Source: The Authors

Table 5 reports the robustness results using the three-year rolling standard deviation of real GDP growth as an alternative measure of vulnerability. The coefficient on FVA remains positive and statistically significant at the 10% level ($\beta = 0.018$; $SE = 0.010$; $t = 1.78$). OPEN is also positive and significant at the 10% level ($\beta = 0.005$; $SE = 0.003$; $t = 1.67$).

These results confirm that the positive association between foreign value-added exposure and growth vulnerability is robust to a shorter rolling window. Although statistical significance is weaker than in the baseline model, the direction and magnitude of the coefficients remain broadly consistent. The model retains modest explanatory power and captures both within-country and cross-country variation, although its overall fit is slightly lower than that of the baseline specification.

6. RESULTS, DISCUSSION AND POLICY IMPLICATIONS

This study examines whether exposure to global production networks is associated with growth vulnerability in G20 economies. Growth vulnerability is measured by the rolling standard deviation of real GDP growth, while the foreign value-added share of exports is used as a proxy for GVC exposure. Trade openness is included to distinguish production-network dependence from broader international trade integration.

The fixed-effects results indicate a positive and statistically significant association between foreign value-added exposure and growth vulnerability. A one-percentage-point increase in the foreign value-added share of exports is associated with an increase of approximately 0.02 points in the volatility of real GDP growth. This relationship remains significant after controlling for trade openness, country-specific characteristics, and common global shocks.

Trade openness is also positively associated with growth vulnerability, suggesting that more externally integrated economies may be more sensitive to international disturbances. However, the persistence of the FVA coefficient indicates that GVC exposure captures a distinct dimension of vulnerability beyond general trade openness.

The robustness analysis supports the baseline findings. When vulnerability is measured using a three-year rather than a five-year rolling window, both FVA and OPEN remain positively associated with growth volatility. Although significance falls to the 10% level, the stability of the coefficient signs and magnitudes suggests that the results are not driven by a particular measurement choice.

The findings are consistent with production-network theory, which emphasizes the transmission of shocks through input-output linkages and cross-border production relationships (Acemoglu et al., 2012; Baqaee & Farhi, 2019; Boehm et al., 2019). They also support evidence that GVCs contributed to the international propagation of pandemic-related output losses (Bonadio et al., 2021).

Nevertheless, the estimated effect is modest. GVC exposure should therefore be interpreted as a transmission and amplification channel rather than a dominant independent source of macroeconomic instability. This interpretation is consistent with Baldwin and Freeman (2022), who argue that supply-chain risk depends on supplier concentration, input substitutability, and the structure of production linkages.

The study contributes to the literature by showing that foreign value-added exposure remains positively associated with growth vulnerability even after controlling for trade openness. This distinction suggests that the architecture of international production matters independently of the overall scale of trade integration.

From a policy perspective, the results do not support broad disengagement from global value

chains. Reducing foreign input dependence or trade openness alone is unlikely to generate substantial stability gains and may sacrifice important efficiency benefits. More effective policies would promote supplier diversification, greater input substitutability, strategic inventories, and stronger domestic productive capacity.

The presence of cross-sectional dependence also highlights the importance of credible macro-economic institutions and international policy coordination. Because global shocks are transmitted across interconnected economies, supply-chain resilience should complement, rather than replace, sound fiscal, monetary, and structural policies.

7. CONCLUSION

The Covid-19 pandemic has triggered a fundamental transformation of global supply chains. While this continues, geopolitical risks arising from international conflicts, such as the war in Ukraine and tensions between Iran and the US, alongside energy crises and supply shocks, have had a profound effect on international economic activity, raising the question, ‘Is the global supply chain coming to an end?’ Examining post-Covid-19 developments reveals that factors determining supply chains are no longer solely cost-driven. Instead, they are shaped by resilience to changing conditions, flexibility in the face of supply shocks, product diversification, and sustainability.

This study investigates the extent to which changes in trade openness indicators (OPEN) and foreign value added in exports (FVA) affect economic fragility in national economies. The analyses conducted showed that both variables have a positive and significant effect on economic fragility. This finding raises the following fundamental question: Does the increase in fragility within countries stem from their own internal dynamics or from activities related to cross-border economic integration?

Recent empirical evidence provides guidance on this question. [Ristanović et al. \(2026\)](#) find that trade openness is the dominant driver of global value chain participation in developing and emerging economies. At the same time, they note that greater reliance on cross-border trade may increase exposure to external shocks, highlighting the need to balance deeper integration with strategies that strengthen resilience and domestic value capture. In contrast, [Javorcik et al. \(2026\)](#) demonstrate that rising customs tariffs resulting from trade wars in major importing countries such as China have led to divergent behaviour among firms: while large firms adopt diversification strategies to reduce their dependence on a single supplier, small firms, due to their limited resources, prefer concentration (i.e. dependence on a single supplier). Furthermore, firms are increasingly reorganising their supply chains through more diversified, regionalised, and localised production models, including locating production within or closer to major consumer markets. These developments do not necessarily indicate the disappearance of global supply chains; rather, they suggest that companies are reorganising their international production networks instead of withdrawing entirely from global trade ([Murray, 2006](#)).

In this context, the [OECD \(2025\)](#) states that global supply chains must be assessed in terms of trade openness and FVA, as these indicators contain factors that trigger countries’ external dependence in production activities and consequently increase economic growth fragility. This is consistent with the findings of this study. A country’s vulnerability is not limited to its own economic activity, but is also shaped by spillover effects arising from cross-border production and supply integration via international channels. However, other studies ([Javorcik et al., 2026](#); [Murray, 2026](#)) suggest that globalisation has not ended, but has instead evolved in response to firm size, geopolitical proximity, and alliance relationships. In this context, the FVA–vulnerability relationship identified in our study does not imply that trade integration should be abandoned. On the contrary, it suggests that managing integration through diversification, flex-

ibility, and strategic partnerships is crucial in reducing the vulnerability of national economies.

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