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Research Article

**The Impact of Global Value Chains on Business Cycles: A Comparative Analysis
of G7 and D8 Countries**

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Abstract

Introduction: This study investigates the effects of global value chain (GVC) participation on domestic business cycles in developed (G7) and developing (six selected D8) countries. Understanding this relationship is crucial, as increasing global integration may generate asymmetric macroeconomic outcomes across country groups.

Method: The analysis employs panel data covering the period 1995–2022. Business cycles are represented by the cyclical component of real GDP obtained through filtering techniques. GVC participation is examined alongside fixed capital formation and labor productivity. The empirical analysis is conducted using the Cross-Sectionally Augmented Autoregressive Distributed Lag (CS-ARDL) approach, which accounts for cross-sectional dependence and heterogeneity.

Results or Findings: The results indicate that fixed capital formation and labor productivity are positively and significantly associated with cyclical economic activity in both country groups. However, the relationship with GVC participation differs markedly: while GVC participation exhibits a positive co-movement with expansionary phases in G7 countries, it is negatively associated with cyclical momentum in the six selected D8 countries.

Discussion or Conclusion: These findings suggest that the macroeconomic effects of GVC integration are heterogeneous, depending on countries' positions within value chains and their modes of integration. The results highlight the importance of upgrading within GVCs for developing countries. Future research may explore sectoral dynamics and the role of institutional factors in shaping these outcomes.

Keywords: global value chain participation, business cycles, CS-ARDL

JEL Codes: F13, F15, E32

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Araştırma Makalesi

**Küresel Değer Zincirlerinin İş Döngüleri Üzerindeki Etkisi: G7 ve D8 Ülkelerinin
Karşılaştırmalı Analizi**

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Öz

Giriş: Bu çalışma, küresel değer zinciri (GVC) katılımının gelişmiş (G7) ve gelişmekte olan (seçilmiş altı D8 ülkesi) ülkelerde yurt içi iş çevrimleri üzerindeki etkilerini incelemektedir. Artan küresel entegrasyonun ülke grupları arasında asimetrik makroekonomik sonuçlar doğurabilmesi nedeniyle, bu ilişkinin anlaşılması önem taşımaktadır.

Yöntem: Analizde 1995–2022 dönemini kapsayan panel veri seti kullanılmıştır. İş çevrimleri, reel GSYH serisinin filtreleme yöntemleriyle elde edilen çevrimsel bileşeni ile temsil edilmektedir. GVC katılımı, sabit sermaye oluşumu ve emek verimliliği değişkenleriyle birlikte ele alınmaktadır. Ampirik analizde, yatay kesit bağımlılığını ve heterojenliği dikkate alan Kesitlerarası Genişletilmiş Otokoregresif Dağıtılmış Gecikme (CS-ARDL) yöntemi kullanılmaktadır.

Sonuçlar ya da Bulgular: Elde edilen sonuçlar, sabit sermaye oluşumu ve emek verimliliğinin her iki ülke grubunda da döngüsel ekonomik faaliyetlerle istatistiksel olarak anlamlı ve pozitif bir ilişki sergilediğini göstermektedir. Buna karşılık, GVC katılımı ile olan ilişki belirgin biçimde farklılaşmaktadır: GVC katılımı G7 ülkelerinde genişleme dönemleriyle pozitif bir birlikte hareketlilik gösterirken, seçilmiş altı D8 ülkesinde döngüsel ivmeyle negatif yönde ilişkili bulunmuştur.

Tartışma ya da Yapılan Çıkarımlar: Bu bulgular, GVC entegrasyonunun makroekonomik etkilerinin homojen olmadığını; ülkelerin değer zincirlerindeki konumlarına ve entegrasyon biçimlerine bağlı olarak değiştiğini ortaya koymaktadır. Sonuçlar, özellikle gelişmekte olan ülkeler için değer zincirlerinde yukarı yönlü dönüşümün önemine işaret etmektedir. Gelecek çalışmalar, sektörel dinamikleri ve kurumsal faktörlerin rolünü daha ayrıntılı biçimde inceleyebilir.

Anahtar Kelimeler: küresel değer zincirine katılım, iş çevrimleri, CS-ARDL

JEL Kodlar: F13, F15, E32

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Introduction

International trade was known in the classical economic literature to support growth by improving resource allocation. However, global value chains have shifted trade from final goods to production stages, giving rise to the phenomenon of task trade (Tian et al., 2022). This transformation shows that production activities are not only about the exchange of goods between countries but also about the restructuring of production processes on an international scale, dividing them into stages (Montalbano & Nenci, 2022). Therefore, a global value chain (GVC) perspective has become indispensable for understanding the relationship between trade and growth.

GVCs encompass the activities performed by firms, producers, and workers throughout the lifecycle of a product or service, from initial design and production to distribution, final delivery, reuse, and recycling (Oliveira et al., 2026). These activities include manufacturing, logistics, commercial operations, financial services, after-sales services, and end-of-life management. Since the 1980s, trade liberalization, lower transportation costs, and technological advances have enabled the division of production processes into stages and their location across different countries, contributing to the development of GVCs (Cigna et al., 2022; Singh et al., 2023). Over the same period, intermediate goods have come to account for more than half of world trade, while foreign direct investment and intra-firm trade have gained importance. Multinational corporations have played a central role in this process by coordinating different stages of production through their subsidiaries and independent suppliers, and now account for a substantial share of global trade (Osabohien et al., 2024). GVCs also allow firms to organize production across countries according to differences in labor conditions, taxation, legal frameworks, and market access. As a result, production has increasingly been organized around vertical specialization across countries. Countries' economic performance has therefore become linked not only to domestic demand and technological capacity but also to their position within global production networks (Chen & Xing, 2022).

GVC participation may shape cyclical output through production and productivity channels, but its relationship with domestic economic activity may differ depending on countries' exposure to external shocks (Mao, 2022; Wang et al., 2022; Jangam & Rath, 2024; Jithin et al., 2023; Zhu & Wang, 2025; Lee et al., 2025). Backward linkages increase reliance on imported inputs and may transmit external supply shocks to domestic production. Forward linkages connect domestic value added to foreign demand and may therefore transmit demand-side changes across countries. These two forms of integration can also affect the degree of business cycle synchronization across economies. The relationship between GVC participation and business cycles may thus vary with a country's position in the value chain, type of integration, and sectoral structure (Jangam & Rath, 2024). Differences between developed and developing economies are also documented in the literature. Zhu and Wang (2025) find that GVC linkages strengthen business cycle co-movement, particularly between developed and developing country pairs. Wang et al. (2022) show that developed economies benefit from productivity gains associated with complex and forward-linked activities. In contrast, developing economies rely more heavily on backward linkages and experience sharper contractions during crises. These differences provide the basis for examining the relationship between GVC participation and domestic cyclical output separately for developed and developing economies. Accordingly, this study expects the relationship between GVC participation and cyclical output to differ between the two country groups. Macroeconomic transmission channels provide the theoretical basis for examining this relationship. In this framework, cyclical output dynamics are associated with productive factors such as capital accumulation and labor performance (Chen & Yao, 2024; Mandal & Taku, 2025; Yin & Wang,

2026). The expansion of global value chains, however, has added an international dimension to production processes (Montalbano & Nenci, 2022). GVC participation is linked to production through technology transfers, information flows, and cross-border intermediate linkages. Cyclical output movements may therefore be associated not only with domestic investment and labor productivity but also with countries' participation in international production networks. On this basis, the empirical analysis examines GVC participation alongside domestic investment and labor productivity within an augmented macroeconomic empirical framework.

This study is motivated by a significant gap in the literature. Existing studies have primarily examined the contribution of trade ties to cross-country business cycle synchronization or analyzed the impact of GVCs on growth. Yet, the systematic effects of GVC participation on countries' own domestic business cycles have not been addressed. In particular, findings on how differences between developed and developing countries are reflected in business cycles via GVCs are extremely limited. Thus, the main objective of our study is to empirically examine the effects of GVC participation on business cycles in both developed and developing countries. The analysis aims to reveal the consequences of different positions in value chains on cyclical dynamics by evaluating developed and developing countries as separate panel groups. Thus, it contributes to the literature on how GVCs influence not only the international coordination dimension but also domestic cyclical fluctuations. The reason CS-ARDL is preferred for the analysis is that it allows the simultaneous examination of long-term relationships and short-term dynamics while accounting for cross-sectional dependence and heterogeneity within the panel. In light of this information, the expected contributions of this study can be summarized at three levels: (i) In terms of contribution to the literature, it is one of the rare studies analyzing the impact of GVCs on domestic business cycles. (ii) In terms of comparative analysis, it systematically reveals the effects of GVCs at different levels of development by separating developed and developing countries. (iii) As a methodological contribution, thanks to the CS-ARDL approach, more reliable results are obtained by considering both heterogeneity and cross-sectional dependence in the panel dataset.

The rest of the study is organized as follows: The second section details the literature on the effects of GVCs on business cycles. The third section describes the model, the dataset, and the methodology, and the fourth section presents the empirical findings. Following a Discussion section that compares the analysis findings with the existing literature, the study concludes with a Conclusion section.

Literature Review

The relationship between trade integration and business cycles has long been debated in the literature. Frankel and Rose (1998) provided the first evidence that stronger bilateral trade linkages are associated with greater business cycle synchronization. However, subsequent studies have shown that greater trade integration does not necessarily imply lower output volatility. For example, Di Giovanni and Levchenko (2009) found that trade openness can increase output volatility through greater sectoral specialization and export concentration. Haddad et al. (2013) demonstrated that export diversification plays a key role in explaining these seemingly contradictory effects. According to their findings, the effect of trade openness on growth volatility depends on the degree of export diversification, and more diversified economies benefit more from greater openness. The role of trade in business cycle dynamics has also been examined through various transmission channels. Using firm-level data for France, Di Giovanni et al. (2018) showed that firms with direct trade or multinational linkages to a country tend to exhibit stronger co-movement with that country's economy. At a general level, Caselli et al. (2020), emphasizing the diversification channel of international trade,

demonstrated that its volatility-reducing effect may outweigh the volatility generated by specialization. D'Aguanno et al. (2021) extended this debate to global value chains (GVCs), emphasising that integration can increase efficiency but that its effects on volatility depend, amongst other factors, on supplier diversification. These studies demonstrate that the effects of trade integration depend not only on the degree of openness but also on the structure of international linkages. Subsequent studies have revealed that the relationship between trade and business cycles varies depending on the source of shocks and the channels of international integration. Using an open-economy model calibrated for China, Ma et al. (2022) found that the effect of trade openness on volatility differs depending on the type of shock affecting the economy. On the other hand, Azcona (2022), approaching the issue from the perspective of shared trade exposure, demonstrated that countries sharing major trading partners—even if their bilateral trade is limited—may exhibit a higher degree of business cycle synchronisation. Other studies have examined the non-trade and institutional dimensions of this relationship. For example, Beck and Nzimande (2023) found that labour mobility in South Africa weakened business cycle synchronisation over time; whilst Gnanon (2023) demonstrated that longer GATT/WTO membership is associated with lower growth volatility, particularly when accompanied by higher export diversification. Recent studies continue to emphasise the importance of economic structure and external exposure. Ardelean et al. (2024) have shown that the balance between market diversity and specialisation plays a significant role in determining growth volatility. Avila Montealegre and Mix (2024), focusing on the co-movement of business cycles, found that part of the effect attributed to bilateral trade reflects countries' shared exposure to third markets. When this shared exposure is taken into account, the direct effect of bilateral trade is significantly weakened. On the other hand, Casal and Guntin (2025) have linked the higher volatility observed in developing economies to these economies' high dependence on more volatile sectors. Overall, these findings reinforce the view that the relationship between international integration and business cycle dynamics depends to a large extent on countries' trade patterns and structural characteristics.

A separate strand of research asks not how global value chains affect business cycles, but how they affect growth and structural change; this is a related but distinct question. Montalbano and Nenci (2022), focusing specifically on agricultural and food value chains, found that forward participation tends to support economic stability, whilst backward participation may accelerate the transmission of shocks; this is a sector-specific rather than a general finding, but it foreshadows a pattern observed elsewhere. Working with a panel comprising 63 developed and emerging economies, Mao (2022) identified a U-shaped relationship: middle-income economies benefit from first withdrawing from foreign-dominated global value chains to establish local value chains, and then re-engaging more deeply once these chains are in place. Wiryawan et al. (2023) also found that participation in global value chains, largely through forward and backward linkages, yields gains in industrial upgrading. Their data showed that, for the most part, low-technology manufacturing contracted rather than improved. Although Mancini et al., (2024) did not themselves test a causal relationship, their new datasets comprising upstreamness and downstreamness indicators have become the standard tool used by other researchers to ask precisely this question: Where does a country stand in the chain, and what does this position mean in terms of the risks it faces and its growth prospects? Owusu (2025), using a sample of 46 emerging countries, confirmed that participation in GVCs increases total labor productivity, that the structural transformation component of this gain is as significant as the intra-sectoral component, and that the benefits are strongest in Asia and Latin America. Lee et al. (2025) compared South Korea and Spain and found that forward linkages in the global value chain had negative effects on growth in both countries, particularly in certain sectors, whilst backward linkages were beneficial only in specific Spanish sub-sectors

and continued to have a negative impact on Korean growth. Zou (2026) modeled the relationship not as linear or U-shaped, but as N-shaped. An initial learning phase leads to a 'scale-up trap' in which the benefits of participation actually diminish; in a subsequent breakthrough phase, deeper linkages finally bear fruit once more. Although these studies have focused primarily on growth and structural transformation rather than business cycles, they point to a significant source of heterogeneity in the effects of participation in GVCs. In particular, differences in income levels, structural transformation and position within value chains suggest that the cyclical effects of GVC integration may also vary between developed and emerging economies.

Studies linking GVCs directly to business cycles have focused primarily on shock transmission and the synchronized movement of economic activity. Altomonte et al. (2012), examining the 2008–2009 global crisis, demonstrated how adjustments in demand for intermediate goods and in inventories contributed to the transmission and amplification of the decline in final demand throughout supply chains. Subsequent studies have focused on the synchronization of business cycles through value-chain trade. Jiang et al. (2019) found that value-added trade reinforced the synchronization of business cycles in East Asia. Yu et al. (2023) reported a similar relationship for China and Belt and Road partner countries, noting that GVC trade is positively associated with business cycle synchronization. These findings suggest that production linkages can transmit fluctuations between economies and interlink production processes. The transmission of shocks via GVCs has also been examined from different perspectives. Cook and Patel (2023), using a dollar-invoiced DSGE model, demonstrated that GVC trade and traditional bilateral trade respond differently to interest rate shocks, and that these responses depend on the invoicing currency. This finding highlights the role of monetary conditions in the transmission of shocks via international production networks. Adopting a different approach, Angelidis and Varsakelis (2023) analyzed global value chains as networks and found that greater interdependence between countries facilitates the transmission of shocks across the network. Taken together, these studies demonstrate that the transmission of shocks via global value chains depends on both the structure of production linkages and the conditions under which international transactions take place. More recent studies have examined the channels through which GVC linkages contribute to business cycle synchronization. Drawing on data from 72 economies over the period 2010–2019, Lee et al. (2024) found that trade integration, particularly in intermediate goods, is a significant determinant of synchronization, alongside foreign direct investment and debt market integration. Choi (2025) focused more directly on the role of intermediate goods and estimated, through model simulations, that they accounted for approximately 31–33 percent of trade-output synchronization, when value-added rents were included, this proportion rose to approximately 55 percent. Kang (2025) demonstrated that synchronization is not limited to direct bilateral trade relations. Using Korean data, the study found that shared exposure to third-country markets, primarily through intermediate inputs, also contributes to business cycle synchronization. Zhu and Wang (2025), using data for 43 countries, similarly found a positive relationship between global value chain linkages and production cycle correlation. However, the magnitude of this relationship varies across different types of value chain linkages. However, much of this literature focuses on cross-country business cycle synchronization or co-movement, rather than on how participation in GVCs affects local business cycle fluctuations. Furthermore, relatively little attention has been paid to whether this relationship differs systematically between developed and emerging economies. This study aims to address this gap by examining the impact of participation in global value chains on business cycles separately for these two groups of countries.

More recent studies have broadened this debate to include the effects of geoeconomic fragmentation and geopolitical tensions on international trade. Bonadio et al. (2025) found that, rather than collapsing under geopolitical tensions, global trade reorganized itself into blocs aligned with the US and China respectively. That intra-bloc trade costs actually fell whilst inter-bloc costs rose. Salvatore and Tripathi (2025), who examined 132 countries between 2017 and 2023, approached the question of fragmentation through the lens of growth rather than cycles: they found that, with the rise of protectionism, trade's role as a driver of growth has weakened and that it now acts as a facilitator rather than a driving force.

Across all three strands, the same tension keeps resurfacing. A significant portion of the literature suggests that deeper trade and global value chain integration could strengthen the synchronization of business cycles across countries. However, the same channels may also facilitate the transmission of shocks, and the resulting effects appear to depend on countries' structural characteristics and their positions within value chains. Taken together, these findings suggest that the cyclical outcomes of participation in GVCs may differ across countries and provide a basis for examining advanced and emerging economies separately.

Model, Data, and Methodology

Model

In order to examine how integration into the global value chain (GVC) interacts with business cycle dynamics, an extended macroeconomic framework has been developed that takes cyclical fluctuations into account and is based on the fundamental macroeconomic transmission channels. In line with empirical studies in the open economy literature (Constantinescu et al., 2019), output dynamics and cyclical deviations (BC_{it}) have been modelled as a function of foreign trade integration, capital accumulation and labour performance:

$$BC_{it} = f(GVC_{it}, GCF_{it}, LP_{it}) \quad (1)$$

Accordingly, the baseline econometric model is formulated as follows:

$$BC_{it} = \beta_0 + \beta_1 GVC_{it} + \beta_2 GCF_{it} + \beta_3 LP_{it} + \varepsilon_{it} \quad (2)$$

In this empirical specification, the explanatory variables are defined as standard macroeconomic proxies rather than direct factor stocks:

BC_{it} represents the business cycle component, obtained by detrending real GDP using the Hodrick-Prescott filter ($\lambda = 6.25$). Expressed in billions of US dollars, this signed measure captures cyclical movements in economic activity (output gap dynamics) rather than the magnitude of volatility per se. GVC_{it} measures total participation in global value chains (the sum of forward and backward linkages) and operates as an indicator of external integration, cross-border production sharing, and international technology diffusion channels. GCF_{it} is gross fixed capital formation as a percentage of GDP, capturing the pace of domestic investment activity and capital accumulation dynamics. LP_{it} denotes labor productivity, calculated as real GDP divided by total employment and expressed in thousands of US dollars for numerical scaling and coefficient readability. While LP_{it} reflects output per worker, it enters the model in normalized levels to capture productive efficiency, organizational capacity, and workforce performance alongside detrended cyclical output.

From a theoretical perspective, increases in GCF are expected to enhance productive capacity through capital deepening (Acemoglu & Guerrieri, 2008) and the demand-side

momentum of investment. Similarly, improvements in *LP* reflect gains in organizational efficiency and skills, exerting an upward effect on cyclical economic activity. In contrast, the net macroeconomic impact of *GVC* participation on business cycle dynamics is theoretically ambiguous. On the one hand, deeper *GVC* integration can support cyclical output through technology transfers, productivity spillovers, economies of scale, and expanded market access. On the other hand, it can heighten vulnerability to external demand and supply shocks, accelerate cross-border shock transmission, and disrupt production during global supply bottlenecks.

Ultimately, the net effect of *GVC* integration depends on country-specific structural characteristics—such as sectoral composition, trade orientation, domestic value-added content, and financial depth. While *GVC* participation tends to bolster economic activity in well-diversified economies embedded in advanced supply networks, it may be associated with weaker cyclical output performance in economies characterized by high financial vulnerability and excessive reliance on imported intermediate inputs (World Bank, 2020).

Data

The effect of *GVC* integration on production is conditioned by country characteristics. To account for this heterogeneity, two country groups were analyzed: The Developing Eight (D8) is an intergovernmental economic cooperation which was established in 1997 by eight founding members: Bangladesh, Egypt, Indonesia, Iran, Malaysia, Nigeria, Pakistan, and Türkiye. Although Azerbaijan joined as the ninth member in 2024, it falls outside the institutional scope of the historical sample period (1995–2022). Among the founding members, Iran and Nigeria were excluded due to data constraints: OECD TiVA does not provide *GVC* participation indicators for Iran, while continuous gross capital formation (GCF) series could not be retrieved for Nigeria across the entire sample period. Consequently, the empirical developing country panel focuses on the remaining six founding members (Bangladesh, Egypt, Indonesia, Malaysia, Pakistan, and Türkiye) with continuous and balanced data, referred to throughout as the “six selected D8 countries”. The remaining six selected D8 countries had a combined nominal GDP of approximately USD 4.5 trillion in 2024, accounting for about 4% of global GDP. Their exports of goods and services reached USD 1.2 trillion (3.5% of global exports), while their population of roughly 950 million accounted for 11.6% of the global total (World Bank, 2025).

The G7 is an informal group of advanced industrialized democracies comprising the United States, Canada, Germany, France, Italy, Japan, and the United Kingdom. Members convene annually to assess global economic and geopolitical developments. In 2024, the G7’s combined GDP is approximately USD 57 trillion, accounting for about 29% of global output (Council on Foreign Relations, 2025). Their exports are projected to reach USD 6.7 trillion, accounting for roughly 32% of global exports (United Nations, 2025). With a population of about 785 million, the G7 constitutes 9.6% of the global population (World Bank, 2025).

GVC data were obtained from the OECD’s Trade in Value Added (TiVA) database, widely regarded as the most comprehensive source for value chain indicators. As TiVA covers the 1995–2022 period, the analysis is restricted to these years. Data for BC, GCF, and LP were sourced from the World Bank’s World Development Indicators (WDI). All variables are annual.

Methodology

The baseline econometric model estimated in this study is as follows:

$$BC_{it} = \alpha_i + \lambda_t + \beta GVC_{it} + \gamma_1 GCF_{it} + \gamma_2 LP_{it} + \varepsilon_{it} \quad (3)$$

In the sample, the time dimension ($T=28$) is larger than the cross-sectional dimension ($N=6, 7$). In macro panels where $T > N$, traditional static panel estimators such as fixed effects and random effects may produce biased and inconsistent estimates if issues of slope heterogeneity, cross-sectional dependence, and non-stationarity are present. Therefore, before selecting the appropriate estimation technique, preliminary diagnostic tests including cross-sectional dependence, slope homogeneity, unit root, and cointegration must be conducted.

Slope Heterogeneity

In panel data models, testing whether the slope coefficients are homogeneous across units is important for selecting the appropriate estimator. For this purpose, the Slope Homogeneity test developed by Pesaran and Yamagata (2008) was used in the study. This test produces consistent results even in cases of heteroscedasticity. The delta ($\tilde{\Delta}_{HS}$) and adjusted delta ($\tilde{\Delta}_{AHS}$) test statistics from the Pesaran and Yamagata (2008) test are formulated as follows:

$$\tilde{\Delta}_{HS} = (N)^{\frac{1}{2}}(2k)^{-\frac{1}{2}} \left(\frac{1}{N} \tilde{S} - k \right) \quad (4)$$

$$\tilde{\Delta}_{AHS} = (N)^{\frac{1}{2}} \left(\frac{2k(T-k-1)}{T+1} \right)^{-\frac{1}{2}} \left(\frac{1}{N} \tilde{S} - 2k \right) \quad (5)$$

Blomquist and Westerlund (2013) extended Pesaran and Yamagata's (2008) slope heterogeneity tests with a bootstrap-based approach and presented the HAC (Heteroskedasticity and Autocorrelation Consistent) estimator. This modification has made the method resistant to heteroskedasticity and autocorrelation. As a result, consistent results have been obtained even with small samples.

$$\tilde{\Delta}_{HAC} = (N)^{\frac{1}{2}}(2k)^{-\frac{1}{2}} \left(\frac{1}{N} \tilde{S}_{HAC} - k \right) \quad (6)$$

Here, $\tilde{S}$ represents the Swamy test statistic, k represents the number of explanatory variables in the model, N represents the number of cross-sectional units, and T represents the number of time periods.

Cross-sectional Dependence (CSD) Test

Cross-sectional dependence (CSD) arises when the units comprising a panel (for example, countries or firms) are not independent of one another, and a shock occurring in one unit affects the other units as well. Given the structure of global value chains, such interactions between countries are economically inevitable. Spillover effects arising from global integration—such as financial crises, fluctuations in oil prices and other common macroeconomic shocks—lead to interdependence amongst panel units.

To account for CSD and guide estimator selection, Pesaran's (2021) CD test was employed. The test statistic is defined as follows:

$$CD = \sqrt{\frac{2T}{N(N-1)}} \left(\sum_{i=1}^{N-1} \sum_{j=i+1}^N \hat{\rho}_{ij} \right) \rightarrow N(0,1) \quad (7)$$

Panel Unit Root Test

The stationarity properties of the series were investigated using the CIPS (Cross-sectionally Augmented IPS), a second-generation unit root test developed by Pesaran (2007). CIPS also accounts for cross-sectional dependence. The Pesaran (2007) CIPS test is a simple arithmetic mean of individual CADF statistics, calculated by including the lagged levels and differences of the series, along with the cross-sectional means, in the standard ADF regression to control for cross-sectional dependence. The CIPS test examines the null hypothesis that the series contains a unit root for all cross-sectional units, against the alternative hypothesis that the series is stationary for at least one unit.

$$CIPS = \frac{1}{N} \sum_{i=1}^N t_i(N, T) \quad (8)$$

Cointegration Test

The cointegration relationship between the variables included in the study must be verified before estimating long-term coefficients. To obtain robust and reliable results and to account for cross-sectional dependence, the Westerlund (2007) panel cointegration test was applied. Westerlund's (2007) estimation equation is as follows:

$$\Delta y_{it} = \delta'_i d_t + \alpha_i (y_{it-1} - \beta'_i x_{it-1}) + \sum_{j=1}^{p_i} \alpha_{ij} \Delta y_{it-j} + \sum_{j=-q_i}^{p_i} \gamma_{ij} \Delta x_{it-j} + e_{it} \quad (9)$$

Westerlund (2007) calculates four different statistics for the cointegration test. Group mean statistics (G_t , G_a) allow for heterogeneity across units and test the alternative that the panel has cointegration in at least one panel. Panel statistics (P_t , P_a) assume a homogeneous structure and are based on the alternative hypothesis that the panel is cointegrated as a whole.

$$G_t = \frac{1}{N} \sum_{i=1}^N \frac{\hat{\alpha}_i}{SE(\hat{\alpha}_i)} \quad (10)$$

$$G_a = \frac{1}{N} \sum_{i=1}^N \frac{T \hat{\alpha}_i}{\hat{\alpha}_i(1)} \quad (11)$$

$$P_t = \frac{\hat{\alpha}}{SE(\hat{\alpha})} \quad (12)$$

$$P_a = T \hat{\alpha} \quad (13)$$

Westerlund's (2007) tests evaluate panel cointegration using an error-correction approach. In addition, Westerlund (2008) applied tests to account for cross-sectional

dependence and to control for the effect of global shocks. Westerlund (2008) generates two test statistics: the panel statistic (DH_p) and the group statistic (DH_g).

$$DH_g = \sum_{i=1}^n \hat{S}_i (\tilde{\phi}_i - \hat{\phi}_i)^2 \sum_{t=2}^T \hat{e}_{it-1}^2 \quad (14)$$

$$DH_p = \hat{S}_n (\tilde{\phi} - \hat{\phi})^2 \sum_{i=1}^n \sum_{t=2}^T \hat{e}_{it-1}^2 \quad (15)$$

The DH_p statistic tests for the existence of a common cointegration relationship across all units. The DH_g statistic accounts for heterogeneous structures. It tests whether cointegration exists in at least one unit. The countries in the dataset differ in their economic structures. Therefore, the Group Mean (DH_g) statistic, which allows the coefficients to vary across units in the panel, provides more reliable results.

CS-ARDL

Cross-sectional dependence and parameter heterogeneity were detected in the panel, and a cointegration relationship was confirmed. In macro panels where $T > N$, these empirical properties render traditional static panel models (e.g., Fixed Effects) and standard micro-panel dynamic estimators (e.g., GMM) biased and inconsistent. Beyond these econometric considerations, the CS-ARDL framework developed by Chudik et al. (2016) is specifically aligned with the core research questions of this study: it allows the estimation of dynamic adjustment speeds (ECT_{t-1}) through which external supply-chain shocks propagate across business cycles, accommodates structural asymmetries by permitting flexible slope estimation across separate G7 and six selected D8 panels, and filters out unobserved global common shocks (e.g., global trade contractions) via cross-sectional averages ($\bar{Z}_t$) to isolate the true domestic cyclical associations of GVC participation. Accordingly, the baseline CS-ARDL specification is formulated as follows:

$$\begin{aligned} BC_{it} = & \alpha_{it} + \sum_{j=1}^P \beta_{ij} BC_{i,t-j} \\ & + \sum_{j=0}^P (\gamma_{1,ij} GVC_{i,t-j} + \gamma_{2,ij} GCF_{i,t-j} + \gamma_{3,ij} LP_{i,t-j}) \\ & + \sum_{j=0}^3 (\delta_{1i} \overline{\Delta BC}_{t-j} + \delta_{2i} \overline{GVC}_{t-j} + \delta_{3i} \overline{GCF}_{t-j} + \delta_{4i} \overline{LP}_{t-j}) + \varepsilon_{it} \end{aligned} \quad (16)$$

To estimate the short-term dynamics between variables and the speed of adjustment of the system back to equilibrium following shocks, the error correction (ECM) form of the CS-ARDL model has been estimated.

$$\begin{aligned}
\Delta BC_{it} = & \phi_i (BC_{i,t-1} - \theta_{1i} GVC_{i,t-1} - \theta_{2i} GCF_{i,t-1} - \theta_{3i} LP_{i,t-1} - \omega'_i \bar{Z}_{t-1}) \\
& + \sum_{j=1}^{p-1} \psi_{1ij} \Delta BC_{i,t-j} + \sum_{j=0}^{q-1} \psi_{2ij} \Delta GVC_{i,t-j} \\
& \sum_{j=0}^{q-1} \psi_{3ij} \Delta GCF_{i,t-j} + \sum_{j=0}^{q-1} \psi_{4ij} \Delta LP_{i,t-j} + \sum_{s=0}^S \kappa'_{is} \Delta \bar{Z}_{t-s} + \mu_i + \tau_t + \varepsilon_{it}
\end{aligned} \tag{17}$$

Here, ϕ_i , is the error correction coefficient and represents the process of fitting the model to long-term equilibrium. θ_{1i} , θ_{2i} and θ_{3i} are the coefficients of the variables GVC, GCF, and LP, respectively. ψ_{1ij} , ψ_{2ij} and ψ_{3ij} , are the short-run dynamic relationship coefficients. p and q denote orders of lag and reflect the lagged effects of the relevant variables. The $\bar{Z}_t$ vector consists of the cross-sectional means of the BC, GVC, GCF, and LP variables and is included in the model with both level and difference terms to control for cross-sectional dependence. Furthermore, μ_i represents country-specific fixed effects, while τ_t represents time effects common to all cross sections. In addition to handling cross-sectional dependence and slope heterogeneity, the dynamic specification of the CS-ARDL estimator plays a crucial role in mitigating potential endogeneity and simultaneity concerns between the dependent variable (BC_{it}) and explanatory variables—most notably labor productivity (LP_{it}). Because BC_{it} is the detrended, cyclical component (output gap) extracted via the HP filter ($\lambda = 6.25$), whereas LP_{it} is measured in normalized levels (thousands of USD) as a structural efficiency proxy, the model substantially mitigates concerns over a direct mechanical accounting identity. Moreover, by incorporating autoregressive distributed lags of the regressors and dependent variable alongside cross-sectional averages ($\bar{Z}_t$), the CS-ARDL framework helps mitigate biases arising from dynamic feedback effects and unobserved common shocks. However, because dynamic macro-panel estimators cannot fully rule out contemporaneous simultaneity in the absence of strictly exogenous quasi-experimental variation, the estimated parameters are interpreted with caution as robust long-run dynamic associations rather than strict unidirectional causal effects. The inclusion of dynamic cross-sectional averages in the CS-ARDL specification effectively partials out strong, pervasive unobserved common factors across units, thereby mitigating potential parameter distortions arising from synchronized global macroeconomic shocks such as the 2020 COVID-19 pandemic.

Although the asymptotic theory of dynamic CCE and CS-ARDL estimators is formally developed for panels with large cross-sectional and time dimensions ($N, T \rightarrow \infty$), Monte Carlo evidence in Chudik and Pesaran (2015) suggests that the approach performs reasonably well with acceptable finite-sample properties in moderate time horizons ($T \approx 30$). Accordingly, the CS-ARDL framework has become widely adopted in empirical macroeconomics for naturally bounded, country-specific panels characterized by small N and moderate T , such as the G7 ($N = 7$), BRICS ($N = 5$), and Nordic groups ($N = 5$) (Adebayo et al., 2023; Dogan & Pata, 2022; Liu et al., 2023; Sharif et al., 2023).

Findings

Preliminary Test Results

Table 1

Heterogeneity Test Results

Test	Parameters	Group of 7		Six selected D8	
		Delta	P-Value	Delta	P-Value
Pesaran and Yamagata, 2008	$\overline{\Delta_I}$	7.262	0.000	5.659	0.000
	Δ_{adj}	8.081	0.000	6.297	0.000
Blomquist and Westerlund, 2013	(Δ_{HAC})	6.286	0.000	26.397	0.000
	$(\Delta_{HAC})_{adj}$	6.994	0.000	29.372	0.000

Note. Calculated using OECD's TiVA and World Bank's WDI data using Stata 17 statistical software.

The results of the Pesaran and Yamagata (2008) and Blomquist and Westerlund (2013) heterogeneity tests, presented in Table 1, indicate that the slope coefficients are not homogeneous across units. This finding reveals significant slope heterogeneity in the panel and suggests that second-generation panel estimation methods that account for heterogeneity are appropriate.

Table 2

CSD Test Results

Test	Group of 7		Six selected D8	
	Statistic	P-Value	Statistic	P-Value
Breusch-Pagan LM	226.10	0.000	86.55	0.000
Pesaran scaled LM	80.29	0.000	32.76	0.000
Pesaran CD	14.68	0.000	5.22	0.000

Note. Calculated using OECD's TiVA and World Bank's WDI data using Stata 17 statistical software.

The Breusch–Pagan LM, Pesaran-scaled LM, and Pesaran CD test results presented in Table 2 show significant cross-sectional dependence between units in both country groups. This finding highlights the importance of common shocks and cross-sectional interactions within the panel, underscoring the need for second-generation panel methods that account for cross-sectional dependence.

Table 3

Pesaran CIPS Panel Unit Root Test Results

Variable	Level, Constant	1st difference, Constant	Level, Constant & Trend	1st difference, Constant & Trend	Order
Group of 7					
BC	−2.116 (0.166)	−3.547 (0.000)	−2.180 (0.644)	−3.436 (0.001)	I(1)
GVC	−2.027 (0.233)	−4.265 (0.000)	−2.251 (0.567)	−4.239 (0.000)	I(1)
GCF	−1.411 (0.829)	−3.765 (0.000)	−1.159 (0.999)	−4.129 (0.000)	I(1)
LP	−0.949 (0.987)	−3.755 (0.000)	−1.642 (0.971)	−3.882 (0.000)	I(1)
six selected D8					

BC	-2.218 (0.124)	-3.859 (0.000)	-2.318 (0.491)	-3.698 (0.000)	I(1)
GVC	-1.869 (0.391)	-4.816 (0.000)	-2.436 (0.370)	-4.874 (0.000)	I(1)
GCF	-2.178 (0.146)	-4.637 (0.000)	-2.484 (0.323)	-4.518 (0.000)	I(1)
LP	-1.998 (0.274)	-3.291 (0.000)	-1.819 (0.902)	-3.638 (0.000)	I(1)

Values in parentheses are p-values.

Note. Calculated using OECD's TiVA and World Bank's WDI data using Stata 17 statistical software.

The panel unit root test results reported in Table 3 indicate that all variables are non-stationary in levels but stationary in first differences, confirming they are integrated of order one, I(1). This common I(1) order of integration satisfies the prerequisite for panel cointegration analysis. It supports the use of the CS-ARDL approach to estimate long-run and short-run dynamics under cross-sectional dependence. Although the HP cyclical component is mean-reverting by construction, severe macroeconomic shocks over the 1995–2022 period induce substantial finite-sample persistence and hysteresis, resulting in an empirical (1) behavior that justifies the dynamic CS-ARDL specification.

Table 4

Westerlund (2007) Cointegration Test Results

	Group of 7		Six selected D8	
	Statistics	Robust p -value	Statistics	Robust p -value
Gt	-1.134	0.320	-2.458	0.020
Ga	-5.376	0.020	-2.482	0.050
Pt	-1.264	0.000	-4.416	0.040
Pa	-2.743	0.000	-3.519	0.110

Note. Calculated using OECD's TiVA and World Bank's WDI data using Stata 17 statistical software. Reported robust p-values are empirically generated via 100 bootstrap replications to account for cross-sectional dependence.

Table 5

Westerlund (2008) Durbin-Hausman Cointegration Test Results

	Group of 7		Six selected D8	
	Statistics	Prob.	Statistics	Prob.
DHg	7.095	0.000	1.651	0.049
DHp	1.468	0.071	5.204	0.000

Note. Calculated using OECD's TiVA and World Bank's WDI data using Stata 17 statistical software.

The cointegration test results reported in Tables 4 and 5 provide strong evidence of a long-run equilibrium relationship among the variables across both country groups. In Table 4, the Westerlund (2007) test rejects the null hypothesis of no cointegration across the majority of statistics in both the G7 (G_a, P_t, P_a at $p < 0.05$) and the six selected D8 panels (G_t, G_a, P_t at $p \leq 0.05$). The Westerlund (2008) Durbin–Hausman cointegration test (Table 5), which explicitly accounts for cross-sectional dependence, also supports the evidence of cointegration across both panels.

CS-ARDL Test Results

The empirical specification of the CS-ARDL model was configured as follows: Optimal lag lengths for the variables and their cross-sectional averages were selected based on the Akaike Information Criterion (AIC) under a maximum lag constraint of 2 (to preserve degrees of freedom in a moderate time horizon), combined with post-estimation diagnostic checks to minimize residual serial correlation and substantially mitigate cross-sectional dependence. Accordingly, for the G7 panel (effective $N \times T = 7 \times 21 = 147$), an ARDL(1,1,0,2) model was estimated with cross-sectional average lags of (1,1,2,2) across (*BC*, *GVC*, *GCF*, *LP*). For the six selected D8 panel (effective $N \times T = 6 \times 23 = 138$), an ARDL(1,1,0,1) model was specified with cross-sectional average lags of (1,0,0,1).

Taken together, the CS-ARDL long-run results in Tables 6 and 7 indicate that the drivers of economic expansions and contractions are broadly similar across G7 and six selected D8 countries. However, the effects of global value chain participation (*GVC*) differ between the two groups.

Table 6

CS-ARDL Test Results for G7 Countries

Variables	Coefficient	T-Stats	P-Value
Long run			
GVC	26.12**	2.55	0.011
GCF	50.45**	2.09	0.036
LP	23.37***	3.44	0.001
Short run			
ECT(-1)	-0.77***	-7.40	0.000
Δ GVC	9.71	1.23	0.219
Δ GCF	22.37***	4.81	0.001
Δ LP	17.88***	2.97	0.003
Obs.	147		
Residual CD	1.65		0.098

*** $p < .01$, ** $p < .05$, * $p < .10$

Note. Calculated using OECD's TiVA and World Bank's WDI data using Stata 17 statistical software.

The long-run coefficient of *GCF* is positive and statistically significant for both G7 and six selected D8 economies, indicating that capital accumulation consistently co-moves with expansionary phases. Physical capital investment is associated with enhanced productive capacity, while the significant positive coefficient on *LP* suggests that labor productivity improvements are closely linked to cyclical output expansion.

Table 7*CS-ARDL Test Results for Six Selected D8 Countries*

Variables	Coefficient	T-Stats	P-Value
Long run			
GVC	-1.20**	-2.31	0.021
GCF	3.56***	3.49	0.000
LP	6.13***	2.83	0.005
Short run			
ECT(-1)	-0.85***	-4.56	0.000
Δ GVC	-0.40	-1.06	0.287
Δ GCF	1.96**	2.53	0.012
Δ LP	5.18**	2.39	0.017
Obs.	138		
Residual CD	3.28		0.001

*** $p < .01$, ** $p < .05$, * $p < .10$

Note. Calculated using OECD's TiVA and World Bank's WDI data using Stata 17 statistical software.

In contrast, the relationship between GVC participation and business cycles varies across country groups. In G7 economies, GVC participation is positively and significantly associated with expansionary cyclical dynamics, whereas in the six selected D8 countries, the relationship is characterized by a conditional, statistically significant and negative association. Although the empirical model uses aggregate GVC participation, this difference is consistent with the broader structural distinctions identified in the literature. Advanced economies often participate in higher-value-added production segments, while emerging economies may be more exposed to external shocks. To formally verify whether the estimated long-run coefficients differ across panels, a two-sample Z-test was conducted. The results confirm statistically significant structural differences between G7 and D8 economies for GVC ($Z = 2.66, p = 0.008$).

The error correction term is negative and statistically significant in both groups, indicating that short-run deviations in economic activity are corrected over time, guiding economies back to their long-run equilibrium. This points to a strong adjustment mechanism that mitigates economic fluctuations in both the G7 and six selected D8 countries.

Post-estimation Pesaran CD tests show that the inclusion of cross-sectional averages reduces residual cross-sectional dependence to statistically insignificant levels in the G7 panel ($CD=1.65, p=0.098$). For the six selected D8 panel, although the test statistic declines relative to the raw series, the residual CD statistic remains statistically significant ($CD=3.28, p=0.001$) under the lag structure chosen to preserve degrees of freedom in a moderate sample ($N=6, T=23$). This divergence may partly reflect the higher structural homogeneity of G7 economies relative to the geographically and structurally more diverse D8 group. While this indicates that unobserved common factors are not completely eliminated in the developing panel, the qualitative consistency and sign stability observed across alternative mean-group specifications (AMG and CCEMG in Table 8) provide supportive evidence for the baseline empirical findings.

Robustness Tests

To assess robustness, two additional estimators are employed: Augmented Mean Group (AMG) and Common Correlated Effects Mean Group (CCEMG). Both estimators are well-suited for macro panels exhibiting slope heterogeneity, non-stationarity, and cross-sectional

dependence. The CCEMG method controls for unobserved common factors by incorporating the cross-sectional means of the dependent and explanatory variables into the model. The AMG estimator tackles similar econometric concerns but models unobserved common factors as a dynamic process rather than through cross-sectional averages (Shen et al., 2021).

Table 8

Robustness Test: Results of AMG and CCEMG Models

Variables	Group of 7		Six selected D8	
	AMG	CCEMG	AMG	CCEMG
GVC	2.425** (1.086)	3.758*** (1.449)	-1.283** (0.594)	-0.766** (0.326)
GCF	15.319** (7.252)	18.804*** (5.701)	1.697* (0.998)	2.142** (0.916)
LP	20.408*** (0.613)	15.438*** (3.745)	5.113** (2.251)	3.181*** (1.146)
Constant	-269.9 (548.22)	470.9 (454.62)	39.15 (27.15)	87.51 (234.29)

*** $p < .01$, ** $p < .05$, * $p < .10$

Standard errors are reported in parentheses.

Note. Calculated using OECD's TiVA and World Bank's WDI data using Stata 17 statistical software.

According to Table 8, both the AMG and CCEMG estimators confirm the sign and statistical significance of the core relationships across both country groups. For G7 economies, GVC participation, capital accumulation, and labor productivity remain positively associated with cyclical activity, while for the six selected D8 countries, the negative GVC association and positive capital and productivity linkages persist. While consistency on coefficient signs confirms the qualitative robustness of the CS-ARDL results, noticeable variations in coefficient magnitudes emerge across estimators. These numerical divergences result primarily from foundational differences in model specification, dynamic structures, and cross-sectional filtering mechanisms across the estimators. First, while CS-ARDL is a dynamic error-correction framework whose long-run coefficients capture cumulative steady-state relationships adjusted by the error-correction mechanism, AMG and CCEMG operate as static mean-group estimators that average unit-specific parameters without incorporating lagged dynamic multiplier effects. Second, the treatment of unobserved common shocks differs across methods: CCEMG and CS-ARDL proxy unobserved factors using cross-sectional averages of the variables, whereas AMG extracts an explicit dynamic common process from first-stage difference regressions. Because this common process absorbs shared macroeconomic trends and productivity trajectories across units, it naturally scales the estimated slope parameters of structural regressors. Consequently, the AMG and CCEMG estimations serve to verify the sign persistence and statistical reliability of the baseline findings across alternative cross-sectional dependence structures rather than implying parameter magnitude equivalence across differing dynamic specifications.

Discussion

The key finding of this study is that participation in global value chains (GVCs) is positively associated with cyclical output in G7 countries. In contrast, there is a statistically significant and negative relationship between GVC participation and cyclical economic activity in the six selected D8 countries. This discrepancy is consistent with the 'double-edged sword'

approach in the literature, which suggests that the effects of trade integration depend on country-specific conditions (D'Aguanno et al., 2021).

The positive coefficient obtained for the G7 group is consistent with literature suggesting that diversified production and trade structures may be associated with greater resilience to external shocks (Caselli et al., 2020). Because the empirical model focuses on aggregate GVC participation, the distinction between forward and backward integration channels is presented here as a theoretical interpretation rather than a directly tested proposition. Whilst our empirical model does not distinguish between the different components of participation in the GVC, the positive relationship found is conceptually consistent with the view that advanced economies participate in the GVC primarily through upstream or forward-linked activities (Montalbano & Nenci, 2022). Such activities, which are characterized by higher technology intensity and domestic value added, can help to mitigate the effects of cyclical fluctuations.

Conversely, the negative relationship observed in the six selected D8 countries may reflect structural characteristics discussed in the trade literature. Developing economies frequently engage in downstream or backward-linked activities based on assembly operations and the processing of imported intermediate inputs. Such participation can increase the extent to which economies are exposed to external demand shocks (Cook & Patel, 2023) and amplify the impact of transmission mechanisms such as the 'bullwhip effect' (Altomonte et al., 2012). Although the aforementioned transmission channels were not directly tested in this study due to the aggregated nature of the data set, these mechanisms provide a plausible theoretical framework for the limited cyclical momentum observed in developing country panels (Zou, 2026).

As emphasized in the literature, the dependence of developing countries on a limited number of products or export markets (Di Giovanni & Levchenko, 2009; Casal & Guntin, 2025) amplifies the cumulative impact of global shocks. Our findings also support the need for structural transformation highlighted by Wiryawan et al. (2023). Should this transformation fail to materialize, developing economies may become trapped in low-value-added production segments and become highly dependent on external demand. The negative GVC coefficient obtained for the six selected D8 countries also indicates that the cyclical output position weakens as participation in the GVC increases.

The negative and statistically significant error correction term (ECT) indicates that deviations from the long-run relationship occurring in the short run are corrected over time. The estimated ECT coefficient for both country groups confirm the existence of a long-run equilibrium relationship between the variables and suggests that short-run deviations disappear over time. This finding is consistent with the co-integration-based literature, which demonstrates that the dynamics associated with the GVC are not merely temporary in nature but, on the contrary, reflect structural relationships (Wang et al., 2022). However, the negative association between GVC participation and cyclical output in the six selected D8 economies suggests that these countries' integration strategies may need to be reassessed. Rather than focusing solely on increasing the volume of GVC participation, these countries should prioritise functional upgrading and the development of domestic value chains (Mao, 2022).

Consequently, the relationship between GVC integration and cyclical output varies across country groups. Whilst GVC participation is positively associated with cyclical output in advanced economies (G7), it is negatively associated with cyclical output in the six selected D8 economies. This finding is consistent with the literature emphasising the decisive role

played by countries' positions within value chains and their structural characteristics in shaping the relationship between global integration and domestic economic dynamics (Mancini et al., 2024; Wiryawan et al., 2023).

Conclusions

This study examines the relationship between global value chain participation and business cycles in developed and developing economies. Previous research has largely focused on the relationship between GVCs and economic growth or on business cycle synchronization across countries. This study instead considers how GVC participation is associated with domestic cyclical movements within individual economies. It therefore adds to the relatively limited literature examining GVC participation in relation to domestic business cycles.

The results show that capital accumulation and labor productivity are positively and significantly associated with business cycles in both country groups, in line with their expected relationships with economic activity. The relationship between GVC participation and cyclical output, however, differs between the two groups. For G7 countries, the positive association is consistent with the view that advanced economies occupy more sophisticated positions in global production networks and are more closely integrated into higher value-added activities. For the six selected D8 economies, the negative association is consistent with studies that point to greater reliance on imported intermediate inputs, lower-value-added assembly activities, and exposure to external demand conditions in developing economies. These characteristics may provide a channel through which changes in global economic conditions are transmitted to domestic activity. Since the analysis uses an aggregate measure of GVC participation, it does not separately estimate the roles of forward and backward linkages. The results nevertheless show that the relationship between GVC participation and cyclical output is not the same across the two country groups. This difference may be related to the form of GVC integration and the development level of the countries concerned. This interpretation is consistent with the double-edged sword perspective discussed in the literature.

Policy implications for emerging economies relate not only to the extent of GVC participation but also to the form that this participation takes. The negative relationship observed for the six selected D-8 economies suggests that higher GVC participation may coincide with weaker cyclical output performance. One policy option is to support domestic firms in moving toward higher-tier intermediate goods production. Supplier development programmes and matching grants could help SMEs obtain international quality certifications in the fields of precision engineering, chemicals and electronics. Support for industrial R&D, product design and accredited testing infrastructure could also help domestic firms produce and export more sophisticated intermediate goods with higher domestic value added. Regional value chains can also be strengthened through arrangements such as the D-8 Preferential Trade Agreement, with the aim of developing complementary production networks before final goods reach advanced markets. For advanced economies, supplier diversification can help reduce dependence on single-source inputs whilst maintaining existing efficiency gains.

The study also has several limitations. Iran and Nigeria were excluded because of data constraints. Their commodity dependence and different economic structures limit the extent to which the results for the six selected countries can be generalized to the wider D8 group. The use of an aggregate GVC participation measure is another limitation, as it does not allow forward and backward linkages to be examined separately. Future research could formally decompose GVC integration into forward and backward components to empirically validate the interpreted transmission channels. Sector-level data, disaggregated trade linkages, and higher-

frequency observations could also be used to examine the relationship between GVC participation and business cycles in greater detail.

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Appendix

Appendix 1: Additional Tables

Table A1

Variable Descriptions, Definitions, and Data Sources

Variable	Indicator Code	Definition / Measurement	Unit	Source
BC	NY.GDP.MKTP.KD	Cyclical component of real GDP extracted using the Hodrick–Prescott filter ($\lambda = 6.25$)	Billion, constant 2015 USD	World Bank (WDI)
GVC	EXGR_GVC	Total GVC participation rate, computed as the sum of backward and forward linkages	% of gross exports	OECD TiVA
GCF	NE.GDI.FTOT.ZS	Gross fixed capital formation (formerly gross domestic fixed investment)	% of GDP	World Bank (WDI)
LP	SL.GDP.PCAP.EM.KD	Labor productivity, calculated as real GDP divided by total employed population	Constant 2017 USD (thousands)	World Bank (WDI)

Note. Created by the author

Table A2

Sample Country Coverage and Group Classifications

Group	N	Included Countries	Excluded / Note
G7 (Developed)	7	Canada, France, Germany, Italy, Japan, United Kingdom, United States	None (balanced panel)
Selected D-8 (Developing)	6	Bangladesh, Egypt, Indonesia, Malaysia, Pakistan, Türkiye	Iran (missing TiVA GVC metrics); Nigeria (missing continuous GCF series); Azerbaijan (joined in 2024, post-sample period)

Note. Created by the author

Table A3

Descriptive Statistics for G7

Variable	Obs	Mean	Std. dev.	Min	Max
BC	182	-3.609	111.337	-651.202	477.082
GVC	182	36.604	4.768	24.800	45.900
GCF	182	21.489	2.939	14.966	32.027
LP	182	109.982	17.106	72.541	142.243

Note. Calculated using OECD's TiVA and World Bank's WDI data using Stata 17 statistical software.

Table A4*Descriptive Statistics for Selected D8*

Variable	Obs	Mean	Std. dev.	Min	Max
BC	156	-0.358	12.851	-59.207	45.049
GVC	156	36.258	9.884	22.600	57.800
GCF	156	23.747	6.146	13.643	43.640
LP	156	33.367	20.733	7.016	83.855

Note. Calculated using OECD's TiVA and World Bank's WDI data using Stata 17 statistical software.

Table A5*Correlation Matrix for G7*

	BC	GVC	GCF	LP
BC	1.000			
GVC	0.090 (0.225)	1.000		
GCF	0.201 (0.007)	-0.236 (0.001)	1.000	
LP	-0.016 (0.829)	0.272 (0.000)	-0.424 (0.000)	1.000

Values in parentheses are p-values.

Note. Calculated using OECD's TiVA and World Bank's WDI data using Stata 17 statistical software.

Table A6*Correlation Matrix for Selected D8*

	BC	GVC	GCF	LP
BC	1.000			
GVC	-0.042 (0.600)	1.000		
GCF	0.198 (0.013)	0.354 (0.000)	1.000	
LP	-0.035 (0.666)	0.723 (0.000)	0.122 (0.129)	1.000

Values in parentheses are p-values.

Note. Calculated using OECD's TiVA and World Bank's WDI data using Stata 17 statistical software.

Information About the Article/Makale Hakkında Bilgiler

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The author declared that the ethical rules for research and publication were followed while preparing the article.

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