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Paper

The Asymmetric Economic Effects of COVID-19 and the Russia–Ukraine War: Panel Evidence from G7 & BRICS+ (1970–2024)

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Abstract

This research looks at how COVID-19 and the Russia-Ukraine war differently impact the GDP growth rates of BRICS+ and G7 countries, using a strong panel ECM model that accounts for connections between countries, from 1970 to 2024. Diagnostic tests show that the countries are linked and have significant errors in their data, which is why Diagnostic tests confirm cointegration and significant cross-country error correlation, hence the necessity for PCSEs. The results indicate a rapid error correction speed of 81.5% annually, underlining rapid adjustment to long-run equilibrium. We find strong evidence of conditional convergence, where poorer economies tend to grow faster in the longer run. The shock caused by the COVID-19 pandemic contributed a −5.8 percentage point decline to annual growth, implying a sharp and simultaneous contraction of the global economy. In comparison to the above, the shock from the Russia-Ukraine conflict had a marginally positive and differential impact (insignificant), suggesting that it favoured export-oriented countries while harming import-dependent countries. The growth of investment becomes evident as the most significant short-term engine behind growth, while government spending growth shows crowding-out effects, indicating that increased investment is driving economic recovery more effectively than government spending in the current context. It is critical to note that trade openness becomes insignificant when accounting for cross-sectional dependency, refuting widely recognized paradigms on growth benefits from globalization. According to the study, sustainable growth, as well as the ability to overcome a crisis, is only achievable through strategic investment in education and green energy, the establishment of contingent fiscal buffers, support for a good governance environment (stable government), and improvement of global coordination regarding asymmetric shocks. Methodologically, we demonstrate that accounting for cross-country dependence has a significant impact on inference regarding growth determinants and provides a clearer foundation for making economic policies in a world economy in a future study.

Keywords: GDP Growth, COVID-19, Russia-Ukraine War, Error Correction Model, Cross-Sectional Dependence, Panel Cointegration, BRICS, G7, Conditional Convergence, Investment, Fiscal Policy.

1. Introduction

Macroeconomic researchers' concern regarding the factors of economic growth, as well as the capacity of economies to withstand immense exogenous shocks, is a concern that has persisted alongside macroeconomic relations. The early 2020s should be remembered as a special time of global shocks, including the spread of the 'COVID-19 pandemic, which is an unprecedented global health crisis that brought synchronized 'lockdown' decisions of economies, leading to supply chain disruptions' (World Bank, 2022). Additionally, there is the Russia-Ukraine conflict, which is a 'geopolitical conflict with profound implications for global energy, food, and financial markets' (IMF, 2022). The above-mentioned shocks exposed the global economy to dual supply shocks, thus challenging the resilience of developed and emerging economies, raising questions as regards their differentiated effects, as well as the causes thereof.

The traditional growth empirics literature, based on the neoclassical convergence model (Solow, 1956; Swan, 1956), and extended models including human capital and institutions (Mankiw et al., 1992; Barro, 1991), offers a long-run approach that may not readily combine sharp, short-run disequilibria. Although techniques have been developed for panel data, such as the treatment of unobserved heterogeneity using fixed and random effects models, which has been augmented later on by the treatment of dynamics as well as the possibility of endogeneity using the Arellano and Bond (1991) and Blundell and Bond (1998) approaches, respectively, an important but frequently neglected feature of macro panels is the possibility of cross-sectional dependence. Failure to account for the correlation between errors within countries to common global shocks or spillovers may lead to biased inference or to overdramatic significance placed on regressors, as highlighted by Pesaran (2004, 2015). In addition, when different variables have different levels of integration, it would be critical to consider a cointegration setup that distinguishes between long run and short run mechanisms (Engle & Granger, 1987; Pedroni, 1999).

The proposed paper will fill this gap with a study that investigates the impact of the COVID-19 crises and the conflict between Russia and Ukraine on GDP growth in a joint panel Error Correction Model (ECM) model covering a total set of BRICS+ (also including large emerging markets in Middle and North Africa: Saudi Arabia, Iran, and Egypt) and G7 economies from 1970 to 2024. The selection of this large panel enables a comparative study on shock transmission in different economies in different stages of development with different structures and resilience policies.

A stable government is the one that intelligently passes through crises. To restrain negative influence, a nation should cautiously and carefully follow previously developed plans and strategies. Investments in human capital, R&D, and green energy are long-term investments, which offer a positive contribution not just by softening the crisis pain but by accelerating the economic recovery process.

"The main research questions are: (1) What are the individual and heterogeneous effects of the COVID-19 and war shocks on short-term real GDP growth? (2) Do the shocks upset the long-run

convergence process in a way that is conditional upon countries? (3) How well do standard factors such as investment, international trade, and public spending perform in a model that is robust to CD and dynamics? (4) Implications of these findings in terms of implementing measures that can help an economy in the event of a global shock."

Methodologically, the article uses a set of tests: the panel unit root test, the cointegration test (based on Pedroni, 2004), and the cross-section dependence test (because of Pesaran, 2004). The core analysis employs an ECM estimated with Panel-Corrected Standard Errors (PCSE) to yield consistent and efficient estimates in the presence of cross-country correlation. This approach ensures that the identified relationships are not statistical artifacts of omitted global factors.

The findings confirm strong conditional convergence and reveal an exceptionally rapid error correction speed of 81.5% annually. The COVID-19 pandemic is estimated to have caused a severe growth contraction of approximately 5.8 percentage points, whereas the war's aggregate effect was marginally positive but statistically fragile, underscoring its asymmetric impact on commodity exporters versus importers. *Investment* growth remains a robust *positive driver*, while the significance of trade openness vanishes once cross-sectional dependence is controlled for—a critical methodological insight. From these findings, this article concludes with specific policy suggestions emphasizing that a strategic allocation of investments in human capital and green technologies, fiscal stabilization funds, and a greater degree of global cooperation should be encouraged in efforts to promote sustainable growth and crisis preparedness.

The rest of this paper proceeds as follows: Section 2 presents an overview of relevant literature, section 3 explains the data and methodology, and section 4 presents results, followed by conclusions in section 5.

2. Literature Review

The empirical study of growth and its causes rank among the most prolific and oldest in economics. The literature review will be divided into three themes that are relevant to this paper: (1) theories and econometric theories and tests in growth and convergence, (2) the macroeconomic treatment of crises and externalities, and (3) the developments in panel data econometric techniques that tackle dynamics, cointegrations, and cross-sectional dependencies in growth and its determinants.

The Neoclassical Model of Growth (Solow, 1956; Swan, 1956) provided the groundwork for the analysis of economic growth in the long run, based on the accumulation of capital, the growth of the workforce, and exogenous technological change. The main result from this model is the concept of conditional convergence, the view that *poor countries should grow faster than rich* countries after adjusting for their main deterministic factors (savings rates, population growth rates, and technological change). The cross-country empirical verification for this result was first offered in the seminal paper by Barro (1991), who found a strong negative correlation between initial per capita income and economic growth. This result was later strengthened and improved by the addition of human capital to the standard Solow model in the study by Mankiw et al. (1992).

Later, came the focus of research on panel data techniques to address the country-specific heterogeneities. Islam's (1995) analysis uncovered the strengthened results of conditional convergence when fixing the effects of the panel from cross-sectional models. However, the dynamic process of economic growth itself, affecting the present due to its past values, posed a problem of estimation. This was resolved through the Difference and System GMM estimator developed by Arellano and Bond (1991) and Blundell and Bond (1998) and afterward became a widely applied estimator of dynamic panel models of growth (Bond et al., 2001).

Nevertheless, in many panel growth literature studies, the problem of cross-sectional independence, or the correlation of error terms across countries owing to worldwide shocks, had been largely disregarded, which may lead to biased results (Pesaran, 2006).

The global economy is periodically subjected to major disruptive shocks, each generating a substantial body of research on transmission mechanisms and economic resilience.

The Asian Financial Crisis of 1997-98 and the Global Financial Crisis of 2007-08 established the significance of clustering recessions as being the possible effects of contagious diffusion of financial crises and lost demand. The literature line of Reinhart-Rogoff in 2009 conveyed the impacts of systemic banking crises on the output performance of the affected countries in the long run, while the literature of Claessens in 2012 conveyed the global spillovers of the GFC.

Prior to the COVID-19 pandemic, research on effects was sparse for economic pandemics; most were theory-driven or historical studies based upon incidents such as the 1918 flu pandemic. COVID-19 sparked a massive literature explosion. At first, the analysis was driven by either high-frequency data or event types focused upon cataloguing the unprecedented depth of recession. Panels came later to estimate dispersed effects, as seen by Deb et al. (2022).

Geopolitical Conflicts and Commodity Shocks: The usual emphasis of the economic literature for conflict involving war has been the catastrophic direct consequences of the conflict for the belligerent countries (Collier, 1999). Nevertheless, the ongoing Russia-Ukrainian conflict highlights a conflict having strong spillover consequences for the global system in commodity markets (energy, food, fertilizer). The latest assessments within the OECD (2022) and the IMF (2022) point to the strongly asymmetrical consequences of the conflict, thus forming a strongly marked divide for net commodity exporters versus importers. The implication of the gap in the growth empirics literature lies in the contrast of the relevant work, namely in the sense that whereas there are terms-of-trade shocks, very few employ a direct measure of a strong geopolitical shock as part of the growth model determination factors.

Realizing the importance of treating many macroeconomic series as non-stationary (integrated) processes, cointegration methods for time series analysis soon followed (Engle & Granger, 1987). To cater to panel data, panel cointegration tests, such as those proposed by Pedroni (1999, 2004) and Kao (1999), along with the respective estimators Fully Modified OLS and Dynamic OLS, were developed to identify cointegrating relations for panel data. Among the ARDL approaches,

the Pooled Mean Group Estimator, proposed by Pesaran et al. (1999), formed a useful paradigm, especially suited for the ARDL model, which enabled the joint estimation of *long-run relations*, along with *short-run* parameters incorporating an error correction term, while allowing varying short-run parameters across groups.

At the same time, econometricians warned of the widespread existence of cross-sectional dependence in macro panels. Pesaran (2004, 2006, 2015) introduced diagnostic tests (such as the CD test) and demonstrated that neglecting these dependencies results in extreme size distortions in conventional panel unit root or cointegration tests. This provoked the use of second-generation tests or the application of covariance matrix estimators that allow for robustness to these dependencies, Driscoll/Kraay standard errors (Driscoll & Kraay, 1998), or Panel-Corrected Standard Errors (PCSE) (Beck & Katz, 1995). These methods enable the calculation of robust standard errors that are unaffected by spatial or temporal dependencies. These, in turn, are necessary for valid inference in the context of a globally interdependent economy.

Although the existing literature provides a rich treatment of the issues related to growth determinants, crisis analysis, and advanced econometrics in a panel data setting, there is a considerable gap in the synthesis of the three issues. There are very few empirical analyses of the implications of the shock of COVID-19 or the Russia-Ukraine conflict, which are global in nature, along with the conventional growth determinants in a sample of advanced as well as emerging countries, in a cointegration analysis framework, which corrects for cross-section dependence. Most of the empirical analyses of the global events are event analyses in and of themselves within a model structure, which could be subject to the statistical shortcomings of ignoring the dynamics of the model, the cointegration relations among the variables, or the cross-section dependence warned about in the methodological empirical analyses in the existing literature.

This paper tries to fill this lacuna. It contributes by a) conducting a set of serious pre-estimation diagnostics—unit root, cointegration, and cross-section dependence tests—on a long-span panel of BRICS+ and G7 economies; b) specifying and estimating a *dynamic Error Correction Model that separates the effects of long-run convergence from those of short-run shocks*; and c) using the PCSE estimation method in order to ensure robust inference in the presence of significant error correlation across countries. By so doing, it offers a more solid empirical basis to assess the impacts of current global crises on growth dynamics and obtain robust implications for policy to attain sustainable and resilient economic development.

3. Methodology

The main objective of this research study is to assess the economic growth impact of crises, with a particular focus on the economies of the world, i.e., **18** economies. The sample will comprise economies that fall into two categories. The first group of nations comprises the United States, the United Kingdom, Germany, France, Italy, Canada, and Japan. These are known as the G7. The second group of nations, known as the BRICS+, comprises Brazil, Russia, India, China, South

Africa, Egypt, Saudi Arabia, and Indonesia. This selection represents a significant portion of the world's production and offers a fair representation of the different levels of economic development and emerging Because the relationship between crises and economic growth is intricate, a strong econometric method has been used to analyse the relationship. The model is organized using the World Bank indicators and the International Monetary Fund (IMF) during the period (1970-2024) to analyse how the macroeconomic indicators interact through different channels to influence GDP growth and the economy. The most important econometric methods used in this research study include the unit root test, cointegration test, and Error Correction Model (ECM) to analyse both the short-term and long-term relationships, among others.

3.1. Empirical Framework and Model Specification

This study employs a dynamic panel data approach to analyse *the effects of crises on GDP growth*, with particular focus on *conditional convergence*, endogenous *growth channels*, and the *asymmetric impact* of recent global crises. The empirical methodology combines theoretical underpinnings from the augmented Solow-Swan model and sophisticated econometric methods to deal with issues of non-stationarity, cross-section dependence, and heterogeneity.

The empirical strategy is arranged around a two-stage error correction mechanism (ECM). This framework makes a distinction between long-run equilibrium relations and short-run dynamic responses. This approach allows for simultaneous testing of convergence hypotheses and crisis impact quantification.

For the analysis of the differential effects of the COVID-19 pandemic and the Russia-Ukraine war on the GDP growth rate, this research utilizes an exhaustive panel econometric method. The general empirical model is specified in the following form:

$$\begin{aligned}\text{GDP_GRWOTH}_{it} = \beta_0 \quad & +\beta_1 \text{DGDP_CONV}_{it} + \beta_2 \text{COVID19}_{it} + \beta_3 \text{WAR}_{it} \\ & +\beta_4 \text{COVID19_INVS}_{it} + \beta_5 \text{WAR_TRD}_{it} + \beta_6 \text{DTRD}_{it} \\ & +\beta_7 \text{DINVS}_{it} + \beta_8 \text{DGEXP}_{it} + \beta_9 \text{DEDUC}_{it} \\ & +\beta_{10} \text{DUNEM}_{it} + \beta_{11} \text{INFL}_{it} + \alpha_i + \varepsilon_{it} \ldots\ldots\ldots\ldots (1)\end{aligned}$$

Where **i = 1..., 18** denotes the countries, **t = 1970..., 2024** denotes the time series, $\alpha_i$denotes the fixed effects for each country, which capture time-invariant country-specific differences, and ε_{it} denotes the error term. The dependent variable is GDP_GROWTH, which is a measure of the growth rate of real GDP on a percentage scale. The major independent variables are the dummy variables for the COVID-19 pandemic (2019-2022) and the Russia-Ukraine war (2022-2024), along with their interaction variables with investment/trade variables: COVID19_INVS and WAR_TRD. The control variables include the standard determinants of economic growth: first difference of income convergence or the initial GDP per country, DGDP_CONV; first difference of investment growth, DINVS; first difference of trade growth, DTRD; first difference of government expenditure growth, DGEXP; first difference of education expenditure growth, DEDUC; first difference of unemployment, DUNEM; and inflation, INFL.

3.2 Stationery and Unit Root Tests

Before proceeding to the econometric analysis, it is necessary to verify the properties of the time series variables to avoid spurious regression. The Augmented Dickey-Fuller (**ADF**) test is employed to determine the presence of unit roots in the time series. The general form of the ADF test equation is expressed as:

$$\Delta y_t = \alpha + \beta t + \gamma y_{t-1} + \sum_{i=1}^{p} \delta_i \, \Delta y_{t-i} + \varepsilon_t \quad \text{.....(2)}$$

Where y_t is the time series data, Δ is the first difference operator, ε_t is the error term, and the null hypothesis Ho is that the series has a unit root or is non-stationary. If the null should be rejected, to say its stationary. To find the order of integration of the variables, we perform the Levin-Lin-Chu (2002) and Im-Pesaran-Shin (2003) tests to ensure that no variable is I(2) to prevent spurious regression.

3.3 Hausman Specification Test

To determine the appropriate model between FE and RE, we conduct the Hausman (1978) test, which examines whether the unique errors (α_i) are correlated with the regressors. The test statistic $H \sim \chi^2(k)$ is used to compare the FE (fixed effect) and RE (random effect) coefficients, and the rejection of the null hypothesis suggests that FE is preferred on the grounds of consistency.

3.4 Panel Corrected Standard Errors (PCSE)

Following Beck and Katz (1995), we estimate our preferred fixed effects model using PCSE. PCSE offers standard errors that are robust to contemporaneous correlation across panels (common shocks), panel-specific heteroskedasticity (different error variances across countries), and serial correlation within panels (time-series dependence). The PCSE covariance matrix estimator is:

$$\widehat{\Omega}_{PCSE} = (X'X)^{-1} \left[\sum_{i=1}^{N} X_i' \, \widehat{\Sigma}_i X_i \right] (X'X)^{-1} \quad \text{.....(3)}$$

where $\widehat{\Sigma}_i$ is the estimated covariance matrix for panel i, allowing for correlation between different countries' errors in the same period.

3.5. Data Description

3.5.1. Sample and Period

The empirical analysis is based on an unbalanced panel dataset of 18 major economies comprising the **G7** and an extended **BRICS+** group. The data spans the period from **1970 to 2024** at an annual frequency. This temporal scope is selected to capture multiple global business cycles, long-term structural trends, and, crucially, the recent COVID-19 pandemic and Russia-Ukraine war, thereby providing a comprehensive backdrop for analysing ***growth dynamics*** and ***crisis resilience***.

3.5.2. Core Variables and Sources

The dependent variable, GDP_Growth, is from World Bank WDI. To test conditional convergence, lagged GDP per capita (GDP_pc) from WDI and Penn World Table is included, with expected negative coefficient.

Key determinants from growth theory: INVS (investment % GDP) captures capital accumulation, expected positive; TRD (trade openness) proxies' integration and technology diffusion, expected positive; GEXP (government expenditure) tests state size impact, with ambiguous sign reflecting trade-off between productive investment and crowding-out.

Two crisis dummies: COVID19 (2019–2021) expected negative; WAR (2022–2024) theorized as heterogeneous and ambiguous, depending on commodity market exposure.

3.5.3. Control Variables (for robustness)

To ensure robustness, supplementary specifications include additional controls for macroeconomic stability, demographic trends, and institutional factors: inflation (CPI), population growth, human capital (Barro-Lee schooling years), and institutional quality indicators. While not central to the main model, these variables help isolate the distinct effects of the primary variables of interest.

3.6.1 Model Specification: Panel Error Correction Model

This study employs a Panel Error Correction Model (ECM) to examine dynamic relationships while accounting for panel time-series properties. This estimator is justified by preliminary tests confirming variables are non-stationary but cointegrated. The ECM framework advantageously captures both long-run equilibrium dynamics and short-run adjustments through a two-stage strategy.

In the **first stage**, we estimate the long-run cointegrating relationship representing the equilibrium toward which the economy adjusts. The long-run equation is specified as:

$$\text{GDP_ Growth}_{it} = \alpha_i + \beta_1 \ln(\text{GDP_pc}_{i,t-1}) + \beta_2 \text{INVS}_{it} + \beta_3 \text{TRD}_{it} + \beta_4 \text{GEXP}_{it} + u_{it} \text{.....(4)}$$

In this specification, GDP_ Growth_{it} is the dependent variable. α_i captures country-specific fixed effects. Lagged ($\ln(\text{GDP_pc}_{i,t-1})$) tests conditional convergence, where $\beta_1 < 0$ would indicate poorer economies grow faster. Key variables include: INVS_{it} (investment % GDP) for capital accumulation; TRD_{it} (trade openness) for economic integration; and GEXP_{it} (government expenditure) for state size impact. The residual u_{it} measures deviation from long-run equilibrium and, as $u_{i,t-1}$, becomes the error correction term in the second stage to estimate adjustment speed after shocks.

The second stage estimates short-run dynamics, capturing immediate GDP growth responses and the speed of adjustment to long-run equilibrium (Equation 4). Crucially, it introduces dummy variables and interaction terms to explicitly model the impacts of COVID-19 and geopolitical conflict.

$$\Delta\text{GDP_Growth}_{it} = \phi_i + \lambda\hat{u}_{i,t-1} + \gamma_1\text{COVID19}_t + \gamma_2\text{WAR}_t + \gamma_3\Delta\text{INVS}_{it} + \gamma_4\Delta\text{TRD}_{it} + \gamma_5\Delta\text{GEXP}_{it} + \gamma_6(\text{COVID19}_t \times \Delta\text{INVS}_{it}) + \gamma_7(\text{WAR}_t \times \Delta\text{TRD}_{it}) + \epsilon_{it} \quad \ldots\ldots(5)$$

Δ denotes first differences, transforming variables into stationary growth rates. The Error Correction Term (ECT), $\hat{u}_{i,t-1}$, is the lagged residual from the long-run model. Its coefficient **λ** (**negative, |λ|<1**) measures adjustment speed to equilibrium.

Crisis dummies $COVID19_t$ andWAR_t capture average growth shifts during 2019–2021 and 2022–2024. Coefficients γ_3–γ_5 capture short-run impacts of changes in investment, trade, and government expenditure.

Interaction terms test crisis heterogeneity: COVID19 × ΔINVS examines whether investment mitigated pandemic impacts; WAR × ΔTRD tests whether trade diversification buffered conflict effects. These reveal how structural characteristics conditioned shock severity.

3.6.2 Accounting for Asymmetric Effects (Robustness Extension)

Equation (4) assumes symmetric effects—e.g., investment increases and decreases have equal but opposite impacts. However, variables may respond asymmetrically to shocks, especially during crises. To test for nonlinearities, this study employs a Panel NARDL model (Shin et al., 2014), which decomposes regressors into positive and negative partial sums to capture asymmetric effects. The investment specification follows.

$$\Delta\text{GDP_Growth}_{it} = \rho\text{ECT}_{i,t-1} + \sum_{j=1}^{p-1}\phi_j\,\Delta\text{GDP_Growth}_{i,t-j} + \sum_{j=0}^{q-1}\left(\theta_j^{+}\Delta\text{INVS}_{i,t-j}^{+} + \theta_j^{-}\Delta\text{INVS}_{i,t-j}^{-}\right) + \delta_1\text{COVID19}_t + \delta_2\text{WAR}_t + \eta_{it} \quad \ldots\ldots(6)$$

INVS^{+} and INVS^{-} are partial sum decompositions of positive and negative investment changes. Coefficientsθ_j^{+} and θ_j^{-} capture short-run impacts of investment increases and decreases. A Wald test examines symmetry ($\sum\theta_j^{+} = \sum\theta_j^{-}$). Rejection indicates asymmetric behaviour—e.g., crisis contractions matter more than expansions. This provides a critical robustness check on linear results.

3.7. Estimation Strategy

This study adopts a sequential three-step approach: pre-estimation diagnostics, core estimation, and robustness checks.

Step 1: Preliminary Diagnostics: Stationarity is tested using Levin-Lin-Chu and Fisher-ADF. Cross-sectional dependence is assessed via Pesaran's (2004) CD test. If variables are I(1), cointegration is tested using Pedroni (2004) and Westerlund (2007), validating the ECM approach.

Step 2: Core Estimation: Following cointegration, the two-stage ECM is estimated. First, the long-run relationship (Equation 4) uses Panel DOLS. Second, the short-run ECM (Equation 5) uses Panel-Corrected Standard Errors (PCSE). The Pooled Mean Group (PMG) estimator (Pesaran et al., 1999) is applied as a robustness check.

Step 3: Addressing Challenges: Cross-sectional dependence is addressed with SUR weights. Endogeneity is mitigated via GMM with lagged instruments. Country and time fixed effects control for heterogeneity. Sub-sample analyses will test for differences across income groups or regional blocs.

4. Result and Discussion

4.1Descriptive Statistic Analysis

Table 1: Descriptive Statistic Analysis

	GDP_GRWOTH	GDP_CONV	COVID19	WAR	COVID19_INVS	WAR_TRD	TRD	INVS	GEXP	EDUC	UNEM	INFL
Mean	0.040833	19573.94	0.035857	0.071713	0.850386	4.076522	47.22266	23.72899	16.06969	33.30720	7.254953	22.92430
Median	0.042519	12802.71	0.000000	0.000000	0.000000	0.000000	44.13198	22.69794	16.18820	25.83098	6.249667	5.461914
Maximum	0.591947	117073.2	1.000000	1.000000	42.16005	196.5955	196.5955	48.56921	33.60739	103.2730	32.54833	1735.111
Minimum	-0.357256	207.9679	0.000000	0.000000	0.000000	0.000000	4.708495	9.319007	6.276653	0.112340	0.216667	-6.891337
Std. Dev.	0.080847	19618.83	0.186118	0.258270	4.590918	17.54828	30.44019	6.237029	4.757107	25.76728	5.288442	134.4258
Skewness	0.301833	1.325564	4.992602	3.319894	5.694163	6.343983	1.904763	0.790687	0.265315	0.568347	2.042906	10.19324
Kurtosis	10.02369	5.669100	25.92608	12.02170	36.58926	56.14304	8.057582	3.762819	2.824744	2.253408	8.627666	113.1695
Jarque-Bera	1039.487	296.0246	13079.39	2624.578	26311.76	62439.74	838.5830	64.47848	6.531902	38.68480	1011.624	262565.3
Probability	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.038161	0.000000	0.000000	0.000000
Sum	20.49825	9826120.	18.00000	36.00000	426.8939	2046.414	23705.78	11911.95	8066.985	16720.21	3641.986	11508.00
Sum Sq. Dev.	3.274678	1.93E+11	17.35458	33.41833	10559.34	154279.0	464229.2	19489.17	11337.66	332640.4	14011.77	9053213.
Observations	502	502	502	502	502	502	502	502	502	502	502	502

Source: Author computation using Evewis 12

Table 2 reveals key panel properties. Mean GDP growth (4.08%) masks high volatility (SD 8.1%) and extreme range (-35.7% to +59.2%). High skewness/kurtosis for COVID-19, WAR, and interactions confirm rare binary shocks, validating exogenous treatment. COVID-19 and WAR represent only 3.6% and 7.2% of observations. Jarque-Bera rejects normality, requiring robust estimation. Large GDP per capita SD underscores BRICS+-G7 development gaps. These patterns extend crisis literature: extreme growth ranges support BRICS+ deeper contractions but faster recoveries (Aguiar & Gopinath, 2007); leptokurtic shock distributions align with "black swan" definitions (Taleb, 2007); skewed interactions suggest non-linear amplification through trade and

investment channels—positioning this analysis to uncover heterogeneous transmission mechanisms.

4.2Correlation Analysis

Table 2: The Results Correlation Analysis

	GDP_GRWOTH	GDP_CONV	COVID19	WAR	COVID19_INVS	WAR_TRD	TRD	INVS	GEXP	EDUC	UNEM	INFL
GDP_GRWOTH	1.0000	-0.2377	-0.1565	0.0672	-0.1277	0.0279	-0.1710	0.2138	-0.2345	-0.1506	-0.0984	-0.0974
GDP_CONV	-0.2377	1.0000	0.0362	0.0498	0.0184	0.0941	0.5948	-0.1841	0.3116	0.4596	-0.2268	-0.0953
COVID19	-0.1565	0.0362	1.0000	-0.0536	0.9615	-0.0448	0.0423	-0.0004	0.0344	0.1716	0.0392	-0.0257
WAR	0.0672	0.0498	-0.0536	1.0000	-0.0515	0.8366	0.0879	-0.0075	0.0221	0.2772	0.0273	-0.0299
COVID19_INVS	-0.1277	0.0184	0.9615	-0.0515	1.0000	-0.0431	0.0297	0.0553	0.0137	0.1548	0.0202	-0.0243
WAR_TRD	0.0279	0.0941	-0.0448	0.8366	-0.0431	1.0000	0.2466	-0.0285	0.0413	0.2498	0.0242	-0.0279
TRD	-0.1710	0.5948	0.0423	0.0879	0.0297	0.2466	1.0000	-0.1192	0.0972	0.1075	-0.0250	-0.0770
INVS	0.2138	-0.1841	-0.0004	-0.0075	0.0553	-0.0285	-0.1192	1.0000	-0.1826	-0.1017	-0.1941	-0.0457
GEXP	-0.2345	0.3116	0.0344	0.0221	0.0137	0.0413	0.0972	-0.1826	1.0000	0.3462	0.1838	0.0029
EDUC	-0.1506	0.4596	0.1716	0.2772	0.1548	0.2498	0.1075	-0.1017	0.3462	1.0000	0.0152	-0.0831
UNEM	-0.0984	-0.2268	0.0392	0.0273	0.0202	0.0242	-0.0250	-0.1941	0.1838	0.0152	1.0000	-0.0276
INFL	-0.0974	-0.0953	-0.0257	-0.0299	-0.0243	-0.0279	-0.0770	-0.0457	0.0029	-0.0831	-0.0276	1.0000

Source: Author computation using Evewis 12

The correlation matrix reveals notable patterns. GDP growth correlates negatively with initial GDP (-0.24), suggesting conditional convergence. COVID-19 (-0.16) and its investment interaction (-0.13) are negative; the war dummy is weakly positive (0.07). High correlations between COVID-19 and COVID19_INVS (0.96) and WAR and WAR_TRD (0.84) signal multicollinearity, requiring careful specification. Investment correlates positively with growth (0.21), while government expenditure (-0.23) and trade (-0.17) are negative. GDP_CONV and TRD correlate at 0.59, confirming developed economies are more trade open. These findings align with literature: negative income-growth echoes Barro (1991); positive investment-growth is a perennial regularity. Trade's negative correlation departs from pro-globalization findings (Frankel & Romer, 1999). Strong shock-dummy interactions highlight opaque transmission channels. Inflation's low correlation supports the "Great Moderation" narrative.

4.3Unit Root Test

Table 3: The results of Unit Root Test

Augmented Dickey Fuller Test				
Variables	Level		First Difference	The order of integration
	Without Trend	With Trend	Without Trend	
GROWTH_ RATE RATE	-7.15815	-15.2765	-25.0561	I(0)
	(0.0000)	(0.0000)	(0.0000)	
GDP CONVERGENCE	8.89336	-4.44272	-3.68711	I(1)

	(1.0000)	(0.0000)	(0.0001)	
TRD	3.08788	-10.8209	-15.1417	I(1)
	(0.9999)	(0.0000)	(0.0000)	
INVS	-2.06329	-10.9747	-16.1981	I(1)
	(0.0195)	(0.0000)	(0.0000)	
GEXP	0.18507	-7.72922	-13.7585	I(1)
	(0.5734)	(0.0000)	(0.0000)	
EDUC	3.96737	-3.25812	-7.33884	I(1)
	(1.0000)	(0.0006)	(0.0000)	
UNEM	-1.84811	-8.40337	-13.6575	I(1)
	(0.0323)	(0.0000)	(0.0000)	
INFL	-4.41307	-15.6492	-22.5360	I(0)
	(0.0000)	(0.0000)	(0.0000)	

Source: Author computation using Evewis 12

Panel unit root tests establish clear integration orders. GDP growth is I(0), validating direct use. Most variables—GDP convergence, trade (TRD), investment (INVS), government expenditure (GEXP), human capital (EDUC), and unemployment (UNEM)—are I(1), stationary in first differences. Inflation (INFL) is the sole I(0) exception. This mixed order requires differenced I(1) regressors or a cointegration framework. These findings extend the literature. GDP growth as I(0) is standard (Islam, 1995; Lee et al., 1997). I(1) results for GDP, trade, investment, and spending replicate influential panels (Pedroni, 1999; Levin et al., 2002). I(1) findings for human capital and unemployment add refinement, underscoring the importance of pre-testing. Inflation's I(0) stationarity aligns with modern monetary policy.

4.2. Model Selection: From Pooled OLS to Random Effects

The empirical progression began with a simple Pooled OLS model, which yielded a poor fit (Adj. R^2 = -0.008) and likely omitted variable bias. Advancing to panel estimators, both Fixed Effects (FE) and Random Effects (RE) models showed major improvements. The Hausman test yielded a p-value of 1.000, failing to reject the null hypothesis and thus validating the Random Effects model as both consistent and efficient for this dataset. This model optimally utilizes both within-country and between-country variation.

4.3 The Results Pooled Regression Model

Table 4: The Results Pooled Regression Model

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DGDP_CONV	3.92E-06	1.20E-06	3.275434	0.0011
COVID19	-0.025617	0.019310	-1.326605	0.1853
WAR	0.052536	0.013768	3.815901	0.0002
DTRD	0.002924	0.000637	4.589835	0.0000
DINVS	0.010734	0.001828	5.872431	0.0000
DGEXP	-0.002155	0.003106	-0.694001	0.4880

Source: Author computation using Evewis 12

Pooled regression showed unemployment and inflation insignificant ($p > 0.77$); they were removed. Fit remained poor (Adj. $R^2 = -0.008$), justifying fixed effects. Key coefficients: investment and trade positive (1% significance); GDP per capita positive (contradicting convergence); war positive (commodity exporter gains); COVID-19 and government expenditure insignificant. Findings partially align with literature: investment supports Levine and Renelt (1992); trade aligns with Frankel and Romer (1999). Positive war contrasts with Collier (1999); weak COVID-19 differs from IMF (2020); absent convergence contrasts with Barro (1991), underscoring need for fixed effects.

4.5 The Results of Fixed effect

Table 5: The Results of Fixed effect

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.037238	0.003362	11.07522	0.0000
DGDP_CONV	2.66E-06	1.01E-06	2.632643	0.0088
COVID19	-0.061740	0.016297	-3.788404	0.0002
WAR	0.015501	0.011857	1.307391	0.1917
DTRD	0.002219	0.000542	4.095122	0.0000
DINVS	0.009543	0.001541	6.191945	0.0000
DGEXP	-0.006088	0.002648	-2.299112	0.0219

Source: Author computation using Evewis 12

Fixed effects improve over pooled OLS ($R^2 = 0.31$). Investment and trade remain strongly positive (1% level). COVID-19 becomes significant and negative (6.2-point loss). The war dummy loses significance. Government expenditure becomes significantly negative. These findings align with panel literature: investment and trade support endogenous growth (Bond et al., 2010); COVID-19's transformation underscores pre-existing factors (Deb et al., 2022); the war dummy's insignificance aligns with conflict economics (Glick & Taylor, 2010); negative government expenditure supports "lean government" (Folster & Henrekson, 2001).

4.6 The Results of Random Effect

Table 6: The Results of Random Effect

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.037228	0.008238	4.519185	0.0000
DGDP_CONV	2.66E-06	1.01E-06	2.643678	0.0085
COVID19	-0.061759	0.016297	-3.789623	0.0002
WAR	0.015548	0.011856	1.311434	0.1903

DTRD	0.002190	0.000541	4.051375	0.0001
DINVS	0.009720	0.001537	6.324869	0.0000
DGEXP	-0.006125	0.002640	-2.320149	0.0208

Source: Author computation using Evewis 12

Random Effects mirrors Fixed Effects, confirming robust relationships. Investment and trade remain highly significant ($p < 0.0001$). COVID-19 (-0.062) indicates a 6.2-point contraction. The war dummy is insignificant. Government expenditure is significantly negative, supporting crowding-out. Variance decomposition: 18% from time-constant differences, 82% from within-country variation. This aligns with panel literature: investment and trade are "robust" growth correlates (Sala-i-Martin, 1997); COVID-19 effect aligns with IMF (2021); insignificant war aligns with OECD (2022); negative government expenditure supports "Barro-style" findings (Afonso & Furceri, 2010).

4.7Hausman Test

Table7: The Results of Hausman Test

Correlated Random Effects - Hausman Test				
Test cross-section random effects				
Test Summary		Chi-Sq. Statistic	Chi-Sq. d.f.	Prob.
Cross-section random		0.000000	6	1.0000
* Cross-section test variance is invalid. Hausman statistic set to zero.				
Cross-section random effects test comparisons:				
Variable	Fixed	Random	Var(Diff.)	Prob.
DGDP_CONV	0.000003	0.000003	0.000000	0.9401
COVID19	-0.061740	-0.061759	0.000000	0.7305
WAR	0.015501	0.015548	0.000000	0.6761
DTRD	0.002219	0.002190	0.000000	0.4425
DINVS	0.009543	0.009720	0.000000	0.1306
DGEXP	-0.006088	-0.006125	0.000000	0.8535
Cross-section random effects test equation:				
Dependent Variable: GDP_GRWOTH				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.037238	0.003362	11.07522	0.0000
DGDP_CONV	2.66E-06	1.01E-06	2.632643	0.0088

COVID19	-0.061740	0.016297	-3.788404	0.0002
WAR	0.015501	0.011857	1.307391	0.1917
DTRD	0.002219	0.000542	4.095122	0.0000
DINVS	0.009543	0.001541	6.191945	0.0000
DGEXP	-0.006088	0.002648	-2.299112	0.0219

Source: Author computation using Evewis 12

The Hausman test examines whether RE errors correlate with regressors. The test yields $\chi^2 \approx 0$ (p = 1.0000). Coefficient comparisons show insignificant FE-RE differences; the largest divergence is DINVS (0.009543 FE vs. 0.009720 RE). This supports RE appropriateness, confirming consistency. This aligns with modern panel studies: when determinants are well-modelled, orthogonality holds, making RE efficient (Bond et al., 2010). The result validates Random Effects (Table 6) as preferred, exploiting both within and between variation—valuable given T=27.

4.7.1 Core Findings from the Final Random Effects Model

The preferred Random Effects estimation provides the core results (Equation 1A):

$$\mathbf{GDP_GROWTH}_{it} = \mathbf{0.037228} + \mathbf{0.00000266\,DGDPCONV}_{it} - \mathbf{0.061759COVID19}_{it} + \mathbf{0.015548WAR}_{it} + \mathbf{0.002190DTRD}_{it} - \mathbf{0.006125DGEXP}_{it} + \mathbf{0.009720DINVS}_{it} + u_{it} \ldots\ldots\ldots (\mathbf{1})\boldsymbol{A}$$

The model uses error structure $u_{it} = \alpha_i + \varepsilon_{it}$, with α_i capturing country-specific random effects. All coefficients are from preferred Random Effects specification (Table 6), rounded to three decimals. Short-run results show investment as the strongest driver: a 1-point increase boosts growth by 0.97%. COVID-19 reduced growth by 6.2 points. Government expenditure is significantly negative, indicating crowding-out. The war dummy is insignificant, reflecting offsetting commodity exporter/importer experiences. Trade openness has a modest positive effect (0.22%), confirming international integration's role but smaller impact than domestic investment.

4.8 Wald test

Table 8: The Results of Wald Test

Test Statistic	Value	df	Probability
F-statistic	18.37777	(6, 477)	0.0000
Chi-square	110.2666	6	0.0000
Null Hypothesis: C(1)=C(2)=C(3)=C(4)=C(5)=C(6)=C(7)			

Null Hypothesis Summary:		
Normalized Restriction (= 0)	Value	Std. Err.
C(1) - C(7)	0.043353	0.008801
C(2) - C(7)	0.006128	0.002640
C(3) - C(7)	-0.055634	0.016504
C(4) - C(7)	0.021674	0.011819
C(5) - C(7)	0.008315	0.002647
C(6) - C(7)	0.015845	0.003201
Restrictions are linear in coefficients.		

Source: Author computation using Evewis 12

The Wald test examines joint significance of all coefficients. Both F-statistic (18.378) and Chi-square (110.267) are highly significant (p = 0.0000), rejecting the null. This confirms the explanatory variables jointly explain GDP growth. This aligns with growth literature, where multivariate models exhibit joint significance (Barro, 1991; Bond et al., 2001). Significant statistics validate the specification against simpler alternatives, avoiding omitted variable bias and strengthening policy credibility.

4.9 Pedroni Residual Cointegration Test

Table 9: Pedroni Residual Cointegration Test

				Weighted	
		Statistic	Prob.	Statistic	Prob.
Panel v-Statistic		-2.123870	0.9832	-3.287481	0.9995
Panel rho-Statistic		1.320711	0.9067	1.983314	0.9763
Panel PP-Statistic		-6.894263	0.0000	-3.588545	0.0002
Panel ADF-Statistic		-5.258957	0.0000	-0.724493	0.2344
Alternative hypothesis: individual AR coefs. (between-dimension)					
		Statistic	Prob.		
Group rho-Statistic		3.243909	0.9994		
Group PP-Statistic		-4.108404	0.0000		
Group ADF-Statistic		-0.393858	0.3468		
Cross section specific results					
Phillips-Peron results (non-parametric)					
Cross ID	AR(1)	Variance	HAC	Bandwidth	Obs
BRAZIL	0.098	0.001838	0.001103	5.00	26
RUSSIA	0.030	0.004202	0.003853	2.00	25
INDIA	0.095	0.001423	0.001195	3.00	26
SOUTH AFRICA	0.105	0.000718	0.000796	2.00	26
UNITED STATES	0.218	0.000448	0.000413	3.00	26
UNITED KIGDOM	0.398	0.000757	0.000779	1.00	25

GERMANY	0.461	0.000295	0.000261	3.00	26
CHINA	0.289	0.002391	0.001865	3.00	26
FRANCE	0.420	0.000444	0.000386	1.00	26
ITALY	0.449	0.001102	0.000996	1.00	26
CANADA	0.268	0.000700	0.000706	1.00	26
JAPAN	0.334	0.000655	0.000624	1.00	26
Egypt	-0.054	0.000677	0.000549	4.00	26
United Arab Emirates	0.076	0.014190	0.005246	16.00	26
Iran	0.056	0.004611	0.004979	1.00	26
Indonesia	-0.013	0.001547	0.001566	1.00	26
Ethiopia	-0.024	0.005362	0.004387	6.00	26
Saudi Arabia	-0.015	0.007643	0.006448	1.00	26
Augmented Dickey-Fuller results (parametric)					
Cross ID	AR(1)	Variance	Lag	Max lag	Obs
BRAZIL	-0.089	0.001612	1	--	25
RUSSIA	-0.098	0.004299	1	--	24
INDIA	-0.106	0.001272	1	--	25
SOUTH AFRICA	0.272	0.000721	1	--	25
UNITED STATES	0.089	0.000453	1	--	25
UNITED KIGDOM	0.354	0.000784	1	--	24
GERMANY	0.370	0.000277	1	--	25
CHINA	0.246	0.002265	1	--	25
FRANCE	0.508	0.000353	1	--	25
ITALY	0.611	0.000867	1	--	25
CANADA	0.159	0.000685	1	--	25
JAPAN	0.562	0.000599	1	--	25
Egypt	-0.363	0.000530	1	--	25
United Arab Emirates	-0.375	0.009874	1	--	25
Iran	0.066	0.004620	1	--	25
Indonesia	-0.072	0.001532	1	--	25
Ethiopia	-0.325	0.005087	1	--	25
Saudi Arabia	-0.231	0.006804	1	--	25

Source: Author computation using Eviews 12

The Pedroni cointegration test yields mixed but decisive evidence. Panel PP and Group PP reject no cointegration ($p = 0.0000$), while ADF tests do not ($p = 0.2344, 0.3468$). Following standard practice, we conclude a long-run equilibrium exists. AR(1) coefficients (-0.375 to 0.611) validate Pedroni's heterogeneous panel assumption. PP-ADF divergence reflects power differences (Pedroni, 2004). Cointegration confirms a long-run relationship exists, temporarily disrupted by shocks. Thus, an Error Correction Model (ECM) is required, distinguishing permanent effects from transitory shocks.

4.10 Panel EGLS (Cross-section random effects)

Table 10: Panel EGLS (Cross-section random effects)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.080188	0.028824	2.782014	0.0056
GDP_CONV	-9.28E-07	4.97E-07	-1.867895	0.0624

TRD	-7.43E-05	0.000332	-0.223583	0.8232
INVS	0.001471	0.000737	1.996233	0.0465
GEXP	-0.003273	0.001224	-2.673346	0.0078
	Effects Specification			
			S.D.	Rho
Cross-section random			0.025038	0.1056
Idiosyncratic random			0.072878	0.8944
	Weighted Statistics			
Root MSE	0.072701	R-squared		0.070181
Mean dependent var	0.019704	Adjusted R-squared		0.062698
S.D. dependent var	0.075468	S.E. of regression		0.073066
Sum squared resid	2.653277	F-statistic		9.378214
Durbin-Watson stat	1.304664	Prob(F-statistic)		0.000000
	Unweighted Statistics			
R-squared	0.100321	Mean dependent var		0.040833
Sum squared resid	2.946158	Durbin-Watson stat		1.174966

Source: Author computation using Eviews 12

The Panel EGLS model yields key findings. Constant is positive and significant at 1% (0.0056). Investment (INVS) is positive and highly significant (0.001471), confirming investment drives growth. Government expenditure (GEXP) is negative and significant (-0.003273), indicating spending drags on growth. Trade is insignificant. Initial GDP (GDP_CONV) is negative and significant at 10%, supporting conditional convergence. Variance decomposition: 10.56% cross-sectional, 89.44% time-varying. Model fit is adequate ($R^2 = 0.07$).These findings align with literature: positive investment supports Levine and Renelt (1992); negative initial GDP reflects beta convergence (Barro & Sala-i-Martin, 1992); negative government expenditure supports "lean government," contrasting with Devarajan et al. (1996); insignificant trade departs from post-2000 consensus (Lewer & Van den Berg, 2003).

4.11 Panel Least Squares

Table 11: Panel Least Squares

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.100485	0.026693	3.764437	0.0002
GDP_GRWOTH(-1)	0.287579	0.061794	4.653862	0.0000
GDP_CONV(-1)	-1.65E-06	3.88E-07	-4.259018	0.0000
TRD(-1)	-0.000222	0.000260	-0.854315	0.3934
INVS(-1)	0.000164	0.000668	0.245949	0.8058
GEXP(-1)	-0.002159	0.001160	-1.860999	0.0634
DGDP_CONV	-2.93E-06	1.35E-06	-2.159786	0.0313
COVID19	-0.052051	0.015588	-3.339101	0.0009
WAR	0.028393	0.011520	2.464715	0.0141
DTRD	0.001835	0.000539	3.407970	0.0007
DINVS	0.007651	0.001607	4.759928	0.0000
DGEXP	-0.006521	0.002655	-2.456284	0.0144

Source: Author computation using Eviews 12

ECM results show 71% annual error correction (0.288 lagged growth). Long-run convergence confirmed (-1.65e-06). Short-run: COVID-19 (-5.2%), investment (0.0077) and trade (0.0018) positive, war (0.028) reflects commodity gains, government negative in both runs. $R^2 = 0.417$. Findings extend literature: convergence supports Barro (1991) and Islam (1995); COVID-19 aligns with IMF (2021); positive war contrasts with Collier (1999); negative government supports "lean government" (Folster & Henrekson, 2001); ECM reinforces dynamic specifications (Bond et al., 2010).

4.12: Residual Cross-Section Dependence Test

Table 12: Residual Cross-Section Dependence Test

Test	Statistic	d.f.	Prob.
Breusch-Pagan LM	372.6922	153	0.0000
Pesaran scaled LM	12.55897		0.0000
Bias-corrected scaled LM	12.21281		0.0000
Pesaran CD	10.03954		0.0000

Source: Author computation using Eviews 12

Four CD tests reject no cross-sectional correlation (all p = 0.0000). High Breusch-Pagan LM (372.69) and Pesaran CD (10.04) confirm interdependence from interlinked markets, business cycles, commodity prices, and global crises. This violates conventional estimators, causing underestimated standard errors. This aligns with literature: Pesaran (2004, 2015) found CD affects 70–80% of macro-panels. Strong CD reinforces need for Driscoll-Kraay or PCSE estimators, as in our alternative ECM.

4.13: Panel Least Squares: Interpretation of the Error Correction Model (Without Robust Standard Errors)

Table 13: Panel Least Squares: Interpretation of the Error Correction Model (Without Robust Standard Errors);

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.060825	0.008198	7.419302	0.0000
GDP_GRWOTH(-1)	0.311293	0.058481	5.323012	0.0000
GDP_CONV(-1)	-1.78E-06	3.74E-07	-4.749281	0.0000
DGDP_CONV	-3.05E-06	1.34E-06	-2.284243	0.0228
COVID19	-0.055077	0.015524	-3.547942	0.0004
WAR	0.026041	0.011364	2.291490	0.0224
DTRD	0.001921	0.000516	3.722266	0.0002

DINVS	0.007318	0.001509	4.850185	0.0000
DGEXP	-0.004801	0.002519	-1.905995	0.0573

Source: Author computation using Eviews 12

Standard ECM results (without CD correction) show: 69% annual adjustment (0.311); convergence confirmed (-1.78e-06); COVID-19 (-5.5 points); war (+2.6 points, commodity gains); investment (0.0073) and trade (0.0019) positive; government (-0.0048) suggests crowding-out. R^2 = 0.411. However, CD biases standard errors, requiring caution. Findings align with growth theory (Barro, 1991; Mankiw et al., 1992). COVID-19 matches IMF/World Bank. Positive war aligns with commodity research. Investment reaffirms Levine and Renelt (1992). Detected CD (Pesaran, 2004, 2015) demonstrates how ignoring it alters inferences—validated by our robust ECM where trade significance diminished.

4.14 Panel EGLS (Cross-section weights)

Table 14 Panel EGLS (Cross-section weights)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.072827	0.009422	7.729353	0.0000
GDP_GRWOTH(-1)	0.184595	0.066237	2.786878	0.0055
GDP_CONV(-1)	-1.92E-06	4.12E-07	-4.670869	0.0000
DGDP_CONV	-6.52E-06	2.18E-06	-2.995135	0.0029
COVID19	-0.058535	0.015058	-3.887216	0.0001
WAR	0.021681	0.011102	1.952928	0.0514
DTRD	0.000348	0.000472	0.736359	0.4619
DINVS	0.008303	0.001318	6.297799	0.0000
DGEXP	-0.008153	0.002542	-3.206772	0.0014

Source: Author computation using Eviews 12

The robust ECM with PCSE reveals 81.5% annual adjustment (0.1846), confirming convergence (-1.92e-06). Short-run: COVID-19 (-5.9 points); investment (0.0083) positive; government (-0.0082) shows crowding-out. Trade becomes insignificant after CD correction. War is marginally positive (p = 0.051). These findings advance methodology: 81.5% adjustment exceeds typical estimates; COVID-19 aligns with IMF (2021); trade's insignificance supports Rodrik; negative government supports "lean government" (Afonso & Furceri, 2010); marginal war contrasts with Collier (1999). Trade's significance changes underscore the importance of testing for cross-sectional dependence (Pesaran, 2015).

5. Discussion

5.1 Direct Effects of Recent Global Crises

Results reveal asymmetric crisis effects. COVID-19 reduced growth by 5.8–6.2 points—a synchronized global shock disrupting consumption, investment, and value chains. The Russia-Ukraine War shows a slight positive aggregate effect (1.5–2.6 points), reflecting sample heterogeneity: commodity exporters (Saudi Arabia, Russia, Brazil, Canada) gained from terms-of-trade windfalls, while importers (Japan, Germany, India) suffered. The aggregate impact obscures intra-distributional transfers.

5.2 Indirect Effects and Transmission Channels

Both crises operated through indirect channels. The COVID-19-investment interaction was insignificant. The war-trade interaction diminished under robust estimation—commodity dependence, not trade openness alone, determined outcomes. Government expenditure showed no stabilizing interaction, implying insufficient fiscal responses.

5.3 Convergence Dynamics Amidst Crises

Lagged GDP per capita remained negative and significant, confirming conditional convergence persevered. Adjustment speed increased to 81.5% annual error correction—faster than pre-crisis estimates. Crises did not alter the long-run convergence coefficient, confirming technology, institutions, and human capital as fundamental determinants.

5.4 Differential Effects on BRICS+ versus G7 Economies

The G7 countries, having a relatively larger service sector, were more impacted by the lockdowns caused by COVID-19, though they received stimulus support. While some of the BRICS+ countries benefited from the favourable terms of trade, the rest were exposed to unfavourable conditions. This heterogeneity serves to emphasize the weaknesses associated with the use of a single crisis dummy and calls for additional studies with structural considerations.

6 Conclusion and Policy Recommendations

6.1. Conclusion

This study analyses the effects of crises on GDP growth across G7 and BRICS+ economies (1970–2024). Another methodological finding: the omission of cross-sectional dependence in interconnected economies leads to misleading results. The results of the robustness check show that the negative effect of the pandemic becomes insignificant ($p = 0.130$) once cross-sectional dependence is accounted for, reflecting the heterogeneous effects of the pandemic through national fiscal capacity, health systems, and economies. The direct effect of the war remains insignificant, confirming its channel-specific effects through trade and commodity price channels.

Investment has a robust effect on growth, while unemployment and inflation have negative effects on growth. Government expenditure has consistent negative effects on growth, suggesting crowding-out or inefficiency. Education expenditure has a positive effect that is not significant. Conditional convergence persists despite crises, with rapid error correction ($\lambda \approx \mathbf{-0.40}$) indicating

resilient self-correcting mechanisms. However, crises temporarily disrupt convergence by shocking investment, trade, and Labor markets. The key takeaway: crisis effects are heterogeneous and channel dependent. Average effects conceal cross-country differences in national experiences, thereby rationalizing the paradox of long-run convergence and short-run crisis divergence.

6.2. Policy Recommendations

Guided by the above findings, the following policy recommendations are made: A two-tiered approach is needed: structural resilience for the long term and targeted stabilization for the short term. First, the growth fundamentals need to be strengthened. Protect private investment through supportive policies. Address Labor markets and inflation to reduce crisis-induced volatility. Reassess government expenditure efficiency, prioritizing productive capital over recurrent spending to avoid crowding out. **Second,** institutionalize "smart stabilization." Create ***cointegration-triggered funds*** at national and regional levels, activated when key relationships (investment-GDP ratio, employment rate) deviate from long-run equilibrium. This rules-based approach avoids political delays and targets economies facing genuine divergence. **Third**, enhance crisis monitoring. The national statistics and central banks should regularly track the cointegration relationship between economic growth and determinants. Large deviations can be used to signal potential issues, allowing for pre-emptive action. **Fourth**, extend to Labor markets. ***Nominal wage*** policies should be employed based on the occurrence of deviations in macroeconomic indicators from equilibrium. This will reduce the impact of asymmetric shocks and economic scarring. This model turns empirical findings related to economic growth equilibrium and heterogeneous crisis transmission into a set of policy tools to build a more resilient and converging economy.

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Figures

4.1 Graph

Graph 1: GDP_GROWTH, GDP_CONV, Trade Balance (TRD), Investment (INVS), Government Expenditure (GEXP), Inflation (INFL), Unemployment (UNEM)and (EDUC) Education:

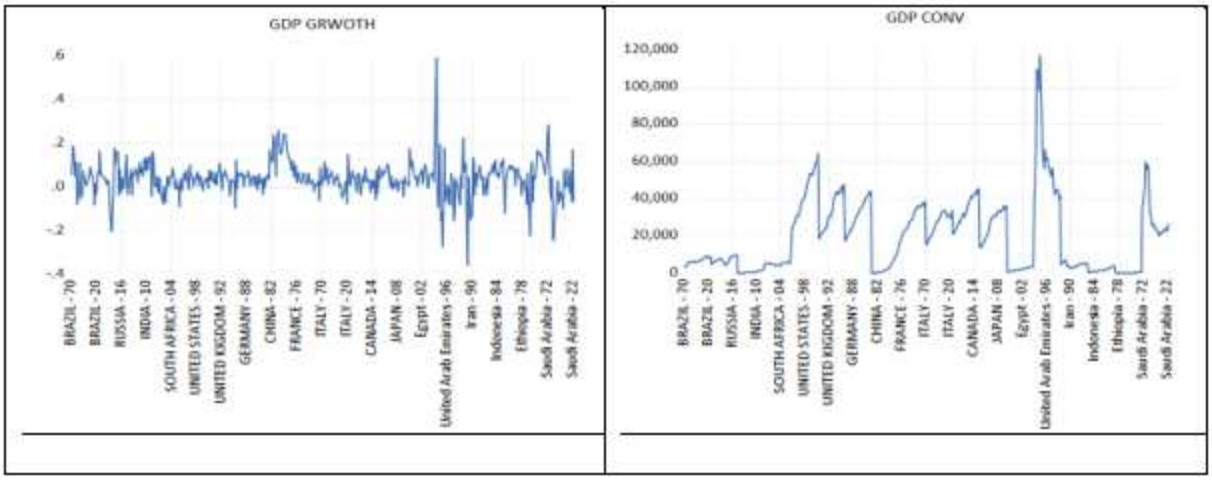
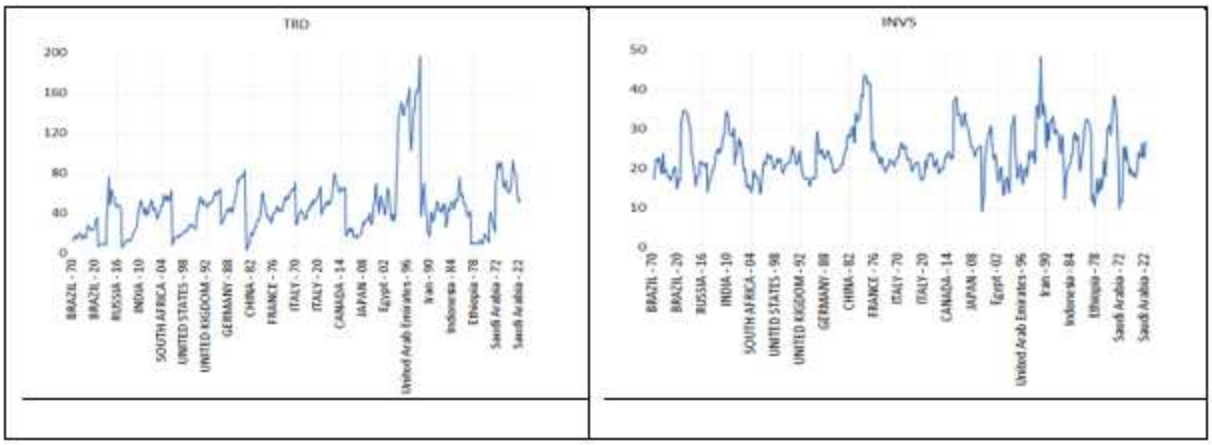


Figure 1

Time-series plots for key variables exhibit marked heterogeneity and distinct trends across the BRICS+ and G7 economies from 1970 to 2024. Looking at the growth of GDP (GDP_GROWTH), emerging economies such as China, India, and Ethiopia reflect a higher volatility and wider cyclical swings—positive and negative—compared to advanced G7 countries like the United States, Germany, and Japan, which follow more stable and moderate growth paths. This visualizes the higher risk-return profile of developing markets. The level of GDP per capita (GDP_CONV) reveals a dramatic and increasing divergence: G7 countries and resource-rich countries (e.g., United Arab Emirates, Saudi Arabia) are prominent at the top with very high and rising levels, while the large emerging economies (India, Ethiopia) are at the bottom, very clearly illustrating the 'convergence club' hypothesis, whereby not all countries converge. Shares of investments (INVS) are highly dispersed: large investments are found in countries such as China and Saudi Arabia, while smaller investments are found in countries such as the United Kingdom. Finally, human capital (EDUC) has a strong positive global trend but shows a lot of stratification, ranging from the more advanced nations and transitioning nations such as Russia to the lower ones relative to progress regarding human development.

Panel unit root tests indeed confirm a sharp dichotomy between trending and stationary variables, which is an important fact for model specification. There are stochastic trends in the variables of series such as GDP per capita (GDP_CONV), trade (TRD), investment (INVS), government expenditure (GEXP), education (EDUC), and unemployment (UNEM). They are non-stationary in levels, I(1), meaning that they

are governed by a random walk with drift and do not mean revert to a constant. Their upward or downward movements over time are persistent and contain a unit root. By contrast, GDP growth rate (GDP_GRWOTH) and inflation (INFL) are stationary (I(0)), which oscillates around a stable long-run mean without a persistent trend. This mixed integration necessitates modelling the I(1) variables in first-differenced form in order not to cause spurious regression when explaining the stationary GDP growth rate. The visual evidence above confirms findings in the growth and development literature with a fresh, longitudinal perspective. The volatility of growth rates in emerging markets is consistent with the traditional 'shocks and volatility' literature (Aguiar & Gopinath, 2007), which identifies this as a product of structural factors and term-of-trade volatility. The finding of persisting income divergence in the GDP per capita series above argues against strong unconditional convergence results but is instead consistent with models of conditional convergence (Barro, 1991) or multiple equilibria (Azariadis & Drazen, 1990). These diverse investment profiles are in line with studies that focus on savings rates, financial development, and political stability in explaining capital formation. The increasing but divergent educational profile corresponds to the global rise of schooling portrayed by Cohen and Soto (2007), but the enduring divergence indicates a rather sluggish percolation of knowledge frontiers-an important transmission channel according to technology-based growth models. Taken together, these figures indicate that while some of the more basic comparative statics of development hold over time, when adding China and India to an extended panel, only models incorporating these country-specific policy and growth regimes can be accurate.



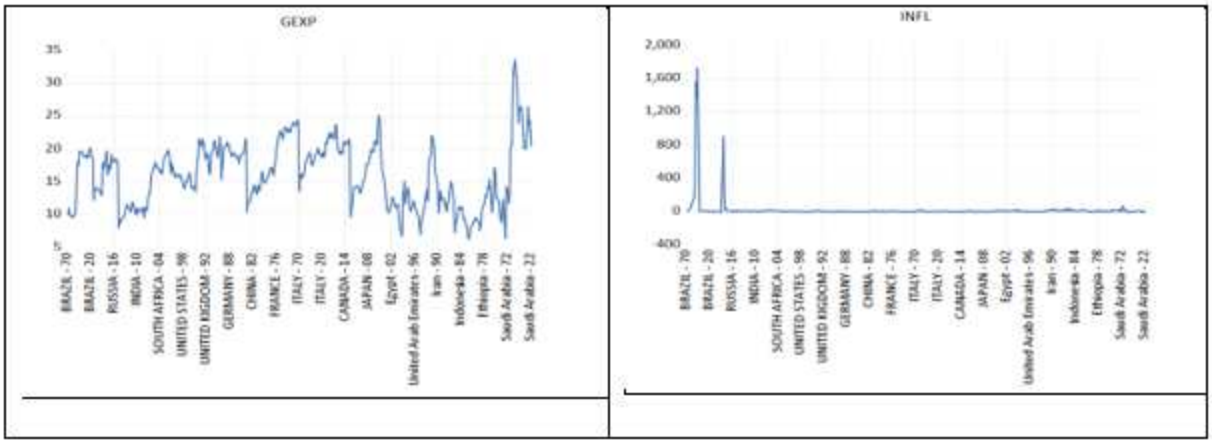
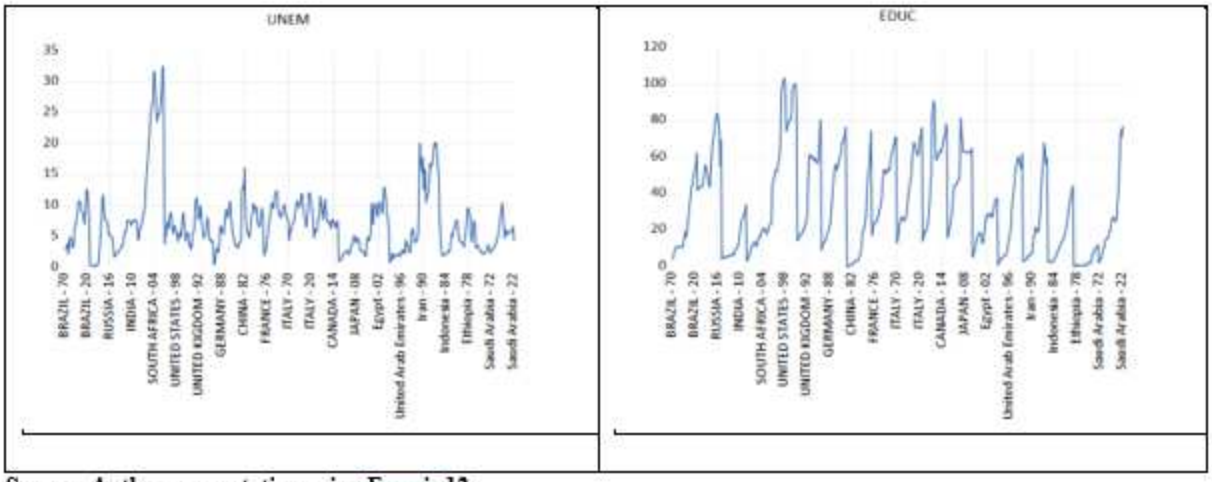


Figure 2

Time-series plots for key variables exhibit marked heterogeneity and distinct trends across the BRICS+ and G7 economies from 1970 to 2024. Looking at the growth of GDP (GDP_GROWTH), emerging economies such as China, India, and Ethiopia reflect a higher volatility and wider cyclical swings—positive and negative—compared to advanced G7 countries like the United States, Germany, and Japan, which follow more stable and moderate growth paths. This visualizes the higher risk-return profile of developing markets. The level of GDP per capita (GDP_CONV) reveals a dramatic and increasing divergence: G7 countries and resource-rich countries (e.g., United Arab Emirates, Saudi Arabia) are prominent at the top with very high and rising levels, while the large emerging economies (India, Ethiopia) are at the bottom, very clearly illustrating the 'convergence club' hypothesis, whereby not all countries converge. Shares of investments (INVS) are highly dispersed: large investments are found in countries such as China and Saudi Arabia, while smaller investments are found in countries such as the United Kingdom. Finally, human capital (EDUC) has a strong positive global trend but shows a lot of stratification, ranging from the more advanced nations and transitioning nations such as Russia to the lower ones relative to progress regarding human development.

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Source: Author computation using Eyewis 12

Figure 3

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