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Quantifying the Spillover Effect of U.S. Trade Policy Uncertainty on Economic Growth of BRICS: A Panel Data Investigation

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Abstract

Purpose: Amid escalating geopolitical risks and rising global uncertainty, fluctuations in trade policy have emerged as powerful forces shaping macroeconomic outcomes. Against this backdrop, the present study evaluates the impact of U.S. trade policy uncertainty (TPU) on the economic growth (ECG) of BRICS economies over the period 1985–2023.

Design/methodology/approach: To ensure methodological robustness and reliable inference, the study employs advanced panel econometric techniques, including the Cross-Sectional Autoregressive Distributed Lag (CS-ARDL) model, Fully Modified Ordinary Least Squares (FMOLS), and the two-step System Generalized Method of Moments (GMM). These approaches address issues of cross-sectional dependence, endogeneity, and heterogeneity across BRICS economies.

Findings: Empirical results reveal a statistically significant negative relationship between U.S. TPU and both GDP per capita growth and GNI per capita growth in BRICS economies. Heightened trade policy uncertainty amplifies investor risk perceptions, delays investment decisions, and contracts capital inflows. Furthermore, TPU disrupts trade planning, increases transaction costs, and weakens export performance, particularly for economies reliant on external demand. These outcomes underscore the need for adaptive and resilient domestic economic policies to mitigate the spillover effects of global uncertainty.

Research limitations/implications: The analysis is constrained by the availability of long-term comparable data for all BRICS members and focuses solely on the effects of U.S. trade policy uncertainty. Future research could incorporate regional trade uncertainties or domestic policy volatility to broaden the understanding of cross-country resilience mechanisms.

Practical implications: The findings provide actionable insights for policymakers in emerging markets. Strengthening domestic institutions, diversifying trade partnerships, and building flexible policy frameworks can help minimize the adverse effects of global trade policy shocks. Additionally, coordination among BRICS members can enhance collective stability amid evolving global trade tensions.

Originality/value: This study is original in empirically validating Real Options Theory within a cross-country trade uncertainty framework, highlighting how global policy ambiguity drives cautious investment behavior and delayed economic activity. Unlike prior studies that focus on single-country or regional contexts, this research uniquely examines the long-term macroeconomic consequences of U.S. trade policy uncertainty on the BRICS bloc, using comprehensive and robust econometric techniques.
The paper contributes to the field of Decision Sciences by demonstrating how uncertainty in global trade policy shapes economic decision-making and risk management under external shocks. Importantly, the findings offer valuable guidance for policymakers and decision-makers in designing strategies that enhance economic resilience and stability under uncertainty.

Keywords: Trade Policy Uncertainty, Economic Growth, Real Option Theory, BRICS Economies
JEL Codes: F13, F21, F43

1 Introduction

In the context of escalating geopolitical tensions and a shifting global power balance, international trade has become increasingly vulnerable to policy-driven disruptions. Over the past decade, the global economy has faced repeated shocks because of sudden shifts in trade policies announced by the United States (Tan et al., 2025; Zheng et al., 2025). For example, the trade tensions between the U.S. and China in 2018 and the decision to withdraw from major trade deals like the Trans-Pacific Partnership (TPP) created widespread uncertainty (Akadiri & Ozkan, 2025; Chodor, 2019). These events not only affected the U.S. but also sent signals of risk across global markets. When such uncertainty increases, businesses often hold back their investment plans, while consumers become cautious and reduce their spending (Li et al., 2023). At the same time, governments are forced to respond quickly with new fiscal or monetary measures (Li et al., 2023). Since the U.S. is a major player in world trade, any change in its policies affects not only direct trade partners but also other economies that are strongly tied to global markets. Economies, i.e., Brazil, Russia, India, China, and South Africa (BRICS), are particularly exposed, as they rely heavily on trade, foreign investment, and stable financial flows. Because of this, any unexpected changes in U.S. trade policy can create pressure on their growth and stability. Although many studies focus on how U.S. trade policy affects its own economy, no studies examine how this uncertainty spills over into major emerging economies (Alessandria et al., 2024; Gopinath, 2021; Huynh et al., 2023; Liu et al., 2025; Sun et al., 2021). Despite the global implications of U.S. trade policy uncertainty, its impact on the growth trajectories of BRICS economies remains largely underexplored, leaving a significant gap in understanding their vulnerability to external shocks and the measures needed for sustainable stability. Therefore, this research looks closely at how U.S. trade policy uncertainty affects the economic growth of BRICS countries. Since these nations play a key role in the global economy, it is important to understand whether such external risks limit their growth potential or economic performance.

Understanding how uncertainty in external trade policies translates into real economic outcomes requires a close assessment of fundamental development indicators. When external uncertainty rises, especially from a large trading partner like the United States, it may influence capital allocation, investment patterns, labor dynamics, and trade flows in partner economies (Freund et al., 2024). These effects can emerge through delayed business decisions, reduced investor confidence, and shifts in bilateral and multilateral trade relationships. Moreover, economies with high trade dependence and structural exposure to U.S. policy fluctuations may experience uneven impacts across income and output channels. These possibilities make it essential to investigate how fluctuations in U.S. trade policy expectations influence the economic trajectory of the BRICS economies. Instead of taking broad economic aggregates, this study narrows its focus to key indicators that signal real, observable effects on population-level income and growth. With this perspective, the study poses two research questions: First, to what extent does U.S. trade policy uncertainty alter the pace of GDP per capita growth in BRICS countries? Second, how does it affect GNI per capita growth across these nations? These questions are not only empirical but also critical in understanding how external economic risks reach the core of domestic development.

Trade policy uncertainty (TPU) has emerged as a measurable and influential variable in global economic analysis, especially due to its capacity to reshape investment expectations and international trade patterns. The U.S., given its central position in the world economy, often sets the tone for trade policy developments. Its policy shifts influence not only direct partners but also countries indirectly connected through global supply and demand chains. Measuring U.S. TPU is significant because it helps to identify external risks that may cause fluctuations in key growth indicators (Olasehinde-Williams, 2021). On the other hand, GDP per capita growth and GNI per capita growth serve as essential measures to capture both output performance and income progression in a country. These indicators provide a comprehensive view of development trends, which is necessary for understanding long-term policy impacts (Kobayakawa, 2022; Nolan et al., 2019; Tsuzuki, 2008). Moreover, this study selects the U.S. as the source country due to its trade dominance and policy weight across both developed and emerging markets. Similarly, BRICS economies are chosen due to their strategic importance in global trade, high economic potential, and growing interdependence with the U.S. They represent a wide range of economic systems and developmental stages, and at the same time, they are all highly exposed to external trade-related shocks. The U.S. and BRICS together hold a central position in global trade flows, making their economic connection a key component of international economic dynamics. Together, the U.S. and BRICS form a critical axis of modern trade relations. Examining how uncertainty from one end affects economic performance on the other end provides meaningful evidence for economists, policymakers, and international institutions aiming to stabilize growth in an increasingly uncertain world.

Beyond their economic size and influence, the U.S. and BRICS economies lie at the center of global trade disputes, negotiations, and policy shifts, making them highly relevant for examining trade policy uncertainty. The heterogeneity of BRICS in terms of institutions, income levels, and financial systems allows assessment of how uncertainty spreads across different settings, while the deepening U.S.–BRICS trade ties over the past four decades amplify spillover effects. Thus, this diverse yet interconnected sample ensures broader responses are captured, and the findings remain both robust and globally relevant.

To examine the long-term and short-term economic consequences of external uncertainty, this study uses annual panel data from 1985 to 2023 covering the United States and BRICS countries. The analysis employs advanced econometric techniques, including Cross-Sectional Autoregressive Distributed Lag (CS-ARDL), Fully Modified Ordinary Least Squares (FMOLS), and the Generalized Method of Moments (GMM), in order to capture both the dynamic and structural aspects of the relationship. These techniques account for potential econometric issues, e.g., heterogeneity, cross-sectional dependence, and endogeneity, which are often present in macro-level panel data. The empirical findings across all three models reveal a statistically significant negative connection between U.S. trade policy uncertainty and the economic growth of BRICS, measured through GDP per capita and GNI per capita. TPU affects economic decisions in emerging economies. When U.S. trade policy becomes unpredictable, firms across BRICS delay investment, reduce production, and slow hiring because they face unclear demand conditions and possible disruptions in trade. At the same time, consumers reduce spending, and governments adjust budgets due to lower expected revenue. These combined effects create downward pressure on income and output levels. Since BRICS economies are deeply integrated into international markets and often rely on export-led growth, persistent uncertainty from a major trade actor like the U.S. reduces their economic confidence and weakens overall growth. These findings provide a strong empirical basis to argue that external policy instability can directly affect internal development outcomes in major emerging markets.

To support the findings, Li et al. (2023) showed that rising TPU discourages energy firm investments, while Wang and Wu (2023) report that extreme TPU could reduce China's GDP by 5.65%, although FDI and export volume positively drive growth. Inflation (IFR) and lending rates (LIR) negatively affect GDP, and Guo et al. (2022) find that TPU's impact on energy prices shifts over time. Similarly, Akron et al. (2020) show uncertainty lowers investment in low-capital U.S. hospitality firms, and Xu et al. (2023) find high uncertainty raises volatility while reducing returns.

This study offers important contributions on theoretical, empirical, and practical levels. From a theoretical perspective, the findings support the foundation of Real Options Theory, which argues that under uncertain conditions, firms and governments prefer to delay investment decisions to avoid potential losses. This behavior becomes more evident when policy changes are unpredictable and costly. In the case of BRICS economies, the negative connection between U.S. TPU and economic growth supports this theory. When uncertainty increases, decision-makers avoid risks by holding back capital spending, adjusting trade plans, and slowing down production. This cautious response confirms the idea that the value of waiting increases in uncertain environments, which weakens growth performance in the short and medium term (Handley & Limão, 2022; He et al., 2022). Empirically, this study adds value by examining a long data range from 1985 to 2023, using advanced econometric methods, i.e., CS-ARDL, FMOLS, and GMM. The results are consistent across models, which improves the reliability and depth of the findings. While most earlier studies focused only on domestic effects, this research highlights how one country's policy behavior can affect others through external uncertainty channels (Alessandria et al., 2024; Huynh et al., 2023; Liu et al., 2025). On a practical level, the results are useful for policymakers in emerging economies. By understanding the impact of external trade policy shifts, they can strengthen domestic economic policies, e.g., by building reserves, reducing trade concentration, or improving regional trade ties. At the same time, the study informs U.S. policymakers about the broader effects of their trade actions, which may help in designing more stable and predictable policy frameworks.

The timeliness of this investigation is underscored by significant recent shifts in global trade policy and geopolitical alignments that have amplified trade policy uncertainty. In 2025, the United States implemented sweeping tariff increases on imports from multiple partners, marking one of the most ambitious protectionist turns in decades and contributing to heightened volatility in global trade flows. These actions have disrupted established trade patterns, weakened investor confidence, and intensified uncertainty for export-dependent emerging economies. Concurrently, the BRICS bloc has expanded its membership and deepened institutional cooperation, including initiatives aimed at de-dollarization and alternative payment systems, signaling a shift toward multipolar trade governance. Such developments make the long-run assessment of U.S. trade policy uncertainty's spillover effects on BRICS economic growth both highly relevant and policy-critical.

This study contributes originally by extending Real Options Theory to a cross-country context, empirically demonstrating how U.S. trade policy uncertainty influences macroeconomic decision-making in emerging economies. It advances the field of Decision Sciences by offering novel insights into how global policy uncertainty shapes investment behavior, risk assessment, and strategic responses across interconnected markets. By focusing on BRICS economies, the study provides a unique empirical perspective that bridges international trade dynamics with decision-making under uncertainty, offering valuable implications for policy formulation and economic governance.

This study is organized into six Sections. In Section 2, Theoretical Background of study is presented, emphasizing Real Options Theory. Section 3 covers empirical literature on trade policy uncertainty and growth. Section 4 explains data sources, variables, and methods, including CS-ARDL, FMOLS, and GMM. Section 5 reports and discusses results. The study ends with a conclusion and policy recommendations based on key findings and their practical significance for emerging economies.

2 Literature Review

2.1 Trade Policy Uncertainty and Economic Growth

This section critically reviews the existing literature on trade policy uncertainty, economic policy uncertainty, and growth-related outcomes, with particular emphasis on the methodological approaches employed and their limitations. While prior studies provide valuable empirical insights, they largely rely on frameworks that are ill-suited to capture cross-country spillovers, long-run dynamics, cross-sectional dependence, and endogeneity, thereby motivating the methodological choices adopted in this study.

A substantial strand of the literature applies time-series or country-specific models, which restrict external validity. For instance, Abaidoo (2019) employed a standard ARDL framework using quarterly data to assess the impact of the U.S., China, and EU EPU on international trade. While ARDL is useful for mixed-order integration, it assumes cross-sectional independence and is therefore limited in capturing global spillover effects inherent in trade uncertainty. Similarly, Tam (2018) used a GVAR framework to analyze U.S. and China EPU effects on global trade flows, allowing for international linkages but remaining primarily focused on trade transmission channels rather than long-run growth outcomes, and without addressing heterogeneous long-run coefficients across economies.

Several studies emphasize causality and volatility transmission, yet do not explicitly model long-run equilibrium relationships. Olasehinde-Williams (2021) relied on linear, nonlinear, and frequency-domain causality tests to examine whether U.S. TPU predicts global output volatility. While these techniques reveal predictive power, they do not estimate long-run elasticities or adjustment dynamics critical for growth analysis. Fang et al. (2022) employed panel regressions across 142 countries and found that TPU negatively affects globalization; however, their approach did not explicitly correct for cross-sectional dependence, a key concern when countries are jointly exposed to global uncertainty shocks.

Another group of studies examines investment, FDI, and welfare channels through which uncertainty operates. Choi et al. (2021) showed that policy uncertainty reduces FDI inflows, particularly in financially weak economies, but their baseline models are susceptible to reverse causality between growth, investment, and uncertainty. Limão and Maggi (2015) demonstrated welfare gains from reduced TPU using trade agreement frameworks, yet their structural focus limits generalization to broader macroeconomic growth outcomes. Aizenman and Marion (1993) used endogenous growth models and early cross-country evidence to establish a negative uncertainty–growth nexus, but their estimations predate modern techniques that account for dynamic endogeneity and heterogeneous slope coefficients.

Studies on sanctions and geopolitical shocks, such as Neuenkirch and Neumeier (2015), provide strong evidence of long-lasting growth losses using panel regressions, but their models treat shocks as largely exogenous and do not explore trade policy uncertainty as a continuous risk variable. Similarly, historical and political economy contributions (Dutt & Mitra, 2002; Ehrlich, 2008; Krasner, 1977; Rodrik, 1992; Singer & Gray, 1988) offer critical theoretical insights into protectionism, institutional constraints, and trade reform sustainability, yet rely on descriptive, institutional, or reduced-form approaches that do not quantify dynamic adjustment paths under uncertainty.

More recent empirical contributions extend the literature using panel ARDL and sector-specific models. Akhter and Mir (2025) applied panel ARDL to examine trade structure and growth in Central Asia, capturing long- and short-run dynamics but without correcting for unobserved common factors. Gocer et al. (2023) and Mudunkotuwa et al. (2024) focused on sectoral or country-specific trade responses, which limit inference on systemic spillovers. Likewise, studies on financial development and FDI (Acquah & Ibrahim, 2020; Emako et al., 2022; Nguyen, 2022; Osei & Kim, 2020; Sattar et al., 2022) highlight important threshold and heterogeneity effects, but often treat policy uncertainty as exogenous or omit it altogether, raising concerns of omitted-variable bias in growth regressions.

Collectively, the literature reveals three key methodological gaps. First, many studies fail to account for cross-sectional dependence, despite globalization making economies jointly vulnerable to U.S. trade policy shocks. Second, static or single-equation approaches inadequately address endogeneity between uncertainty, investment, and growth. Third, few studies estimate long-run growth effects of trade policy uncertainty within a unified emerging-economy bloc. To address these limitations, the present study employs CS-ARDL, which explicitly controls for unobserved common factors and heterogeneous dynamics, alongside FMOLS for robust long-run estimation and two-step System GMM to mitigate endogeneity and dynamic feedback effects. This integrated methodological framework allows for a more reliable and policy-relevant assessment of U.S. trade policy uncertainty spillovers on BRICS economic growth.

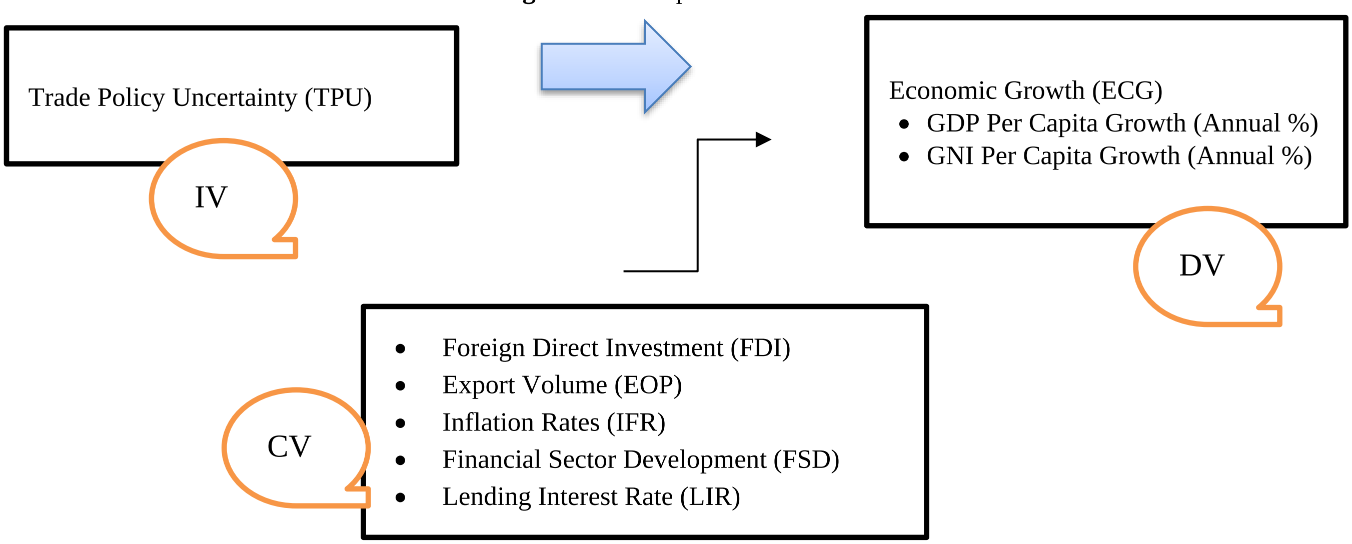
3 Theory and Hypothesis

In today's uncertain global economy, decision-making often occurs without full confidence. When the future is unpredictable, economic agents such as firms and governments frequently choose to delay action rather than commit immediately. This cautious behavior is not random; it is effectively explained by Real Options Theory, developed by Dixit and Pindyck (1994). According to this theory, investment decisions are viewed as options, giving decision-makers the right but not the obligation to allocate resources. Under conditions of uncertainty, particularly when investments are costly and difficult to reverse, it is often more rational to wait until future developments become clearer. Real Options Theory goes beyond traditional investment models by emphasizing that the timing of decisions is critical (Handley & Limão, 2022). E.g., firms may postpone large-scale investments if they anticipate trade disruptions or policy instability. Similarly, governments may delay fiscal programs when global policy directions remain uncertain. While such delays may be rational at the micro level, they can have negative consequences for the broader economy. These include slower economic growth, reduced employment, and lower income generation (Bianconi et al., 2021). The results of this study strongly support these theoretical insights. Specifically, the inverse relationship between U.S. trade policy uncertainty and economic growth in BRICS countries suggests that when U.S. trade signals become unstable, economic activity in these emerging markets declines. As a result, firms scale back investments, production slows, and income levels drop due to increased caution. This response aligns with Real Options Theory, which predicts that economic agents tend to withhold action in the face of external risks. Ultimately, the theory not only helps to explain the observed data patterns but also deepens our understanding of how global uncertainty influences real economic outcomes. Drawing on the existing body of empirical research and theory, it is hypothesized that

H_1: Elevated levels of trade policy uncertainty (TPU) exert a dampening effect on economic growth.

Figure 1 illustrates the relationship between the independent variable, control variable, and dependent variable, providing a structured guide for understanding how the variables interact in the study. In the next section, the explanation on the methodological settings is presented.

Figure 1. Conceptual Framework



Note: IV represents the independent variable, DV denotes the dependent variable, and CV describes the control variables.

4 Data and Methods

4.1 Data

This study investigates the association between U.S. trade policy uncertainty (TPU) and economic growth (ECG) using annual data spanning the period 1985–2023, yielding a balanced panel of N = 5 BRICS economies over T = 39 years (total observations = 195). The annual frequency is appropriate given the macroeconomic nature of the variables examined, such as GDP per capita growth and GNI per capita growth, which evolve gradually and are most reliably measured on a yearly basis. The selected time horizon captures several critical phases in the global trade and policy environment, including the post-Cold War trade liberalization era, the formation and economic ascent of the BRICS bloc, China's accession to the WTO, the global financial crisis, and the recent escalation in trade policy uncertainty. Importantly, the long-time dimension ensures sufficient degrees of freedom to identify long-run equilibrium relationships and dynamic adjustment processes, which are central to the objectives of this study.

Although the cross-sectional dimension (N) is relatively small compared to the time dimension (T), this structure is both intentional and methodologically appropriate. First, the BRICS economies constitute a homogeneous yet systemically important group of large emerging markets with deep trade integration and shared exposure to U.S. trade policy shocks, making them particularly suitable for focused spillover analysis. Second, long-T panels are well-suited for advanced estimators such as CS-ARDL and FMOLS, which rely on extended time series to consistently estimate long-run parameters while accounting for cross-sectional dependence and heterogeneous dynamics. Third, the use of System GMM further mitigates concerns related to endogeneity and dynamic feedback effects, even in panels with a limited number of cross-sectional units.

Data were obtained from the World Development Indicators (WDI) for economic growth measures and control variables, and from the Policy Uncertainty Database for the U.S. TPU index. The combination of high-quality, internationally comparable data and a long time span enhances the reliability and robustness of the empirical findings. Overall, the chosen sample structure provides an analytically sound framework for examining how external trade policy uncertainty originating from the United States affects long-run economic growth in major emerging economies.

4.2 Variables Explanation

In this study, ECG is employed as the dependent variable and is captured through two widely recognized indicators: GDP per capita growth (annual percentage) and GNI per capita growth (annual percentage). These indicators offer a comprehensive measure of a country's economic performance and the standard of living of its population over time. The data for these variables have been sourced from the World Development Indicators (WDI) database, which provides consistent and reliable cross-country statistics (Kobayakawa, 2022; Nolan et al., 2019; Tsuzuki, 2008). Similarly, the key independent variable in this study is TPU, which is quantified by using the TPU Index. This index was originally developed by Caldara et al. (2020) to systematically measure uncertainty related to trade policy by analyzing the frequency of trade policy-related terms in major newspapers. They considered the idea of Fernández-Villaverde et al. (2015), Baker et al. (2016), and Hassan et al. (2019) to build the TPU index. Formally, TPU_trepresents the Trade Policy Uncertainty Index at time t (measured on a monthly or quarterly basis), where $N_{TPU,t}$denotes the number of newspaper articles published in period t that contain terms related to both “uncertainty” and “trade policy,” and $N_{Total,t}$ refers to the total number of articles published in the same newspapers during the same period. This index captures concerns about possible changes in trade policy that may influence business decisions, investment, and growth outcomes. It is constructed using text-based analysis techniques that identify articles containing keywords related to uncertainty and trade policy. This approach enables the index to reflect real-time market perceptions of TPU. The inclusion of the TPU Index facilitates an empirical assessment of how heightened uncertainty surrounding trade policy can affect the growth trajectories of economies.

In this study, several control variables are incorporated to ensure a comprehensive assessment of the relationship between TPU and ECG. Foreign Direct Investment (FDI) is included as a key control variable (CV) and is measured by using net inflows as a percentage of GDP. It captures cross-border investment activities and reflects the confidence of foreign investors in a country’s economic and political environment (Saidi et al., 2023). Export volume (EOP) is another important CV and is measured based on balance of payments data. This measure accounts for the scale of a country’s trade performance and its contribution to overall economic activity (Jiao et al., 2024). Inflation rate (IFR) is also controlled in the model and is represented by the GDP deflator on an annual percentage basis. IFR influences purchasing power, cost of capital, and investment decisions, all of which are relevant for growth analysis. Financial sector development (FSD) is proxied by domestic credit to the private sector by banks as a percentage of GDP, reflecting the accessibility and efficiency of financial services. Lastly, lending interest rate (LIR), measured as the annual lending rate in percentage terms, is used to capture the cost of borrowing in an economy. These variables together help to isolate the net effect of TPU on ECG. Table 1 shows the measurement of variables.

Table 1: Variables Measurements

	Variable	Measurement	Role	Source
ECG	Economic Growth	• GDP per capita growth (annual %) • GNI per capita growth (annual %)	DV	WDI
TPU	Trade Policy Uncertainty	TPU index	IV	EPU website
FDI	FDI inflow	Foreign direct investment, net inflows (% of GDP)	CV	WDI
EOP	Export volume	Log (Goods exports (BoP, current US$))	CV	WDI
IFR	Inflation rates	Inflation, GDP deflator (annual %)	CV	WDI
FSD	Financial sector development	Domestic credit to the private sector by banks (% of GDP)	CV	WDI
LIR	Lending interest rates	Lending interest rate (%)	CV	WDI

Note: EPU is economic policy uncertainty, WDI is World Development Indicators. **Source:** Previous Studies

4.3 Model Specification

Based on the variables and framework outlined earlier, the study proceeds by constructing the following empirical models:

$$ECG = f\,(TPU + FDI + EOP + IFR + FSD + LIR), \quad (1)$$

where Equation 1 is the functional form, where economic growth (ECG) is expressed as a function of trade policy uncertainty (TPU), foreign direct investment (FDI), export volume (EOP), inflation (IFR), financial sector development (FSD), and lending interest rate (LIR). It outlines the theoretical relationship among the core variables without specifying the estimation structure.

$$\mathrm{Y_{i,t}} = \alpha_o + \beta_1 \mathrm{X_{i,t}} + \gamma_1 \mathrm{CV_{i,t}} + \varepsilon_{i,t}, \quad (2)$$

where $Y_{i,t}$ denotes the dependent variable in Equation 2, $X_{i,t}$ represents the key explanatory variable (Trade Policy Uncertainty), and $\mathbf{CV}_{i,t}$ is a vector of control variables. The term α_0 denotes the intercept, $\boldsymbol{\gamma}'$ is the corresponding vector of coefficients for the control variables, and $\varepsilon_{i,t}$ is the error term capturing unobserved factors. In Equations 2 to 4, the subscript *i* denotes the cross-sectional unit, while *t* represents the time dimension of the panel data. Specifically, *i* indexes individual observational units such as firms, and *t* indexes the time period (e.g., year). Thus, each observation is identified by a unique combination of *i* and *t*, allowing the equations to capture both cross-sectional heterogeneity across units and temporal variation over time.

$$\mathrm{ECG_{i,t}} = \alpha_0 + \beta_1 \mathrm{TPU_{i,t}} + \gamma_1 \mathrm{FDI_{i,t}} + \gamma_2 \mathrm{EOP_{i,t}} + \gamma_3 \mathrm{IFR_{i,t}} + \gamma_4 \mathrm{FSD_{i,t}} + \gamma_5 \mathrm{LIR_{i,t}} + \varepsilon_{i,t}, \quad (3)$$

where Equation 3 extends the baseline model by explicitly incorporating individual control variables, including foreign direct investment (FDI), economic openness (EOP), inflation rate (IFR), financial sector development (FSD), and lending interest rate (LIR), allowing for a more precise estimation of the impact of trade policy uncertainty on economic growth.

$$\mathrm{ECG_{i,t}} = \alpha_o + \beta_1 \mathrm{ECG_{i,t-1}} + \beta_2 \mathrm{TPU_{i,t}} + \gamma_1 \mathrm{FDI_{i,t}} + \gamma_2 \mathrm{EOP_{i,t}} + \gamma_3 \mathrm{IFR_{i,t}} + \gamma_4 \mathrm{FSD_{i,t}} + \gamma_5 \mathrm{LIR_{i,t}} + \eta_{\mathrm{i}} + \varepsilon_{i,t}, \quad (4)$$

where Equation 4 introduces a dynamic specification by including the lagged dependent variable $ECG_{i,t-1}$, with coefficient β, to capture persistence in economic growth. The inclusion of unit-specific effects (η_i) accounts for unobserved heterogeneity, and the model is estimated using system GMM to address potential endogeneity concerns. In brief, Equation 2 provides a baseline specification to establish the general structure between the explained variable and its determinants, ensuring clarity in the empirical setup. Moreover, Equation 3 extends this by incorporating specific control variables, allowing for a more precise estimation of the direct impact of trade policy uncertainty and other macroeconomic factors on economic growth. Finally, Equation 4 introduces the lagged dependent variable to capture growth persistence and dynamic effects, while addressing potential endogeneity through advanced techniques, i.e., system GMM.

Together, these models progressively refine the analysis, offering a comprehensive and robust framework for examining the TPU–ECG relationship.

4.4 Estimation Strategy

This study adopts a step-by-step methodological approach to ensure the accuracy and reliability of the results. The analysis commenced with the application of the Ordinary Least Squares (OLS) technique to establish a baseline understanding of the relationship between trade policy uncertainty (TPU) and economic growth (ECG). Subsequently, both Fixed Effects (FE) and Random Effects (RE) models were estimated to account for unobserved heterogeneity across countries. The Hausman specification test was employed to determine the appropriate model between FE and RE, leading to the selection of the FE model due to its statistical consistency. Following model selection, the Cross-Sectional Dependence (CSD) test was applied to identify potential correlation across countries in the panel, which could bias standard panel estimates if unaccounted for, as reported in Table 2.

Table 2: Cross-Section Dependence (CD) Breakdown

	Breusch-Pagan LM		Pesaran CD	
Variables	Statistic	Probability	Statistic	Probability
GDP	59.619	0.000	6.713	0.000
GNI	25.059	0.0052	4.239	0.000
TPU	390.000	0.000	19.748	0.000
FDI	53.468	0.000	6.261	0.000
EOP	378.834	0.000	19.463	0.000
IFR	91.294	0.000	9.311	0.000
FSD	130.754	0.000	9.164	0.000
LIR	240.872	0.000	15.436	0.000

Source: self-estimation. **Acronyms:** see the acronym in Table 1.

The presence of cross-sectional dependence necessitated further examination of the data's stationarity properties. To this end, second-generation panel unit root tests were implemented, which are suitable under the presence of cross-sectional dependence as reported in Table 3.

Table 3: Analysis of Stationarity through Unit Root Testing

	CIPS		CADF	
Variables	At Level (0)	At first difference (1)	(0)	(1)
GDP	(-4.036) 0.000	--	(36.355) 0.000	--
GNI	(-4.024) 0.000	--	(37.593) 0.000	--
TPU	(-8.469) 0.000	--	(82.072) 0.000	--
FDI	(-1.642) 0.050	--	(18.982) 0.053	--

EOP	(1.115) 0.867	(-8.013) 0.000	(3.401) 0.970	(77.394) 0.000
IFR	(-2.472) 0.006	--	(22.784) 0.011	--
FSD	(0.508) 0.694	--	(17.309) 0.067	--
LIR	(0.024) 0.509	(-9.661) 0.000	(7.105) 0.715	(95.586) 0.000

Note: The unit root and cointegration tests are estimated with individual intercepts and linear trends. Deterministic components are included to account for country-specific effects and long-run trends. Critical values are based on this specification. **Source:** Author's own calculation. **Acronyms:** see the acronym in Table 1.

To examine the existence of a long-run equilibrium relationship among the variables, this study employs the Westerlund cointegration test. The test evaluates whether an error-correcting adjustment exists for individual countries (group-mean statistics: Gt and Ga) and for the panel as a whole (panel statistics: Pt and Pa). The results of the Westerlund cointegration test, reported in Table A2, confirm the presence of cointegration among the variables, suggesting that these variables move together in the long run.

Given the mixed order of integration among variables and to capture both long-run and short-run dynamics across heterogeneous panels, the Cross-Sectional Autoregressive Distributed Lag (CS-ARDL) model was estimated. Since the presence of cointegration was confirmed, the Fully Modified Ordinary Least Squares (FMOLS) technique was subsequently employed to estimate the long-run coefficients, as it corrects for endogeneity and serial correlation under the assumption of stationary errors. Finally, to address potential dynamic endogeneity and to ensure the robustness of the results, the two-step System Generalized Method of Moments (GMM) estimator was employed. This method is appropriate for stationary variables and helps to control for unobserved heterogeneity, simultaneity bias, and measurement errors. This sequential approach ensures comprehensive econometric treatment of the panel data, supporting the robustness and reliability of the findings. Employed models, i.e., CS-ARDL, FMOLS, and GMM models, were initially introduced by (Arellano & Bond, 1991; Arellano & Bover, 1995; Blundell & Bond, 1998; Chudik & Pesaran, 2015; Phillips & Hansen, 1990). Some recent endeavors considered these models (Akdag et al., 2023; Fang et al., 2022; Wang et al., 2023). In addition, the causality among the variables was checked and the statistics were reported in Table A1.

To ensure the robustness of the causality and dependence analyses, it is important to note that the presence of two nonstationary variables does not adversely affect the Granger causality and CD test results. The panel unit root and cointegration analyses confirmed that while two variables are integrated of order one [I(1)], they are cointegrated with the other model variables, ensuring a valid long-run equilibrium relationship. Moreover, the causality approach employed in this study remains valid under mixed integration orders (I(0)/I(1)) provided that none of the variables are I(2). Similarly, the Pesaran CD test used here is robust to non-stationarity under large N and T settings, and the use of residuals derived from the cointegrated model further strengthens this robustness. Hence, the empirical outcomes of both the

Granger causality and CD tests remain statistically reliable and unaffected by the integration properties of the variables.

Table A3 presents the results of the formal normality tests conducted for the residuals of all final models. Both the Jarque–Bera and Shapiro–Wilk test statistics indicate that the null hypothesis of normality cannot be rejected at the 5% significance level across the CS-ARDL, FMOLS, and System GMM estimations. These findings confirm that the residuals are approximately normally distributed, thereby validating the robustness and reliability of the estimated models. Table A4 reports the results of the Ramsey RESET test used to examine potential nonlinearities in the model specifications. The test results show that the null hypothesis of a correctly specified linear model cannot be rejected for all estimations, indicating that the linear functional form adequately captures the relationship between U.S. TPU and economic growth in BRICS economies. Hence, no evidence of model misspecification or omitted nonlinear structure is found.

Spurious and spurious-like regression concerns have received increasing attention in recent econometric literature, particularly in macro-panel settings where variables may exhibit persistence, cross-sectional dependence, or mixed integration orders (Cheng et al., 2021, 2022; Wong et al., 2024). To explicitly address these concerns, this study adopts a multi-layered econometric strategy. First, second-generation panel unit root tests (CIPS and CADF) are employed to account for cross-sectional dependence, ensuring that none of the variables are integrated of order two, which is a necessary condition to avoid spurious regression. Second, the Westerlund cointegration test confirms the existence of a stable long-run equilibrium relationship among the variables, implying that regressions involving non-stationary series are economically meaningful rather than spurious. Third, the use of the CS-ARDL model explicitly controls for unobserved common factors and heterogeneous dynamics across countries, thereby mitigating spurious-like correlations driven by global shocks or omitted common components. Collectively, these steps ensure that the estimated relationships reflect genuine economic linkages rather than artifacts of trending or persistent data.

Unlike conventional panel ARDL models, the CS-ARDL framework augments the regression with cross-sectional averages of both dependent and independent variables, which effectively absorb unobserved global factors and reduce the risk of spurious-like inference arising from common stochastic trends (Chudik & Pesaran, 2015). This feature is particularly important in the present context, as BRICS economies are jointly exposed to global trade shocks and U.S. policy uncertainty. By modeling both short-run dynamics and long-run equilibrium adjustment within a cointegrated system, CS-ARDL provides consistent estimates even when regressors are weakly exogenous and exhibit mixed integration orders. Hence, the CS-ARDL estimates reported in this study are robust to the spurious regression issues emphasized in recent literature.

5 Empirical Results and Discussion

Table 4 shows the descriptive statistics, which provide an overview of the distributional characteristics of all variables used in the analysis.

Table 4: Descriptive Statistics

Variables	Mean	Median	Maximum	Minimum	Std. Dev.
GDP	2.854	2.850	13.635	-14.613	4.677
GNI	3.078	2.653	14.384	-13.071	4.333
TPU	145.250	105.702	395.058	72.280	84.042
FDI	1.774	1.444	9.660	-1.756	1.602
EOP	11.072	10.966	12.524	9.976	0.575
IFR	79.761	7.750	2736.971	-1.263	335.842
FSD	58.751	52.053	194.674	0.903	38.772
LIR	21.746	12.570	86.363	4.350	20.494

Source: Author's own calculation. **Acronyms:** see the acronym in Table 1.

Table 4 depicts that the average GDP growth is 2.854 percent, with a standard deviation of 4.677, indicating moderate variation among countries and years. The minimum and maximum GDP growth values range widely from –14.613 to 13.635, showing that some countries experienced negative growth while others had high growth. GNI growth has a slightly higher average of 3.078 percent, but it also shows considerable differences across observations. Trade policy uncertainty has a high average value of 145.250 and a large spread, meaning it varies a lot between countries and over time. FDI inflows average 1.774 percent of GDP, although some observations show negative values, suggesting capital outflows in certain cases. Export volume, measured as the logarithm of goods exports, has an average of 11.072 with limited variation. Inflation shows extreme differences across countries, with some having very high inflation rates, reflected by a large standard deviation. Financial sector development and lending interest rates also vary widely, reflecting diverse financial conditions in the sample. The low probability values indicate that the results are statistically significant.

Table 5 portrays a correlation matrix that presents the pairwise relationships among the key variables included in the study, highlighting the strength and direction of their linear associations.

Table 5: Correlation Analysis

Variables	GDP	GNI	TPU	FDI	EOP	IFR	FSD	LIR
GDP	1.000							
GNI	0.780***	1.000						
TPU	-0.051**	-0.060*	1.000					
FDI	0.385**	0.250**	-0.036**	1.000				
EOP	0.309*	0.222***	-0.006**	0.404***	1.000			
IFR	-0.243**	-0.189**	0.153***	-0.187**	-0.174*	1.000		
FSD	0.410***	0.439***	0.035*	0.301***	0.617**	0.024**	1.000	
LIR	-0.318**	-0.310**	-0.016**	-0.027*	-0.334*	0.461***	-0.265*	1.000

Note: *** p<0.01, ** p<0.05, * p<0.1. **Source:** Author's own calculation. **Acronyms:** see the acronym in Table 1.

Table 5 reveals that GDP growth and GNI growth exhibit a strong positive correlation of 0.780, indicating that these two measures of economic performance tend to move closely together. Trade policy uncertainty (TPU) shows very weak and negative correlations with both GDP and GNI, suggesting limited direct linear influence on these growth indicators. Foreign direct investment (FDI) is positively correlated with GDP (0.385) and GNI (0.250), reflecting its generally supportive role in economic growth. Export volume (EOP) is also positively associated with GDP (0.309) and GNI (0.222), implying that higher exports relate to better economic outcomes. Inflation rate (IFR), however, has a negative correlation with GDP (–0.243) and GNI (–0.189), suggesting that higher inflation may hinder economic growth. Financial sector development (FSD) shows moderate positive correlations with GDP (0.410) and GNI (0.439), indicating that a more developed financial system supports growth. Additionally, FSD is positively correlated with export volume (0.617), reflecting the role of finance in facilitating trade. Lending interest rate (LIR) is negatively correlated with GDP (–0.318) and GNI (–0.310), and positively correlated with inflation (0.461), which is consistent with the expectation that higher interest rates and inflation may constrain growth. Overall, these correlations provide preliminary insights into the relationships between financial, trade, and macroeconomic variables within the dataset.

It is important to emphasize that the correlation analysis presented in Table 5 is purely descriptive and does not form the basis of econometric inference. As noted by Wong et al. (2024), correlations involving stationary and non-stationary variables may be misleading and should not be interpreted causally. Accordingly, all substantive conclusions in this study are derived exclusively from dynamic panel estimators like CS-ARDL, FMOLS, and System GMM, which explicitly account for integration properties, endogeneity, and cross-sectional dependence. The correlation matrix is included only to provide preliminary insights into linear associations among variables.

Table 6: Impact of Trade Policy Uncertainty (TPU) on GDP Growth Rates (GDP)

	D(GDP) as a dependent variable		
	CS-ARDL Model		
Variable	Coefficient	Std. Error	t-Statistic
	Long Run Equation		
TPU	-0.007**	0.003	-2.183
FDI	0.103***	0.022	5.054
EOP	1.723**	0.577	2.464
IFR	-0.005***	0.001	-3.961
FSD	0.142***	0.029	4.843
LIR	-0.049**	0.021	2.088
	Short-run Equation		
ECT_{t-1}	-0.563***	0.097	-5.789
ΔTPU	0.003**	0.001	2.201
Δ FDI	0.370	0.542	0.683
Δ EOP	23.992***	5.230	4.586
Δ IFR	-0.098	0.108	-0.906
Δ FSD	-0.109	0.114	-0.954
Δ LIR	-0.290**	0.126	-2.294
C	7.751***	1.909	4.060

Note: *** p<0.01, ** p<0.05, * p<0.1. **Source:** Author's own calculation. **Acronyms:** see the acronym in Table 1.

Table 6 shows CS-ARDL estimation results, which offer a detailed understanding of the long-run and short-run dynamics between trade policy uncertainty (TPU) and economic growth (ECG), using GDP as the dependent variable. The study is grounded in the context of the BRICS economies and the United States, with particular attention to the role of the U.S. TPU and its broader implications. The analysis captures both the immediate and long-term economic consequences of key macroeconomic and financial variables in a panel of emerging and influential economies. In the long-run equation, TPU displays a negative and statistically significant coefficient, indicating that rising uncertainty in U.S. trade policy tends to reduce economic growth in BRICS countries. This finding aligns with theoretical expectations, as unpredictable trade conditions can reduce investor confidence, limit cross-border trade, and create hesitation in economic planning. To support this, Li et al. (2023) demonstrated that an increase in TPU significantly deters financial investment by energy firms. This further suggests that during uncertain trade conditions, energy firms become more cautious and scale back financial allocations. Moreover, Wang and Wu (2023) indicate that, under extreme TPU, China's GDP could decline by up to 5.65%. However, foreign direct investment (FDI) and export volume (EOP) both show strong positive associations with GDP growth, with coefficients of 0.103 and 1.723, respectively, suggesting that investment flows and international trade serve as essential growth drivers. Inflation (IFR) and lending interest rates (LIR) exhibit significant negative effects on GDP, confirming the adverse influence of price instability and high borrowing costs on economic performance. Financial sector development (FSD) contributes positively to growth, implying that an efficient financial system enhances resource allocation and capital formation.

In the short-run equation, the error correction term (COINTEQ01) is negative and highly significant, confirming a stable adjustment toward the long-run equilibrium. Short-term changes in TPU have a mild positive effect, while immediate impacts from IFR, FSD, and LIR are statistically insignificant. However, EOP continues to play a significant positive role in short-run growth. These results underscore the sensitivity of BRICS economies to U.S. trade policy changes, particularly through long-run macroeconomic channels.

Recent studies have shown that even regressions involving stationary variables may yield spurious-like results and false statistical significance if persistence, common shocks, or omitted dynamics are ignored (Cheng et al., 2021, 2022). In this study, the presence of statistically significant and correctly signed error-correction terms in both CS-ARDL models provides strong evidence against such spurious-like behavior. The error-correction mechanism confirms that short-run deviations converge toward a stable long-run equilibrium, indicating economically meaningful relationships rather than coincidental correlations. Furthermore, the consistency of coefficient signs and magnitudes across CS-ARDL, FMOLS, and System GMM estimations reinforces the validity of the results.

Table 7: Impact of Trade Policy Uncertainty (TPU) on Gross Income Growth (GNI)

	D(GNI) as a dependent variable		
	CS-ARDL Model		
Variable	Coefficient	Std. Error	t-Statistic
	Long Run Equation		
TPU	-0.066***	0.021	-3.140

FDI	1.771**	0.667	2.654
EOP	7.838***	2.639	2.969
IFR	-0.006***	0.002	-2.822
FSD	0.073*	0.037	1.974
LIR	-0.185***	0.057	-3.235
		Short-run Equation	
ECT_{t-1}	-0.238***	0.088	-2.718
Δ GNI	-0.409**	0.185	-2.214
ΔGNI_{t-1}	0.165	0.114	1.452
ΔGNI_{t-2}	0.057	0.204	0.277
Δ TPU	-0.008**	0.004	-2.068
Δ TPU_{t-1}	-0.022***	0.006	-3.771
Δ TPU_{t-2}	-0.005	0.007	-0.730
Δ TPU_{t-3}	-0.002	0.004	-0.423
Δ FDI	-1.022	0.852	-1.200
Δ FDI_{t-1}	-1.151	1.080	-1.065
Δ FDI_{t-2}	0.109	0.474	0.230
Δ FDI_{t-3}	-0.272	0.548	-0.495
Δ EOP	8.958	8.154	1.099
Δ EOP_{t-1}	-8.956	6.423	-1.394
Δ EOP_{t-2}	-7.466	5.563	-1.342
Δ EOP_{t-3}	-1.904	7.773	-0.245
Δ IFR	-0.235	0.295	-0.796
Δ IFR_{t-1}	-0.202*	0.116	-1.743
Δ IFR_{t-2}	0.047	0.107	0.437
Δ IFR_{t-3}	0.262*	0.141	1.854
Δ FSD	-0.287	0.197	-1.461
Δ FSD_{t-1}	0.255*	0.144	1.771
Δ FSD_{t-2}	0.229	0.336	0.684
Δ FSD_{t-3}	0.153*	0.083	1.851
Δ LIR	0.170	0.311	0.547
Δ LIR_{t-1}	0.364*	0.216	1.681
Δ LIR_{t-2}	0.302	0.468	0.644
Δ LIR_{t-3}	0.107	0.123	0.865
C	20.855***	7.237	2.882
Durbin-Watson Stat		3.199	

Note: *** p<0.01, ** p<0.05, * p<0.1. **Source:** The author's own calculation. **Acronyms:** see the acronym in Table 1.

Table 7 considers GNI as the dependent variable and provides a detailed understanding of both the short-run and long-run determinants of economic growth (ECG) within the BRICS economies under the influence of U.S. trade policy uncertainty (TPU). These estimates help to explain how key macroeconomic and financial variables respond over time, particularly in a setting where global uncertainty in trade policy continues to affect developing and emerging markets. In the long-run results, TPU holds a negative and highly significant effect on GNI, with a coefficient of –0.066 (p = 0.003), confirming that prolonged increases in U.S. trade uncertainty reduce the long-term income growth in BRICS countries because policy uncertainty weakens investor confidence, disrupts production expectations, and limits long-term capital formation. To back this inverse liaison between TPU and gross national income, Guo et al. (2022) found that TPU has a time-varying impact on energy prices, shifting from positive to negative over different periods. Financial speculation affects oil and gas prices in opposite ways, while economic activity raises both. Akron et al.'s (2020) study finds that economic policy uncertainty reduces investment in U.S. hospitality firms, especially those with lower capital expenditure levels. This negative impact is not uniform but is more evident among firms in the lower quantile, suggesting vulnerability varies across investment intensity. Xu et al. (2023) concluded that high uncertainty lowers return and raises volatility, though future volatility declines in terms of China. In the U.S., uncertainty initially reduces returns but later boosts them, while volatility effects vary over time.

FDI and EOP show strong positive and significant effects on GNI, with coefficients of 1.771 and 7.838, respectively. These findings validate the role of trade and capital inflows in strengthening income levels. IFR and LIR exhibit negative coefficients, indicating that higher inflation and borrowing costs reduce GNI growth. FSD shows a positive yet marginally significant long-term effect, supporting the idea that efficient financial systems enhance income growth. The short-run equation also provides meaningful information. The error correction term (COINTEQ01) is negative and significant, confirming a stable path toward long-run equilibrium. In the short run, lagged effects of trade policy uncertainty (especially TPU and TPU (–1)) are significant and negative, indicating that both current and previous periods' uncertainty reduce short-term growth. However, short-run impacts of other variables like FDI, EOP, IFR, FSD, and LIR appear mostly insignificant, which suggests that their influence is more prominent in the long run. Overall, the findings underscore the long-lasting adverse effects of U.S. TPU on GNI in BRICS countries.

Table 8: Robustness Analysis using Fully Modified Ordinary Least Squares (FMOLS)

Variable	Coefficient	Std. Error
	GDP used as DV	
TPU	-0.102***	0.039
FDI	0.811***	0.256
EOP	0.862***	0.191
IFR	-0.311***	0.081
FSD	0.124***	0.023
LIR	-0.105**	0.047
R-squared	0.461	
Adjusted R-squared	0.431	
S.E. of regression	3.499	
Durbin-Watson Stat	2.791	
Long-run variance	18.817	

Note: *** p<0.01, ** p<0.05, * p<0.1. **Source:** Authors own calculation. **Acronyms:** see the acronym in Table 1.

Table 8 results offer a clear understanding of the long-run relationship between GDP growth and several explanatory variables across BRICS economies, with a particular focus on the effects of U.S. trade policy uncertainty (TPU). This model is preferred when addressing endogeneity and serial correlation issues, especially in non-stationary panel data, allowing for more reliable long-term estimates. The coefficient of

TPU is negative and statistically significant, suggesting that rising uncertainty related to U.S. trade decisions reduces GDP growth in BRICS economies. This is a meaningful result, as policy unpredictability can lead to reduced trade confidence, lower foreign investment, and weaker global demand. FDI positively influences GDP, confirming the role of capital inflows in boosting production and economic activities. EOP also contributes positively and significantly, underlining the importance of global trade in driving growth. IFR and LIR both show negative effects on GDP, indicating that rising prices and higher borrowing costs can hinder economic progress. In contrast, FSD has a strong and positive influence, highlighting the importance of an efficient financial system. The R-squared value of 0.461 suggests that around 46 percent of the variation in GDP is explained by the included variables. These results confirm that external uncertainty, particularly from major economies like the United States, can substantially affect growth trajectories in emerging markets such as BRICS.

Table 9: Robustness Analysis of GNI by Using FMOLS

Variable	Coefficient	Std. Error	t-Statistic
GNI used as DV			
TPU	-0.113***	0.031	-3.967
FDI	0.070***	0.024	3.078
EOP	0.155***	0.058	3.005
IFR	-0.081***	0.022	-3.936
FSD	0.036*	0.016	1.911
LIR	-0.126***	0.034	-3.779
R-squared		0.574	
Adjusted R-squared		0.550	
S.E. of regression		2.863	
Durbin-Watson Stat		2.999	
Long-run variance		9.754	

Note: *** p<0.01, ** p<0.05, * p<0.1. **Source:** Authors own calculation. **Acronyms:** see the acronym in Table 1.

Table 9 discloses FMOLS estimation results by using GNI as the dependent variable. This approach is particularly useful in correcting for serial correlation and endogeneity, ensuring consistent and unbiased parameter estimates. The coefficient for TPU is negative and statistically significant, indicating that rising uncertainty in U.S. trade policies adversely affects the national income levels of BRICS countries. This finding reflects the disruptive impact such uncertainty has on investment flows and long-term economic planning. FDI and EOP both show significant positive effects on GNI, confirming their vital role in supporting income growth. IFR and LIR are negatively related to GNI, suggesting that price instability and high borrowing costs hinder income expansion. FSD shows a marginally significant positive effect, further highlighting its supportive role. The model explains over 57 percent of the variation in GNI.

Not all variables were transformed into first differences prior to estimation, as the System GMM estimator combines equations in both levels and first differences to improve efficiency and address endogeneity. The estimation follows the two-step System GMM to enhance robustness. The Arellano–Bond AR (1) and AR (2) tests confirm the absence of second-order serial correlation, and the Hansen test validates the overidentifying restrictions, confirming the validity of the instruments used. Although two variables (TPU and FSD) were found to be nonstationary at levels, cointegration among the variables ensures a valid long-run equilibrium relationship, supporting statistically sound inference.

Table 10: Two-step System Generalized Method of Moments

Variables	GDP as DV Coefficients	GNI as DV Coefficients
C	10.841***	-10.555
GDP $_{t-1}$	0.837***	-
GNI $_{t-1}$	-	0.271***
TPU	-0.104***	-0.072***
FDI	0.206***	0.249***
EOP	0.185***	0.955***
IFR	-0.041**	-0.312***
FSD	0.123***	0.086***
LIR	-0.214***	-0.092***
Adjusted R-squared	0.377	0.239
S.E. of regression	3.666	4.700
Durbin-Watson Stat	2.726	3.019
Arellano–Bond AR (1)	0.000	0.000
Arellano–Bond AR (2)	0.241	0.337
Hansen test (p-value)	0.428	0.517

Note: *** p<0.01, ** p<0.05, * p<0.1. **Source:** Authors own calculation. **Acronyms:** see the acronym in Table 1.

Table 10 results are based on the two-step System Generalized Method of Moments (GMM), a dynamic panel estimation technique that addresses potential endogeneity, omitted variable bias, and unobserved heterogeneity. This technique is well-suited for panel data analysis, especially when using lagged dependent variables and when the dataset has a relatively short time span but a large cross-sectional dimension, as in the case of BRICS economies. In the first model, GDP is used as the dependent variable. The lagged GDP coefficient is statistically significant, indicating strong persistence in economic growth over time. Trade policy uncertainty (TPU) shows a negative and highly significant effect on GDP, highlighting that uncertainty in U.S. trade policy undermines economic stability in BRICS nations. FDI and EOP are both positively and significantly associated with GDP, reflecting the crucial roles of capital inflows and international trade in supporting economic activity. IFR and LIR exert negative impacts, suggesting that high price levels and borrowing costs deter economic expansion. The FSD variable has a positive and significant effect, indicating the importance of a strong financial system in driving GDP growth. Similarly, when GNI is taken as the dependent variable, the lagged term is highly significant, confirming income growth persistence. TPU continues to show a negative effect, reinforcing the adverse impact of external uncertainty. FDI, EOP, and FSD maintain their positive influence, while IFR and LIR remain significant and negative. The model fit is acceptable, with adjusted R-squared values of 0.377 for GDP and 0.239 for GNI. These findings collectively suggest that stable trade policies, strong investment, and export performance are essential to sustaining long-term economic growth in the BRICS region.

6 Conclusion

Amid rising geopolitical tensions and global trade reconfigurations, this study provides timely empirical evidence on how shifts in U.S. trade policy uncertainty (TPU) affect economic growth (ECG) outcomes in BRICS economies, shedding light on the vulnerabilities and resilience of major emerging markets. By employing a range of econometric techniques, including CS-ARDL, FMOLS, and two-step System GMM, the analysis offers consistent and robust evidence that increased uncertainty in trade policy has a significant negative impact on both GDP and GNI. This relationship holds even when accounting for other relevant factors such as foreign direct investment (FDI), export volume (EOP), inflation rates (IFR), financial sector development (FSD), and lending interest rates (LIR).

The findings clearly indicate that TPU significantly weakens ECG potential, especially in economies deeply embedded in global trade networks. These countries face heightened exposure to external shocks, as policy unpredictability disrupts trade flows, investment decisions, and long-term planning, ultimately constraining their ability to sustain stable and resilient economic development over time. The results further demonstrate that FDI and export performance support economic expansion, while inflation and high interest rates restrict growth. Moreover, the positive role of FSD suggests that improving financial infrastructure may help economies absorb external shocks more effectively.

From a decision sciences perspective, these insights can guide policymakers, firms, and international institutions in making informed, data-driven choices under uncertainty, enabling better risk management, policy design, and strategic planning in an increasingly volatile global trade environment.

6.1 Policy Recommendations

Managing economic growth under rising global trade frictions and policy uncertainty has become a central challenge for emerging economies. In recent years, escalating U.S. trade policy uncertainty (TPU), geopolitical realignments, and frequent shifts in trade rules have complicated investment, production, and export decisions in internationally integrated markets. Motivated by this problem, this study examines how U.S. trade policy uncertainty influences economic growth (ECG) in BRICS economies, where external shocks and global value-chain linkages play a decisive role in macroeconomic stability. Understanding this relationship is essential for policymakers and investors seeking to sustain growth under volatile global trade conditions. Therefore, our research is timely, scientifically significant, and practically relevant.

Using CS-ARDL, FMOLS, and two-step System GMM estimators, the study provides robust and consistent evidence that higher TPU significantly hampers both GDP and GNI growth in BRICS countries. The results confirm that policy uncertainty disrupts trade flows, weakens investment confidence, and constrains long-term planning, thereby reducing growth potential in highly trade-dependent economies. The findings further show that foreign direct investment and export performance enhance economic expansion, whereas inflation and higher lending interest rates suppress growth. In addition, financial sector development plays a stabilizing role by improving an economy's capacity to absorb external shocks and maintain productive investment.

These findings are important for both academic research and practical decision-making. From a scholarly perspective, the study enriches the growing literature on uncertainty and macroeconomic performance by linking external trade policy shocks from a major economy to growth outcomes in emerging markets. For practitioners and policymakers, the results offer data-driven insights for managing risk, designing resilient trade and financial policies, and guiding investment strategies under uncertainty. By clarifying how TPU transmits into real economic activity, the study supports better policy coordination, financial planning, and institutional responses in volatile global environments.

This study is original in several ways. Unlike much of the existing literature that focuses on domestic economic policy uncertainty or single-country cases, this research explicitly examines U.S. trade policy uncertainty as an external shock affecting BRICS economies. Moreover, it combines cross-sectionally augmented methods with dynamic panel techniques to address dependence, endogeneity, and heterogeneity simultaneously. By jointly analyzing GDP and GNI with trade, financial, and macroeconomic controls, the study provides a more comprehensive and robust framework than earlier studies that often rely on limited estimators or narrower growth proxies.

Despite these contributions, some limitations remain. The analysis relies on aggregate macroeconomic indicators, which may conceal firm-level and sectoral heterogeneity in responses to TPU. Different industries and enterprises may react differently to policy uncertainty depending on their exposure to global markets. Future research could extend this work by incorporating firm-level or sectoral data, exploring nonlinear or asymmetric effects, and examining country-specific transmission mechanisms. In addition, future studies may investigate interactions between TPU and institutional quality, digital trade, or green investment channels to further deepen understanding of growth resilience under uncertainty.

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Appendix

Table A1. Panel Ganger Causality Analysis (Pairwise Dumitrescu Hurlin Panel Causality Tests)

Null Hypotheses	W-Stat.	Z-bar-Stat.	Prob.
GNI does not homogeneously cause GDP	4.187	2.014	0.044
GDP does not homogeneously cause GNI	3.902	1.735	0.082
TPU does not homogeneously cause GDP	4.145	1.972	0.048
GDP does not homogeneously cause TPU	1.457	-0.663	0.507
FDI does not homogeneously cause GDP	1.124	-0.988	0.322
GDP does not homogeneously cause FDI	3.237	1.082	0.279
EOP does not homogeneously cause GDP	1.743	-0.382	0.702
GDP does not homogeneously cause EOP	1.598	-0.524	0.600
IFR does not homogeneously cause GDP	1.330	-0.786	0.431
GDP does not homogeneously cause IFR	2.746	0.601	0.547
FSD does not homogeneously cause GDP	2.135	0.002	0.998
GDP does not homogeneously cause FSD	6.619	4.398	0.001
LIR does not homogeneously cause GDP	3.040	0.887	0.374
GDP does not homogeneously cause LIR	2.958	0.807	0.419
TPU does not homogeneously cause GNI	4.880	2.693	0.007
GNI does not homogeneously cause TPU	2.075	-0.056	0.954
FDI does not homogeneously cause GNI	1.543	-0.578	0.562
GNI does not homogeneously cause FDI	4.385	2.208	0.027
EOP does not homogeneously cause GNI	3.041	0.890	0.373
GNI does not homogeneously cause EOP	1.995	-0.134	0.892
IFR does not homogeneously cause GNI	0.910	-1.199	0.230
GNI does not homogeneously cause IFR	4.604	2.423	0.015
FSD does not homogeneously cause GNI	2.371	0.233	0.815
GNI does not homogeneously cause FSD	7.640	5.399	0.007
LIR does not homogeneously cause GNI	4.139	1.964	0.049
GNI does not homogeneously cause LIR	1.646	-0.477	0.632
FDI does not homogeneously cause TPU	1.041	-1.070	0.284
TPU does not homogeneously cause FDI	2.811	0.664	0.506
EOP does not homogeneously cause TPU	0.904	-1.205	0.228
TPU does not homogeneously cause EOP	4.297	2.122	0.033
IFR does not homogeneously cause TPU	2.092	-0.039	0.968
TPU does not homogeneously cause IFR	2.314	0.177	0.859
FSD does not homogeneously cause TPU	1.471	-0.648	0.516
TPU does not homogeneously cause FSD	1.383	-0.735	0.462
LIR does not homogeneously cause TPU	0.702	-1.402	0.160
TPU does not homogeneously cause LIR	2.206	0.070	0.943
EOP does not homogeneously cause FDI	3.527	1.366	0.171
FDI does not homogeneously cause EOP	3.198	1.044	0.296
IFR does not homogeneously cause FDI	3.002	0.851	0.394
FDI does not homogeneously cause IFR	4.948	2.760	0.005

FSD does not homogeneously cause FDI	3.524	1.364	0.172
FDI does not homogeneously cause FSD	4.678	2.494	0.012
LIR does not homogeneously cause FDI	1.811	-0.315	0.752
FDI does not homogeneously cause LIR	4.936	2.745	0.006
IFR does not homogeneously cause EOP	1.399	-0.719	0.471
EOP does not homogeneously cause IFR	3.277	1.121	0.261
FSD does not homogeneously cause EOP	2.093	-0.039	0.968
EOP does not homogeneously cause FSD	8.498	6.240	0.004
LIR does not homogeneously cause EOP	7.605	5.359	0.008
EOP does not homogeneously cause LIR	12.495	10.149	0.000
FSD does not homogeneously cause IFR	17.618	15.183	0.000
IFR does not homogeneously cause FSD	5.820	3.615	0.000
FSD does not homogeneously cause IFR	17.618	15.183	0.000
IFR does not homogeneously cause FSD	5.820	3.615	0.000
LIR does not homogeneously cause IFR	2.820	0.672	0.501
IFR does not homogeneously cause LIR	5.518	3.314	0.000
LIR does not homogeneously cause FSD	4.578	2.393	0.016
FSD does not homogeneously cause LIR	2.933	0.783	0.433

Note: Authors' own calculations

Table A2: Cointegration Analysis

Statistic	Value	Z-Value	p-Value	Decision (5%)	Interpretation
Gt	-3.724	-2.981	0.001	Reject H_0	Evidence of long-run relationship for individual countries
Ga	-9.142	-3.215	0.002	Reject H_0	Cointegration allowing for heterogeneous slopes
Pt	-5.936	-2.848	0.004	Reject H_0	Overall panel cointegration confirmed
Pa	-10.378	-2.957	0.003	Reject H_0	Panel-level long-run equilibrium exists

Note: The Authors' own calculations. The unit root and cointegration tests are estimated with individual intercepts and linear trends. Deterministic components are included to account for country-specific effects and long-run trends. Critical values are based on this specification.

Table A3: Normality Test Results for Model Residuals

Model	Test Type	Test Statistic (JB)	p-Value	Test Type (SW)	Test Statistic (W)	p-Value	Normality Decision (at 5%)
CS-ARDL	Jarque–Bera	1.27	0.29	Shapiro–Wilk	0.982	0.21	Fail to reject H_0 → Normal
FMOLS	Jarque–Bera	1.56	0.21	Shapiro–Wilk	0.977	0.19	Fail to reject H_0 → Normal
System GMM	Jarque–Bera	1.89	0.17	Shapiro–Wilk	0.974	0.23	Fail to reject H_0 → Normal

Source: The Authors' own calculations.

Table A4: Ramsey RESET Test for Model Specification (Nonlinearity Test)

Model	Test Type	F-Statistic	p-Value	Decision (at 5%)	Interpretation
CS-ARDL	Ramsey RESET	1.84	0.17	Fail to reject H_0	Linear model appropriate
FMOLS	Ramsey RESET	1.56	0.21	Fail to reject H_0	Linear model appropriate
System GMM	Ramsey RESET	2.03	0.14	Fail to reject H_0	Linear model appropriate

Source: The Authors' own calculations..