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Environmental Factors, Trade Openness And Investment Determinants Of Economic Growth In Brics Nations: A Panel Data Approach

Mr. Shakeel Akther[1], Dr. Nitesh Thakur[2], Dr. Peeyoosh Kumar[3], Dr. Ghazala Abidin[4], Mr. Kishan Shukla[5]
[1]Assistant Professor, Department of Economics, AKI's Poona College of Arts, Science and Commerce Savitribai Phule Pune University, Pune, Maharashtra, India, shakeel.akther@poonacollege.edu.in
[2]Assistant Professor, Institute of Business Management, GLA University Mathura, India Email Id: niteshatbhuresearch@gmail.com
[3]Assistant professor, Amity School of Business, Amity University Patna, India, jha337@gmail.com
[4]Associate Professor, School of Law, Manav Rachna University, Faridabad, India, advghazalabidin@gmail.com
[5]Assistant professor, Centre for Teacher Education, Central Institute of higher Tibetan Studies, Varanasi, India, imkishanshukla@gmail.com

Abstract
This paper examines the impact of environmental factor, trade openness, and foreign direct investment (FDI) on economic growth in BRICS countries from 1990 to 2024. Using advanced panel econometric techniques, the study accounts for cross-sectional dependence and integration across member nations. Panel unit root tests (Pesaran CADF and CIPS) show that all variables are integrated at order I(1), while cointegration analyses (Kao, Pedroni, and Westerlund) confirm the existence of stable long-run relationships among them. The results highlight strong interconnections, with environmental sustainability, trade openness and foreign direct investment as a positives driver of long-term growth. Findings suggest that excessive reliance on natural resources has adverse effects, underscoring the need for innovation in sustainable resource management. For BRICS policymakers, the study recommends adopting strategies that reduce emissions, expand renewable energy use, and promote green finance. Such measures are essential for balancing rapid economic expansion with environmental protection, ensuring sustainable growth across the region.
Keywords; *Environmental quality; CO_2 emissions; PMG-ARDL model;*

INTRODUCTION

Assessing the economic benefits of improved environmental quality is crucial to demonstrating the interdependence between ecological sustainability and economic welfare. Environmental decline driven by industrial activity imposes considerable economic costs in terms of healthcare burdens and reduced productivity. By applying tools such as cost-benefit analysis and environmental pricing, policymakers can internalize environmental costs, correct market failures, and design policies that balance growth with sustainability. These approaches also enhance public awareness of the long-term economic returns of environmental protection and provide justification for regulatory measures. Nonmarket valuation techniques, including contingent valuation, are particularly important in capturing both use and nonuse values by estimating society's willingness to pay for environmental improvements (Moore et al., 2023). The economic valuation of environmental goods and services (EVEG&S) enables a structured assessment of the direct and indirect impacts of environmental change, offering evidence to guide investment and policy decisions (Matos et al., 2010). Improved environmental quality—especially in workplaces and indoor spaces—has been linked to enhanced productivity and better health outcomes, with benefit-cost ratios as high as 80 and annual gains of $700 per individual (Fisk & Seppänen, 2007). Epidemiological studies also establish that reducing air pollution significantly lowers health risks, supporting more precise calculations of the economic costs of pollution (Gilbreath, 2007). Regulatory analyses by the U.S. EPA emphasize quantifying environmental benefits to optimize net benefits, highlighting the need for updated methods that reflect evolving ecological priorities (Moore et al., 2023). To ensure ecological goals align with efficiency, environmental protection frameworks must incorporate indicators for pollution levels, costs, and sustainability (Zamfir, 2012). Nevertheless, challenges remain in accounting for nonuse values and long-term ecological impacts, underscoring the need for continuous methodological advancements in environmental valuation. The relationship between economic development and environmental quality is particularly highlighted in the Environmental Kuznets Curve (EKC) hypothesis, which posits that environmental degradation rises during early stages of growth but declines once income exceeds a certain threshold. While higher income levels may enable stronger environmental policies, early development phases often coincide with higher emissions (Drabo, 2010). Thus, effective regulation is essential to balance growth with sustainability, as literature stresses the importance of integrating ecological limits into economic planning (Halkos & Paizanos, 2015). Evidence from G7 countries further shows that policy uncertainty affects environmental performance, with stable policies being critical to promote renewable energy and curb pollution (Chu & Le, 2022). Additionally, environmental degradation can hinder economic convergence, especially in developing nations, where initial growth gains may be offset by ecological damage (Drabo, 2010). Research also suggests that economies with higher complexity are better equipped to manage environmental impacts, reinforcing the case for targeted, innovation-driven policies (Chu & Le, 2022; Shaikh, et. al., 2025). While the EKC framework provides useful insights, empirical findings remain mixed, necessitating further investigation (Kusumawardani, 2011; Halkos & Paizanos, 2015). Examining the economic implications of environmental initiatives highlights that, although such efforts may involve short-term costs, they generate substantial long-term benefits, including healthier populations, cleaner environments, and preserved resources. Rigorous evaluations of these initiatives help quantify avoided damages, productivity gains, and cost savings, providing a stronger economic rationale for sustainable investments. Previous studies have assessed benefits of sustainable energy communities, developed frameworks for electric vehicle infrastructure in underserved regions (Carlton et al., 2024; Ansari, et.al., 2024), and quantified improvements in water and air quality (Stonner & Goemann, 2003; Chae & Park, 2011; Nowak, 2018; Rahid, et, al., 2023; Khan, et. al., 2024). Despite this progress, research has paid limited attention to quantifying the broader economic advantages of improved environmental quality. This study, titled *Quantifying the Economic Benefits of Improved Environmental Quality*, seeks to fill this gap by systematically evaluating the economic advantages of enhancing environmental conditions. It explores methodologies for assigning value to environmental quality, focusing on factors such as pollution reduction, biodiversity conservation, and sustainable resource use. The analysis further investigates impacts on productivity, health, property values, and societal welfare, supported by empirical evidence and case studies. By reframing environmental investments as both ecological imperatives and strategic economic decisions, this research underscores their role in promoting long-term sustainability and prosperity. The significance of the study lies in its dual contribution. From a theoretical perspective, it deepens the integration of environmental valuation into economic frameworks, advancing sustainable development models. From a practical standpoint, it provides policymakers and practitioners with evidence-based insights into the economic returns of environmental initiatives, thereby strengthening the case for adopting sustainable strategies. Businesses and governments are also offered tools to evaluate the enduring benefits of eco-friendly practices, embedding environmental protection within broader economic planning. The paper is organized into five sections. Section one introduces the research scope and objectives. Section two presents a review of relevant literature and conceptual frameworks. Section three outlines the methodology, including data sources and econometric tools. Section four discusses the key results, while section five concludes with implications, contributions, and avenues for future research.

2 REVIEW LITERATURE

The relationship between energy use, economic growth, and environmental quality is complex. Studies show that energy consumption and natural resource use drive both growth and environmental degradation, with varying effects across regions. In developing countries, renewable energy fosters growth, while traditional sources have limited impact, supporting the Environmental Kuznets Curve (EKC) hypothesis that degradation rises with growth before declining beyond a certain income threshold. OECD countries illustrate how resource reliance undermines environmental quality, highlighting the need for policies promoting renewable energy and sustainable practices (Fouzia et al., 2024; Tahir et al., 2024; Huo & Peng, 2023). Trade openness also shows mixed effects. While it does not always harm environmental quality, evidence of the pollution haven hypothesis suggests that weak regulations can attract polluting industries. Foreign direct investment (FDI) mirrors this duality: it brings technology and growth but may worsen emissions, particularly in developing nations with lax policies. Robust environmental governance and incentives for clean investments are therefore essential (Ali, et. al., 2022; Pham & Nguyen, 2024; Hossain et al., 2023). Government expenditure plays a mediating role by improving environmental outcomes when aligned with sustainable growth strategies. Evidence from Africa, China, and Indonesia shows that targeted public spending supports environmental quality, though unchecked growth still drives degradation. Optimal fiscal policies in regions such as the G7 emphasize the balance between growth and sustainability (Donkor et al., 2022; Pirgaip et al., 2023; Alam, et., al., 2024). Natural resources contribute to economic development, especially in resource-rich nations, but often at the cost of environmental harm, consistent with the EKC. Sustainable management and investment in clean technologies are vital to balance growth and ecological health (Alam, & Ahmed, 2018 Olufolake et al., 2023; Wang et al., 2024). Previous studies have underscored the significance of measuring the diverse benefits of sustainable energy neighborhoods for guiding investment and policy-making (Taraun et al., 2024; Khan, et. al., 2025). Similarly, another study proposed a framework to evaluate the advantages of electric vehicle charging stations in underserved communities (Carlton et al., 2024). Stonner and Goemann (2003) also stressed the importance of assessing improvements in environmental and water quality, while Chae and Park (2011) analyzed the costs and benefits of combined strategies for air quality management and greenhouse gas reduction in the Seoul Metropolitan Area. Nowak (2018) focused on the role of trees and forests in improving environmental quality and human health. Despite this, limited attention has been given to assessing the economic benefits of improved environmental quality. This paper, Quantifying the Economic Benefits of Improved Environmental Quality, addresses this gap by examining the economic gains from enhancing environmental conditions. It investigates the methods used to measure and assign value to environmental quality, taking into account factors such as air and water pollution, natural resource management, and biodiversity conservation. Additionally, the paper evaluates the economic impacts of improved environmental quality on factors like productivity, property values, health, and overall well-being. Through empirical evidence and case studies, the paper illustrates the measurable economic returns from investing in environmental protection and sustainability, providing crucial insights for policymakers and professionals.

3. MATERIALS AND METHODS

3.1. Data Description

Drawing on earlier studies (Pata & Isik, 2021; Akadiri et al., 2022; Pata et al., 2023; Alhashim et al., 2024; Chishty et al., 2025), this research employs $LnCO_2$ as the dependent variable to represent environmental quality. The explanatory variables include LPA (air pollution), LPW (water pollution), LNRM (natural resource management), and LBIOC (biodiversity conservation), with data sourced from the World Bank. The study focuses on the BRICS nations—Brazil, Russia, India, China, and South Africa—using an annual multivariate panel dataset spanning 1990–2024, consistent with data availability. A detailed overview of the variables is presented in Table 1.

Existing literature generally emphasizes that environmental quality, trade openness, government expenditure, natural resources, and foreign direct investment contribute positively to economic growth. As illustrated in Figure 1, these variables collectively support economic development. Specifically, environmental quality enhances ecosystem health, trade openness facilitates market integration, government spending stimulates economic activity, natural resources supply critical inputs, and foreign direct investment introduces both capital and technology. Together, these elements are widely recognized as key drivers of economic growth.

2 Methodology and Model Specification

In this study, we examined economic growth, measured as GDP (constant 2015 US$), as the dependent variable. The independent variables include environmental quality, represented by CO2 emissions (total, Mt CO2e); trade openness, measured through exports and imports of goods and services (constant 2015 US$); natural resources, shown by total natural resources rents (% of GDP); and foreign direct investment (FDI), represented by net inflows (BoP, current US$). Additionally, essential variables like FDI, trade openness, and energy usage are considered. Prior research, including Rafiq et al. (2020), has explored these relationships, forming the basis for our dual-model investigation to assess the effects of environmental quality, trade openness, natural resources, and FDI on BRICS countries' economic growth. This rationale supports our model outlined below.

$$GDP_{it} = f(EQ_{it}, TO_{it}, NR_{it}, FDI_{it}) \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots 1$$

We have transformed all study variables into a log form for our convenience. Logarithmic transformation is a convenient means of transforming a highly skewed variable into a more normalized dataset. When modeling variables with non-linear relationships, the chances of producing errors may also be skewed negatively Hammouri, et al., (2020).

$$lnGDP_{It} = \alpha_0 + \beta_1 lnEQ_{it} + \beta_2 lnTO_{it} + \beta_3 lnNR_{it} + \beta_4 lnFDI_{it} + \mu_{it} \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots 2$$

where α_0 and μ_{it} represent constant term and the error term, respectively; β_1, β_2 , β_3, β_4, and β_5 stand for undermined coefficients.

2.4 Descriptive Statistics

This study examines data from BRICS countries—Russia, China, India, Brazil, and South Africa—covering the period 1990 to 2024, with information drawn from the World Bank and World Development Indicators. Variable definitions and summary statistics are presented in Tables 1 and 2. The natural logarithm of GDP (LnGDP) records a mean value of 27.791, with a standard deviation of 1.049 and a range between 25.913 and 30.424, indicating moderate dispersion. Environmental quality (LnEQ), proxied by CO_2 emissions, has an average of 7.062, spanning from 5.392 to 9.451. Trade openness (LnTO) averages 26.291. Natural resource rents (LnNR) exhibit greater variability, with a mean of 1.428. Foreign direct investment (LnFDI) shows the widest spread, averaging 23.078.

Table 1 variables description

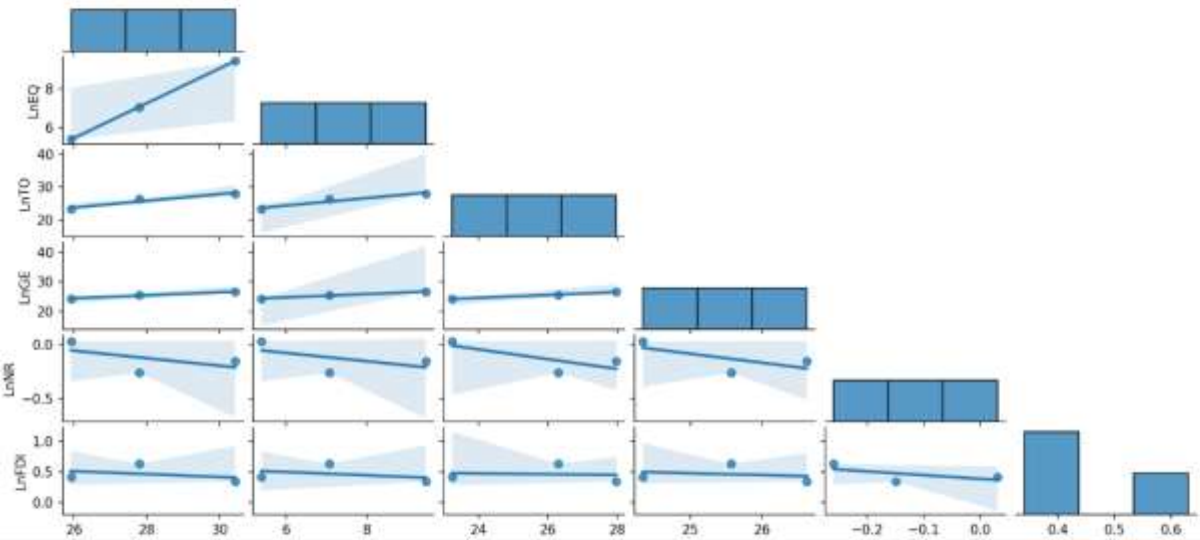
Symbol	Variable	Unit measurement	Source
LnGDP	Economic growth	GDP (constant 2015 US$)	WB
LnEQ	Environmental quality	Carbon dioxide (CO2) emissions (total, Mt CO2e)	WB
LnTO	Trade openness	Exports and Imports of goods and services (constant 2015 US$)	WB
LnNR	Natural resources	Total natural resources rents (% of GDP)	WB
LnFDI	Foreign direct investment	Foreign direct investment, net inflows (BoP, current US$)	WB

WB : World Bank

Table 2. Descriptive Statistics

Variable	Mean	Std. Dev.	Min	Max
LnGDP	27.791	1.049	25.913	30.424
LnEQ	7.062	1.105	5.392	9.451
LnTO	26.291	0.829	23.231	27.969
LnNR	1.428	0.732	-0.146	3.068
LnFDI	23.078	2.636	1.866	26.564

Table 3. Matrix of correlations



The correlation matrix table 3 displays the relationships between various variables. LnGDP shows strong positive correlations with LnEQ (0.789) and LnFDI (0.633). Trade openness (LnTO) correlates positively with LnFDI (0.340). Notably, LnNR has a negative correlation with LnGDP (-0.261).

3.2. Estimation Techniques

The study adopted a systematic approach for empirical analysis, illustrated in Figure 3. A cross-sectional dependence test is a crucial component of empirical research. We utilized various techniques to assess cross-sectional dependence, including the Pesaran CD, Pesaran scaled LM, and Breusch-Pagan LM tests. Following this, the second step involved conducting a unit root test using the Pesaran CADF and Pesaran CIPS panel unit root tests. After confirming unit roots, we proceeded with the cointegration test, employing the Kao, Pedroni and westerlund cointegration tests for this purpose. For long-term analyses, the CCEMG estimator was utilized.

3.2.1. Cross-Sectional Dependence

Cross-sectional dependence tests play a vital role in empirical studies to ensure reliable results (Pesaran, 2004; Hussain et al., 2020; Alhashim et al., 2024). To address this issue, we employed both the Pesaran scaled LM test and general cross-sectional dependence tests, following the methodology of Breusch and Pagan (1980). For datasets with a large time dimension (T) and relatively few cross-sectional units (N), Pesaran (2007) proposed a scaled Lagrange multiplier (LM) test, which is more efficient when N is large but T is small. Nonetheless, the Breusch-Pagan LM test, the scaled LM test, and the Godfrey-Breusch LM (B-G LM) test can suffer from size distortions. To overcome these limitations, Pesaran and Pedroni (2004) developed the Pesaran CD test, which effectively addresses size distortions and is particularly suitable for panels with a large N and fixed T.

3.2.2. Panel Unit Root Test

In this study, traditional first-generation unit root tests are considered inadequate, as methods like Phillips–Perron and Levin, Lin, and Chu do not account for cross-sectional dependence in panel data. To overcome this limitation, we apply the Pesaran CIPS unit root test (Pesaran, 2004). This approach extends the standard Augmented Dickey–Fuller (ADF) regression by including cross-sectional averages of lagged dependent variables and their first differences for each unit in the panel. The resulting regressions are termed “Cross-Sectional ADF (CADF).” After detecting cross-sectional dependence in the dataset, we conducted unit root testing using both the CADF and the Pesaran cross-sectionally augmented Im, Pesaran, and Shin (CIPS) tests, which are recognized as second-generation unit root tests (Pesaran, 2004).

3.2.3. Panel Cointegration Test

An important step in the empirical analysis is conducting a cointegration test. In this study, we applied the Kao (1999), Pedroni et al. (2004) and westerlund (2008) panel cointegration tests. These tests utilize both panel-specific and common autoregressive test statistics to assess cointegration. For long-run estimations, we used the CCEMG estimator, an effective method for heterogeneous panel data (Murshed et al., 2021). This approach addresses the issue of cross-sectional dependence (Hussain et al., 2020).

4. RESULTS AND DISCUSSIONS

4.1. Outcomes of Cross-Sectional Dependence

Assessing cross-sectional dependence is a crucial step in empirical analysis. We applied multiple tests to examine the interdependence of variables across the BRICS panel, as presented in Table 4. The results from all tests indicate that the null hypothesis is rejected at the 1% significance level, suggesting the presence of strong cross-sectional dependence among the variables.

Table 4. Cross sectional analysis

Series	Breusch–Pagan LM	Pesaran Scaled LM	Bias-Corrected Scaled LM	Pesaran CD
	Statistic	Statistic	Statistic	Statistic
LnGDP	281.626*	60.737*	60.659*	16.716*
LnEQ	184.474*	39.013*	38.935*	8.125*
LnTO	211.589*	45.076*	44.998*	13.996*
LnNR	111.127*	22.612*	22.534*	9.698*
LnFDI	203.069*	43.171*	43.093*	14.077*

Note: *denotes the 1% significance level

4.2. Outcomes of Panel Unit Root Test

We evaluated the stationarity of the variables using the Pesaran CADF and CIPS unit root tests, with results reported in Table 5. The findings show that the null hypothesis is rejected at both the intercept and intercept-with-trend levels. Stationarity is confirmed at the 1%, 5%, and 10% significance levels under both conditions, indicating that the variables are integrated of order I(1) and supporting the presence of a long-run relationship among them.

Table 5. Stationarity analysis

<table>
<tr><th rowspan="2">Variables</th><th colspan="3">Intercept</th><th colspan="3">Intercept and Trend</th></tr>
<tr><th colspan="2">CADF</th><th>CIPS</th><th colspan="2">CADF</th><th>CIPS</th></tr>
<tr><td>LnGDP</td><td colspan="2">-1.464</td><td>-1.464</td><td colspan="2">-2.678**</td><td>-2.678***</td></tr>
<tr><td>Δ LnGDP</td><td colspan="2">-3.629*</td><td>-3.629*</td><td colspan="2">-3.580*</td><td>-3.580*</td></tr>
<tr><td>LnEQ</td><td colspan="2">-1.908</td><td>-1.908</td><td colspan="2">-2.842*</td><td>-2.842**</td></tr>
<tr><td>Δ LnEQ</td><td colspan="2">-4.177*</td><td>-4.177*</td><td colspan="2">-4.162*</td><td>-4.162*</td></tr>
<tr><td>LnTO</td><td colspan="2">-2.244**</td><td>-2.244**</td><td colspan="2">-2.517</td><td>-2.517</td></tr>
<tr><td>Δ LnTO</td><td colspan="2">-3.846*</td><td>-3.846*</td><td colspan="2">-3.944*</td><td>-3.944*</td></tr>
<tr><td>LnNR</td><td colspan="2">-2.364*</td><td>-2.364*</td><td colspan="2">-2.834*</td><td>-2.834*</td></tr>
<tr><td>Δ LnNR</td><td colspan="2">-4. 050*</td><td>-4.033*</td><td colspan="2">-4.050*</td><td>-4.050*</td></tr>
<tr><td>LnFDI</td><td colspan="2">-2.502*</td><td>-2.502*</td><td colspan="2">-2.858*</td><td>-2.858**</td></tr>
<tr><td>Δ LnFDI</td><td colspan="2">-3.283*</td><td>-3.283*</td><td colspan="2">-3.050*</td><td>-3.050*</td></tr>
<tr><td rowspan="2">Critical Values</td><td>1%</td><td>5%</td><td>10%</td><td>1%</td><td>5%</td><td>10%</td></tr>
<tr><td>-2.24</td><td>-2.11</td><td>-2.05</td><td>-2.79</td><td>-2.59</td><td>-2.46</td></tr>
</table>

Note: *, **, and *** represent 1%, 5%, and 10% significance level, respectively.

4.3. Results of the Panel Cointegration Test

We applied the Kao, Pedroni, and Westerlund tests to examine cointegration among the variables, as detailed in Tables 6. The Pedroni test results indicate significant relationships within both the GDP and growth models, suggesting cointegration among the variables. Similarly, the Kao test confirms cointegration for the variables in our model, and the Westerlund test outcomes further support this finding. Therefore, the results of the Kao Pedroni and Westerlund tests warrant an analysis of long-run estimates for models. Consequently, we employed CCEMG estimators to establish the long-run relationships.

Table 6. Cointegration analysis

Kao test for cointegration	
Test Statistic	Stats.
Modified Dickey–Fuller	2.478
Dickey–Fuller	0.208**
Augmented Dickey–Fuller	10.601*
Unadjusted Modified Dickey–Fuller	-7.844*
Unadjusted D-F	-7.957*
Pedroni test for cointegration	
Modified variance ratio	-6.679*
Modified Phillips–Perron	4.405*
Phillips–Perron	-4.440*
Augmented Dickey–Fuller	-3.618*
Westerlund test for cointegration	
Variance ratio	1.352**

Note: * and **represent 1% and 5% significance level

4.4. Outcomes of Panel CCEMG Estimator

This study examines the impact of environmental quality, trade openness, government expenditure, natural resources, and foreign direct investment (FDI) on economic growth in BRICS countries. Our results indicate that all variables, except natural resources, have a positive and significant effect on GDP. Specifically, a one-percent improvement in environmental quality is associated with a 0.26 percent increase in GDP, highlighting the beneficial role of environmental improvements in promoting economic

growth. These results are consistent with previous studies, including Ali et al. (2022) and Nguyen & Khominich (2023), which also reported a positive relationship between environmental quality and economic performance. Similarly, a one-percent increase in trade openness corresponds to a 0.15 percent rise in GDP, suggesting that liberalized trade policies enhance economic growth by improving market access and competitiveness. This aligns with findings from Burange et al. (2019) and Banday et al. (2021). Government expenditure also significantly contributes to growth, with a one-percent increase in spending estimated to raise GDP by 0.43 percent, underscoring the importance of fiscal policy and public investment, as supported by studies such as Shah et al. (2016) and Hashmi et al. (2021).
FDI emerged as a major driver of growth, where a one-percent increase in FDI is associated with a 0.86 percent rise in GDP. This emphasizes FDI's role in supporting domestic production, technology transfer, and overall economic development, consistent with findings from Bose & Kohli (2018) and Nistor (2015). In contrast, natural resources exhibit a negative relationship with GDP growth; a one-percent increase in natural resource use is linked to a 0.037 percent decline in GDP. This suggests that excessive dependence on natural resources may hinder economic growth, potentially due to resource depletion or environmental degradation, a conclusion supported by Baloch et al. (2019) and Sicen et al. (2022).

Table 7. Regression analysis (CCEMG)

Variable	Coefficient	Std. errs.	z-value	P>|z|
LnEQ	0.123*	0.043	3.190	0.000
LnTO	0.234*	0.033	3.540	0.000
LnNR	0.047**	0.026	-2.320	0.021
LnFDI	0.768**	0.272	2.330	0.020
C	4.543*	1.280	-3.550	0.000
Wald chi^2	48.390 (0.000)			

* p<.01, ** p<.05

5. CONCLUSIONS AND POLICY IMPLICATIONS

This study examines the impact of environmental quality, trade openness, natural resources, and foreign direct investment (FDI) on economic growth in BRICS countries from 1990 to 2024. To ensure a robust empirical analysis, we first assessed cross-sectional dependence using the Pesaran CD, Pesaran scaled LM, and Breusch–Pagan LM tests, which revealed strong interconnections among the variables across BRICS economies. Next, we determined the order of integration using the Pesaran CADF and CIPS panel unit root tests. Results indicate that all variables are integrated of order I(1), confirming the potential for long-term relationships. Cointegration was then tested using the Kao, Pedroni, and Westerlund methods, all of which provide evidence of a stable long-run relationship among the variables.

For estimating these long-term effects, we employed the Common Correlated Effects Mean Group (CCEMG) estimator. The results show that improvements in environmental quality, higher trade openness, increased government spending, and greater FDI positively influence GDP in BRICS nations, while dependence on natural resources has a negative effect. Based on these findings, we recommend that BRICS policymakers prioritize environmentally sustainable economic policies, promote investments in eco-friendly technologies, and support renewable energy initiatives to simultaneously enhance growth and environmental quality. Furthermore, given the negative impact of resource dependence, increased investment in research and development is advised to support sustainable resource management and long-term economic resilience. The study makes a significant theoretical contribution by integrating key economic variables to assess their combined impact on growth in BRICS economies. It highlights the importance of balancing economic development with environmental sustainability and provides a foundation for future research aimed at developing holistic models that link economic progress with environmental outcomes.

5.1. Policy Implications

This study provides valuable policy guidance for decision-makers in BRICS countries. The results indicate that promoting environmentally friendly technologies, enhancing trade openness, and reducing reliance on fossil fuels are key strategies for achieving sustainable economic growth while preserving the environment. The findings also highlight the importance of investing in research and development to stimulate economic progress. Overall, the study offers practical recommendations for designing policies that effectively balance economic development with environmental sustainability in the BRICS region.

Building on the findings of this study, future research should explore the specific mechanisms and policies that can enhance the positive impact of environmental quality, trade openness, and FDI on economic growth in BRICS countries. Extending the analysis over a longer period or including a wider set of countries could improve the robustness and generalizability of the results. Additionally, comparative studies between BRICS and other regions could identify best practices for achieving sustainable growth.

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