Exchange Rate Dynamics and Trade Competitiveness in BRICS: A Panel Data Approach

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Abstract

This paper aims to analyze the relationship between exchange rate dynamics, trade competitiveness, and macroeconomic variables in BRICS countries, utilizing annual data from 1996 to 2023. By applying advanced econometric techniques, including cointegration and the Vector Error Correction Model (VECM), the study examines both short-term dynamics and long-term relationships. The results show that approximately 19% of deviations from the long-run equilibrium in REER are corrected each period, indicating a moderate adjustment speed toward long-term equilibrium. In the short run, GDP significantly increases REER reducing trade competitiveness, whereas currency depreciation and increased trade openness decrease REER, enhancing competitiveness. Inflation's impact on REER remains minimal. These findings highlight both the short-term and long-term dynamics of exchange rates in BRICS economies and their implications for trade competitiveness.

Keywords: *Trade Openness, Real Effective Exchange Rate (REER), BRICS Countries, Currency Depreciation, Economic Growth, Panel Data.*

JEL Codes: F31, F43, F14, C33, O47, E31

Introduction

In an increasingly interconnected global economy, the exchange rates adopted by a country plays a critical role in shaping its trade competitiveness and overall macroeconomic stability. Exchange rate dynamics influence relative prices, investment flows, inflation, and a nation's external balance, thereby determining its economic trajectory. (Krugman, 1995; Obstfeld & Rogoff, 1995). For emerging economies such as the BRCS nations— Brazil, Russia, India, China, and South Africa— exchange rate policy is an essential tool for promoting sustainable growth and deeper integration into global markets.

Economic theory highlights a close link between exchange rates and trade flows. Currency appreciation makes imports relatively cheaper and exports more expensive, reducing external competitiveness, while depreciation has the opposite effect. Empirical studies support this relationship. For instance, Bahmani-Oskooee (1991) found that currency depreciation improves the trade balance in least-developed countries in the long run, a conclusion reinforced in later work on Middle Eastern economies (Bahmani-Oskooee, 2010).

Despite the extensive literature on exchange rate dynamics and macroeconomic performance, much of the existing research focuses on short-term fluctuations. The long-term implications of exchange rate dynamics for trade competitiveness remain underexplored, particularly within BRICS, whose varying exchange rate arrangements provide a rich comparative setting. One of the most comprehensive measures for assessing external competitiveness is the Real Effective Exchange Rate, which adjusts for inflation differentials and trading partner weights. Analyzing REER in BRICS offers insight into how nominal exchange rates, inflation, trade openness, and economic growth jointly shape their competitive positions.

Between 2000 and 2023, BRICS currencies experienced significant REER fluctuations. During major global shocks such as the 2008 financial crisis and commodity-price collapses commodity-exporting economies like Brazil and Russia experienced sharp currency depreciations in the range of 30–40%. In contrast, India did not face such large depreciations; the rupee weakened only moderately (around 10–15%) and, in some periods, remained relatively stable in real-effective terms compared to other emerging markets. Such movements underscore the importance of exchange rates dynamics. Countries with floating exchange rates, such as India, Brazil, South Africa, and Russia, are more exposed to external volatility yet benefit from long-run adjustment flexibility. Conversely, China's managed floating regime provides greater exchange rate stability, supporting its export-driven sectors and creating a more predictable environment for trade and investment.

Understanding these dynamics is particularly relevant today, as BRICS collectively represent approximately 42% of the global population and nearly 25% of world GDP. While exchange rate movements significantly affect inflation and trade competitiveness, comparative evidence on their determinants and long-run pass-through effects across BRICS is limited.

Despite strong economic growth, BRICS economies continue to experience significant exchange rate volatility, yet existing studies largely focus on short-run dynamics or single-country cases, offering limited comparative evidence on long-term trade competitiveness. To address this gap, the present study examines how key macroeconomic factors, nominal exchange rates, inflation, GDP, and trade openness affect the real effective exchange rate and shape long-run trade competitiveness in BRICS. By providing a cross-country, long-term empirical analysis, the study contributes to policy discussions on how emerging economies can design effective exchange rate strategies to strengthen economic stability and global competitiveness.

The remainder of the paper is structured as follows: Section 2 reviews the related literature, Section 3 outlines the data and methodology, Section 4 presents the data analysis, Section 5 discusses the findings in the context of existing research, and Section 6 concludes with policy implications and limitations.

Review of Literature

The Real Effective Exchange Rate is a widely used measure of international competitiveness, yet conventional approaches often oversimplify its calculation. Ghose and Kharas (1993) critique traditional REER measures for assuming zero cross-price elasticities and equal elasticities with trading partners, overlooking the complexity of trade adaptation to exchange rate changes. Their alternative index, which incorporates bilateral price changes through an import demand system, provides a nuanced perspective on competitiveness. However, their analysis is limited to the Philippines, highlighting the need for cross-country studies in emerging economies.

Bose (2014) examines real exchange rates and competitiveness in New Zealand, revealing that RER appreciation typically reduces price competitiveness of tradables. Yet, strong primary export demand can offset these effects, improving terms of trade, RER, and income levels. This underscores that the impact of exchange rate movements is context-specific, influenced by export composition and market structure, and highlights the need for careful measurement of competitiveness using country-specific indices.

Garcia-Herrero and Koivu (2009) examine China's trade balance and effective exchange rate, showing high sensitivity of the trade balance to REER changes. However, causality between the variables is not formally tested. Bhagwati *et al.* (2015) assess the Indian Rupee's valuation using REER models and the Harrod-Balassa-Samuelson effect, concluding significant overvaluation and highlighting the consequences of REER misalignment on competitiveness. These studies reinforce the importance of evaluating both misalignment and the dynamic effects of exchange rates on trade performance.

Historical and theoretical perspectives further contextualize these findings. Maciejewski (1983) emphasizes the EER as an appropriate measure of international competitiveness when adjusted for relative prices. Mundell (1963) and the Mundell-Fleming model highlight how exchange rate regimes influence adjustment processes, with flexible regimes allowing depreciation to act as a stabilizer for trade competitiveness, while fixed regimes constrain policy options**.** Nabli and Véganzonès-Varoudakis (2004) shows that currency overvaluation in MENA countries hindered manufactured exports, whereas improved exchange rate management and flexibility promoted export diversification.

The Balassa-Samuelson Effect provides additional insights, linking trade openness to REER depreciation in developing economies through relative price adjustments and resource reallocation toward tradable sectors. Empirical studies support this theoretical relationship: Gantman and Dabós (2018) demonstrate that trade openness significantly affects REER in emerging markets, though heterogeneous samples limit BRICS-specific conclusions. Recent BRICS-focused studies highlight methodological limitations that the present study addresses.Vieira and Silva (2023) and Fadilah et al. (2024) use ARDL approaches to establish long-run relationships but omit key competitiveness variables and fail to account for cross-sectional dependence. Vieira and Silva (2023) further confirm long-run cointegration with weak exchange rate pass-through to inflation, but their models do not capture short-run dynamics or shared shocks across BRICS.

In summary, prior literature provides valuable insights on exchange rates, competitiveness, and trade openness but suffers from three key limitations: (i) many studies ignore the combined role of REER, trade openness, and GDP, (ii) cross-sectional dependence across emerging economies is often unaddressed, and (iii) long run relationships are frequently omitted. The present study fills these gaps by employing a panel framework for BRICS countries (1996–2023), integrating both long-run and short-run relationships, and providing policy-relevant insights on managing exchange rates and trade competitiveness in emerging markets.

Methodology

The study adopts a quantitative, applied research design, using a panel data approach to analyze the interactions between the variables. The use of panel data allows for examining both cross-sectional (across countries) and time-series (over years) variations, offering a more robust analysis of the dynamic relationships among the variables.

Table 1: Data Sources for the Study (1996-2023)

Variable	Measurement / Definition	Source
Real Effective Exchange Rate (REER)	Trade-weighted real exchange rate, adjusted for relative prices	IMF / BIS
Nominal Exchange Rate (NER)	Domestic currency per US Dollar	IMF / Central Banks of respective countries
Trade Openness (TO)	(Exports + Imports) / GDP	World Development Indicators (WDI)
GDP	Real GDP (constant prices)	World Development Indicators (WDI)
Inflation (INF)	Consumer Price Index (CPI) annual % change	IMF / WDI

Real effective exchange rate: The real effective exchange rate (REER) is the weighted average of a country's currency in relation to an index or basket of other major currencies. The weights are determined by comparing the relative trade balance of a country's currency against that of each country in the index. An increase in a nation's REER is an indication that its exports are becoming more expensive and its imports are becoming cheaper, reducing its trade competitiveness. In this study, REER serves as a proxy for trade competitiveness because it reflects how a country's exchange rate, adjusted for inflation, influences its ability to compete in international markets.

Nominal exchange rate: The nominal Exchange Rate (NER) refers to the value of one country's currency in terms of another country's currency. It represents the relative price at which one currency can be exchanged for another. Mathematically, it is expressed as:

$$NER = \frac{Units\ of\ Domestic\ currency}{One\ Unit\ of\ Foreign\ Currency}$$

where: Domestic Currency = The amount of the home country's currency required to buy one unit of a foreign currency. Foreign Currency = The amount of a foreign currency that can be exchanged for one unit of the domestic currency. In our study, the NER is used as a proxy for exchange rate fluctuations that impact trade, helping to measure how changes in the value of a currency influence a country's position in international markets.

Trade Openness: Trade Openness is the sum of imports and exports normalized by GDP. It refers to the extent to which a country allows the free flow of goods, services, capital, and labor across its borders. It is often used as an indicator of a country's integration into the global economy. A highly open economy has fewer restrictions on trade (such as tariffs, quotas, and regulatory barriers) and allows easier access to international markets, whereas a closed economy has more restrictions and lower international trade activity.

$$Trade\ Openness = \frac{Exports + Imports}{GDP} * 100$$

The more open the economy, the more sensitive it may be to changes in exchange rates, affecting its global competitiveness.

GDP (Gross Domestic Product): GDP is the total monetary or market value of all the finished goods and services produced within a country's borders over a specific time period, typically a year or a quarter. In our study, GDP (Gross Domestic Product) is used as a proxy for economic activity or economic growth.

Inflation: Inflation is the rise in the general price level of goods and services, reducing a currency's purchasing power. It is commonly measured by the Consumer Price Index (CPI) or Producer Price Index (PPI) and serves as an indicator of price stability.

In order to assess the long-term and short-term effects of the Real Effective Ex-change Rate on trade competitiveness, as influenced by key macroeconomic variables such as Nominal Exchange Rate, GDP, inflation, and trade openness, we specify the following econometric model: The econometric model for this study is based on the theoretical framework commonly used in empirical studies of REER determination (e.g., MacDonald and Ricci, 2002; Obstfeld and Rogoff, 1995), where the Real Effective Exchange Rate is modeled as a function of nominal exchange rate, trade openness, GDP, and inflation, capturing the key macroeconomic fundamentals that influence exchange rate behavior is specified as follows:

$$REER_{it} = \beta_0 + \beta_1 \cdot NER_{it} + \beta_2 \cdot TO_{it} + \beta_3 \cdot GDP_{it} + \beta_4 \cdot INF_{it} + \varepsilon_{it}$$

Where:

$REER_{it}$: Real Effective Exchange Rate for country *i* at time *t*, used as the dependent variable.

NER_{it}: Nominal Exchange Rate for country *i* at time *t*.
TO_{it}: Trade Openness for country *i* at time *t*.
GDP_{it}: Gross Domestic Product for country *i* at time *t*.
INF_{it}: Inflation rate for country *i* at time *t*.
ϵ_{it}: Error term capturing unobserved factors.

The study employs a range of econometric techniques to analyze the relationship between exchange rate dynamics and trade competitiveness in BRICS countries. The analysis begins with descriptive statistics and line graphs to summarize data characteristics and trends. Panel unit root properties are examined using second-generation tests, namely the Cross-sectionally Augmented Im–Pesaran–Shin (CIPS) and Cross-sectionally Augmented Dickey–Fuller (CADF) tests. Long-run relationships among the variables are investigated using Pedroni and Kao panel cointegration tests. Given the existence of cointegration, a Vector Error Correction Model (VECM) is estimated to capture both long-run equilibrium relationships and short-run dynamics. Finally, residual diagnostic tests are conducted to ensure model adequacy.

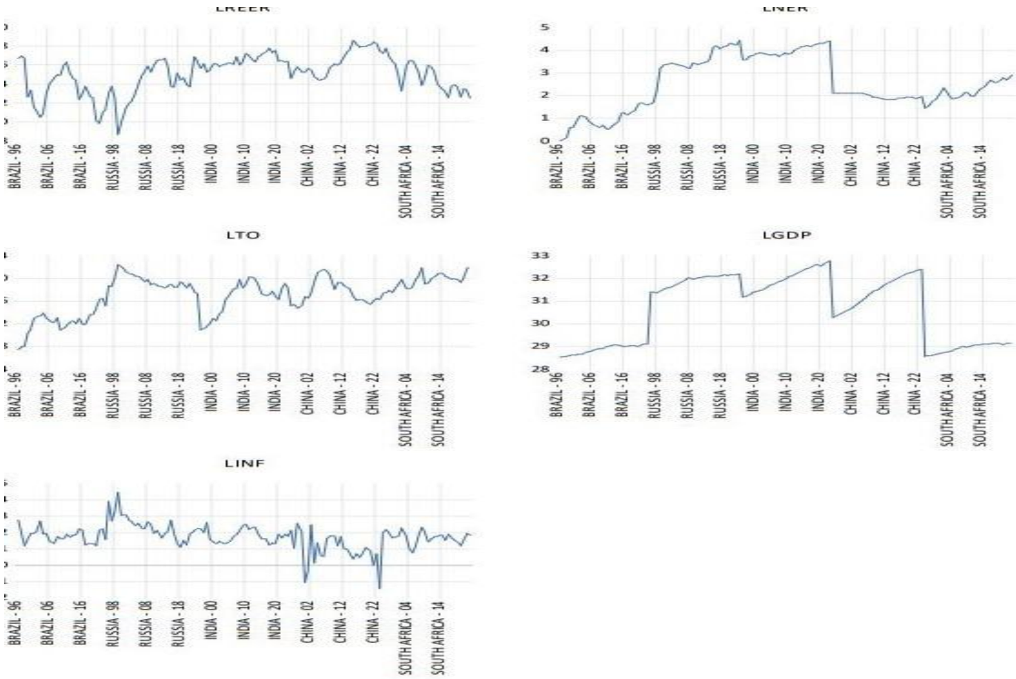
Data Analysis

Table 2: Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
LREER	140	4.5068	0.2039	3.8702	4.8678
LNER	140	2.5099	1.1802	0.0050	4.4445
LTO	140	3.7117	0.3307	2.7495	4.2397
LGDP	140	30.6288	1.4808	28.5424	32.7837
LINF	140	1.7015	0.7703	-1.4488	4.4513

Source: Author's calculations

Descriptive statistics in Table 2 summarize the characteristics of the variables used in the study. The Real Effective Exchange Rate has a mean value of 4.51 with moderate variability, indicating relatively stable exchange rate movements. LNER shows greater variation, with an average of 2.51, reflecting differences in currency valuation across the dataset. Trade openness records a mean of 3.71 with low variability, suggesting consistent openness levels. GDP averages 30.63 in log terms, highlighting differences in economic size across countries and over time. Inflation has a mean of 1.70 and exhibits a wide range, including negative values, indicating the presence of both inflationary and deflationary periods.



As shown in Figure 1 above In Brazil, The Log of Real Effective Exchange Rate fluctuates between 4.0 and 4.6, indicating periods of both appreciation and depreciation, with peaks suggesting increased competitiveness. The Log of Nominal Exchange Rate steadily increases from 2.5 to 4.5, showing gradual depreciation. Trade openness ranges from 2.8 to 4.0, reflecting growing trade integration with occasional dips. The Log of GDP increases from 28 to 32, signaling steady economic growth. Inflation fluctuates between 1 and 4.5, indicating periods of stability and high inflation.

In Russia, The LRER moves between 4.1 and 4.8, reflecting changes in currency competitiveness. The LNER shows a consistent rise from 2.0 to 4.2, indicating gradual depreciation. The LTO ranges from 3.0 to 4.2, reflecting growing trade integration despite occasional declines. LGDP increases from 29 to 32, showing economic growth. Inflation fluctuates between 1 and 4.5, reflecting both stable and inflationary periods.

In India, The LRER fluctuates between 4.0 and 4.5, indicating moderate fluctuations in currency competitiveness. The LNER increases from 2.5 to 4.0, showing steady depreciation. The LTO ranges from 3.2 to 4.2, indicating growing trade open-ness. LGDP increases from 29 to 33, reflecting strong economic growth. Inflation fluctuates between 2.5 and 4.0, with occasional spikes.

In China, The LRER is stable between 4.1 and 4.5, indicating controlled competitiveness. The LNER rises from 2.0 to 3.8, showing gradual depreciation. LTO increases from 3.0 to 4.4, reflecting higher trade integration. LGDP grows from 30 to 33, indicating substantial economic growth. Inflation remains stable between 1 and 3.5.

In South Africa, The LRER fluctuates between 3.8 and 4.4, reflecting periods of appreciation and depreciation. The LNER increases from 3.0 to 4.2, indicating nominal exchange rate depreciation. The LTO ranges from 2.8 to 4.0, showing a trend toward openness despite fluctuations. LGDP increases from 28 to 31, reflecting moderate growth. LINF fluctuates between 0.5 and 5.0, indicating both stable and high inflation periods.

Before estimating the model, we tested for cross-sectional dependence using Pesaran CD test. The results (CD 0.9017) indicate no significant cross-sectional dependence among the BRICS countries. The SUR estimator was applied to improve efficiency, although standard panel estimators would also be valid. Since there is cross-sectional dependence in our data we use second-generation unit root tests. First generation unit root tests (like ADF, IPS, LLC) assume no cross-sectional dependence in the panel data. These tests can lead to biased and in-consistent results when there is cross-sectional dependence, which is common in economic and financial panel datasets (e.g., countries being influenced by global factors). 2nd generation unit root tests are specifically designed to account for cross-sectional dependence and provide more reliable results under these conditions. Tests like CIPS (Cross-sectional Im, Pesaran and Shin) and CADF (Cross-sectional Augmented Dickey-Fuller) are examples of Second generation unit root tests. These tests adjust for cross-sectional dependence by considering the common factors that might affect all units (countries) in the panel, such as global or common economic trends

Table 3: Unit Root Test

Variable	CIPS(0)	CIPS(1)	CADF(0)	CADF(1)
REER	-1.715	-3.463***	-1.529	-5.359***
NER	-0.976	-2.967**	-1.839	-3.991**
TO	-1.503	-3.463***	-0.732	-4.782***
GDP	-2.012	-3.848***	-1.853	-4.166**
INFLATION	-3.096**	-2.738***	-2.728	-3.843**

$p{*}{*}{*} < 0.01, p{*}{*} < 0.05, p{*} < 0.1$

Source: Author's calculations

In Table 3, the results of the unit root tests conducted on panel data for five countries indicate that all variables are non-stationary at the level, as the null hypothesis of a unit root could not be rejected. However, after taking the first difference of the variables, they become stationary, as evidenced by the rejection of the unit root hypothesis. This implies that all variables are integrated of order 1 (I(1)). To determine the presence of a long-term relationship between the variables, the next step is to investigate cointegration, as the stationarity in first differences suggests the potential for a stable long-term equilibrium. The 2nd generation CIPS and CADF tests were employed to confirm the stationarity properties, leading to the conclusion that the variables are indeed I (1), setting the stage for further cointegration analysis.

Table 4: Cointegration analysis using Pedroni and Kao tests

Methods	Within dimension (panel statistics)			Between dimension		
	test	statistic	prob	Test	statistic	prob
Pedroni (Engle-Granger based)	Panel v-statistic	0.5801	0.2809	Group statistic	-0.8319	0.7973
	Panel rho-statistic	0.2114	0.5837	GroupPP-statistic	-3.1318	0.0009***
	Panel PP-statistic	-2.4921	0.0063***	GroupADF-statistic	-2.5412	0.0055***
	Panel ADF-statistic	-2.3241	0.0101**			
Pedroni (Weighted)	Panel v-statistic	0.7261	0.2337			
	Panel rho-statistic	0.03743	0.5149			
	Panel PP-statistic	-2.7031	0.0034***			
	Panel ADF-statistic	-1.4885	0.0683*			
Kao (Engle-Granger based)	ADF	-2.5776	0.0050***			

Source; Author's calculations

To test for the long-run relationship among the variables, the study employed the Pedroni and Kao tests of cointegration. The results, as presented in Table 4, indicate that both tests confirm the existence of a long-run relationship among the variables. This relationship is statistically significant providing strong evidence of cointegration among the variables in the model. The table summarizes the results of seven statistical cointegration tests, including the Pedroni and Kao tests. Four of the probability values are less than 5%, indicating significant cointegration. Specifically, the Panel PP-Statistic and Panel ADF-Statistic (intra-individual tests), as well as the Group ADF-Statistic (inter-individual test), provide evidence of a long-run relationship among the variables. Additionally, the Kao test also shows a p-value of less than 5%, further confirming the existence of a cointegration relationship between the variables in the model. Certainly, proceeding with the presence of cointegration, the next logical step is to specify the Vector Error Correction Model (VECM). This model is particularly suited for situations where co-integration exists among the variables. By incorporating the error correction term, the VECM allows us to examine both the short-term dynamics and the long-term equilibrium relationships among the variables.
VECM shows 2 things: a) short-run relationship b) long run adjustment.

Table 5: Error Correction Term Results

Parameter	**Coefficient**	**Standard Error**	**t-Statistic**	**Significance**
Error Correction Term	-0.1938	0.03781	-5.1267	Highly Significant

Source: Author's calculations

The Error Correction Term (ECT) in shows long run adjustment of the model after any shocks. ECT in the Vector Error Correction Model. Table 5 shows a coefficient of -0.193, a t-statistic of -5.12, and a standard error of 0.03, indicating it is statistically significant. This negative coefficient confirms the presence of a long-term equilibrium relationship among the variables, with deviations from this equilibrium being corrected over time. Specifically, the magnitude of -0.193 suggests that approximately 19.3% of any deviation from the long-run equilibrium in the Real Effective Exchange Rate is adjusted in each period. This moderate adjustment speed means that if REER deviates from its equilibrium path due to short-run shocks, it will gradually return to this path, although it may take several periods to do so.
Long run cointegrating equation is:

$$ECT_{\{t-1\}} = \left[1.000\, LREER_{\{t-1\}} - 0.0014\, LNER_{\{t-1\}} - 0.0783\, LTO_{\{t-1\}} - 0.1059\, LGDP_{\{t-1\}} - 0.1997\, LINF_{\{t-1\}} - 0.6 \right]$$

It is an error correction term equation signifying a long-run relationship among the variables. Short-run dynamics: The short-run coefficients show the immediate impact of each independent variable (in its first-differenced form) on the dependent variable in each period.

Table 6: Short run coefficients in VECM

Variable	Coefficient	t statistic	Standard error
REER(Short Run)	-0.6515	-3.4143	0.1908
NER (Short-Run)	-0.4135	-3.0101	0.1374
Trade Openness (Short-Run)	-0.3770	-3.3774	0.1116
GDP (Short-Run)	0.79779	2.9507	0.2703
Inflation (Short-Run)	-0.0248	-1.7334	0.0142

Source: Author's calculations

Table 6: The first-difference coefficient for Nominal Exchange Rate is -0.41, with a t-statistic of -3.01 and a standard error of 0.137. This negative coefficient suggests an inverse short-term effect, where an increase in NER leads to a decrease in REER. The t-statistic, compared with the standard error, indicates a relatively strong effect. The first-difference coefficient for Trade Openness is -0.377, with a t-statistic of -3.377 and a standard error of 0.111. This indicates a short-term negative relationship with REER, where an increase in Trade Openness is associated with a decrease in REER. The relatively high t-statistic suggests that this effect is likely meaningful. The first-difference coefficient for GDP is 0.7977, with a standard error of 0.27 and a t-statistic of 2.9. This indicates a positive short-term effect of GDP on REER, meaning that an increase in GDP is associated with a significant increase in REER. The t-statistic of 2.9 is well above the typical threshold of 2 (for a 5% significance level), suggesting that this relationship is statistically significant. The magnitude of the coefficient (0.7977) implies a relatively strong positive short-term impact, meaning that changes in GDP contribute substantially to the movement of REER in the short run. The first-difference coefficient for Inflation is -0.02, with a standard error of 0.014 and a t-statistic of -1.733. This indicates a very small negative short-term effect of inflation on REER, meaning that an increase in inflation is associated with a slight decrease in REER in the short run. The t-statistic of -1.733 suggests that the effect may not be statistically significant at conventional levels (e.g., 5% significance), as it is below the typical threshold for significance (around -2).

Now for p values of error correction term, estimated equation is:

$$\Delta\, LREER_t = C_1\, LREER_{\{t-1\}} - 0.0014\, LNER_{\{t-1\}} - 0.0783\, LTO_{\{t-1\}} - 0.1997\, LINF_{\{t-1\}} - 0.1059\, LGDP_{\{t-1\}} - 0.6254 + C_2 \Delta LREER_{\{t-1\}} + C_3\, \Delta\, LREER_{\{t-2\}} + C_4\, \Delta\, LNER_{\{t-1\}} + C_5\, \Delta\, LNER_{\{t-2\}} + C_6\, \Delta\, LTO_{\{t-1\}} + C_7\, \Delta\, LTO_{\{t-2\}} + C_8 \Delta\, LINF_{\{t-1\}} + C_9 \Delta\, LINF_{\{t-2\}} + C_{\{10\}} \Delta\, LGDP_{\{t-1\}} + C_{11} \Delta LGDP_{\{t-2\}} + C_{12}$$

The p-value associated with the error correction term in our analysis after estimating Equation 5 is found to be 0.000, which is below the commonly accepted significance level of 0.05. This indicates a statistically significant relationship. Consequently, we can confidently conclude that the error correction term is meaningful in our model. In broader terms, the negative coefficient associated with the error correction term, along with its significant p-value, suggests the existence of an error correction mechanism. This mechanism implies that, over time, any deviations observed in the short run from the long-run equilibrium will be systematically corrected. In essence, the model demonstrates a tendency to return to a stable, long-term equilibrium following any transient disturbances.

Table 7: Residual Diagnostics with Interpretation

Diagnostics	Test	p-value	Interpretation
Serial Correlation	Serial Correlation LM Test	0.6380	No evidence of serial correlation in residuals.
Heteroscedasticity	White Test	0.2491	Residuals are homoscedastic.
Normality	Jarque Bera Test	0.2300	Residuals are normally distributed.
Cross-Sectional Dependence	Pesaran CD Test	0.9017	No cross-sectional dependence present.

Source: Author's calculations

The diagnostic tests in Table 7 indicate that the model satisfies key assumptions: no serial correlation, homoscedastic residuals, and normally distributed errors. These results strengthen the reliability and validity of the model's estimates. By correcting for cross-sectional dependence (e.g., using SUR or cluster-robust standard errors), we account for any potential correlation that might exist between cross-sections, making our statistical inference more reliable. Although variance inflation factors (VIF) were not calculated, the independent variables (NER, GDP, Trade Openness, Inflation) are theoretically distinct and the residual diagnostics indicate that multicollinearity is unlikely to affect the results.

Discussion

The descriptive statistics reveal key patterns in the dataset. The Real Effective Ex-change Rate shows moderate variability, indicating stable exchange rate movements. The Nominal Exchange Rate exhibits significant variation, reflecting diverse currency valuation trends. Trade Openness is relatively consistent, with low variability, while GDP highlights economic size differences across countries or time periods. Inflation shows a wide range, including deflationary periods, indicating varied macroeconomic conditions. These patterns provide a solid foundation for analyzing the relationships between these variables and their impact on trade competitiveness and exchange rate dynamics. The Real Effective Exchange Rate in the BRICS countries fluctuates over time, reflecting periods of both appreciation and depreciation, which impacts trade competitiveness. A higher REER typically suggests a loss in trade competitiveness, while a lower REER signals greater competitiveness. The Nominal Exchange Rate shows a general depreciation across most countries, indicating a trend of weakening domestic currencies, which may influence trade dynamics, making exports cheaper and imports more expensive.

Economic growth, measured by GDP, is generally on an upward trajectory in these countries, suggesting improving economic conditions. Trade openness is increasing, which signals growing integration into global markets, further enhancing trade potential despite occasional fluctuations. Inflation fluctuates across the countries, but there is no consistent pattern. This suggests that inflationary pressures may influence exchange rate and trade dynamics, but the impact varies by country.

The use of second-generation unit root tests confirms that all variables are integrated of order one (I (1)); hence they become stationary after first differencing. This indicates that long-term relationships among the variables are possible. The subsequent cointegration analysis supports the existence of a stable, long-term equilibrium between the variables, further suggesting that these economic factors are interrelated in the long run. The significant cointegration results confirm that these variables move together in the long run, which aligns with the theory of long-run equilibrium in exchange rate models.

The ECT in the VECM indicates that deviations from long-term equilibrium are corrected over time. This suggests that short-term shocks to exchange rates or other economic factors will gradually adjust to restore long-term balance, reinforcing the stability of the system. By theory we know that an increase (appreciation) in REER implies that exports become more expensive and imports become cheaper; therefore, an increase indicates a loss in trade competitiveness. It aligns with our analysis which reveals several key relationships between the variables and the Real Effective Exchange Rate. Firstly, the Nominal Exchange Rate has a negative short-term relationship with REER, implying that a depreciation of the nominal exchange rate leads to a decrease in REER, thereby enhancing trade competitiveness.

The most important result, though, is strong support for the hypothesis of the existence of a negative relationship between trade openness and the REER (i.e., increasing trade openness depreciates the REER), Trade Openness is negatively correlated with REER, suggesting that greater openness to trade results in a depreciation of REER, which supports improved competitiveness. This suggests that greater integration into global trade markets drives the value of a country's currency relative to its trading partners, making exports more competitive and imports less attractive. The analysis highlights the significant role that trade openness plays in shaping exchange rate dynamics and influencing a country's competitiveness in the international market. On the other hand, GDP has a positive short-term effect on REER; economic growth leads to an appreciation of REER, which may reduce competitiveness. Although Inflation is negatively related to REER, the effect is minimal and statistically insignificant, indicating that inflation has a negligible short-term impact on competitiveness. Overall, the findings emphasize that currency depreciation, in-creased trade openness, and economic growth are significant drivers of changes in REER, which ultimately affect trade competitiveness.

This paper aligns with several well-established economic theories, particularly those concerning exchange rate dynamics and trade competitiveness. The negative relationship between the Nominal Exchange Rate and the Real Effective Exchange Rate supports the theory of competitive devaluation, which suggests that a weaker currency boosts export competitiveness by making domestic goods cheaper on international markets. Similarly, the positive effect of trade openness on trade competitiveness aligns with theories of comparative advantage and trade liberalization, which emphasize that increased openness leads to more efficient re-source allocation and improved global competitiveness. The positive relationship between GDP and REER is consistent with the Balassa-Samuelson effect, which posits that economic growth, particularly in productivity, tends to lead to currency appreciation, affecting the REER. Finally, while inflation's minimal effect on REER supports theories that emphasize inflation's longer-term rather than short-term impact on competitiveness, it suggests that other factors such as exchange rates and trade policies play a more dominant role in shaping competitiveness.

The diagnostic tests confirm that the model satisfies key assumptions: no serial correlation, homoscedastic residuals, and normally distributed errors. These results suggest that the model is well-specified and the estimates are reliable.

Furthermore, correcting for cross-sectional dependence using methods like SUR (Seemingly Unrelated Regression) ensures that any latent correlations between cross-sections (countries) are accounted for, improving the robustness of the statistical inference. Based on findings, we recommend that BRICS countries focus on promoting man-aged currency depreciation to enhance trade competitiveness by making exports more affordable. Encouraging greater trade openness through the removal of trade barriers and regional integration is also crucial. While fostering economic growth, policymakers should balance it with exchange rate stability to avoid undermining competitiveness. Although inflation's effect on REER is minimal, controlling inflation remains vital for long-term stability. Lastly, adopting a flexible exchange rate regime will allow BRICS countries to better manage external shocks and optimize their trade competitiveness in the global market.

Limitations and Future Research

While this study provides valuable insights into the relationship between exchange rate dynamics and trade competitiveness in BRICS countries, it has some limitations. First, the analysis is limited to macroeconomic variables such as NER, GDP, trade openness, and inflation, without incorporating micro-level factors. Second, the study uses annual data, which may overlook short-term fluctuations and intra-year dynamics. Third, while diagnostic tests suggest the model is robust, the potential for multicollinearity among independent variables was not formally tested. Future research could extend this analysis by including additional countries, more granular sectoral data, higher-frequency observations, and exploring other determinants of trade competitiveness, financial market development.

Conclusion and Policy Implications

In conclusion, this study provides a detailed analysis of the interactions between exchange rate dynamics, trade competitiveness, and macroeconomic variables in BRICS countries. The results indicate that depreciation of the Nominal Exchange Rate and greater trade openness significantly improve trade competitiveness by lowering the Real Effective Exchange Rate, while economic growth increases REER, highlighting a trade-off between promoting competitiveness and sustaining growth. Inflation, in contrast, has a minimal short-term impact on REER.

These findings are consistent with existing literature. The positive effect of currency depreciation on trade competitiveness aligns with the Mundell-Fleming framework, which emphasizes that flexible exchange rates stabilize economies by boosting exports. Similarly, the role of trade openness in lowering REER reflects the Balassa-Samuelson effect, showing that increased exposure to international markets reduces relative prices and enhances competitiveness. Our results also echo empirical evidence from Vieira and Silva (2024) and Fadilah et al. (2024), who identify long-run cointegration in BRICS exchange rates, though this study extends their analysis by including key competitiveness variables and addressing cross-sectional dependence. From a policy perspective, these insights suggest that BRICS policymakers should focus on managing exchange rate flexibility and trade liberalization while balancing economic growth objectives. Targeted interventions in exchange rate policies can enhance competitiveness without triggering adverse inflationary pressures. Moreover, fostering trade openness and supporting structural reforms in tradable sectors can provide sustainable improvements in international competitiveness.

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