International Journal of Economics and Financial Issues

ISSN: 2146-4138

available at http: www.econjournals.com

International Journal of Economics and Financial Issues, 2025, 15(1), 42-54.

Impact of Economic Growth and Exchange Rate Volatility on FDI Inflows: Cointegration and Causality Tests for the BRICS Countries

Mohammad I. Elian[1], Ahmed Bani-Mustafa[2], Nabeel Sawalha[3], Ahmad R. Alsaber[3]*, Jiazhu Pan[4]

[1]Department of Finance, American University of Kuwait (AUK), Kuwait, [2]Department of Mathematics and Physics, College of Engineering, Australian College of Kuwait (ACK), Kuwait, [3]Department of Management, American University of Kuwait (AUK), Kuwait. [4]Department of Mathematics and Statistics, University of Strathclyde, UK. *Email: aalsaber@auk.edu.kw

Received: 18 August 2024 **Accepted:** 10 November 2024 **DOI:** https://doi.org/10.32479/ijefi.17311

ABSTRACT

This paper examines impact of economic growth, exchange rate volatility, and the real exchange rate on Foreign Direct Investment (FDI) inflows to BRICS economies. We employed the cointegration testing to investigate the long-term relationship between the selected regressors and Granger Non-Causality test to analyze the direction of causality between variables. Diagnostic tests were conducted to check serial correlation in our model and to detect model misspecification. The stability of parameters at a 5% significance is graphically presented. The results indicate that economic growth is a positive significant determinant of FDI inflows in both the short and long term, and exchange rate volatility and the real exchange rate have a negative insignificant impact on FDI inflows in the short run, with the exchange rate showing a positive significant link in the long run. The relationships with control variables are mixed: The coefficients of gross fixed capital formation display a positive and significant relationship with FDI inflows in the short run, but an insignificant one in the long run. Trade openness and inflation demonstrated an insignificant link to FDI inflows, while GDP per capita had a positive significant impact in both terms. These findings offer valuable insights for policy reforms and economic integration across countries.

Keywords: Foreign Direct Investment Inflow, Economic Growth, Exchange Rate Volatility, Emerging Markets, ARDL
JEL Classifications: F31, F21, F55, O55, C32

1. INTRODUCTION

For the last three decades, the world has been experiencing immense progress in terms of economic integration among nations. This has eased the flow of Foreign Direct Investment (FDI) across countries, hence being a crucial dynamic in global economic integration.[1] Regarding the current paper's concern, the main stipulator of growth for emerging economies such as Brazil, Russia, India, China, and South Africa (BRICS) lies in the inflow of FDI that generates direct, stable, and lengthy permanent relationships among their economies.[2] Notably, economic efficiencies, large population, potential consumer market, fast-growth economies, and diverse export-import

1 For example, in addition to Brazil, Russia, India, China and South Africa (BRICS), other integrated economic groups include, Asia-Pacific Economic Cooperation (APEC), Transatlantic Trade and Investment Partnership (TTIP), Regional Comprehensive Economic Partnership RCEP), and MINT (Mexico, Indonesia, Nigeria, and Turkey), Eurozone countries, Association of Southeast Asian Nations (ASEAN), Developing Economies, Developed Economies, Non-OECD Nations, Pacific African countries, African nations, North African nations, Southern African countries and Sub-Saharan nations (SS).

2 FDI inflow has many positive economic externalities to the host country where it boosts economic growth through capital formation and technology spillover, mitigates domestic investment-saving imbalances reflecting infrastructure development and enterprise performance enhancement, triggers trade integration and productivity boost to support domestic capital deficiencies, surges human capital materialization via better managerial skills and through business know-how or learning by doing and alike (Dinh et al., 2019; Iamsiraroj and Ulubaşoğlu, 2015; Makiela and Ouattara, 2018).

policies have positioned BRICS as major recipients of global FDI inflow.[3] This holds particularly accurate for China and India, as both nations present themselves as attractive destinations for foreign direct investment (FDI) inflow. This attractiveness stems from their integration and alignment in various aspects, including geographical, demographic, and historical factors (Hölscher et al., 2010; Sekmen and Gökirmak, 2020).

So far, foreign investors have shown considerable interest in the BRICS economies, especially those seeking enhanced returns by leveraging factors such as expensive market size (notably in China and India), low labour cost (as for China and India), availability of natural resources such oil and gas (as for Brazil and Russia), younger energetic population (as for India), and high growth potential (as for most BRICS countries). In 2018, BRICS accounted for an average of 26 per cent of global FDI inflows, contributing to 50% of world economic growth (Bose and Kohli, 2018; Gherghina et al., 2019; Malik and Savadatti, 2018). Collectively, across the G20, BRICS economies represent 26.46% of the world land area, sharing 42.42% of the global population, hold 13.24% of the World Bank voting power and 14.91% of IMF quota shares, and contribute 23.2% of the gross World product in nominal GDP terms and 32% in terms of GDP by purchasing power parity (Malik and Savadatti, 2018). These macro indicators prompt academia and policymakers to explore why BRICS countries have varied performances in attracting FDI inflow, the factors determining FDI inflow into the BRICS, and their prospects as attractive FDI destinations.

Nevertheless, the BRICS economies continue to experience a fluctuating FDI inflow due to certain macroeconomics factors, namely economic growth, and exchange rate volatility. So far, various studies have examined the influence of these factors on FDI inflows, both across different cross-country and within country-specific, however, the empirical results have been ambiguous. (Nupehewa et al., 2022; Wang et al., 2022; Cicea and Marinescu, 2021; Sarker and Khan, 2020; Osei and Kim, 2020; Bilas, 2020; Dong and Fan, 2020). While certain studies have indicated a positive correlation between economic growth and FDI, suggesting that economic growth provides necessary conditions for FDI in any economy, other studies have contradicted this finding. Similarly, some research has confirmed a positive relationship between exchange rate volatility and FDI, asserting that exchange rate fluctuations lead to increased FDI inflows into host countries (Chowdhury and Wheeler, 2008). On the contrary, alternative research proposes a detrimental or negligible effect of exchange rate volatility on the inflow of FDI (Havi, 2021; Akinlo and Gbenga Onatunji, 2021; Moraghen et al., 2021; Moraghen et al., 2020).

Against this backdrop, this paper tests for the short-run and long-run impact of economic growth, exchange rate volatility, and real exchange rate on FDI inflow in the context of the BRICS countries. The current paper also investigates the causality direction between FDI and its determining factors. We propose that BRICS economies' investment capacities are enhanced by steady and sustained FDI inflow, necessitating major economic reforms to rectify distortions. These reforms are aimed at improving economic growth prospects, thus making these countries more attractive for FDI inflow. A country's growth prospects are posited to offer higher saving rates for foreign investors, thereby providing favorable conditions for FDI inflow, assuming that FDI's positive externalities and technology spillovers are contingent on the host economy's development capacity.

Further reform adjustments include managing the country's currency exchange rate. Adjusting market conditions through currency devaluation is one of several strategies implemented to attract FDI inflow.[4] We assert that the impact of exchange rate volatility on FDI inflow is conditional, related to the country's level of trade openness. It may have a positive or neutral effect on FDI in relatively closed economies, but a negative influence in highly open economies. Regarding the real exchange rate, we contend that substantial capital inflows from FDI can exert pressure on the host currency's exchange rate, often leading to appreciation, which in turn can reduce trade competitiveness, exacerbate public debt, and deteriorate macroeconomic attributes like the current account balance.

The Autoregressive Distributed Lag (ARDL) bounds testing method for cointegration is employed to evaluate our FDI panel model using annual macroeconomic data from 1981 to 2018. Diagnostic tests, namely the Breusch-Godfrey LM and Ljung-Box tests, are applied to detect serial correlation in our ARDL model, while Ramsey's RESET test assesses model misspecification. The cumulative sum (CUSUM) of recursive residuals, the cumulative sum of squares (CUSUMSQ) of recursive residuals, and MOSUM graphs are generated to verify the stability of the parameters at a 5% significance level. We include additional control variables like trade openness, inflation, GDP per capita, and gross fixed capital formation to account for variations in FDI inflow. The causality direction between FDI and the proposed determining factors is examined using the Granger Non-Causality testing given by Toda and Yamamoto (1995).

This paper contributes to the existing literature in four significant ways. First, it examines the FDI model within the context of BRICS, a group of strong global players and leaders among emerging markets. This may offer more thoughtful of the relationship between FDI and the deliberated regressors, hence, signifying short-term or long-term reactions. Second, testing for the long-run relationship between FDI and its macro determinants adds value to economic development literature and informs policy implications for stimulating higher FDI inflow rates and mitigating FDI inflow volatility, hereafter, allowing FDI stakeholders to duly integrate their FDI reforms into macroeconomic objectives for all-inclusive, sustainable economic growth and development.

3 For example, China and India exports are dominated by manufactured goods, while Russia and Brazil exports are dominated by raw material, oil, and gas. Brazil and India relatively provide less attention to product export, while Russia and China are susceptible to export.

4 Other reforms may include tax exemptions, privatization, and capital inflow restrictions. Considering that most of the reforms are also followed by the developed economies where the flow of FDI to their economies is not less important as compared to the developing economies, since investors are looking for higher returns, given the high rates of the capital marginal efficiency in emerging economies.

Third, the current study conducts an in-depth examination of the dynamic causal relationship between FDI and the proposed determining regressors across the BRICS countries. Applying the method for Granger Non-Causality testing proposed by Toda and Yamamoto (1995) along with relevant diagnostic tests would enhance the novelty of the current paper. Furthermore, our model emphasizes the role of economic openness as a conduit through which FDI inflow can effectively stimulate economic growth, a crucial strategy for many emerging economies. Fourth, we utilize the ARDL bound test (Pesaran et al., 2001), which allows the modelling of variables stationary at different lags (I(0) and I(1)) and testing their cointegration, overcoming the limitations of traditional cointegration tests that require all variables to be of order I(1) (Elian and Kisswani, 2018).

Our empirical findings indicate that economic growth has a positive and significant influence on FDI inflows within the BRICS countries, persisting over both the short- and long-term periods. This suggests a sustainable and stable relationship between these macro-variables. Conversely, exchange rate volatility and the real exchange rate display a negative and insignificant impact on FDI inflows in the short term, although the exchange rate exhibits a positive and significant connection in the long run. Gross fixed capital formation demonstrates a positive and significant correlation with FDI inflows in the short run but becomes negative and insignificant in the long term. Trade openness and inflation are found to have a negative and insignificant association with FDI inflows. Additionally, GDP per capita revealed a positive and significant impact in both the short and long term.

The paper is structured as follows: Section 2 reviews related literature, Section 3 outlines the methodology, Section 4 describes the data and provides an empirical analysis, Section 5 discusses the results, and Section 6 presents conclusions and policy implications.

2. LITERATURE REVIEW

Numerous studies have examined the impact of economic growth and exchange rate volatility on FDI inflows, either across economies or on a country-specific basis worldwide. Thus far, economic growth has been recognized as crucial in stimulating FDI inflows to host economies. However, the results regarding the relationship between growth and FDI are not consistent due to variations in econometric techniques, time frames, measures of exchange rate volatility, model misspecification and the selection of countries for analysis (Akinlo and Gbenga Onatunji, 2021). Iamsiraroj and Ulubaşoğlu (2015) found that among 108 empirical studies they reviewed, 43% reported a positive and significant effect on FDI on growth, while 17% indicated a significant negative effect, and 40% reported a statically insignificant effect.

Chan et al. (2014) concluded that economic growth positively affects FDI, while Yormirzoev (2015) confirmed a positive association between economic growth and FDI in Central and Eastern Europe (CEE) and the Commonwealth of Independent States from 1992 to 2009. Hlavacek and Bal-Domanska (2016) investigated CEE countries from 2000 to 2012, revealing a positive, statistically significant relationship between economic growth, FDI, and investment growth. Tahir et al. (2019) also confirmed a significant long-run positive relationship between FDI and economic growth in various regions. Conversely, Mencinger (2003) identified a negative association between growth and FDI in 8 Eastern European countries in 2004, indicating that foreign investors often prioritize takeovers in the host country's economy. Sağlam (2017) reported a negative association between economic growth and FDI in 14 European transition countries from 1995 to 2014. Gherghina et al. (2019) concluded a non-linear relationship between these two variables in 11 CEE countries from 2003 to 2016. Dinah et al. (2019) identifed that while FDI contributes to long-term economic growth, it exerts a negative influence in the short term for developing and emerging markets. Elian et al. (2020) found that there is a positive and significant long-run estimate of GDP on FDI inflows for Russia, India, China, and South Africa. However, for Brazil, their results revealed an insignificant impact between the two macro-variables. Sarker and Khan (2020) revealed a long-run relationship between FDI and GDP. Their causality test reveals a unidirectional causality running from GDP to FDI. Nupehewa et al. (2022) suggested that there is a bi-directional causality between FDI and economic growth in the Asian region. In contrast, the causality appears to be unidirectional in the American region. A non-directional causality was observed in European, Oceanian, Mediterranean, and African regions.

Furthermore, the exchange rate volatility and real exchange rates have been recognized as critical factors in encouraging greater FDI inflow. Nonetheless, the correlation between these macroeconomic variables remains a topic of debate. Görg and Wakelin (2002) observe no notable impact of exchange rate volatility on FDI. Broll and Wong (2006) and Asmae and Ahmed (2019) concluded that exchange rate volatility positively influences FDI inflow. Nasir et al. (2017) suggested that exchange rate volatility predominantly affects FDI inflow in the short run, causing uncertainty among foreign investors. The findings of Mosteut and Masih (2017) indicate that exchange rate volatility is significantly associated with foreign direct investment, while it shows no significant relationship between the exchange rate and gross domestic product. This implies that currency volatility should not be a concern for foreign investors. Eregha (2019) investigated the effect of exchange rate changes on FDI inflow in the West African Monetary Zone from 1980 to 2014, finding that exchange rate changes are more likely to be anticipated innovations affecting FDI inflow.

Conversely, Hanusch et al. (2018) reported a negative impact of exchange rate volatility on FDI inflow. Latief and Lefen (2018) concluded that exchange rate volatility significantly and negatively impacts both international FDI and trade in countries associated with the "One Belt and One Road" (OBOR) initiative. Balaban et al. (2019) observed that the influence of exchange volatility on FDI varies among sectors in transition economies. The empirical results of Asmae and Ahmad (2019) demonstrate that real exchange rate volatility significantly impacts FDDI flows in Morocco and Turkey during the period spanning from 1990 to 2017.

The empirical evidence regarding the real exchange rate's impact on FDI is mixed. Vita and Abbott (2007) found no significant correlation, suggesting that exchange rate changes do not confer cost of capital advantages. Campa (1993), however, reported a positive impact, noting that home currency appreciation increases profits for foreign investors. Other studies (Sazanami et al., 2003; Udomkerdmongkol et al., 2009; Lily et al., 2014) indicate a negative relationship, where a weaker home currency can enhance FDI inflow by reducing investment costs for foreign investors. Moraghen et al. (2020) demonstrated that in the short term, both exchange rate and exchange rate volatility have minimal impact on FDI inflows. However, their findings reveal that a real depreciation of the Mauritian currency against the U.S. dollar has increased FDI inflows. By using a Vector Error Correction Model spanning from 1976 to 2018, Moraghen et al. (2021) concluded that exchange rate volatility negatively affects FDI, while a depreciating real exchange rate attracts foreign investors. Conversely, Havi (2021) found that the depreciation of the real exchange rate, along with the degree of economic openness and their interaction term, does not encourage foreign direct investment inflows. Qabhobho et al. (2022) showed no Granger causality between FDI and GDP but observed a unidirectional causality from GDP to trade openness and from FDI to exchange rate. They also identified a bidirectional causality between GDP and exchange rate, as well as between trade openness and exchange rate.

Additionally, our paper posits that FDI inflows are affected by other macroeconomic factors, particularly trade openness, inflation, and GDP per capita. Trade openness is widely acknowledged as a key catalyst for promoting higher rates of FDI inflows into countries. Aizenman and Noy (2006) identified a positive relationship between trade openness and FDI, suggesting that trade and financial liberalizations motivate FDI, especially in developing economies. Balakrishnan et al. (2013) confirmed the positive impact of trade openness on FDI inflow in the Middle East and North Africa region. Oloyede and Kolapo (2018) showed that open economies are more likely to attract FDI. The results of Tahmad and Adow (2018) indicate the existence of a long-term equilibrium relationship between trade openness and FDI flows. Hassan (2022) revealed that over the long term, trade openness has a positive impact on FDI inflows in the GCC economies, and panel causality analysis indicates a unidirectional causal relationship between trade openness and inflation to FDI. The cointegration tests conducted by Hao (2023) indicate a long-term cointegration relationship between trade openness and FDI inflows in China.

Inflation is also commonly considered to influence FDI inflows to host economies. Inflation diminishes the purchasing power of currencies and often leads to higher interest rates, potentially affecting a country's capabilities as a destination for FDI. However, research on the relationship between inflation and FDI inflows has yielded inconsistent findings. Obiamaka (2011) found no impact of inflation on FDI inflow, whereas Andinuur (2013) notes that higher inflation rates result in higher nominal interest rates, which in turn lead to lower FDI inflow. Faroh and Shen (2015) reported a negative relationship, while Kelvin and Ogbonna (2019) showed a positive long-run association between inflation and FDI inflow within the Nigerian context spanning from 1981 to 2017. Results of Fuat and Haşmet (2020) indicate the absence of short-term causality between inflation and foreign direct investments. However, they note a is negative and significant coefficient, indicating a long-term causality between inflation and foreign direct investment.

In relation to GDP per capita, this variable has been regarded as a measure of a country's economic welfare. Jaspersen et al. (2000) found an inverse impact of GDP per capita on FDI inflow, whereas Uneze (2013) concluded that there is a bidirectional relationship between gross fixed capital formation and economic growth, suggesting a positive influence on FDI inflow. Kurečić et al. (2015) reported a positive effect, suggesting that higher GDP per capita, indicating expanding markets and greater purchasing power, attracts more FDI. Jaiblai and Shenai (2019) observed higher FDI inflow relative to GDP in ten sub-Saharan economies.

3. METHODOLOGY

3.1. Data and Proxies of Variables

This study uses a panel analysis technique to examine a data set consisting of 190 data points across 39 years (1981-2019) for the BRICS-5. The World Bank's World Development Indicators and the IMF's International Financial Statistics are the sources of our panel data. We can get over the consistency and measurement issues amongst variable proxies by extracting data from a single information source. FDI inflow as a percentage of GDP is employed as a stand-in for FDI (FDIF). We choose our explanatory regressors based on the UNCTAD (2002) taxonomy of FDI drivers.[5] The host economy's infrastructure availability is captured by the economic growth rate, which is determined by GDP annual growth (GDPG). The 3-year moving average standard deviation of the most recent yearly fluctuations in the real exchange rate is used as the benchmark frame to calculate the predicted volatility of the real exchange rate (FXVoL). This index indicates risk or uncertainty regarding the magnitude of exchange rate changes by displaying the real exchange rate change as a percentage over the data from the prior year. The literature frequently uses this unconditional measure (Serenis and Tsounis, 2014; Thuy and Thuy, 2019):

$$\text{FX}, VoL_t = \sqrt{\frac{1}{n-1}\sum_{k=1}^{n}\left(ER_t - ER_{t-1}\right)^2}$$

where *FXVoL* is the real exchange rate volatility, n is the number of periods, t is time and *ER* refers to the exchange rate.

The annual nominal exchange rate (NER) of the home currency in relation to the US dollar multiplied by the ratio of the home currency's price level to the US dollar's price level is defined as the real exchange rate (FXRate). By maintaining US prices (PUS) in the numerator and domestic prices (PHOME) in the denominator, the NER is adjusted for the price differential in accordance with Osinubi and Amaghionyeodiwe (2009). This converts the nominal

5 See the UNCTAD (2002) for the FDI five policy determinants.

exchange rate to real and reflects the purchasing power parity method (PPP):

$$FXRate_{it} = O_{ex}, \left(\frac{P_{US}}{P_{HOME}}\right)$$

where $FXRate_{it}$ is the real exchange rate for country i at time t, O_{ex} is the official exchange rate, P_{US} is the U.S. consumer price index (CPI_{US}) and P_{HOME} is the host country's consumer price index (CPI_{HOME}). Local currency units are used to establish the official exchange rate in relation to the US dollar. A genuine appreciation (depreciation) of the exchange rate signifies a true appreciation or depreciation of the local or national currency. The ratio of average goods and services imports to exports as a percentage of GDP is used to calculate the level of trade openness (ImpExp). The trade openness variable serves as a policy variable by providing information on the host economy's infrastructure availability. Since nations differ greatly in terms of their endowments of labor, natural resources, and income levels, we contend that such a factor generates positive FDI impacts and shows that open trade nations do better than closed trade nations.

The consumer price index (annual percent) of the host economy is used to calculate the inflation rate (Inf). Along with representing political risk and institutional strength, it serves as a stand-in for macroeconomic stability (Balakrishnan et al., 2013; Asongu et al., 2018). The gross fixed capital formation (GFGF) as a percentage of GDP is used to measure improvements in the general soundness of the economy for investments. This improvement in the economy is what attracts larger levels of foreign direct investment (FDI) inflow. GDP per capita (LGDP) is measured by the natural logarithm and it is used to a proxy market size of the host economy since it captures the demand of goods and services, the country's economic wellbeing, and the purchasing power of its population. Table 1 summarizes the operationalization details of all Variables used.

3.2. Model Specification

To investigate the potential association between FDIF and the suggested influential variables, the following model has been employed:

$$FDIF_t = \beta_0+\beta_1 GDPG_t+\beta_2 FXVol_t+\beta_3 FXRate_t+\beta_4 ImpExp_t+\beta_5 Inf_t+\beta_6 GFCF_t+\beta_4 LGDP_t+\varepsilon_t \quad (1)$$

Where FDIF, GDPG, FXVol, FX Rate, ImpExp, Inf, GFCF, and LGDP are Foreign direct investment, GDP Growth, FX Volatility FX rate, Import & Export, Inflation, GFCF, and Log GDP per capita, respectively. ε_t is the error term which is presumed to be follow a normal distribution. Model intercept is denoted by β_0, whereas coefficients for FDIF, GDPG, FXVol, FX Rate, ImpExp, Inf, GFCF, and LGDP are represented by $\beta_1,\ldots,\beta_7$, respectively.

Since model (1) depicts the link between time series (panel) data, each variable in the model must have its stationary condition tested. Phillips-Perron test (Phillips and Perron, 1988) and Augmented Dickey-Fuller test (Dickey and Fuller, 1979) are used to assess the stationary state of the modeled variables. Table 2 shows that out of all the variables, only two are I(0) level stationery and the rest are I(1) (first-differenced). The Autoregressive distributed lag (ARDL) bound test (Pesaran et al., 2001) evaluates the cointegration of model variables that are stationary at distinct lags (I(0) and I(1)).

The ARDL approach offers several benefits over conventional techniques in addition to this one. By include various lags for the dependent and independent variables in the model, it addresses the endogeneity issue in addition to estimating the short- and long-term correlations between variables. Using the ARDL limits technique, the long-run relationship between FDIF and all variables in model (1) is expressed as follows:

$$FDIF_t = \beta_0 + \sum_{i=1}^{n1}\gamma_i FDIF_{t-i} + \sum_{i=0}^{n2}\beta_{1i} GDPG_{t-i} + \sum_{i=0}^{n3}\beta_{2i} FXVol_{t-i} + \sum_{i=0}^{n4}\beta_{3i} FXRate_{t-i} + \sum_{i=0}^{n5}\beta_{4i} ImpExp_{t-i} + \sum_{i=0}^{n6}\beta_{5i} Inf_{t-i} + \sum_{i=0}^{n7}\beta_{6i} GFCF_{t-i} + \sum_{i=0}^{n8}\beta_{7i} LGDP + \varepsilon_t \quad (2)$$

Using auto.ardl function in Rstudio the ARDL bound technique automatically determines the ideal numbers of optimal lags for each variable, denoted by $n_1,\ldots,n_7$. Additionally, the function allows for the automatic determination of the optimal model with varying lag times based on various selection criteria (AIC and BIC). Additionally, it offers resources for testing the cointegration (long-term) relation using the boundaries test protocol and visualizing it. Model 2's cointegration between variables is tested using the ARDL bound technique (Pesaran et al., 2001). It generates F-statistics at three distinct significant levels (1%, 5%, and 10%), along with lower and upper critical values.

To reject the null hypothesis that there is no cointegration, the F-test statistics must be higher than the upper bound. The error correction model (ECM), which can be shown as follows, is then used by the ARDL technique to estimate the short-run model (which is based on model 2):

$$\Delta FDIF_t = \beta_0 + \sum_{i=1}^{n1}\gamma_i \Delta FDIF_{t-i} + \sum_{i=0}^{n2}\beta_{1i}\Delta GDPG_{t-i} + \sum_{i=0}^{n3}\beta_{2i}\Delta FXVol_{t-i} + \sum_{i=0}^{n4}\beta_{3i}\Delta FXRate_{t-i} + \sum_{i=0}^{n5}\beta_{4i}\Delta ImpExp_{t-i} + \sum_{i=0}^{n6}\beta_{5i}\Delta Inf_{t-i} + \sum_{i=0}^{n7}\beta_{6i}\Delta GFCF_{t-i} + \sum_{i=0}^{n8}\beta_{7i}\Delta LGDP + \delta EC_{t-1} + \varepsilon_t \quad (2)$$

where δ is the adjustment parameter of the of Error Correction term lagged for one period (EC_{t-1}) towards the long-run equilibrium, and Δ is the first difference.

The short- and long-run models 1 and 2 are used in the ARDL bound technique to assess the link between variables, although the direction of this relationship is not specified. To investigate the cause-and-effect direction among the variables of interest, this work uses the Toda Yamamoto (1995) test. Because it considers cointegrated and non-stationary variables, the Toda Yamamoto test offers an advantage over the conventional Granger causality test.

All variables' stationarity is tested using the ADF and PP unit root tests (Asteriou and Hall, 2007). Model diagnostic tests are employed to verify the ARDL model's assumptions. The Breusch-Godfrey and Ljung-Box tests for residual autocorrelation and normality, as well as the Breusch–Pagan–Godfrey test for heteroskedasticity, were used to verify the assumptions of normality and independence of residuals. If there is a model misspecification, Ramsey's RESET Test is applied. The Cumulative Sum (CUSUM) and the Cumulative Sum of Square (CUSUMSQ) of recursive residuals are used to verify the stability of the coefficients (Brown et al., 1975; Bani-Mustafa et al., 2019).

4. EMPIRICAL FINDINGS

4.1. Explanatory Statistics

Descriptive statistics for the variables covered in this research are displayed in Table 3 for the five BRICS countries during a 38-year period (1981-2018). The total FDIF average for all countries, as shown in Table 3, is 1.62 (SD = 1.53), with a significant degree of variability with a minimum of −0.77 and a maximum of 6.2. The average FDIF for the same study period (1981-2018) is displayed in Figure 1. The overall trend of the FDIF increased over time, starting from low values in 1991 and growing (with occasional variation) until 2008, when it began to decline.

Table 3 demonstrates that the minimal FDIF means for SA and India are 0.94 (SD = 1.26) and 0.92 (SD = 0.9), respectively, with higher variance for SA. China has the highest FDIF mean (2.74; SD = 1.69), followed by Brazil (2.17; SD = 1.56). With the exception of Brazil, which maintains the same level following the increase, the overall trend of FDIF over time is nearly the same for all countries, beginning with low values and increasing until terminating at the end of the study period with a fall (Figure 2).

A summary of GDP Growth, FX Rate, FX Volatility, and control factors is also shown in Table 3. For the same period (1981-2018), the BRICS countries' FX volatility is 21.75 (SD = 54.29). FX volatility was essentially steady until 1997, when it began to fluctuate sharply until 2009, at which point it began to rise linearly until 2018, as shown in Figure 3. With an average of 53.7 (SD = 92.6), China had the highest FX volatility, followed by India with an average of 27.85 (SD = 51.3). With an average of 1.01 (SD = 1.73), India had the lowest average.

Between 1981 and 2018, the FX rate averaged 214.2 (SD = 450.2). Figure 4 shows that for the whole study period (1981-2018), India's FX rate was the highest. Foreign exchange rates for India began rising in 1989 and had a hump from 1996 and 2008, after which they began to rise rapidly till the end of the study period in 2018. India had the highest average FX rate among the BIRCS countries, at 573.9 (SD = 581.9), with Russia coming in second with an average of 275.4 (SD = 494.5). Brazil had the lowest average FX rate, at just 23.24 (SD = 26.69).

The average GDP growth rate for all the members of BRICS is 4.18 (SD = 4.66). Figure 5 shows the ups and downs in GDP growth across the 1981-2018 study period. The average GDP growth is highest in 2007 and lowest in 2009 (perhaps due to the 2008 financial crisis). China experienced the greatest GDP growth, averaging 9.55 (SD = 2.75), ahead of India, which averaged 6.16 (SD = 2.75). Russia had the lowest GDP growth rate, averaging 0.764 (SD = 5.59).

Table 1: Variables definition and measurement

Variable	Measurement
Foreign Direct Investment Inflow (fDIF)	The ratio of net foreign direct investment inflow per cent of GDP
Independent variables	
Gross domestic product growth rate (GDPG)	GDP annual growth
Expected volatility of real exchange rate (FXVoL)	a window of the 3-year moving average standard deviation of annual changes in the real exchange rate
Real exchange rate (FX Rate)	annual nominal home-to-host currency exchange rate multiplied by the ratio of the two currencies consumer price index level
Control variables	
Trade openness (ImpExp)	Import and export (per cent of GDP)
Inflation rate (Inf)	Inflation, consumer prices (annual per cent)
Gross fixed capital formation (GFCF)	Natural logarithm
Real GDP per capita (GDPPC)	Natural logarithm: GDP per capita (constant 1981 US$)

Table 2: ADF and PP unit root test

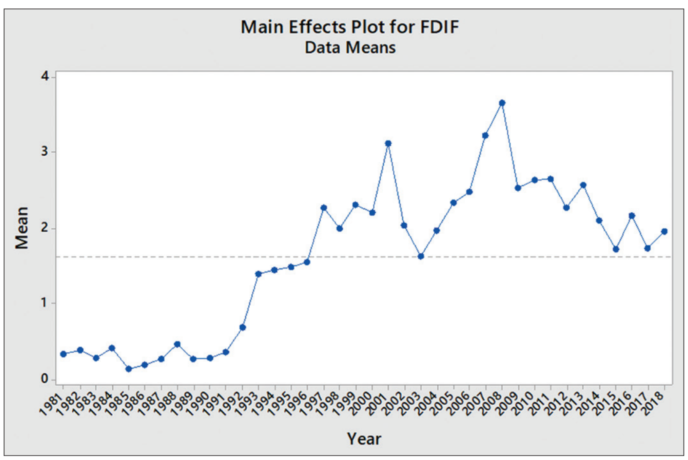
Variables	Augmented Dickey-Fuller test		Phillips-Perron test		Order of integration
	Level	1st Difference	Level	1st Difference	
	t-value	t-value	t-value	t-value	
FDIF	−1.80	−9.63***	−1.55*	−9.11***	I (1)
GDPG	−2.73	−12.86***	−6.16***	−10.77***	I (1)
FXRate	−2.61	−11.76***	0.64	−7.95***	I (1)
FXVol	−3.16*	−11.11***	−2.36***	−11.77	I (0)
ImportExp	−2.48	−12.28***	−0.9	−9.56***	I (1)
Inflation	−3.19*	−9.60***	−3.61***	−11.42***	I (0)
GFCF	−1.50	−14.95***	−1.29*	−8.54***	I (1)
LGDPPC	−1.6679	−15.34***	3.46	−6.87***	I (1)

*is significant at 10% level, ** at 5% and *** at 1% level

Table 3. Descriptive statistics of control variables, FX volatility, FX rate, and FDIF

Variable	Country	N	Mean	StDev	Min	Median	Max
FDIF by country	Brazil	38	2.167	1.562	0.129	1.851	5.034
	China	38	2.743	1.694	0.21	2.933	6.187
	India	38	0.923	0.897	0.003	0.695	3.621
	Russia	38	1.337	1.265	0.175	0.967	4.503
	South Africa (SA)	38	0.943	1.258	−0.766	0.548	5.983
FDIF total	Total	190	1.623	1.529	−0.766	1.027	6.187
FXRate by country	Brazil	38	23.24	26.69	0	23.26	110.06
	China	38	138.7	469.7	−932.8	93.7	1879.7
	India	38	573.9	581.9	27.5	409.5	2938.9
	Russia	38	275.4	494.5	7.7	67.8	2403.5
	South Africa (SA)	38	59.8	162	−808.6	70.6	276.1
FXRate	Total	190	214.2	450.2	−932.8	68.5	2938.9
FXVol by country	Brazil	38	1.01	1.734	0	0.487	9.753
	China	38	53.7	92.6	0.1	14.2	378.1
	India	38	27.85	51.35	0.6	12.78	233.93
	Russia	38	14.97	28.88	0.43	2.13	118.83
	South Africa (SA)	38	11.25	36.46	0.07	2.38	175.95
FXVoL total	Total	190	21.75	54.29	0	3.36	378.12
GDPG	Brazil	38	2.256	3.205	−4.393	2.606	7.988
	China	38	9.557	2.75	3.907	9.347	15.139
	India	38	6.158	1.916	1.057	6.285	9.628
	Russia	38	0.764	5.586	−14.531	0.795	10
	South Africa (SA)	38	2.165	2.176	−2.137	2.443	5.604
GDPG total	Total	190	4.18	4.664	−14.531	4.3	15.139
ImportExp	190	190	19.233	8.274	6.11	19.193	55.289
Inflation	190	79.7	327.1	−1.4	7.9	2947.7	Inflation
GFCF	190	25.023	7.708	14.387	22.32	45.69	GFCF
LGDPPC	190	3.3462	0.5052	2.2946	3.4577	4.2043	LGDPPC

Figure 1: FDIF variation by year



4.2. Empirical Results

4.2.1. Unit root test

The unit root test results for all variables utilizing the ADF and PP tests are presented in Table 2. Before implementing ARDL, it is required to verify that all variables are either I(0) or I(1) and none are I(2), as demonstrated by the two tests. According to (Ranco et al., 2015), if any of the variables is stationary at level I(2), the ARDL results will be biased.

4.2.2. ARDL bounds test

The auto.ardl and ardl Bound functions from the dLagM and ardl libraries in Rstudio are used to fit the ARDL model. These functions determine the optimum number of lags for each variable based on the Akaike Information Criteria (AIC) (Akaike, 1974). As indicated in Table 4, the F statistics for the ARDL bound test to check for cointegration of model variables are 11.706; this is >I(0) and I(1) at all alpha levels. This indicates that, at the 1% significance level, FDIF is cointegrated with a subset of the variables in our model throughout the 1981-2018 research period.

4.2.3. Short-run estimates

Short-run estimates of our ARDL model (3) are illustrated in Table 5. Results revealed that only 3 years back value of FDIF has a negative and significant impact on itself. GDP growth, GDP per capita, GFCF have a positive and significant impact on FDIF in the short term. Import & Export and Inflation have a negative and significant impact on FDIF in the short-run. FX Volatility and FX rate don't have a significant effect on FDIF in the short-run. As expected, the error correct model is negative and significant at the 1% level. The annual rate of convergence towards equilibrium (38.1%) is represented by the coefficient of ECT, which is −0.381.

4.2.4. Long-run estimates

This study aims to investigate the long-term correlation between foreign direct investment (FDIF) and the primary variables of interest, which are GDP growth, FX rate, and FX volatility, as well as the direction of cause and effect among these factors. Table 6 shows the outcomes of the long-run estimations. The findings show that while FX Volatility is strongly and negatively correlated with FDIF, GDP growth, GDP per capita, and FX rate have a significant and positive long-run association with FDIF.

Figure 2: Yearly variation of FDI variation by country

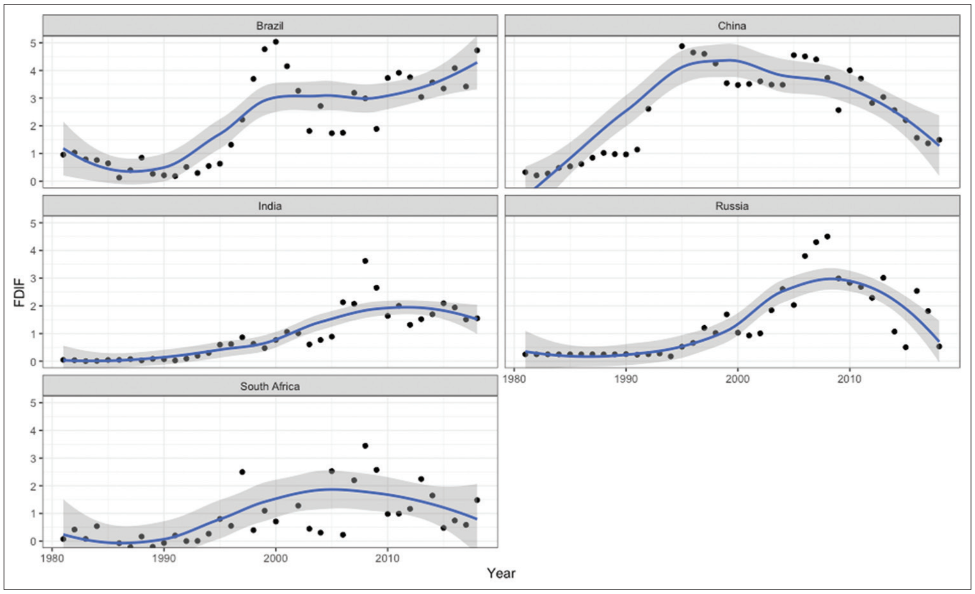


Figure 3: FX volatility variation by year

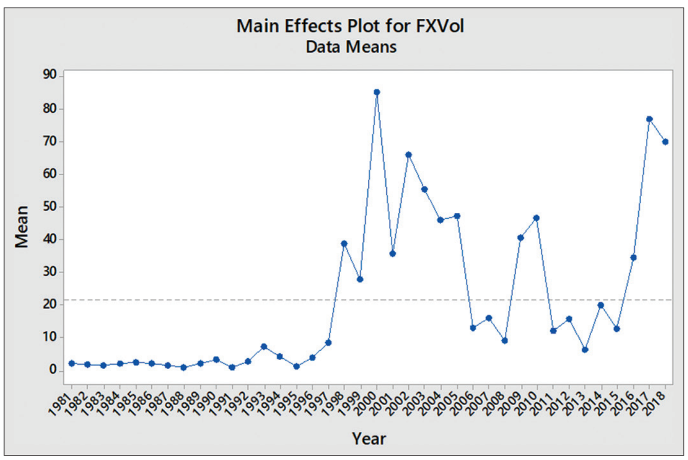
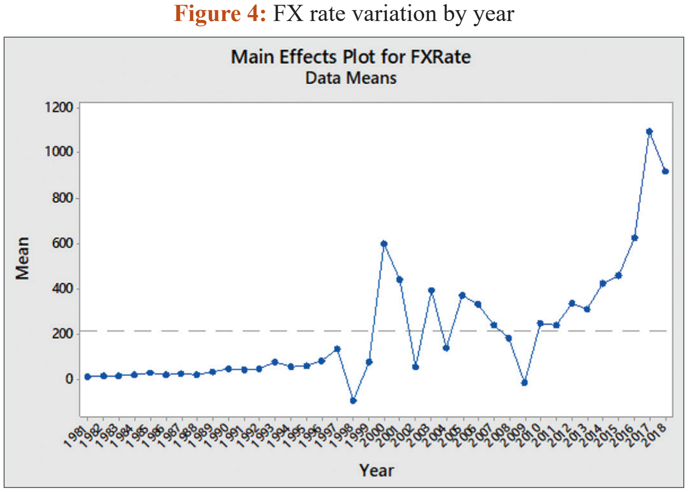
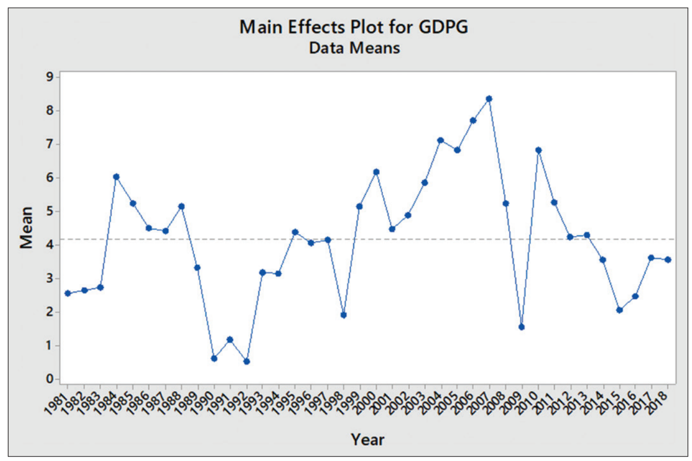


Figure 4: FX rate variation by year



In the long run, the GFCF results indicate a negative and minor impact on FDI inflow, but trade openness and inflation have a negative and large impact on FDIF.

Figure 5: GDPG variation by year



A variety of diagnostic tests for our ARDL model are also included in Table 6. The Ljung-Box and Breusch-Godfrey tests check if the model contains serial correlation. There is no proof of serial correlation in the model because both tests have P-values of 0.76, which are higher than the significance level alpha=0.05. Ramsey RESET tests the model to check for any irregularities. It determines whether the model needs to include non-linear combinations of the anticipated variables. The P = 0.11 indicates that the model is adequate. The homoskedasticity assumption is not violated when using the Breusch-Pagan Test for homoskedasticity (constant variance) with a P-value of more than 5%. Even with a normality test value of <5%, Figure 6 illustrates the residuals' symmetry. Regression modeling is generally robust to normality, but not to variance homogeneity (Box, 1953).

Finally, to verify the parameter stability at the 5% significance level, the CUSUM, CUSUMSQ, and MOSUM graphs (red lines) in Figure 7 are constructed. Plots generally indicate that the long-run coefficients are stable and fall within five percentiles, except for CUSUMSQ, which first recorded a sharp shift in parameters before

Table 4: Cointegration test results

Wald F-statistics	Level percentage	Lower bound I (0)	Upper bound I (1)	Outcome
11.706	1	3.34	4.63	Cointegrated
	5	2.69	3.83	
	10	2.38	3.45	

Table 5: Short-run coefficient of short-run ARDL model (3)

Variable	Estimate	Std.Err	P-value
(*Intercept*)	−0.900	0.1628	<0.001
(*Δ*(*FDIF*))	−0.477	0.0653	<0.001
Δ(*GDPG*)	0.071	0.0206	0.0006
Δ(*ImpExp*)	−0.023	0.0092	0.0133
Δ(*Inflation*)	−0.067	0.0363	0.0633
Δ(*FXRate*)	−0.000032	0.0002	0.8698
Δ(*FXVoL*)	−0.053	0.0633	0.4002
Δ(*LGDPPC*)	0.492	0.2214	0.0264
Δ(*GFCF*)	0.043	0.0120	0.0004
ECT(−1)	-0.381	0.0520	<0.001

Table 6: Long-run coefficient of short-run ARDL model (2)

Variable	Estimate	Std.Err	P-value
GDPG	0.156	0.0745	0.002
ImportExp	−0.188	0.0378	0.008
Inflation	−0.123	0.1731	0.004
FXRate	0.814	0.0007	0.0001
FXVol	−0.278	0.3032	<0.0001
LGDPPC	0.587	0.6256	0.086
GFCF	−0.056	0.0434	0.352
Diagnostics tests			
R-squared		0.72	
Adjusted R-squared		0.70	
Breusch-Godfrey test LM Test		0.09 (0.76)	No serial correlation
Ramsey's RESET test for model specification		2.24 (0.11)	The model is properly specified
Ljung-Box test for the autocorrelation		0.55 (0.76)	No heteroscedasticity
Breusch-Pagan test for the homoskedasticity		29.02 (0.46)	No heteroscedasticity

Table 7: Toda yamamoto causality test

Independent Variable	Response	Chi-square	df	P-value
FX Rate →	FDIF	41.24	11	<0.001
FX Vol →	FDIF	29.54	11	0.0019
GDPG →	FDIF	51.9	11	<0.001
FDIF →	FXRate	11.78	11	0.380
	FXVol	11.1	11	0.435
	GDPG	28.54	11	0.003

stabilizing (in the long run) inside five percentiles. This suggests that the data has undergone a structural shift, which could be the result of grouping all the BRICS countries together. Therefore, modelling each country separately or grouping related countries together could be more appropriate, although that is outside the scope of this study.

4.2.5. Toda yamamoto causality test

We employed the Toda Yamamoto causality test (Toda and Yamamoto, 1995) to determine whether FDIF Granger Causes GDPG, FX Rate, and FX Volatility after calculating the long-run connection between FDIF and variables of interest using the ARDL model. We utilized first-order difference with the optimum number of lags because our variables are I(1). Several selection criteria, including the Information Criterion (AIC), Schwarz Information Criterion (SC), Final Prediction Error (FPE), and Hannan-Quinn (HQ) Information Criterion, are used in determining the numbers of lag order of VAR. The Granger Causality test findings for Toda and Yamamoto are given in Table 5.

Based on chi-square test statistics with 11 degrees of freedom (in line with the optimal lag length) and the corresponding P-values, the estimates of the VAR Granger Causality WALD test are calculated. The findings indicate that all the study's variables (FX Volatility, FX Rate, and GDP Growth) have a substantial and unidirectional causal relationship with FDIF, except for GDP Growth, which has a bidirectional causal relationship (Table 7).

5. DISCUSSION OF RESULTS

The outcome of economic growth demonstrates a positive and significant factor of FDI inflow over both the short and long periods. The results indicate that, ceteris paribus, a $1 billion increase in the GDP of BRICS would lead to an average short-term rise of US$71 million in FDI inflow and a long-term increase of $156 million, according to the long-run estimates. The result reinforces the growth led FDI nexus where growth would provide FDI suppliers with greater profit openings, leading to higher rates of capital formation through FDI inflow. It also highlights that the FDI's positive externalities and technology spillovers are subject to the gain improvement of the host economy. Furthermore, the significant positive impact of economic growth in both the short and long term highlights the BRICS-5 economy's recent economic growth, which, in turn, has attracted foreign investors to these economies. These findings align with previous research (Hlavacek and Bal-Domanska, 2016; Mittal and Mittal, 2019).

The negative and significant impact of long-term exchange rate fluctuations on FDI inflow implies that, when exchange rate volatility is minimal, FDI inflow tends to rise due to reduced operational costs. This result contradicts (Sechel-Ioana and Gheorghe, 2014) who asserts a positive impact of exchange rate volatility on FDI inflow in the BRICS countries, however, the negative impact of exchange rate volatility is concluded by (Dal Bianco and Loan, 2017) for Latin American and Caribbean countries, (Hanusch et al., 2018) for developing and developed countries, (Latief and Lefen, 2018) for developing countries, (Barguellil et al., 2018) for developing and emerging countries, (Eregha, 2019) for West African Monetary Zone, (Nasir, 2016) and (Maryam and Mittal, 2020) for BRICS countries.

Figure 6: ARDL model residuals

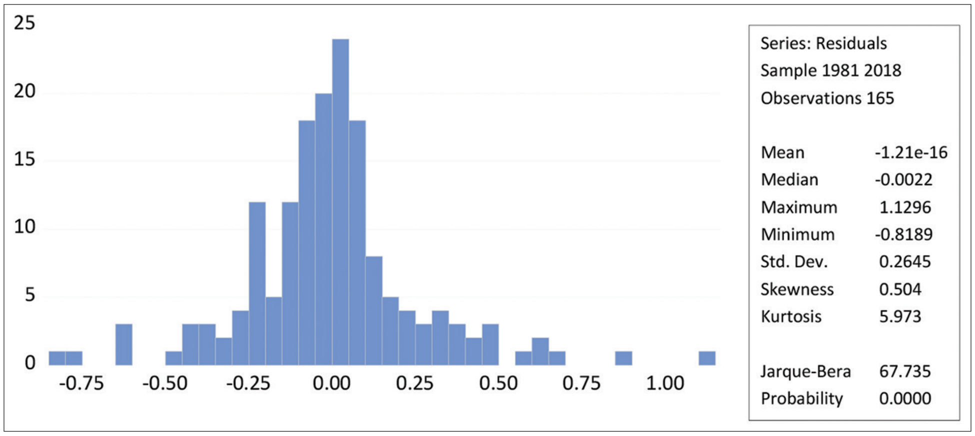
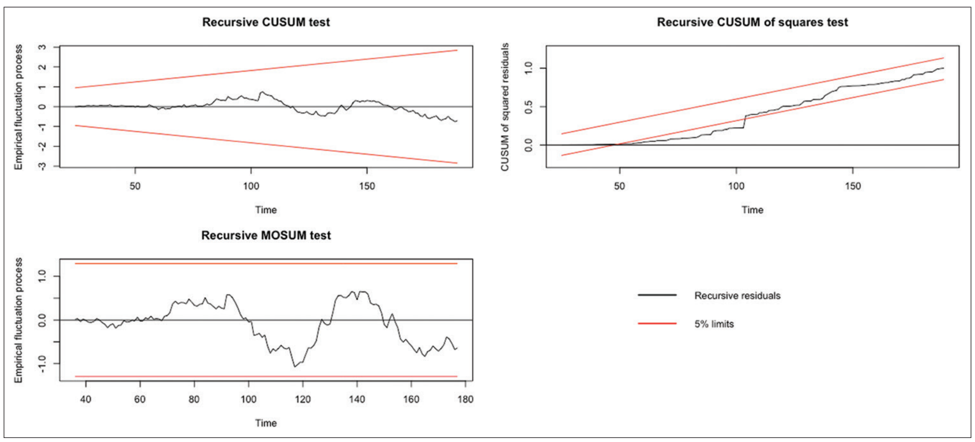


Figure 7: CUSUM, CUSUMSQ, and MOSUM



The short-term adverse effect of the exchange rate indicates that a high exchange rate would increase commodity prices and, subsequently, inflation, which diminishes the purchasing power of the currency. This, in turn, leads to decreased FDI inflows to the BRICS host countries. The outcome related to short-run exchange rates aligns with the conventional viewpoint, which posits that a decrease in the value of the host country's currency would draw in FDI due to the lowered production expenses within the host country. This result is consistent with the findings (Dal Bianco and Loan, 2017). Furthermore, the short-term results reveal that there are no capital cost advantages for either the host or the foreign (home) country during this period. This result contradicts the conclusions of (Lily et al., 2014) who found a negative long-run relationship between the exchange rate and FDI in the context of ASEAN economies. In the long run, the positive and substantial influence indicates that changes in the exchange rate can lead to an increase or decrease in FDI inflow. These fluctuations would impact the investors' profit margins, potentially contributing to economic instability. Furthermore, the long-term positive and significant results indicate that an increase in home currency value would lower import expenses, leading to higher profits for foreign investors and, consequently, stimulating FDI inflow into the host economy.

The trade openness and inflation coefficients both reveal a negative and significant impact on FDI inflow, both in the short and long run. The trade openness outcome denotes that trade-open economies do not necessarily have the advantage of attracting greater amounts of FDI, pointing to the trend of decreasing openness across the BRICS markets. The results highlight disparities in the export-import-oriented policies among the BRICS economies. In simpler terms, these results can be justified by the variations in the export and import structures adopted by the BRICS economies. As for the export structure, China and India's exports primarily focus on manufactured goods, while Russia and Brazil's exports are dominated by commodity exports surpassing manufacturing goods, with a particular emphasis on raw materials, oil, and gas, especially in the case of Russia. Moreover, in terms of export trends, Brazil and India allocate relatively less emphasis to their exports, while Russia and China exhibit a higher susceptibility to exports (Prabhakar et al., 2015). A similar observation can be made regarding the distinctions among the BRICS economies in terms of import structure, economic efficiencies, business environmental factors, size of the share of BRICS's FDI inflows, infrastructure, and their level of economic cooperation. For the BRICS countries, the presence of a long-run relationship between trade openness and FDI is consistent with the findings of Prabhakar et al. (2015) and Asongu et al. (2018).

The negative coefficient associated with inflation aligns with expectations, indicating that BRICS economies with lower inflation rates tend to attract higher levels of FDI inflows. This suggests a trend toward more stable and lower inflationary macroeconomic conditions within the BRICS markets. The low coefficient value may signify a need for more macroeconomic stability across the BRICS markets. Nevertheless, the negative coefficient also implies that higher inflation rates would distort the tax system and lead to elevated nominal interest rates, resulting in higher cost of capital rates, and discouraging more FDI inflow to the host economy. In a multicounty context, the adverse impact of inflation on FDI inflow is also noted by (Muruganantham et al., 2017) for the BRICS countries.

In the short term, the coefficients of gross fixed capital formation are positive and statistically significant. However, in the long run, the results reveal a negative and insignificant impact on FDI inflows. The short-run result suggests that FDI and domestic investment may hold a complementary status, indicating a need for various FDI inflow incentives aimed at attracting FDI that BRICS economies should consider promoting to stimulate both domestic investment and FDI inflow. The long-term results may indicate that foreign investors place less emphasis on capital formation when making decisions to invest in BRICS countries. These findings contrast with the conclusions of (Prakash and Kumar, 2017) and (Maryam and Mittal, 2020), both of which indicate that gross capital formation has a significant long-term impact on FDI inflow in BRICS economies. These variations in findings can be attributed to differences in the FDI-related factors considered in the regression models and methodologies employed for testing, as well as disparities among the BRICS economies in terms of economy enhancements and investment promotion reforms.

The coefficients associated with GDP per capita exhibit a positive and significant impact on FDI inflow, both in the short and long run. This variable serves as an indicator of a country's economic well-being and the size of its market holds great importance for foreign investors seeking to conduct business in the host country. GDP per capita is often used as a gauge of citizens' welfare and their purchasing power. A higher GDP per capita implies more favorable prospects for FDI inflow into the host economy since FDI is incentivized to expand markets and leverage the increased purchasing power of people since FDI suppliers can potentially gain higher returns in their capital. In the cross-country context, the influence of GDP per capita result was confirmed earlier by (Kurečić et al., 2015) for Central and Eastern European countries, (Jaiblai and Shenai, 2019) for sub-Saharan economies and (Nasir et al., 2017) for BRICS countries.

6. CONCLUSIONS AND POLICY IMPLICATIONS

In this paper, we examine both the short-run and long-run effects of economic growth, exchange rate volatility, and real exchange rate on the FDI inflows in a panel dataset of the BRICS economies. Additionally, we account for other regressors that contribute to the variation in FDI inflows, including trade openness, inflation, GDP per capita, and gross fixed capital formation. The ARDL bound of cointegration is used for the BRICS annual macroeconomic dataset for the years 1981 to 2018, inclusive. We include several diagnostic tests used to examine the presence of serial correlation and misspecification in our ARDL model, while graphs are generated to check the stability of the parameters at a 5% significance level. Moreover, this paper tests the causality direction between FDI and the proposed regressors by using (Toda and Yamamoto, 1995) Granger Non-Causality testing method.

The results of the current paper indicate that economic growth has demonstrated a positive and significant effect on FDI inflow in both the short-run and long-run. This suggests the existence of a sustainable long-term equilibrium relationship among the two macro-variables. The signs of the real exchange rate and exchange rate volatility are negative and insignificant in the short run; while in the long run, the real exchange rates exert a positive and significant impact on FDI inflows, while exchange rate volatility has a negative and significant impact on FDI inflow. Both the coefficients of trade openness and inflation reveal a negative and significant impact on FDI inflow, both in the short run as well as the long run. The coefficients of gross fixed capital formation have a positive and significant in the short run but become negative and insignificant in the long run. Additionally, GDP per capita has a positive and significant impact on FDI inflow in both the short-run as well as the long-run.

The policy implications of these results include the following. First, considering the short and long-run results of economic growth, BRICS countries are advised to formulate their economic policies to pursue innovative dynamic controls to ensure and maintain economic growth sustainability. This is of paramount importance, considering the inherent potential of BRICS economies to draw in increased FDI inflows due to their attractiveness to foreign investors. Secondly, BRICS policymakers may adopt an exchange rate policy that predominantly aims to stabilize exchange rates volatility. Such polices would stimulate foreign investments, particularly for trade-open economies, and would also control for inflation and potential market imperfections. Third, given the long-run reversed significant impact of trade openness on FDI inflow, BRICS countries are advised to provide exceptional attention to the long-run strategy in their export quality and define comparative advantage strategies to expand their international trade market access points, rather than relying solely on currency devaluation. Fourth, BRICS governments, alongside offering large-scale markets and strategic geographical destinations, should establish a robust legal framework investment that fosters competition within the marketplace. This will serve as a catalyst for consistent and sustainable FDI inflows.

Nevertheless, as a recommendation for future research, it seems that there is a need to delve deeper into the determinants of FDI on an individual-country basis. This is essential due to the discrepancies among the BRICS economies in terms of their economic efficiencies and deficiencies, export-import oriented policies, investment promotion, boost capital formation policies, natural resources, political and environmental risks, infrastructure, the share of FDI inflow, and defregulations of financial markets.

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