

BRICS Economic Synergy: Unveiling the FDI-Trade Nexus

A Comparative Study of FDI and Trade Relationships

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This research paper comprehensively analyses the relationship between Foreign Direct Investment (FDI) and international trade within the BRICS nations (Brazil, Russia, India, China, and South Africa) from 1990 to 2022. The selection of BRICS as the focal point of this study is particularly significant due to the bloc's collective influence on the global stage. These nations, characterized by their substantial economic size, growing markets, and diverse economic landscapes, have emerged as pivotal players in international trade and investment. The study employs a combination of empirical techniques, including Granger Causality, Johansen cointegration analysis, and Vector Error Correction Models (VECM), to uncover the intricate dynamics between FDI inflows and trade in these emerging economies.

The findings reveal nuanced patterns in the interactions between FDI and trade across the BRICS nations. While FDI is identified as a complement to trade in most BRICS countries, notable variations exist. Johansen Cointegration test reveals long-run equilibrium relations between FDI, export, and import for all BRICS nations. In terms of responses to system shocks, VECM outcomes exhibit variances among nations. Common Granger causality results indicated unidirectional Granger causality from FDI to exports in all BRICS nations except Russia.

This initial research doesn't intend to recommend policies or establish impact structures; rather, it serves as an initial exploration to comprehend the dynamics, offering a foundation for more advanced structural models in the future.

The study is structured into distinct sections: Section I introduces the topic and its rationale. Section II delves into the existing literature regarding the FDI-trade relationship. Section III outlines the empirical methodology, detailing the statistical methods employed. Section IV presents the findings, while Section V provides the concluding remarks.

I. Introduction

The BRICS, consisting of Brazil, the Russian Federation, India, China, and South Africa, has now emerged as one of the world's most significant economic groups. Together, they account for over a quarter of global GDP and encompass 42 percent of the world's population. Notably, these nations have witnessed a steady increase in their economic influence over recent decades, playing vital roles in global growth, investment, and trade.

The inception of the BRIC acronym by Jim O'Neil in 2001 marked the beginning, and since then, the group has not only expanded but also deepened its cooperation. In 2011, South

Africa became a part of this economic alliance, resulting in the BRICS economies. BRICS has progressively taken on an institutional character and this transformation is evident through their high-level political engagements, including annual summits, and the establishment of economic institutions like the New Development Bank (NDB) and the Contingent Reserve Arrangement (CRA).

FDI in the BRICS

Foreign investment has played a pivotal role in the growth of BRICS economies since 2001, with annual foreign direct investment inflows to the bloc more than quadrupling from 2001 to 2021 and contributing significantly to gross fixed capital formation. The growth in FDI inflows to the BRICS was very robust in the first decade but has remained relatively flat since 2011. To deal with the challenging global investment environment, and also in response to the need to leverage foreign investment for sustainable development, the BRICS economies have continued to move in the general direction of a more open and supportive investment policy environment.

The changing economic weights of the BRICS economies over the past decade have metamorphosed the shape of the global economy. According to the World Bank, the share of BRICS in global GDP grew from 18 percent in 2010 to 26 percent in 2021. A significant reason for this upward trend is the growth of China, which accounted for over 70 percent of BRICS GDP, in 2021.

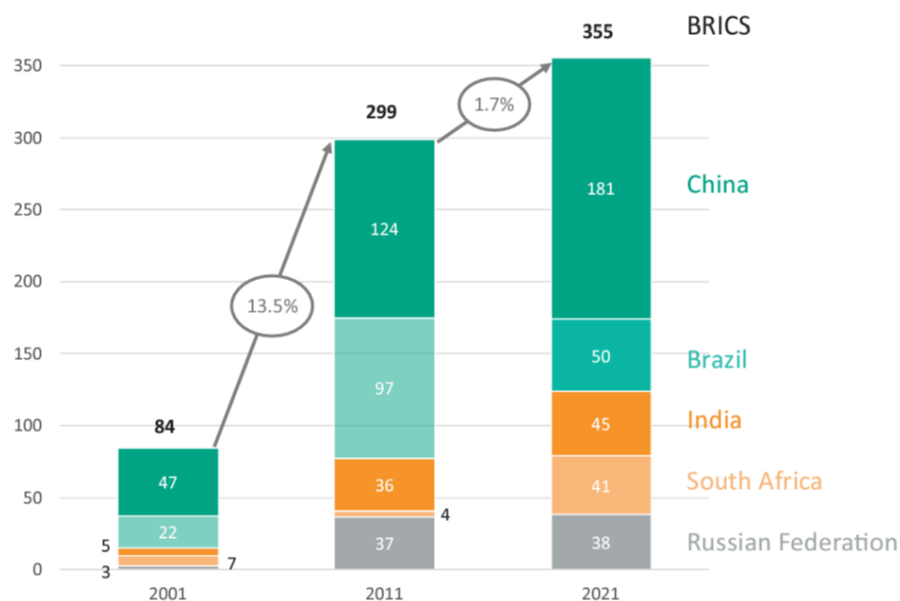


Figure 1¹: FDI inflows to the BRICS, 2001-2021, and compound annual growth rate (Billions of dollars and percent)

Recently, economic growth within the BRICS has displayed disparities, mirroring global trends since the pandemic's onset. Data up to July 2022² reveals a rebound in 2021 followed by

¹ Source: UNCTAD, FDI/MNE database (www.unctad.org/fdistatistics).

Note: South Africa is included in the 2001 figure although it joined the BRICS in 2011.

² UNCTAD Report- BRICS Investment Report 2023

progressively challenging conditions in 2022. Analysing the BRICS as a synergy, there are several downside risks to the output. The Ukraine conflict is disrupting commodity markets both in the short and most likely in the long run as well, inflation in BRICS economies might prove resistant to decline but tighter financial conditions might lead to debt concerns in some group members.

In the realm of trade, BRICS economies account for 18% of global exports, with their share on the rise. Notably, the growth rate of intra-BRICS exports surpasses the global average. This uptick in intra-BRICS exports suggests that increased economic cooperation is delivering tangible benefits and has played a role in the growth of intra-bloc investment, albeit at a moderate pace.

UNCTAD’s FDI data show that the BRICS, as a collective, have seen a more than fourfold increase in their annual FDI inflows, from \$ 84 billion in 2001 to \$355 billion in 2021 (Refer to figure 1). BRICS share in global FDI inflows also doubled from 11 percent in 2001 to 22 percent in 2021. The first decade of the 21st century was characterized by a strong growth rate in FDI inflows to the BRICS, which increased annually by 13.5 percent. At the level of individual economies, performance exhibited a wide spectrum. China, for instance, experienced annual FDI inflow growth exceeding 10% from 2001 to 2011, but this figure tapered down to 4% from 2011 to 2021.

Conversely, the Russian Federation and India witnessed remarkable annual FDI inflow growth rates during the first decade of the 21st century, reaching approximately 30% and over 20%, respectively. However, in the last ten years, their performance waned, with growth rates hovering just above zero percent and at 2%, respectively. Brazil initially demonstrated strong FDI inflow growth in the early 2000s, but this trend reversed in the second decade, albeit with signs of recovery since 2015.

Despite slowing and fluctuating growth from 2011 to 2021, the grouping performed better than the world average, and its share in global FDI flows posted an increase over the decade (figure2).

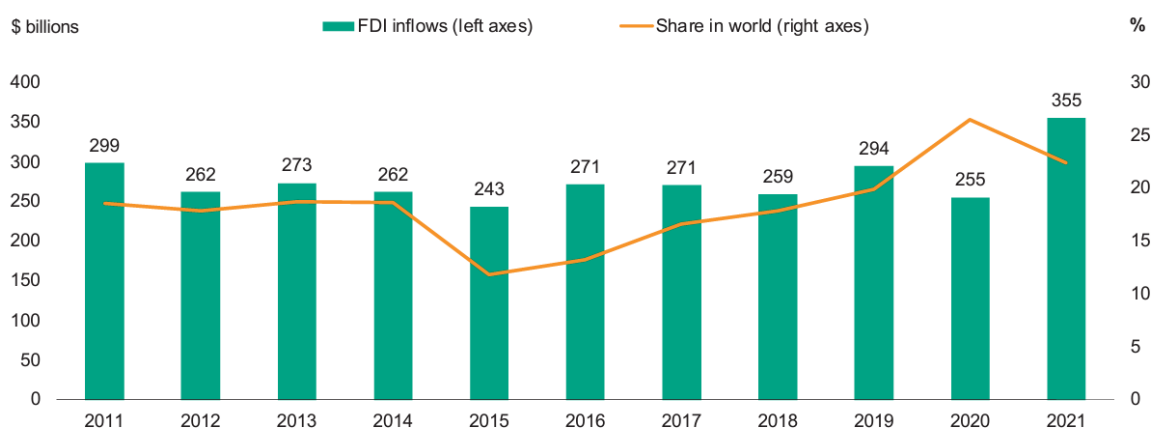


Figure 2³: FDI inflows to the BRICS and share in world inflows, 2011-2021 (billions of \$ & percent)

³ Source: UNCTAD, FDI/MNE database (www.unctad.org/fdistatistics).

Top investors in the BRICS economies

Over the past years, there has been relative stability in the top 10 investor economies (Refer to figure 3), measured by their FDI stock, in the BRICS nations. In 2020, the United States emerged as the largest paramount investor within the bloc in terms of FDI stock. Following closely, the United Kingdom held the spot of the second-largest ultimate investor in the BRICS, while China secured the third position, displaying a growing involvement over the course of the decade.

Other significant sources of top investment to the BRICS included Japan, Hong Kong (China), Germany, the Netherlands, France, Switzerland, and Spain in that order. It's worth highlighting that international financial centre played a pivotal role in channelling investments into the BRICS, and some of them, like Cyprus and Singapore, ranked among the most substantial sources of FDI to the bloc in terms of immediate investors.

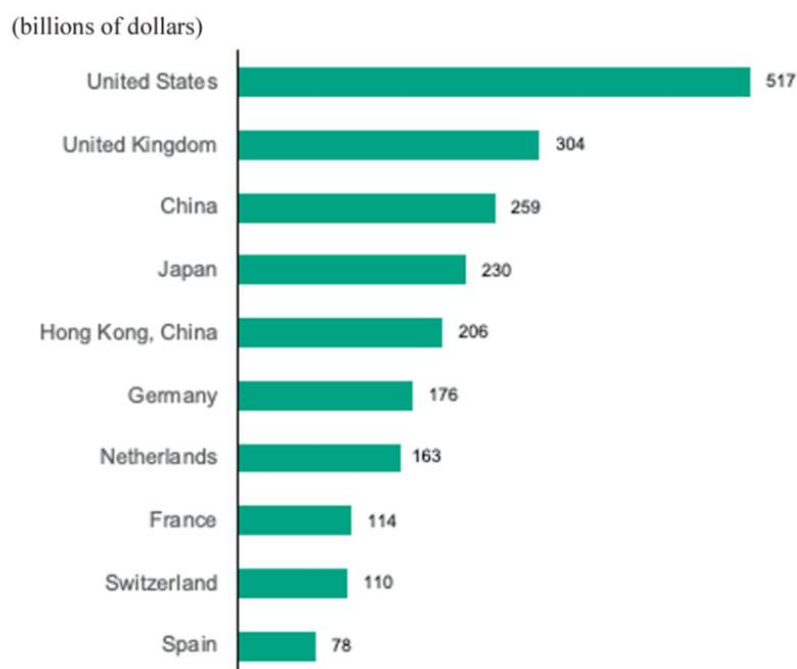


Figure 3: Top 10 economies as ultimate investors in the BRICS, by FDI stock, 2020

Over the last ten years, Foreign Direct Investment (FDI) has shifted its focus toward the BRICS nations, attracted by the prospect of establishing manufacturing centres for a wide range of products, spanning both capital and labour-intensive industries. Additionally, the pursuit of renewable energy sources has drawn investors to these BRICS countries, akin to moths being drawn to a flame. This evolving landscape compels us to explore whether the upsurge in FDI during recent years has reinforced existing relationships or forged new connections between FDI and trade.

The Significance of the FDI-Trade Relationship

The interaction between FDI and export assumes significant importance within the strategic planning and development frameworks of BRICS countries. A harmonious coexistence of FDI and export activities can boost the competitiveness of foreign markets, benefiting exports

from BRICS nations and strengthening their domestic industries. However, if FDI displaces local firms' export activities, it could potentially undermine these influential nations' domestic industries. The exploration of these dynamics holds tremendous promise for BRICS governments, offering them a strategic tool to align their FDI and trade policies synergistically for fostering sustained economic growth.

BRICS: A Collective Economic Force

BRICS nations have emerged as a collective economic force, significantly impacting global trade and investment patterns from 1990 to 2022. China, with its export-oriented growth model, has become an economic powerhouse. India has attracted FDI in technology and services, while Brazil has seen substantial FDI in agribusiness. Russia's natural resource wealth has shaped its FDI and trade, and South Africa serves as a hub for resource-driven exports. A comparative analysis will help establish whether these countries collectively follow similar causal relationships between FDI and trade or diverge from them.

Comparative Analysis Among BRICS Nations

China's remarkable export growth was propelled by Foreign Direct Investment (FDI), which acted as a conduit for technology transfer and knowledge diffusion. This infusion of technological advancements made Chinese products highly competitive in the global marketplace.

In the Indian context, FDI played a pivotal role in the expansion of the country's Information Technology (IT) and Business Process Outsourcing (BPO) industries. This not only attracted substantial FDI but also significantly contributed to the growth of service exports. Furthermore, FDI indirectly bolstered the export of goods, albeit with certain vulnerabilities to fluctuations in oil prices due to heavy oil imports.

Turning to Brazil, the nation witnessed a significant influx of FDI in the agribusiness sector, leading to the exportation of various agricultural commodities. This dynamic relationship between FDI and agricultural exports played a central role in Brazil's emergence as a major global player in this field. However, it also brought to the forefront environmental challenges like deforestation that had tangible implications for international trade.

In Russia, the FDI landscape predominantly revolved around the energy and extractive industries, propelling the country into a position of prominence in global exports of oil, gas, and minerals. This symbiotic relationship with FDI made Russia highly sensitive to fluctuations in global commodity prices, affecting its trade dynamics.

South Africa, with its rich natural resource deposits, attracted FDI primarily in mining and related sectors. This investment significantly influenced the country's exports, particularly in minerals and precious metals. The efficiency of resource extraction and processing was greatly enhanced through FDI, directly impacting South Africa's trade balance.

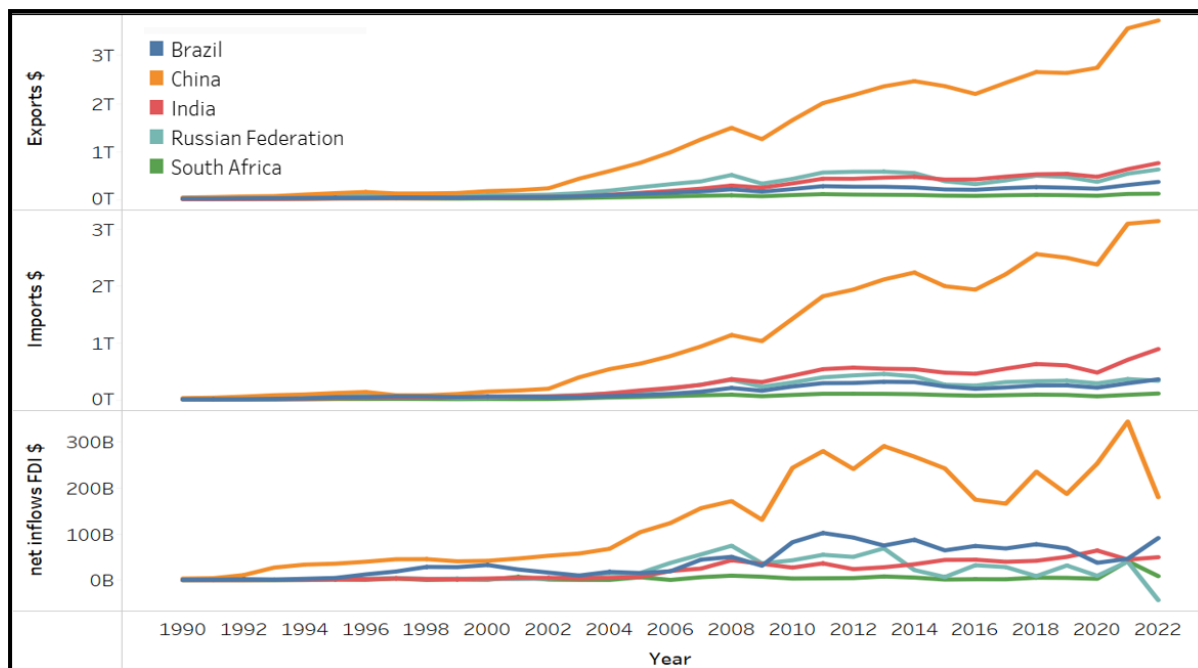


Figure 4: FDI & Trade over the years in BRICS nations

While China, India, and Brazil experienced FDI as a catalyst for export-led growth, Russia and South Africa relied on natural resource exports. These resource-driven exports were sensitive to global factors. Understanding these nuances is crucial for tailored policy approaches and leveraging BRICS' economic potential.

The intricate relationship between FDI and trade in BRICS nations holds profound implications for international trade strategies, economic policymaking, and global business practices. As these nations continue to shape global diplomacy and trade, deciphering the nature of the FDI-trade nexus within BRICS is imperative for navigating the complexities of the 21st-century global economy. Figure 4 depicts FDI, exports, and imports amongst BRICS nations for the study period of 1990 to 2022.

In a world of global value chains and rapid global market integration, economies across the world are liberalizing their trade barriers, inviting FDIs to gain the fruits of globalization. To understand the long-term relationship between FDI and trade, this paper will try to examine the causal⁴ relationships between FDI and trade using Granger causality in BRICS nations followed by assessing long-run relationships using Johansen Cointegration Analysis and VECM.

In essence, this research paper is a journey through the intricate web of globalization. It's an exploration of how economic powerhouses are evolving, how they're shaping international trade patterns, and how they're influencing the flow of capital across borders. It's a testament

⁴ Using the term "causality" alone is a misnomer, as Granger-causality is better described as "precedence", or, as Granger himself later claimed in 1977, "temporally related". Rather than testing whether X causes Y, the Granger causality tests whether X forecasts Y

to the interconnectedness of our world, where FDI from one corner of the globe can impact the production and export of goods on the opposite side.

II. Literature Review

In the context of BRICS nations, this section focuses on evaluating the existing body of research that examines both the immediate and enduring connections between Foreign Direct Investment (FDI) and trade. This examination is of particular importance as it provides policymakers with valuable insights that can aid in the development of more effective trade strategies within their respective countries. The comprehension of these causal relationships plays a crucial role in the formulation and optimization of trade policies, ultimately benefiting the BRICS consortium as a whole.

While there exists a substantial volume of literature on Granger Causality for various countries, research concerning long-term cointegration and Vector Error Correction Model (VECM) analysis is limited. This section delves into the findings of several researchers, their methodologies, and the outcomes of their investigations into Granger causality and relationship dynamics. Though the literature reviewed is expansive, a snapshot of the results of some of the studies is exhibited in Table 1.

Liu et al.'s 2001 research examines the relationship between Foreign Direct Investment (FDI) and trade within China, focusing on the period spanning from 1984 to 1998. The study's results suggest that the growth in China's imports serves as a catalyst for an upswing in FDI inflows from the home country. Consequently, this influx of FDI plays a role in fostering an expansion of exports from China to the home country.

Srivastava and Sen (2004) conducted an investigation into the cause-and-effect relationship between the net inflow of Foreign Direct Investment (FDI) and the export of services within the Indian economy spanning from 1991 to 2002. Their empirical findings reveal that, during the post-liberalization era, there is evidence of a one-way causal link from FDI to service exports in the short term within the Indian economy. This analysis leads to the conclusion that FDI has played a constructive role in fostering the expansion of service exports in India following the initiation of economic reforms in the nation.

Amit Saini et.al. (2017) conducted research on the association between Foreign Direct Investment (FDI) and the growth of exports in India, utilizing data spanning from 1991 to 2012. Their findings revealed a mutual cause-and-effect relationship between FDI and exports. Additionally, when subjected to cointegration analysis, the results indicated a stable, long-term equilibrium relationship between FDI and exports.

Renu Sharma (2013) and her research team, in their 2013 study, investigated the causal relationship between Foreign Direct Investment (FDI) and exports through a comparative analysis of India and China. They employed Granger causality tests to assess this relationship using data spanning from 1976 to 2011. For China, the results indicated a unidirectional causality from FDI to both imports and exports. Moreover, a bidirectional causal link was observed between imports and exports in the Chinese context. In contrast, India's results

diverged from China's findings. India displayed bidirectional causality between FDI and imports, FDI and exports, as well as between exports and imports. This study delves into the question of whether FDI acts as a substitute for or a complement to international trade, and it explores whether FDI drives international trade or vice versa in both the Indian and Chinese contexts.

Studies	Nádia Campos et.al (2013)	by Ahmet YAĞMUR ERSOY et.al. (2017)	Renu Sharma et.al (2013)	Srivastava & Sen (2004)	Amit Saini et.al. (2017)	Liu et al. (2001)	Renu Sharma et.al (2013)	Sunde et.al (2016)	Ahmed et.al. (2007)
Direction of Causality									
Sample Size	Brazil	Russia	India	India	India	China	China	South Africa	5 Sub Saharan African Economies
Period of Study	(1980-2000)	(1996-2016)	(1976-2011)	(1991-2002)	(1991-2012)	(1984-1998)	(1976-2011)	(1970-2014)	(1985-2005)
FDI → X	✓	✓	✓	✓	✓	✓	✓	✓	✓
FDI → M	✓		✓				✓		
X → FDI			✓		✓				✓
X → M			✓				✓		
M → X			✓				✓		
M → FDI			✓			✓			

Table 1: Literature Review of Granger Causality for BRICS nations

Tafirenyika Sunde (2016) conducted extensive research on the causal dynamics in the case of South Africa. The research employed the Autoregressive Distributed Lag (ARDL) model for assessing long-term relationships among economic growth, foreign direct investment, and exports. To examine short-term dynamics, an error correction model was utilized. Additionally, the research used the Vector Error Correction Model (VECM) Granger causality approach to investigate the direction of causality. The study confirmed the existence of cointegration among the variables. It revealed that both FDI and exports play a role in stimulating economic growth. The VECM Granger causality analysis identified a one-way causality from foreign direct investment to economic growth, a one-way causality from foreign direct investment to exports, and a two-way causality between economic growth and exports. In summary, the findings of the article substantiate the hypothesis that foreign direct investment drives economic growth in South Africa.

The study by Nádia Campos and Cristina Lelis Leal Calegario (2013) aimed to investigate if the growth of Foreign Direct Investment (FDI) in Brazil had any impact on the country's trade balance, specifically regarding exports and imports. They also explored whether different FDI strategies had predictable effects on trade balances. The results showed that FDI led to an increase in exports, but it also led to higher levels of imports, especially for companies

pursuing market-seeking strategies. Additionally, the study found that FDI influenced exports both in the short and long term. However, while it had a short-term effect on imports, this effect did not persist in the long term. Furthermore, the study's Granger causality test revealed that FDI inflows into Brazil, with a lag of three years, stimulated export activity. This suggests that FDI strategies do not automatically guarantee positive impacts on the trade balance.

A study by Ahmet Yağmur ERSOY et.al. (2017) delves into the econometric analysis of the relationship between foreign direct investments and export of Russian federation. They utilized quarterly data spanning from 1996 to 2016, encompassing FDI, exports, and Gross Domestic Product (GDP) and conducted Granger Causality Tests. The outcomes resulted in a unidirectional relationship running from FDI to exports. The study also revealed that Foreign Direct Investment (FDI) has an impact on exports, but exports do not exert any influence on FDI. Additionally, based on the Granger Causality Test, exports only affect FDI after a lag of five quarters. In practical terms, this suggests that FDI can potentially lead to exports about one year and three months after the initial investment. This finding aligns with the nature of investments, which typically require a certain amount of time for investment establishment, production, and marketing before resulting in exportable products.

III. Data & Methodology

Annual time series data for each of the BRICS countries was sourced from the World Development Indicators, World Bank database, covering the time span from 1990 to 2022 (Although for other countries FDI inflows started way earlier, to align with India's LPG policy 1990 was chosen). The study incorporated three key variables: net Foreign Direct Investment (FDI) inflows, exports, and imports, all of which were measured in current dollar values (US\$ billion). As each of these time series exhibited discernible trends and skewness, a logarithmic transformation was employed to standardize and normalize these variables.

The literature mentioned above illustrates that numerous researchers have previously explored the connection between Foreign Direct Investment (FDI) and exports in both developing and developed nations. However, there remains an absence of research that specifically addresses this causal relationship within the context of the BRICS nations and both export & import exclusively. Consequently, this study addresses this gap by not only examining the causal relationship within each of these countries but also by attempting to identify commonalities among these emerging economies.

The primary objective of this study was to explore the co-integration relationship between Foreign Direct Investment (FDI) inflows and trade in the BRICS nations. To achieve this, the Granger Causality Test was applied to anticipate the direction of influence. Furthermore, the presence of a long-term equilibrium relationship was tested using co-integration statistics, a method pioneered by Søren Johansen. To facilitate the examination of causality and co-integration statistics, it was imperative to establish a stochastic structure for the time series data. To this end, Augmented Dickey-Fuller test was used to determine the stationary nature of the time series data.

Augmented Dickey Fuller Test

To conduct statistical tests such as Granger causality and Johansen's Cointegration test, it is essential that the data series exhibit stationarity. When the series are non-stationary at their original levels, they can typically be made stationary through differencing. For Granger Causality analysis, stationary series are required, whereas for Johansen's cointegration test, we aim for the series to be at $I(1)$, meaning they are stationary at the first difference but non-stationary at the original levels. The analysis commences by verifying the stationarity of the data series, a critical step in preparing for subsequent causality assessments. To accomplish this, the Augmented Dickey-Fuller (ADF) test is employed. The presence of a unit root in the data series holds significant importance for the causality evaluations.

The results of the unit root tests for each of the five countries revealed that the null hypothesis of a unit root for the selected variables (log values)—specifically, FDI, exports (EXP), and imports (IMP)—was not rejected when examined at their original levels, indicating non-stationarity. However, upon applying the first differencing, these series were observed to become stationary and integrated at the first order at a 1 % level of significance. To achieve stationarity at a lower order of integration, all variables (FDI, EXP, and IMP) were log-transformed.

The detailed empirical statistics of each of the series and country is presented in the Appendix of ADF test results. Given all the series are non-stationary levels and stationery at the first difference, the next step is to test for Johansen's Cointegration.

Johansen's Cointegration

Johansen's cointegration analysis is a statistical method used to determine whether there exists a long-term relationship among a set of variables. In this case, one is interested in analysing the cointegration relationship between three variables: Foreign Direct Investment (FDI), imports (IMP), and exports (EXP), all expressed in logarithmic form.

The prerequisite for performing a cointegration test is that the time series data should be integrated of order 1, denoted as $I(1)$. In other words, the individual series should be non-stationary at their levels (they may have a unit root) but should become stationary when differenced once. This is because cointegration is a concept that relates to the presence of a long-term equilibrium relationship among non-stationary variables. When variables are integrated of order 1 ($I(1)$), it suggests that they have a stochastic trend and can exhibit spurious correlations if analysed in levels. However, if there is a cointegrating relationship among these $I(1)$ variables, it implies that they share a common long-term trend despite having individual stochastic trends. Therefore, the key prerequisites for performing a cointegration test are:

Integration Order ($I(1)$): The individual time series should be integrated of order 1, which means they are non-stationary at levels but become stationary when differenced once.

Linear Combination: There should exist a linear combination of these I(1) variables that is stationary, indicating a long-term equilibrium relationship.

If these conditions are met, it suggests that cointegration might be present among the variables. As stated earlier, by using the Augmented Dickey-Fuller (ADF) test to test for stationarity, it is confirmed that the variables are non-stationary at levels⁵ and stationary at first differences that is all series are I(1).

The optimal lag length for each country is presented in Appendix II.

Model Specification

Specifying the vector autoregressive (VAR) model to estimate the cointegration relationship:

$$\ln(\text{FDI}) = \alpha_1 + \sum(\beta_{1i} * \ln(\text{FDI}(t-i))) + \sum(\beta_{2i} * \ln(\text{IMP}(t-i))) + \sum(\beta_{3i} * \ln(\text{EXP}(t-i))) + \varepsilon_1(t)$$

$$\ln(\text{IMP}) = \alpha_2 + \sum(\beta_{4i} * \ln(\text{FDI}(t-i))) + \sum(\beta_{5i} * \ln(\text{IMP}(t-i))) + \sum(\beta_{6i} * \ln(\text{EXP}(t-i))) + \varepsilon_2(t)$$

$$\ln(\text{EXP}) = \alpha_3 + \sum(\beta_{7i} * \ln(\text{FDI}(t-i))) + \sum(\beta_{8i} * \ln(\text{IMP}(t-i))) + \sum(\beta_{9i} * \ln(\text{EXP}(t-i))) + \varepsilon_3(t)$$

Where α_1 , α_2 , and α_3 are constant terms, and $\varepsilon_1(t)$, $\varepsilon_2(t)$, and $\varepsilon_3(t)$ are error terms.

Parameters of the VAR model were estimated using Johansen's cointegration test in the statistical software EViews. This test will provide information about the number of cointegrating vectors (i.e., long-term relationships) present. Based on the results, if cointegration is found, it indicates a long-term equilibrium relationship among the variables.

If cointegration is established, one can construct an Error Correction Model (ECM) to understand the short-term dynamics of the system. The ECM will help analyse how the variables adjust to deviations from their long-term equilibrium.

Vector Error Correction Model (VECM)

The Vector Error Correction Model (VECM) is a powerful econometric tool used to explore the long-term relationships and short-term dynamics between variables in a time series framework. In the context of this research on the relationship between Foreign Direct Investment (FDI) and trade in BRICS nations, the VECM methodology allows us to investigate how deviations from the long-run equilibrium are corrected and to analyse short-term interactions between these key economic indicators.

If the Johansen cointegration test confirms the presence of cointegration, we specify a VECM. The VECM accounts for both short-term dynamics and long-term equilibrium relationships among the variables. The model includes lagged differences of the variables to capture short-term adjustments and the cointegrating vectors to represent the long-term equilibrium. The below equations are used to analyze the long-term and short-term relationships between log-transformed FDI, exports, and imports in the BRICS nations

⁵ Refer Appendix for ADF unit root test results

$$\Delta \ln(\text{FDI}) = \alpha_1 + \sum(\beta_{1i} * \Delta \ln(\text{FDI}(t-i))) + \sum(\beta_{2i} * \Delta \ln(\text{IMP}(t-i))) + \sum(\beta_{3i} * \Delta \ln(\text{EXP}(t-i))) + \sum(\delta_{1i} * \text{EC}(t-i)) + \varepsilon_1(t)$$

$$\Delta \ln(\text{IMP}) = \alpha_2 + \sum(\beta_{4i} * \Delta \ln(\text{FDI}(t-i))) + \sum(\beta_{5i} * \Delta \ln(\text{IMP}(t-i))) + \sum(\beta_{6i} * \Delta \ln(\text{EXP}(t-i))) + \sum(\delta_{2i} * \text{EC}(t-i)) + \varepsilon_2(t)$$

$$\Delta \ln(\text{EXP}) = \alpha_3 + \sum(\beta_{7i} * \Delta \ln(\text{FDI}(t-i))) + \sum(\beta_{8i} * \Delta \ln(\text{IMP}(t-i))) + \sum(\beta_{9i} * \Delta \ln(\text{EXP}(t-i))) + \sum(\delta_{3i} * \text{EC}(t-i)) + \varepsilon_3(t)$$

$$\text{EC}(t) = \gamma_1 * (\ln(\text{FDI}(t-1)) - \ln(\text{IMP}(t-1))) + \gamma_2 * (\ln(\text{FDI}(t-1)) - \ln(\text{EXP}(t-1))) + \gamma_3 * (\ln(\text{IMP}(t-1)) - \ln(\text{EXP}(t-1)))$$

Where $\Delta \ln(\text{FDI})$, $\Delta \ln(\text{IMP})$, and $\Delta \ln(\text{EXP})$ are the first differences of the logarithmic variables, α_1 , α_2 , and α_3 are constant terms, $\varepsilon_1(t)$, $\varepsilon_2(t)$, and $\varepsilon_3(t)$ are error terms, $\text{EC}(t)$ is the error correction term, and δ_{1i} , δ_{2i} , δ_{3i} , γ_1 , γ_2 , and γ_3 are parameters to be estimated. Parameters of the VECM are estimated using the statistical software EViews

Analyze the error correction mechanism, which is captured by the coefficients of the error correction term ($\text{EC}(t)$). This term measures how the variables adjust to deviations from their long-term equilibrium relationship.

Granger Causality

It is a statistical concept used to assess whether one time series can predict or influence another time series. It's named after Clive Granger, an economist who developed this approach. Granger causality doesn't establish a definitive cause-and-effect relationship like traditional causality does; instead, it explores whether past values of one variable can provide useful information for predicting another variable.

In this study, the aim is to investigate pairwise Granger Causality between three key variables: Foreign Direct Investment (FDI), imports (IMP), and exports (EXP) in the context of the BRICS countries. Differenced logarithmic transformations will be employed to stabilize the variance of the variables. The Granger Causality test will be used to assess whether one variable Granger causes another while controlling for the third variable.

Below is the theoretical framework for the three series

The variables are represented as:

$\Delta \ln(\text{FDI}(t))$: The first difference of the logarithm of FDI at time t.

$\Delta \ln(\text{IMP}(t))$: The first difference of the logarithm of Imports at time t.

$\Delta \ln(\text{EXP}(t))$: The first difference of the logarithm of Exports at time t.

For each pairwise combination, two models are established:

Model 1 for Imports Granger-Causing Exports:

$$\Delta \ln(\text{EXP}(t)) = \alpha_1 + \beta_1 * \Delta \ln(\text{EXP}(t-1)) + \beta_2 * \Delta \ln(\text{IMP}(t-1)) + \epsilon_1(t)$$

In this model, an assessment is made of whether past values of the first difference of logarithmic exports ($\Delta \ln(\text{EXP}(t-1))$) and the first difference of logarithmic imports ($\Delta \ln(\text{IMP}(t-1))$) Granger-cause the current first difference of logarithmic exports ($\Delta \ln(\text{EXP}(t))$).

Model 2 for Exports Granger-Causing Imports:

$$\Delta \ln(\text{IMP}(t)) = \alpha_2 + \beta_3 * \Delta \ln(\text{IMP}(t-1)) + \beta_4 * \Delta \ln(\text{EXP}(t-1)) + \epsilon_2(t)$$

In this model, an examination is conducted to determine whether past values of the first difference of logarithmic imports ($\Delta \ln(\text{IMP}(t-1))$) and the first difference of logarithmic exports ($\Delta \ln(\text{EXP}(t-1))$) Granger-cause the current first difference of logarithmic imports ($\Delta \ln(\text{IMP}(t))$).

A similar approach is followed for each pair of variables (FDI, IMP), (FDI, EXP), and (IMP, EXP) and five countries, with two models established for each case.

The results of each are discussed in the next section of empirical results.

IV. Empirical Results & Discussions

The following section presents results from cointegration, VECM, and Granger causality.

Johansen's Cointegration Test Results

The unit root property of the data series plays a pivotal role in both cointegration and causality analyses. With the confirmation⁶ that the series share the same order of integration, $I(1)$, the Johansen cointegration test was conducted to investigate the presence of a long-term relationship between FDI and GDP for each individual BRICS nation. The results are presented in Table 2. The Johansen trace statistics and maximum eigen statistics collectively indicated that, for BRICS, the null hypothesis suggesting no cointegrating vector could be rejected at a 5 percent significance level. Thus, the findings support the hypothesis of cointegration between FDI and trade, implying a stable long-term relationship among these three variables in the BRICS nations.

Results indicate that these variables are interdependent in the long run. Changes in one variable will have a lasting effect on the others. For instance, an increase in FDI may lead to increased (or decreased) exports or imports over the long term. From a policy perspective, it suggests that policies affecting one of these variables may also impact others in the long term. For example, policies promoting FDI may influence a country's trade balance through their

⁶ Refer Appendix I & II to see ADF results for BRICS

impact on exports and imports. This clearly brings out the idea that BRICS nations' policymakers should be cautious of policy choices as the effect of policy change might look to impact the intended variable in the short run, but in the long run, trade and FDI share an equilibrium relationship. Any deviation in one of these aspects or a policy adjustment aimed at influencing one of these variables independently is unfeasible. While a policy change may seem to affect the targeted variable in the short term, the long-term relationship between trade and FDI will lead to changes in others as well.

Countries	Trace statistics	5% critical value for trace statistics	Max-eigen statistics	5% critical value for max-eigen statistics	Remarks
Brazil	65.59390*	29.79707	39.31251*	21.13162	Cointegration
Russia	33.39402*	29.79707	21.07329	21.13162	Cointegration
India	45.71278*	29.79707	30.95489*	21.13162	Cointegration
China	47.37939*	29.79707	32.49244*	21.13162	Cointegration
S. Africa	42.09911*	29.79707	35.03105*	21.13162	Cointegration

Table 2: Results of Johansen's Cointegration test
*Note: * indicates the estimates are significant at the 5% level.*

Table 3 shows the relationship exports (cointegrating equation with exports as dependent variable) share with imports and FDI in the long run. In India & South Africa, exports are positively impacted by both Imports and FDI in the long run. This implies that if policies are targeted to increase either FDI or Imports, it will eventually increase Exports as well in the long run.

In the situations observed in China and Brazil, imports exert a positive influence on exports. This underscores the phenomenon of importing capital-intensive inputs, subsequently driving the export of capital-intensive products. Recent trends in both China and Brazil involve the importation of technology and the production of high-tech goods, providing empirical support for these findings. Moreover, the outcomes also suggest that an uptick in FDI (Foreign Direct Investment) inflows has a marginal negative impact on exports. Several plausible explanations exist for this phenomenon.

Firstly, FDI might stimulate the production of goods primarily intended for domestic consumption, diverting focus from exports. Secondly, FDI could be primarily motivated by the desire to tap into the expansive domestic markets of Brazil and China. Consequently, foreign enterprises may prioritize serving the domestic market over exporting goods, resulting in an adverse relationship between FDI and exports. Another factor to consider is the allocation of FDI across different industries. If a significant proportion of FDI is channelled into industries with limited export potential as opposed to export-oriented sectors, it can lead to an unfavourable relationship.

Country	Variable	coefficient	Inference
Brazil	LnExp	1	Imports positively & FDI negatively affect Exports in the long run
	LnImp	13.099**	
	LnFDI	-8.2506**	
Russia	LnExp	1	FDI positively affects Exports in the long run
	LnImp	-0.2571	
	LnFDI	1.0587**	
India	LnExp	1	Imports & FDI positively impact Exports in the long run
	LnImp	0.80955**	
	LnFDI	0.12236**	
China	LnExp	1	Imports positively & FDI negatively impact Exports in the long run
	LnImp	9.9788**	
	LnFDI	-16.0418**	
South Africa	LnExp	1	Imports & FDI positively affect Exports in the long run
	LnImp	0.7733 **	
	LnFDI	0.16681 **	
Note- ** significance at 5%			

Table 3: Results from Cointegrating Equations

Cointegration doesn't reveal how quickly any deviations from this equilibrium are corrected. VECM allows exploration of short-run dynamics and provides information on the speed of adjustment to the long-run equilibrium. Thus next, we look at VECM results to understand short-run adjustment dynamics.

VECM Test Results

To understand the short- and long-term dynamics of the cointegrating relationships, VECM is developed for BRICS nations. Table 4 shows results for Russia and China, while Table 5 exhibits results for India, Brazil, and South Africa depending on optimal lags.

In Table 4, the VECM result for Russia shows that the error correction term, ECT (-0.4142) in the first equation (i.e., ΔLnExp equation) is negative and statistically significant at five percent level. This suggests the presence of long run equilibrium relationship amongst the variables. It also implies that 41 percent of disequilibrium from the previous period's shock converges back to the long run equilibrium in the current period. One can also say that, there exists a long run causality running from Imports & FDI to exports in Russia. Now, consider the second equation (ΔLnImp equation), the ECT term is again negative and statistically significant indicating that previous year's deviations from the long run equilibrium are corrected for within the current year at a convergence speed of 37 percent. Above two results signify bidirectional long run causality between export and import given FDI. FDI on the other hand shares an equilibrium relation with exports and imports in the long run but no long run causality exists.

Countries	Dependent variable	c	ECT	Inference
Russia	$\Delta \ln \text{Exp}$	0.1760	-0.4142**	Import & FDI \rightarrow Exports
	$\Delta \ln \text{Imp}$	-0.0648	-0.3699**	Export & FDI \rightarrow Imports
	$\Delta \ln \text{FDI}$	-0.9428	-0.0518	No long-run causality exists
China	$\Delta \ln \text{Exp}$	0.1115**	-0.00279	No long-run causality exists
	$\Delta \ln \text{Imp}$	0.10026*	-0.00465	No long-run causality exists
	$\Delta \ln \text{FDI}$	-0.0334	-0.02335**	Export & Imports \rightarrow FDI
Note- ** significance at 5%				

Table 4: VECM results

The VECM findings for China indicate a significant and negative error correction term (ECT) of -0.02335 in the third equation, which corresponds to the $\Delta \ln \text{FDI}$ equation. This result is statistically significant at a 5 percent confidence level, signifying the presence of a stable long-run equilibrium relationship among the variables. It also implies that about 2.3 percent of any deviation from equilibrium in the previous period is corrected back towards the long-run equilibrium in the current period. However, there is no evidence of correction in case of shock to the system of exports and imports in China.

In Table 5, the VECM result for Brazil shows that the error correction term, ECT (-0.0546) in the second equation (i.e., $\Delta \ln \text{Imp}$ equation) is negative and statistically significant at 5 percent level. This suggests the validity of long run equilibrium relationship among the variables. It also implies that 5.4 percent of disequilibrium from the previous period's shock converges back to the long run equilibrium in the current period. In other words, there exists long run causality running from Exports & FDI to Imports.

Similarly consider the third equation ($\Delta \ln \text{FDI}$ equation), the ECT term is again negative and statistically significant indicating that the previous year's deviations from the long-run equilibrium are corrected for within the current year at a convergence speed of 14 percent. Above two results signify bidirectional long-run causality between FDI and imports given exports. Exports on the other hand share an equilibrium relation with FDI and imports in the long run but no long-run causality exists.

Looking at the short-run dynamics, in equation 2 ($\Delta \ln \text{Imp}$) Imports are affected by previous period's values of itself, export, and FDI significantly. For instance, a percent change in previous period's export leads to a 2.2 percent increase in current imports while a percent.

The VECM result for South Africa shows that the error correction term, ECT (14.859) in the third equation (i.e., $\Delta \ln \text{FDI}$ equation) is positive and statistically significant at 5 percent level. This suggests that deviations are not getting corrected or the series is not returning back to its long run equilibrium. Since in the first two equations the ECT term is insignificant, implying no long run causality.

Looking at the short run dynamics, in equation 2 ($\Delta \ln \text{Imp}$) imports are affected by the previous period's values of itself, imports, and FDI significantly (4 period previous FDI has the potential to impact current imports). For instance, a percent increase in previous period's export leads to a 1.15 percent increase in current imports while a percent increase in previous period's imports leads to 1.12 percent decrease in current imports. Similarly, one can interpret short run dynamics for FDI equation.

Countries →	Brazil			South Africa			India		
Dependent Variable →	$\Delta \ln \text{Exp}$	$\Delta \ln \text{Imp}$	$\Delta \ln \text{FDI}$	$\Delta \ln \text{Exp}$	$\Delta \ln \text{Imp}$	$\Delta \ln \text{FDI}$	$\Delta \ln \text{Exp}$	$\Delta \ln \text{Imp}$	$\Delta \ln \text{FDI}$
$\Delta \ln \text{Exp}_{t-1}$	1.380429*	2.2031**	2.7056	0.5212	1.1058	-4.6225	0.4056	1.0040	-4.5033**
$\Delta \ln \text{Exp}_{t-2}$	0.7021	1.3119	3.7148*	0.6110	1.1513*	5.5915*	-0.1797	-0.0282	-1.9766
$\Delta \ln \text{Exp}_{t-3}$	0.0481	0.6058	-0.6554	0.0899	0.1755	6.1561	0.3997	0.4000	-1.4544
$\Delta \ln \text{Exp}_{t-4}$	0.4377	1.0667	2.2398	0.4800	0.2679	5.2497			
$\Delta \ln \text{Imp}_{t-1}$	-1.4215**	-2.3488**	-3.6065*	-0.2952	-0.6104	0.8888	-0.2375	-0.6400	4.4508**
$\Delta \ln \text{Imp}_{t-2}$	-0.4086	-1.0396	-2.9334*	-0.7195	-1.1261**	-3.7281	0.3262	0.1843	1.643095
$\Delta \ln \text{Imp}_{t-3}$	0.2289	-0.4124	0.3007	0.4478	0.3072	-3.5981	-0.1188	-0.2970	2.5068
$\Delta \ln \text{Imp}_{t-4}$	-0.3103	-0.7897	-1.2766	-0.4190	-0.2389	-1.5696			
$\Delta \ln \text{FDI}_{t-1}$	0.1988	-0.7897**	0.8558**	-0.0222	-0.0313	0.8411*	-0.1637	-0.1664	0.1056
$\Delta \ln \text{FDI}_{t-2}$	-0.0448	0.1640	0.4593	-0.0359	-0.0400	0.3333*	0.0505	0.1139	-0.1136
$\Delta \ln \text{FDI}_{t-3}$	0.0234	0.2847	0.6213	0.0281	0.0342	0.0910	0.0522	0.0972	-0.2209
$\Delta \ln \text{FDI}_{t-4}$	0.1032	0.2301	0.5213	-0.0395	-0.0534*	0.275*			
ECT	-0.0166	-0.0546**	-0.1392**	0.397	0.3029	14.859**	0.8616**	0.8480	3.5717**
c	0.0236	-0.0111	0.0016	0.0297	0.0144	-0.0011	0.0191	-0.0074	-0.0028
Inference	No long run causality exists	Exports & FDI → Imports	Exports & Imports → FDI	No long run causality exists	No long run causality exists	Permanent shocks	Permanent shocks	No long run causality exists	Permanent shocks

Note- ** significance at 5%, * significance 10%

Figure 5: VECM results for Brazil, South Africa & India

Results for India shows that the error correction term, ECT (0.8616) in the first equation (i.e., $\Delta \ln \text{Exp}$ equation) is positive and statistically significant at the five percent level. This suggests that the previous period's shocks didn't converge back to the long-run equilibrium, instead shocks lead to permanent deviations in exports in the long run. Similarly considering the third equation (i.e. $\Delta \ln \text{FDI}$ equation), the ECT term is again positive and statistically significant indicating that shocks to FDI are permanent in nature.

Granger Causality Result

Table 6 shows a consolidated⁷ view of Granger causality results for BRICS nations.

⁷ Detailed Granger tables and results are presented in the Appendix III for each of the BRICS nations

Sample Size	Brazil	Russia	India	China	South Africa
FDI → X	✓ *		✓ **	✓ *	✓ *
FDI → M			✓ **	✓ **	✓ **
X → FDI	✓ *		✓ **	✓ *	
X → M				✓ **	✓ *
M → X	✓ *			✓ **	
M → FDI			✓ **	✓ *	
Note- ** significance at 5%, * significance at 10%					

Table 6: Granger Causality Results for BRICS

The findings regarding Brazil's causality relationships indicate a two-way Granger causality between net FDI inflows and exports, alongside a one-way causality from imports to exports. This implies that both imports and FDI have the potential to predict and influence Brazil's exports temporally.

A previous study conducted by Pereira and colleagues in 2013 uncovered a short-term Granger causality effect, showing a causal link from FDI to exports and from FDI to imports during the period spanning from 1980 to 2000. The outcome of Granger causality from FDI to exports in this current research aligns with the prior study's findings. However, over the past 22 years, the causality dynamics have evolved, leading to increased interdependence among these variables. This transformation underscores FDI's significance as a complementary force to trade in Brazil.

The causality result for Russia is a null set indicating that neither of the series has the potential to predict the future values of the other.

The causality findings for India indicate a mutual relationship between net FDI inflows and exports, as well as between FDI and imports. This outcome is consistent with the research conducted by Amit Saini et al. (2017), which also identified a bidirectional causality between FDI and exports. Saini advocated for export-led growth and highlighted how an upsurge in FDI can establish a beneficial cycle of heightened exports and increased investments within the country. This, in turn, can aid India in reaching its goals of achieving a \$3 trillion economy and a \$1 trillion export target. Srivastava and Sen undertook a comparable investigation spanning from 1991 to 2012. Their findings also revealed a unidirectional causality, specifically from FDI to exports. This growing causality nexus signifies the influence of globalization on the heightened interdependence between FDI and trade. Consequently, in the context of India, FDI is considered a complement to trade.

Since 1991, foreign direct investment (FDI) inflows have been recognized as an additional financial resource to accelerate economic growth in developing nations. It presents both opportunities and challenges for both the home and host countries. The findings suggest that the government should consider revising its economic policies to attract higher levels of foreign direct investment and promote exports on a global scale. Proactive policy adjustments could facilitate the expansion of new markets for Indian exports and contribute to the accumulation of foreign exchange reserves. Over the past three decades, FDI has emerged as

a significant source of funding coupled with advanced technologies and managerial expertise, it has the potential to drive sustainable development in India over the long term.

The findings for China reveal a bidirectional Granger causal relationship among all three, net FDI inflows, imports, and exports. In a study by Renu Sharma & Mandeep Kaur (2013), bidirectional causality was identified between imports and exports, with unidirectional causality existing from FDI to imports and FDI to exports until 2011. However, an additional 11 years of data has altered this relationship to a tri-directional Granger causality, where each variable influences the others. This indicates that FDI continues to act as a complement in China's economic dynamics.

These empirical findings suggest a positive developmental cycle for China, where an increase in FDI in the country results in greater imports, subsequently leading to increased exports. Moreover, this synergy-driven process is amplified by the relationship between more imports and more exports. Over the past three decades, China has experienced rapid growth in both inward FDI and trade. Being a labour-abundant developing nation, China's competitive advantage as a host country lies in its relatively lower labour costs. The collaboration of foreign expertise in technology, management, and marketing with China's labour force and other resources enhances the competitiveness of foreign subsidiaries, enabling them to export goods back to their home countries. The causality from FDI to China's export growth may also be influenced by China's specific FDI policy, which encourages foreign-invested firms to engage in export activities. Many of the newly industrialized economies manufacture labour-intensive products in China and then transfer these products back to their home economies (Liu et al., 1997).

The observed unidirectional Granger causality from FDI to imports, FDI to exports, and exports to imports in South Africa can be elucidated by several factors, which are intrinsic to the country's economic structure and its role in the global economy.

Firstly, South Africa's economic composition plays a pivotal role. The country's economic landscape relies heavily on natural resources and raw materials, making it a prominent player in these markets. Consequently, FDI directed towards resource extraction or processing may necessitate the importation of machinery, technology, and equipment, which are vital for efficiently utilizing these resources. This influx of FDI, therefore, results in increased imports to fulfil these technological requirements.

Secondly, this dynamic interplay between FDI, imports, and exports is further reinforced by the nature of South Africa's economy. While the nation may lack a comparative advantage in high-end technology and a tech-savvy domestic market, it excels in its capacity to provide valuable raw materials. As a result, an augmentation in FDI, especially within sectors requiring advanced technology, could lead to an influx of imported high-tech machinery and equipment. Subsequently, these imported inputs are integrated into the production process, eventually culminating in the creation of high-end exportable products.

This phenomenon forms a self-reinforcing cycle: FDI spurs imports (especially high-tech inputs), which, in turn, catalyse exports of the finished products. Consequently, the observed unidirectional causality reflects the intricacies of South Africa's economy, where FDI is

instrumental in driving both imports and exports, as the nation leverages its natural resource wealth in the global market.

Furthermore, South Africa's role as an emerging economy and its status as a hub for natural resources reinforce the significance of this causal relationship. Overall, this causal nexus between FDI, imports, and exports illustrates how the country's economic structure and global positioning contribute to these relationships, highlighting the importance of FDI in shaping its trade dynamics.

The Granger causality analysis conducted across BRICS nations offers valuable insights into the interplay between foreign direct investment (FDI), imports, and exports within this influential group of emerging economies. These findings collectively depict a complex web of relationships that underscore the significance of FDI in shaping trade dynamics across BRICS.

V. Conclusion

This research paper has endeavoured to examine the intricate dynamics of foreign direct investment (FDI), exports, and imports within the BRICS nations through a comprehensive analysis involving cointegration, Vector Error Correction Model (VECM), and Granger causality tests. The primary objective was to unravel the long-term relationships among these crucial economic variables and elucidate the short-term adjustment dynamics, thereby shedding light on the interplay between FDI and international trade in the BRICS context. This preliminary research does not aim to prescribe a policy or bring out the impact structure. It's a first step to simply understand the dynamics that can aid in building better structural models in the future.

The results didn't definitively confirm that FDI complements trade, especially in China and Brazil, where there's a negative connection with exports (Johansen's cointegration result). However, Granger causality indicates that FDI Granger causes exports. It's important to interpret these findings cautiously because a negative relationship doesn't necessarily mean FDI is discouraging trade. Specific factors in each country, such as investments in non-trading sectors, might make the data show a negative link between the two.

Cointegration Insights

The cointegration analysis revealed compelling evidence of stable long-term relationships among FDI, exports, and imports in all BRICS nations. This signifies that these variables are interdependent in the long run, and changes in one variable exert a lasting influence on the others. Policymakers across the BRICS countries must recognize that policy interventions targeting one of these variables can have far-reaching consequences on the others over the long term. Consequently, the findings underscore the importance of exercising caution and considering the broader implications of policy decisions, as deviations or policy adjustments targeting one variable in isolation may prove impractical.

VECM and Short-Run Dynamics

To delve further into the dynamics of these relationships, VECM analysis was employed, shedding light on the short-term adjustment mechanisms and the pace at which deviations from equilibrium are corrected. This comprehensive analysis illuminated critical insights for each BRICS nation.

Although South Africa and India exhibit a long-term equilibrium relationship between their FDI inflows and trade, it's crucial to note that these variables may not naturally return to equilibrium when unexpected shocks impact the system. This suggests that an exceptionally significant shock could potentially disrupt this equilibrium. As a result, policymakers should exercise caution when formulating policies and navigating global shocks. Any deviations from this equilibrium will require deliberate policy decisions and proactive efforts to restore balance.

Granger Causality Results

The Granger Causality outcomes affirm that in BRICS nations, FDI acts as a complementary factor to trade, with the exception of Russia. In the era of globalization, these emerging economies are fuelling their economic expansion through technological FDI, resulting in the importation of machinery and advanced technology. Consequently, this facilitates the production of goods that meet international quality standards, positioning them for exportation. In the past, these economies primarily exported agricultural and low-capital-intensive products. However, with the globalization trend and growing investor interest in emerging markets due to cost-effective labour and more promising returns, these nations are gradually transitioning towards advanced economies by manufacturing and exporting capital-intensive goods.

The Broader Picture

In a broader context, the findings point towards a noteworthy transformation in the economies of BRICS nations. Traditionally known for exporting agricultural and low-capital-intensive goods, these economies have witnessed a significant shift. With globalization driving increased investor interest due to factors like cheap labour and better returns, BRICS nations are converging towards producing and exporting capital-intensive goods. The synergy between FDI inflows, technology transfers, and trade is instrumental in shaping this transformation. These nations now appear to be guided by export-oriented strategies, seeking to establish their presence on the global stage as producers of high-quality, capital-intensive goods.

This research paper's comprehensive examination of FDI, exports, and imports in the BRICS nations illuminates the intricate web of economic relationships in a rapidly changing global landscape. As these nations continue to play a pivotal role in the world economy, it becomes increasingly important for policymakers and stakeholders to grasp the multifaceted dynamics highlighted in this study. By recognizing the interdependence of FDI and trade, BRICS nations can strategically position themselves for sustained economic growth and global competitiveness in the 21st century.

Future Scope

The future scope of research in the realm of FDI and trade within BRICS nations is promising and multifaceted. Firstly, given the dynamic nature of the global economy, ongoing studies should continually monitor and analyse the evolving patterns of FDI inflows and their impact on exports and imports in these nations, particularly in response to significant global events and policy changes. Secondly, one can explore the potential repercussions of the BRICS nations' collaborative initiatives, such as the New Development Bank and the Belt and Road Initiative, on FDI and trade dynamics within the bloc and in their interactions with other regions. Additionally, there is scope to delve deeper into the sustainability aspect, investigating how environmentally conscious investments and responsible business practices within BRICS countries align with FDI-driven trade. Lastly, a comparative analysis with other emerging economies and regional blocs can provide broader insights into the FDI-trade relationship in the context of globalization and economic integration and the rising role of China in intra- BRICS Investment. Future research endeavours may offer comprehensive guidance to policymakers, businesses, and investors on harnessing the full potential of FDI to enhance trade, economic growth, and sustainable development in BRICS nations and beyond.

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APPENDIX

I. ADF Test Results

Results of ADF test on log variables ⁸ at first levels

The results of all countries indicate a p-value more than 0.1, indicating acceptance of the null hypothesis of the existence of a unit root at even 10%. Thus, all series are non-stationary at levels.

- **Brazil**

Null Hypothesis: LOG_X_B_\$ has a unit root
 Exogenous: None
 Lag Length: 0 (Automatic - based on SIC, maxlag=8)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	3.227138	0.9994
Test critical values:		
1% level	-2.639210	
5% level	-1.951687	
10% level	-1.610579	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: LOG_M_B_\$ has a unit root
 Exogenous: None
 Lag Length: 0 (Automatic - based on SIC, maxlag=8)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	2.545565	0.9964
Test critical values:		
1% level	-2.639210	
5% level	-1.951687	
10% level	-1.610579	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: LOG_NET_INFLOWS_FDI_B_\$ has a unit root
 Exogenous: None
 Lag Length: 0 (Automatic - based on SIC, maxlag=8)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	1.669161	0.9743
Test critical values:		
1% level	-2.639210	
5% level	-1.951687	
10% level	-1.610579	

*MacKinnon (1996) one-sided p-values.

⁸ Read Variable Names- D_LOG_M_B_\$-
 D- First difference
 LOG- logarithmic transformation of the series
 M-imports, X-exports, FDI- net FDI inflows
 B- Brazil, R-Russia, I-India, C-China, S-South Africa
 \$- Dollar values

- **Russia**

Null Hypothesis: LOG_X_R_\$ has a unit root
 Exogenous: None
 Lag Length: 0 (Automatic - based on SIC, maxlag=6)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	1.896238	0.9836
Test critical values: 1% level	-2.650145	
5% level	-1.953381	
10% level	-1.609798	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: LOG_M_R_\$ has a unit root
 Exogenous: None
 Lag Length: 0 (Automatic - based on SIC, maxlag=6)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	1.487406	0.9627
Test critical values: 1% level	-2.650145	
5% level	-1.953381	
10% level	-1.609798	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: LOG_NET_INFLOWS_FDI_R_\$ has a unit root
 Exogenous: None
 Lag Length: 1 (Automatic - based on SIC, maxlag=7)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	1.009324	0.9132
Test critical values: 1% level	-2.650145	
5% level	-1.953381	
10% level	-1.609798	

*MacKinnon (1996) one-sided p-values.

- **India**

Null Hypothesis: LOG_X_I_\$ has a unit root
 Exogenous: None
 Lag Length: 0 (Automatic - based on SIC, maxlag=8)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	5.008700	1.0000
Test critical values: 1% level	-2.639210	
5% level	-1.951687	
10% level	-1.610579	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: LOG_M_I_\$ has a unit root
 Exogenous: None
 Lag Length: 0 (Automatic - based on SIC, maxlag=8)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	3.886408	0.9999
Test critical values:		
1% level	-2.639210	
5% level	-1.951687	
10% level	-1.610579	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: LOG_NET_INFLOWS_FDI_I_\$ has a unit root
 Exogenous: None
 Lag Length: 0 (Automatic - based on SIC, maxlag=8)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	1.861118	0.9828
Test critical values:		
1% level	-2.639210	
5% level	-1.951687	
10% level	-1.610579	

*MacKinnon (1996) one-sided p-values.

- **China**

Null Hypothesis: LOG_X_C_\$ has a unit root
 Exogenous: None
 Lag Length: 0 (Automatic - based on SIC, maxlag=8)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	4.698167	1.0000
Test critical values:		
1% level	-2.639210	
5% level	-1.951687	
10% level	-1.610579	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: LOG_M_C_\$ has a unit root
 Exogenous: None
 Lag Length: 0 (Automatic - based on SIC, maxlag=8)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	3.890430	0.9999
Test critical values:		
1% level	-2.639210	
5% level	-1.951687	
10% level	-1.610579	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: LOG_NET_INFLOWS_FDI_C_\$ has a unit root
 Exogenous: None
 Lag Length: 0 (Automatic - based on SIC, maxlag=8)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	2.033861	0.9882
Test critical values:		
1% level	-2.639210	
5% level	-1.951687	
10% level	-1.610579	

*MacKinnon (1996) one-sided p-values.

- **South Africa**

Null Hypothesis: LOG_X_S_\$ has a unit root
 Exogenous: None
 Lag Length: 0 (Automatic - based on SIC, maxlag=8)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	2.308400	0.9937
Test critical values:		
1% level	-2.639210	
5% level	-1.951687	
10% level	-1.610579	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: LOG_M_S_\$ has a unit root
 Exogenous: None
 Lag Length: 0 (Automatic - based on SIC, maxlag=8)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	2.117913	0.9902
Test critical values:		
1% level	-2.639210	
5% level	-1.951687	
10% level	-1.610579	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: LOG_NET_INFLOWS_FDI_S_\$ has a unit root
 Exogenous: None
 Lag Length: 1 (Automatic - based on SIC, maxlag=7)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	1.044058	0.9183
Test critical values:		
1% level	-2.644302	
5% level	-1.952473	
10% level	-1.610211	

*MacKinnon (1996) one-sided p-values.

Results of ADF test on log variables ⁹ at first difference.

⁹ Read Variable Names- D_LOG_M_B_\$-
 D- First difference
 LOG- logarithmic transformation of the series
 M-imports, X-exports, FDI- net FDI inflows

The results of all countries indicate a p-value less than 0.01, indicating rejection of null hypothesis of existence of a unit root at 1%. Thus, all series are stationary at first difference.

- **Brazil**

Null Hypothesis: D_LOG_X_B_\$ has a unit root
 Exogenous: Constant
 Lag Length: 0 (Automatic - based on SIC, maxlag=7)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-4.834373	0.0005
Test critical values: 1% level	-3.661661	
5% level	-2.960411	
10% level	-2.619160	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D_LOG_M_B_\$ has a unit root
 Exogenous: Constant
 Lag Length: 0 (Automatic - based on SIC, maxlag=7)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-4.656308	0.0008
Test critical values: 1% level	-3.661661	
5% level	-2.960411	
10% level	-2.619160	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D_LOG_FDI_B_\$ has a unit root
 Exogenous: Constant
 Lag Length: 0 (Automatic - based on SIC, maxlag=7)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-5.305173	0.0001
Test critical values: 1% level	-3.661661	
5% level	-2.960411	
10% level	-2.619160	

*MacKinnon (1996) one-sided p-values.

- **Russia¹⁰**

B- Brazil, R-Russia, I-India, C-China, S-South Africa
 \$- Dollar values

¹⁰ Russia's export data is available from 1994, net inflows fdi from 1992,

Null Hypothesis: D_LOG_X_R_\$ has a unit root
 Exogenous: Constant
 Lag Length: 0 (Automatic - based on SIC, maxlag=6)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-4.682903	0.0009
Test critical values: 1% level	-3.699871	
5% level	-2.976263	
10% level	-2.627420	

*Mackinnon (1996) one-sided p-values.

Null Hypothesis: D_LOG_M_R_\$ has a unit root
 Exogenous: Constant
 Lag Length: 0 (Automatic - based on SIC, maxlag=6)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-4.138033	0.0035
Test critical values: 1% level	-3.699871	
5% level	-2.976263	
10% level	-2.627420	

*Mackinnon (1996) one-sided p-values.

Null Hypothesis: D_LOG_FDI_R_\$ has a unit root
 Exogenous: Constant
 Lag Length: 0 (Automatic - based on SIC, maxlag=6)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-7.271061	0.0000
Test critical values: 1% level	-3.689194	
5% level	-2.971853	
10% level	-2.625121	

*Mackinnon (1996) one-sided p-values.

- India**

Null Hypothesis: D_LOG_X_I_\$ has a unit root
 Exogenous: Constant
 Lag Length: 0 (Automatic - based on SIC, maxlag=7)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-4.636549	0.0008
Test critical values: 1% level	-3.661661	
5% level	-2.960411	
10% level	-2.619160	

*Mackinnon (1996) one-sided p-values.

Null Hypothesis: D_LOG_M_I_\$ has a unit root
 Exogenous: Constant
 Lag Length: 0 (Automatic - based on SIC, maxlag=7)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-4.559560	0.0010
Test critical values: 1% level	-3.661661	
5% level	-2.960411	
10% level	-2.619160	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D_LOG_FDI_I_\$ has a unit root
 Exogenous: Constant
 Lag Length: 0 (Automatic - based on SIC, maxlag=7)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-6.700519	0.0000
Test critical values: 1% level	-3.661661	
5% level	-2.960411	
10% level	-2.619160	

*MacKinnon (1996) one-sided p-values.

- **China**

Null Hypothesis: D_LOG_X_C_\$ has a unit root
 Exogenous: Constant
 Lag Length: 0 (Automatic - based on SIC, maxlag=7)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-4.029309	0.0040
Test critical values: 1% level	-3.661661	
5% level	-2.960411	
10% level	-2.619160	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D_LOG_M_C_\$ has a unit root
 Exogenous: Constant
 Lag Length: 0 (Automatic - based on SIC, maxlag=7)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-4.282440	0.0021
Test critical values: 1% level	-3.661661	
5% level	-2.960411	
10% level	-2.619160	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D_LOG_FDI_C_\$ has a unit root
 Exogenous: Constant
 Lag Length: 0 (Automatic - based on SIC, maxlag=7)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-3.792594	0.0072
Test critical values: 1% level	-3.661661	
5% level	-2.960411	
10% level	-2.619160	

*MacKinnon (1996) one-sided p-values.

- **South Africa**

Null Hypothesis: D_LOG_X_S_\$ has a unit root
 Exogenous: Constant
 Lag Length: 0 (Automatic - based on SIC, maxlag=7)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-5.155112	0.0002
Test critical values: 1% level	-3.661661	
5% level	-2.960411	
10% level	-2.619160	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D_LOG_M_S_\$ has a unit root
 Exogenous: Constant
 Lag Length: 0 (Automatic - based on SIC, maxlag=7)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-4.459691	0.0013
Test critical values: 1% level	-3.661661	
5% level	-2.960411	
10% level	-2.619160	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D_LOG_FDI_S_\$ has a unit root
 Exogenous: Constant
 Lag Length: 0 (Automatic - based on SIC, maxlag=7)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-8.491398	0.0000
Test critical values: 1% level	-3.670170	
5% level	-2.963972	
10% level	-2.621007	

*MacKinnon (1996) one-sided p-values.

II. Optimal Lag Length

Since optimal lag length is critical to the techniques used, a number of criteria were considered and the optimal lag was chosen based on the majority rule.

The lags below are considered for Johansen's cointegration test and VECM. Please note that Stata automatically takes (p-1) lags, that is one less lag, than what's optimal and the rationale behind this is that since VECM and Johansen use first difference in their calculations, one set of observations is lost, to compensate for that loss, one less lag is taken.

- **Brazil**

Selection-order criteria

Sample: 1995 - 2022 Number of obs = 28

lag	LL	LR	df	p	FPE	AIC	HQIC	SBIC
0	-26.3506				.001633	2.09647	2.14011	2.23921
1	54.2253	161.15	9	0.000	9.9e-06	-3.0161	-2.84155	-2.44515*
2	63.0104	17.57	9	0.041	.00001	-3.00074	-2.69529	-2.00159
3	69.1965	12.372	9	0.193	.000013	-2.79975	-2.36339	-1.37239
4	84.939	31.485	9	0.000	9.5e-06	-3.28136	-2.71409	-1.42579
5	101.535	33.193*	9	0.000	7.0e-06*	-3.82396*	-3.12579*	-1.54018

Endogenous: logexportsb logimports b lognetinflowsfdb

Exogenous: _cons

- **Russia**

Selection-order criteria

Sample: 1992 - 2022 Number of obs = 31

lag	LL	LR	df	p	FPE	AIC	HQIC	SBIC
0	-288.585				29683.9	18.8119	18.8572	18.9507
1	-258.033	61.104*	9	0.000	7421.95*	17.4215*	17.6024*	17.9766*
2	-250.183	15.699	9	0.073	8150.49	17.4957	17.8124	18.4671

Endogenous: log_x_r log_m_r log_fdi_r

Exogenous: _cons

- **India**

. varsoc logexportsi logimports i lognetinflowsfdi

Selection-order criteria

Sample: 1994 - 2022 Number of obs = 29

lag	LL	LR	df	p	FPE	AIC	HQIC	SBIC
0	-9.2316				.000467	.843559	.887858	.985003
1	71.0767	160.62	9	0.000	3.4e-06	-4.07426	-3.89706*	-3.50848*
2	81.7728	21.392	9	0.011	3.1e-06	-4.19123	-3.88113	-3.20111
3	88.8615	14.178	9	0.116	3.8e-06	-4.05942	-3.61643	-2.64497
4	102.549	27.375*	9	0.001	3.1e-06*	-4.38268*	-3.8068	-2.5439

Endogenous: logexportsi logimports i lognetinflowsfdi

Exogenous: _cons

- **China**

Selection-order criteria

Sample: 1993 - 2022

Number of obs = 30

lag	LL	LR	df	p	FPE	AIC	HQIC	SBIC
0	-13.4925				.000603	1.0995	1.14432	1.23962
1	60.8297	148.64*	9	0.000	7.8e-06*	-3.25531*	-3.07601*	-2.69483*
2	66.1248	10.59	9	0.305	.00001	-3.00832	-2.69454	-2.02748
3	72.1017	11.954	9	0.216	.000013	-2.80678	-2.35852	-1.40558

Endogenous: logexportsc logimportsc lognetinflowsfdic

Exogenous: _cons

- **South Africa**

Selection-order criteria

Sample: 1995 - 2022

Number of obs = 28

lag	LL	LR	df	p	FPE	AIC	HQIC	SBIC
0	-76.7174				.059639	5.6941	5.73773	5.83683
1	-25.8333	101.77	9	0.000	.003011	2.70238	2.87692	3.27332*
2	-15.6231	20.42	9	0.015	.002836	2.61594	2.92139	3.61509
3	-7.78883	15.669	9	0.074	.003294	2.6992	3.13556	4.12656
4	4.08422	23.746	9	0.005	.003062	2.49398	3.06125	4.34956
5	23.0774	37.986*	9	0.000	.001903*	1.78018*	2.47836*	4.06396

III. Granger Causality Results

- **Brazil**

Pairwise Granger Causality Tests

Date: 09/14/23 Time: 11:18

Sample: 1990 2022

Lags: 5

Null Hypothesis:	Obs	F-Statistic	Prob.
D_M_B_\$ does not Granger Cause D_X_B_\$	27	2.26530	0.0975
D_X_B_\$ does not Granger Cause D_M_B_\$		1.49319	0.2468
D_FDI_B_\$ does not Granger Cause D_X_B_\$	27	2.26803	0.0972
D_X_B_\$ does not Granger Cause D_FDI_B_\$		2.51925	0.0727
D_FDI_B_\$ does not Granger Cause D_M_B_\$	27	1.90197	0.1501
D_M_B_\$ does not Granger Cause D_FDI_B_\$		2.20868	0.1042

- **Russia**

Pairwise Granger Causality Tests
 Date: 09/14/23 Time: 11:40
 Sample: 1990 2022
 Lags: 1

Null Hypothesis:	Obs	F-Statistic	Prob.
D_M_R does not Granger Cause D_X_R	27	2.06324	0.1638
D_X_R does not Granger Cause D_M_R		2.91181	0.1008
D_FDI_R does not Granger Cause D_X_R	27	0.44711	0.5101
D_X_R does not Granger Cause D_FDI_R		1.03156	0.3199
D_FDI_R does not Granger Cause D_M_R	27	0.32337	0.5749
D_M_R does not Granger Cause D_FDI_R		0.22412	0.6402

- **India**

Pairwise Granger Causality Tests
 Date: 09/14/23 Time: 11:41
 Sample: 1990 2022
 Lags: 6

Null Hypothesis:	Obs	F-Statistic	Prob.
D_M_I_\$ does not Granger Cause D_X_I_\$	26	0.28970	0.9314
D_X_I_\$ does not Granger Cause D_M_I_\$		0.26029	0.9459
D_FDI_I_\$ does not Granger Cause D_X_I_\$	26	4.01636	0.0170
D_X_I_\$ does not Granger Cause D_FDI_I_\$		6.17986	0.0030
D_FDI_I_\$ does not Granger Cause D_M_I_\$	26	2.91392	0.0501
D_M_I_\$ does not Granger Cause D_FDI_I_\$		3.29642	0.0338

- **China**

Pairwise Granger Causality Tests
 Date: 09/14/23 Time: 11:42
 Sample: 1990 2022
 Lags: 7

Null Hypothesis:	Obs	F-Statistic	Prob.
D_M_C does not Granger Cause D_X_C	25	4.52208	0.0161
D_X_C does not Granger Cause D_M_C		7.12956	0.0031
D_FDI_C does not Granger Cause D_X_C	25	2.95967	0.0588
D_X_C does not Granger Cause D_FDI_C		2.48139	0.0934
D_FDI_C does not Granger Cause D_M_C	25	3.19578	0.0474
D_M_C does not Granger Cause D_FDI_C		2.98496	0.0574

- **South Africa**

Pairwise Granger Causality Tests

Date: 09/14/23 Time: 11:46

Sample: 1990 2022

Lags: 7

Null Hypothesis:	Obs	F-Statistic	Prob.
D_M_S does not Granger Cause D_X_S	25	1.67848	0.2207
D_X_S does not Granger Cause D_M_S		2.72334	0.0736
D_FDI_S does not Granger Cause D_X_S	25	3.03210	0.0550
D_X_S does not Granger Cause D_FDI_S		2.07793	0.1421
D_FDI_S does not Granger Cause D_M_S	25	3.29439	0.0434
D_M_S does not Granger Cause D_FDI_S		1.38555	0.3088