TRADE RELATION BETWEEN INDIA AND OTHER BRICS COUNTRIES: A MULTIDIMENSIONAL APPROACH USING GRAVITY MODEL AND GRANGER CAUSALITY

ABSTRACT

The aim of the study is to explore the trade relation between India and other BRICS nations in the short-run as well as in the long-run. For empirical analysis, this study employed the Granger Causality Test for short-run impact and Gravity Model using Dynamic Ordinary Least Square (DOLS) and Fully Modified Ordinary Least Square (FMOLS) for long-run impact. Granger Causality test results strongly support India’s trade with other BRICS nations. Long-run results from the Gravity model using DOLS and FMOLS found highly significant for the selected variables (GDP, PCGDP, PCGDPD, Exchange Rate, Trade-GDP ratio and Distance) other than inflation and trade agreement. Except for inflation, per capita GDP differential and distance, all the other variables (GDP, PCGDP, Exchange Rate, Trade-GDP ratio and Trade Agreement) have a positive coefficient to the volume of trade of BRICS nations. This implies that the policymakers in India should strengthen their trade relations with other BRICS nations by promoting the made in India, SEZs, EOUs and expanding second-generation reforms to reap the potential benefits from the global economy.

Keywords: BRICS, Gravity Model, Granger Causality Model, Foreign Trade, Economic Integration

JEL Classification: C51, F10, F15, F17, F19, F41

RIASSUNTO

Le relazioni commerciali tra l’India e gli altri BRICS: un approccio multidimensionale tramite l’utilizzo del modello gravity e della Granger causalità

Lo scopo di questo articolo è studiare la relazione commerciale tra l’India e gli altri paesi BRICS sia nel breve che nel lungo periodo. Nell’analisi empirica questo studio ha utilizzato il test di Granger causalità per analizzare l’impatto nel breve periodo ed i modelli DOLS (Dynamic Ordinary Least Square) e FMOLS (Fully Modified Ordinary Least Square) per analizzare
l'impatto nel lungo periodo. I risultati del test di Granger causalità supportano fortemente il commercio tra India e gli altri BRICS. I risultati di lungo periodo ottenuti utilizzando i modelli DOLS e FMOLS sono molto significativi per le variabili selezionate (GDP, PCGDP, PCGDPD, tasso di cambio, rapporto PIL/commercio e distanza) più che per l'inflazione e gli accordi commerciali. A parte l'inflazione, il differenziale PIL pro-capite e la distanza, tutte le altre variabili (PIL, PCGDP, tasso di cambio, rapporto PIL/commercio e gli accordi commerciali) hanno un coefficiente positivo rispetto al volume dei commerci tra i paesi BRICS. Questo implica che l'India dovrebbe rafforzare le sue relazioni commerciali con gli altri BRICS promuovendo il Made in India, le zone economiche speciali (SEZ) e le unità ‘export oriented’ (EOU) ed ampliando le riforme di seconda generazione per raccogliere i potenziali benefici dell'economia globalizzata.

1. INTRODUCTION

Developing countries have gradually emerged as a regional and global engine of growth over the last two and half decades and witnessed higher growth in world trade which in turn influenced major macroeconomic variables in the international arena. Since the 1950s, many regional, bilateral, multilateral and intra-regional trade agreements took place among the grouping nations. Notably, BRICS economies, an acronym for the economies of Brazil, Russia, India, China and South Africa creates a strong counterweight and alternative to the existing world powers like US, EU and Japan in both economic and political areas.

BRICS countries account for nearly 41 percent of world population, 25 percent of the world's GDP, 27 percent of the world's land area, hold the significantly high level of forex reserves and most attractive destinations for foreign investment occupy significance in the research.

Initially Jim O’Neill, former chief economist and chairperson of Goldman Sachs who conceived the idea of BRICS, compared it with G7 (so-called US, Canada, UK, France, Italy, Germany and Japan) and projected that the BRICs would represent the world’s leading economies in 2050. Also, he has projected that the GDP of BRICs would be higher than the GDP of North America and China would be the largest economy in the world followed by the US, India, Japan, and Brazil.
After the success of full-fledged economic reforms, India extended furthermore reform process in the external front with other BRICS countries in the 21st century. Since 2004, India has widened its liberal trade and investment policies with Brazil, Russia, and China. Further, it has extended with South Africa since its inclusion in the group in 2010. For India, cooperation with the BRICS is more important not only in terms of exports and imports but also in terms of addressing its food and energy security issues, combatting terrorism in the region and so on. Engaging with China has been one of the important mechanisms of India’s foreign policy to combat terrorism in the region. The BRICS hold the promise of greater understanding and cooperation among the member states for solving bilateral issues (India’s foreign policy and BRICS).

From the above background, it is clear that the BRICS all together try to increase their dominance in world trade and India also attempts to increase its trade and economic cooperation among other BRICS countries as well as with the rest of the world. Past literature reveals that economic reform creates a positive impact on the Indian Economy in almost all spheres. But there are no studies that clearly evaluate the impact of other countries on India’s foreign trade. Similarly, impact analysis (pre and post BRICS formation) on India’s foreign trade with other countries has not been done, yet. Hence a multidimensional impact analysis of trade and other relation between India and other BRICS countries occupies significance. Against these backgrounds, the present study has given rise to several policy issues and research questions. For instance: is India’s trade relation with other BRICS favorable or not? Do BRICS countries reap the benefits equally or not? Does comparative advantage create an excessive gap between them? Is there any significant impact of BRICS trade on major macroeconomic variables of India? Is the progress of BRICS trade in the line of Jim O’Neill’s projection?

It will be academically significant to evaluate credible and reasonable responses to the above research questions. The relevance of the answer lays in providing the intra-regional trade relations with both growth foundations and justifications in the Indian contexts. The basic stimulus of the present paper is to arrive at intra-regional trading inferences. In this context, the present study challenges to examine the impact of major macroeconomic variables that influence trade of BRICS nations. The study also aims to analyse both the short-run and long-run relationship between India’s foreign trade with other BRICS nations.
2. Literature Review

This study focuses on the blend of theoretical and empirical studies relating to the application of the most appropriate econometric technique to analyze the trade and economic relations between intra-regional countries. More specifically, the suitability of the Gravity model and Granger Causality test to assess the effectiveness of India’s trade relations with other BRICS countries.

Tinbergen (1962) is the one who first applied the Newtonian Gravity model in International Trade. Furthermore, studies like Anderson (1979), Helpman and Krugman (1985) and Deardorff (1998) strengthened the effectiveness of the Gravity Model in International Trade. Linnemann (1966) was the first one to develop the most common clarification of the Gravity model that was used by Aitken (1973) and Sapir (1981).

Among the past studies, the studies by Anderson and Wincoop (2003), Limão and Venables (2001), Sohn (2005) and Nguyen (2010) are the most reputed and relevant studies in the context of intra-regional trade.

The traditional Gravity model of international trade focused only on two independent variables like differences in GDP and distances between two respective trading centers/partners. Later many explanatory variables like per capita GDP, exchange rate, Trade GDP ratio, Inflation, Taxes are added in the equation developed in the past studies like Bergstrand (1985), Dell’Ariccia (1999), Frankel (1997), Limão and Venables (2001), Nguyen (2010), Bilquees et al. (2010), Frankel (2010) and so on. Similarly, Mazenda (2016), Abidin et al. (2016) and others developed new dimensional intra-regional trade models using Granger Causality, Dynamic Ordinary Least Square (DOLS) and Fully Modified Ordinary Least Square Model (FMOLS).

Sahu and Heng (2017) investigated India’s competitive advantage and the influence of trade gravity variables in determining India’s exports with its top 50 trading partners. The study has applied an augmented gravity model to India’s exports and estimated the same in a panel data framework from 2000 to 2014. The study finds that India’s exports with its top trading partners were more sensitive to distance, GDP, population, and real exchange rate. However, to our surprise, we could not find significant evidence of the effect of trade agreements on India’s exports.
Mishra et al. (2015) delivers a detailed theoretical justification for the application of the gravity model in the context of India’s trade relation with other BRICS countries. Using 20 years of data from 1990 to 2010, the study found that there is a positive relationship between gross national product/per capita GNP of the nation and its volume of trade. They also found that the transport cost plays a negative role in influencing foreign trade among BRICS nations, other variables related to foreign trade like exchange rate, inflation, and the import-GDP ratio does not play a major role in influencing it.

Mottet (2013) examined cooperation and competition among the BRICS countries and other emerging powers. They found that the members of BRICS align periodically with the bloc to demand greater representation in the international institutions and to resist Western dominance. Despite their appearances as a unified bloc of fastest-growing economies, BRICS countries mismatch in their political setup, economic systems, huge differences in per capita incomes, geopolitical rivalries and conflicts among them that are undermining their reciprocal collaboration.

Mizuho Research Institute (2006) did a comparative analysis of BRICS trade which mainly focused on how economic growth, budget deficit, disposable per capita income and currency affect trade in the bloc. The study found that China owns the strongest trade competitiveness compared to all other members in the group, second is Russia, followed by India, Brazil and South Africa. According to trade competitiveness based on economic growth, the population and the fiscal deficit of China creates its competitive advantage and the disposable per capita income of South Africa has the advantage of foreign trade. The study also found that the exchange rate appreciation has a high level of negative effect on China’s foreign trade.

Kaya (2014) examined the relationship between exchange rates, exports and GDP for BRICS countries over a period of 26 years from 1985 to 2011. This study did not find any significant relationship between exports and exchange rate. Which means changes in exchange rate does not influence exports of BRICS nations. Also, this study found that the BRICS countries do not increase their exports significantly when the exchange rate falls. Finally, the study witnesses BRICS country’s GDP per capita measures are significantly lower when their currency values are low.
Underlying the robust trend in bilateral trade between India and the rest of BRICS countries has been the rising trend in India’s trade deficit with the rest of BRICS which increased from the US $ 8.7 Billion in 2006 to $ 58.4 Billion in 2015. India maintained its largest trade deficit with China, followed by Russia, South Africa, and Brazil. Before enhancing trade with other BRICS countries, India should address issues relating to the trade deficit and they have to focus export potential to other BRICS countries (EXIM Bank of India, 2016).

Mathur et al. (2016) investigated the impact on India aligning with RCEP (Regional Comprehensive Economic Partnership) and BRICS beneath the conjecture of the free trade area. The important objective of the study is to evaluate gains and losses to the Indian economy from intra-regional trade. The outcome discloses that it would be favorable for India to have trade relationships with RCEP member countries under free trade in merchandise trade. The study suggested that if India wants to continue free trade with BRICS, it must negotiate for the entry of comparatively advantageous commodities into their markets for reciprocity, also it should allow other countries comparatively advantageous commodities into the domestic market.

Mazenda (2016) addresses the central issue on whether South Africa’s alignment with BRICS has led to sustainable growth as was predicted. The study uses Autoregressive Redistributive Econometric Modeling and quarterly data from 1990 to 2014. The study found an insignificant long-run relationship between South Africa’s trade, FDI and economic growth with other BRICS countries but they found a little short-run effect on South Africa’s Growth. Granger Causality test result shows no causality between South Africa’s growth and its trade with other BRICS countries.

2.1 Research Gap

Oodles of research studies have been done in relation to the application of the Gravity model in international trade. There are several studies in which scholars applied the Gravity model and analyzed trade flows between many intra-regional groups using the panel data method. Interestingly, this study found that many scholars applied either Gravity model or Granger causality model in their analysis. There is no single study that uses both the models together for analysis even though there is a significance to assess the impact of trade variables on major
macroeconomic variables and predict its future trends. Similarly, all the past studies are limited to exports or imports or the volume of trade with limited periods. Hence, the present study tries to fill the gap by applying both the Gravity Model and Granger Causality model with more explanatory variables that are highly correlated to major macroeconomic variables. Further extent, the present study uses 27 years of data to differentiate the impact of other BRICS countries on the Indian Economy during pre and post one decade of formal meetings of BRICS.

3. **Empirical Model and Estimation Techniques**

The present paper uses two pioneering models to analyze the influence of other BRICS countries on India’s foreign trade. First, the study uses Tinbergen’s reformulated Gravity model of Trade from Newton’s law of universal gravitational, in order to assess the impact of other BRICS countries in influencing the volume of trade of India. To regress gravity equations, this study will employ the Dynamic Ordinary Least Square (DOLS) method and Fully Modified Ordinary Least Square (FMOLS) Method. The traditional OLS method struggle with serial correlation and heteroscedasticity problems. DOLS and FMOLS are usually better at considering endogeneity by adding leads and lags. Secondly, the study uses the Grangers causality test to forecast future trade relations between India and other BRICS countries. All the estimates and analysis will be done by using Evviews 10 SV software.

3.1 **The Gravity Model**

This model originates from the Newtonian physics popularly known as Newton’s gravity law in mechanics proves that two bodies attract each other proportionally to the product of each body masses divided by the square of the distance among the relevant centers of gravity.

\[ F = G \frac{M_1 M_2}{D^2} \]  

Where, F is the force between the masses; G is the gravitational constant; M_1 is the first mass; M_2 is the second mass, and D is the distance between the centers of the masses.

The gravity model for trade is similar to the Newtonian law. The similarity is as follows: the trade movements between two countries are proportional to the product of each country’s “economic mass”, generally measured by GDP (national income) and inversely proportional to the distance...
between the country’s respective “Economic Centers of Gravity”, generally their capitals. This formulation can be generalized to

\[ VOT_{ij} = \alpha \frac{(Y_i, Y_j)}{D_{ij}} \]  

(2)

Where \( VOT_{ij} \) represents the volume of trade from country to country, \( Y_i \) and \( Y_j \) typically represent the GDPs for countries \( i \) and \( j \), \( D_{ij} \) denotes the trade costs incurred due to distances between the respective destinations.

The traditional approach to estimate this equation takes log values of both the sides which led to a log-log model in the following form:

\[ \ln(\text{VOT}_{ij}) = \beta_0 + \beta_1 \ln(Y_i) + \beta_2 \ln(Y_j) - \beta_3 \ln(D_{ij}) + \epsilon_{ij} \]  

(3)

The comprehensive gravity model of trade expresses the volume of trade,exports/imports between two nations (groups/nation), populations, distance (a proxy of transportation costs) and set of dummy variables either facilitating or restricting trade between two groups.

As the gravity model is initially expressed in a multiplicative method. From which, this paper linearises the model by taking the usual logarithm of many macroeconomic variables related to trade. So the model in log-linear form can be expressed as,

\[ \ln X_{ijt} = \beta_0 + \beta_1 \ln(Y_{it}) + \beta_2 \ln(Y_{jt}) + \beta_3 \ln(Y_{it}) + \beta_4 \ln(Y_{jt}) + \beta_5 \ln(D_{ijt}) + \sum S_{ijht} + U_{ijt} \]  

(4)

Where \( y_i \) and \( y_j \) are \textit{per capita} GDP of country \( i \) and country \( j \), \( S_{ijh} \) is a summation of superior (preferred) trade dummy variables. Dummy variable proceeds the significance one when a certain state is fulfilled, if not, considered as zero.

From the tradition gravity model, this study reformulates the traditional equation into a dynamic equation with more variables relating to the Volume of Trade, Exports, and Imports of India and other BRICS countries.

\[ \log (\text{VOT}_{ijt}) = \]

\[ \alpha_0 + \alpha_1 \log (\text{GDP}_{it}) + \alpha_2 \log (\text{GDP}_{jt}) + \alpha_3 \log (\text{PCGDP}_{it}) + \alpha_4 \log (\text{PCGDP}_{jt}) + \]
\[\alpha_{5} \log(D_{ijt}) + \alpha_{6} \log(PCGDPD_{ijt}) + \alpha_{7} \left(\frac{\text{VOT}_{\text{GDP}i}}{\text{GDP}_i}\right) + \alpha_{8} \left(\frac{\text{VOT}_{\text{GDP}j}}{\text{GDP}_j}\right) + \alpha_{9}(\text{INF}_{it}) + \alpha_{10}(\text{INF}_{jt}) + \alpha_{11}(\text{EXC}_{ijt}) + \alpha_{12} \log(TA_{ijt}) + \delta_{ijt}\]

(5)

Where,

- \(i = \text{India, } j = \text{Brazil, Russia, China and South Africa, } t = \text{time (study period from 1991 to 2016)}\),
- \(\text{VOT}_{ij} = \text{Volume of Trade between country } i \text{ (India) and country } j \text{ (BRICS)}\),
- \(\text{GDP}_i = \text{Gross Domestic Product of Country } i\),
- \(\text{GDP}_j = \text{Gross Domestic Product of country } j\),
- \(\text{PCGDP}_i = \text{Per capita GDP of Country } i\),
- \(\text{PCGDP}_j = \text{Per capita GDP of Country } j\),
- \(D_{ij} = \text{Distance between country } i \text{ and country } j\),
- \(\text{PCGDPD}_{ij} = \text{Per capita GDP differential between country } i \text{ and } j\),
- \(\text{INF}_i = \text{Inflation of Country } i\),
- \(\text{INF}_j = \text{Inflation of Country } j\),
- \(\text{EXC}_{ij} = \text{Exchange rate of country } i \text{ and } j\),
- \(\text{VOT/GDP}_i = \text{Trade- GDP ratio of country } i\),
- \(\text{VOT/GDP}_j = \text{Trade- GDP ratio of country } j\),
- \(\text{TA}_{ij} = \text{Trade Agreement between country } i \text{ and } j \text{ (dummy variable)}\),
- \(\alpha\text{’s} = \text{parameters and } \delta = \text{error term}\).

*Per capita* GDP provides a good proxy for the level of development and infrastructures that are essential to conducting trade, and as such the more developed the countries are, the more would be the trade between the pairs of countries (Frankel, 1997).

The TR / GDP variable indicates the openness of the country. The more open the country is the more would be the trade.

### 3.2 Granger Causality Test

In the Granger Causality Test, the directional relationships between two variables are very sensitive which can be used efficiently by using the optimal number of lags in the model. It can be inferred from the computed statistical values, based on the given equations, if the beta coefficients become zero or less than the conventional value of 0.05 and the computed F statistic is low for the first hypothesis in the equation (1) indicate that the lagged IGDP do not possess in the regression (Accepting null hypothesis). This means India’s GDP does not Granger cause Volume of trade of other BRICS countries, similarly for other beta coefficients in the first hypothesis of the rest of equations. When we move to the second hypothesis which states that the BRCS volume of trade does not Granger cause India’s GDP if the computed F statistic is low or P-value is less than the conventional value, we can reject the hypothesis and infer that BRCS
volume of trade does cause India’s GDP. Similar results can be derived for other beta coefficients in the second hypothesis of the rest of the equations.

To test causality between India’s GDP, Exports, Imports and Volume of Trade with other BRICS countries Exports, Imports and Volume of Trade, the following model developed by Engel and Granger, (1987) will be used. The models are:

(a) GDP of India and Volume of Trade of other BRICS countries

\[
IGDP_t = \beta_0 + \sum_{i=1}^{n} \beta_{1i} IGDP_{t-i} + \sum_{i=1}^{n} \beta_{2i} BVOT_{t-i} + u_{1t}
\]

\[
BVOT_t = \beta_3 + \sum_{i=1}^{n} \beta_{4i} BVOT_{t-i} + \sum_{i=1}^{n} \beta_{5i} IGDP_{t-i} + u_{2t}
\] (6)

(b) Exports of India and Imports of other BRICS countries

\[
IX_t = \beta_0 + \sum_{i=1}^{n} \beta_{1i} IX_{t-i} + \sum_{i=1}^{n} \beta_{2i} BM_{t-i} + u_{1t}
\]

\[
BX_t = \beta_3 + \sum_{i=1}^{n} \beta_{4i} BM_{t-i} + \sum_{i=1}^{n} \beta_{5i} IX_{t-i} + u_{2t}
\] (7)

(c) Imports of India and Exports of other BRICS countries

\[
IM_t = \beta_0 + \sum_{i=1}^{n} \beta_{1i} IM_{t-i} + \sum_{i=1}^{n} \beta_{2i} BX_{t-i} + u_{1t}
\]

\[
BX_t = \beta_3 + \sum_{i=1}^{n} \beta_{4i} BX + \sum_{i=1}^{n} \beta_{5i} IM_{t-i} + u_{2t}
\] (8)

(d) The volume of Trade of India and Volume of Trade of other BRICS countries

\[
IVOT_t = \beta_0 + \sum_{i=1}^{n} \beta_{1i} IVOT_{t-i} + \sum_{i=1}^{n} \beta_{2i} BVOT_{t-i} + u_{1t}
\]

\[
BVOT_t = \beta_3 + \sum_{i=1}^{n} \beta_{4i} BVOT + \sum_{i=1}^{n} \beta_{5i} IVOT_{t-i} + u_{2t}
\] (9)
3.3 Data Description and Sources

In the above equations, where IGDP is India’s GDP, BVOT is volume of trade of other BRICS countries like Brazil, Russia, China and South Africa, IX is India’s Exports, BX is Exports of BRCS, BM is imports of BRCS, IM is India’s Imports, IVOT India’s Volume of Trade, BVOT is BRCS’s Volume of Trade, β and u are coefficients and error terms respectively.

To test the selected variables using the appropriate econometric technique with more observations, this study chooses twenty-six years of data from 1991 to 2016. The reason for choosing the study period is to compare the performances of external sector variables during pre and post one decade of the official meetings of BRICS nations. The study uses only time series secondary data collected from the Handbook of statistics of Indian Economy (Reserve Bank of India), World Integrated Trade Solution Statistics (WITS), World Bank Data and BRICS Joint Statistical Publication.

4. Empirical Results

To analyze the trade relation between India and other BRICS nations in the short-run as well as in the long-run, this study is designed at four stages. Stage one focuses on the application of the ADF-Fisher Unit Root Test to check the presence of unit root for stationary conditions. Stage two uses Pedroni’s cointegration test to verify the association between the selected variables for regressions. Stage three and four employs two pioneering econometric models called Granger Causality test and Gravity model of trade for empirical results.

4.1 ADF-Fisher Unit Root Test

There are six major unit root tests that can be applied for stationary conditions for panel and cross-section data. Of which, the most important and relevant unit root test for this study is ADF-Fisher unit root test. Using the ADF-Fisher unit root test, we can check stationary conditions at three levels (Unit root at Level, at first difference and a second difference).

The null hypothesis of the ADF-Fisher unit root is that the variables have a unit root. Stating that the variables are non-stationary if the probability values are more than the conventional value. Based on the above conception from Table 1, the study has applied the ADF-Fisher test at the level and found Non-Stationary. Due to which, the study uses unit root at first difference and found all the probability values are less than the conventional value. So the study rejected the
null hypothesis of Unit Root and accepts the alternative hypothesis and inferred that the variables are stationary at first difference.

**TABLE 1 - ADF Fisher Unit Root Test (at first difference)**

<table>
<thead>
<tr>
<th>Variables</th>
<th>Statistic</th>
<th>Prob</th>
</tr>
</thead>
<tbody>
<tr>
<td>LnVOT$_{ijt}$</td>
<td>49.4573</td>
<td>0.0000</td>
</tr>
<tr>
<td>LnGDP$_{it}$</td>
<td>18.9839</td>
<td>0.0001</td>
</tr>
<tr>
<td>LnGDP$_{jt}$</td>
<td>27.4412</td>
<td>0.0006</td>
</tr>
<tr>
<td>LnPCGDP$_{it}$</td>
<td>18.4207</td>
<td>0.0001</td>
</tr>
<tr>
<td>LnPCGDP$_{jt}$</td>
<td>27.4117</td>
<td>0.0006</td>
</tr>
<tr>
<td>LnExports$_{it}$</td>
<td>11.6324</td>
<td>0.0030</td>
</tr>
<tr>
<td>LnExports$_{jt}$</td>
<td>45.8609</td>
<td>0.0000</td>
</tr>
<tr>
<td>LnImports$_{it}$</td>
<td>9.74683</td>
<td>0.0076</td>
</tr>
<tr>
<td>LnImports$_{jt}$</td>
<td>36.7366</td>
<td>0.0000</td>
</tr>
<tr>
<td>LnPCGDPD$_{ijt}$</td>
<td>26.8513</td>
<td>0.0008</td>
</tr>
<tr>
<td>LnExchange Rate$_{ijt}$</td>
<td>47.7545</td>
<td>0.0000</td>
</tr>
<tr>
<td>LnInflation$_{it}$</td>
<td>28.2321</td>
<td>0.0000</td>
</tr>
<tr>
<td>LnInflation$_{jt}$</td>
<td>65.0289</td>
<td>0.0000</td>
</tr>
<tr>
<td>LnVOT/GDP$_{it}$</td>
<td>12.3983</td>
<td>0.0020</td>
</tr>
<tr>
<td>LnVOT/GDP$_{jt}$</td>
<td>64.8891</td>
<td>0.0000</td>
</tr>
<tr>
<td>LnTA$_{ijt}$</td>
<td>17.3681</td>
<td>0.0000</td>
</tr>
<tr>
<td>LnDistance$_{ijt}$</td>
<td>21.9461</td>
<td>0.0000</td>
</tr>
</tbody>
</table>

4.2 Pedroni’s Cointegration Test

After verifying the stationary conditions, this study examines whether there is cointegration between the selected variables or not. For that purpose, the present study has observed three popular and essential cointegration tests. They are Pedroni’s residual cointegration, Kao’s cointegration, and Fisher’s cointegration. Of which, the present study has applied Pedroni’s cointegration test due to its significance and relevance to this study.

The null hypothesis of Pedroni’s cointegration test is the variables have no cointegration. According to this test, if the probability values for the majority of the test results establish less than 0.05 led to the rejection of the null hypothesis. In such an instance, the study can infer that the variables are cointegrated.
### Table 2 - Pedroni Residual Cointegration Test (Dependent Variable is Volume of Trade $ij$)

<table>
<thead>
<tr>
<th>Tests</th>
<th>Statistic</th>
<th>Prob</th>
<th>Weighted Stat</th>
<th>Prob</th>
</tr>
</thead>
<tbody>
<tr>
<td>Panel V-Stat</td>
<td>-0.038004</td>
<td>0.5152</td>
<td>-0.833361</td>
<td>0.79</td>
</tr>
<tr>
<td>Panel Rho – Stat</td>
<td>0.698733</td>
<td>0.7576</td>
<td>0.579800</td>
<td>0.71</td>
</tr>
<tr>
<td>Panel PP – Stat</td>
<td>-5.983097</td>
<td>0.0000</td>
<td>-7.247671</td>
<td>0.00</td>
</tr>
<tr>
<td>Panel ADF – Stat</td>
<td>-4.653448</td>
<td>0.0000</td>
<td>-4.301881</td>
<td>0.00</td>
</tr>
<tr>
<td>Group Rho – Stat</td>
<td>1.381945</td>
<td>0.9165</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>Group PP – Stat</td>
<td>-8.349807</td>
<td>0.0000</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>Group ADF – Stat</td>
<td>-4.377081</td>
<td>0.0000</td>
<td>---</td>
<td>---</td>
</tr>
</tbody>
</table>

Out of the 11 test results depicted in Table 2, the probability values of 6 results are less than the conventional value. So the study rejects the null hypothesis and accepts the alternative hypothesis. Stating that there is a long-run relationship exists between the selected variables (VOT$_{ij}$, GDP$_{it}$, GDP$_{jt}$, PCGDP$_{it}$, PCGDP$_{jt}$, Exchange Rate$_{ijt}$, and Distance$_{ijt}$). Other independent variables are restricted from cointegration for the greater degree of freedom). From the test result, the study observed that there is cointegration between the selected variables and exposed positive signal to run the appropriate model for analysis.

#### 4.3 Granger Causality to Test Short-Run Trade Relation between India and other BRICS Nations

To assess the impact of India’s trade with other BRICS countries in the short run, this study uses several major macroeconomic variables like GDP, Exports, Imports, Volume of Trade of India and Imports, Exports, Volume of trade of other BRICS nations. This study has tested eight null hypotheses using the Granger Causality test and the results are given in Table 3.
### Table 3 - Granger Causality Test Result

<table>
<thead>
<tr>
<th>Null Hypothesis</th>
<th>Lags</th>
<th>Obs</th>
<th>F-Statistics</th>
<th>Prob</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>IGDP Does not Granger Cause BVOT</td>
<td>2</td>
<td>24</td>
<td>5.44310</td>
<td>0.0135</td>
<td>Unidirectional Causality</td>
</tr>
<tr>
<td>BVOT Does not Granger Cause IGDP</td>
<td>2</td>
<td>24</td>
<td>1.58698</td>
<td>0.2305</td>
<td></td>
</tr>
<tr>
<td>IX Does not Granger Cause BM</td>
<td>2</td>
<td>24</td>
<td>9.56936</td>
<td>0.0013</td>
<td>Bidirectional Causality</td>
</tr>
<tr>
<td>BM Does not Granger Cause IX</td>
<td>2</td>
<td>24</td>
<td>6.39491</td>
<td>0.0075</td>
<td></td>
</tr>
<tr>
<td>IM Does not Granger Cause BX</td>
<td>2</td>
<td>24</td>
<td>2.75588</td>
<td>0.0889</td>
<td>Unidirectional Causality</td>
</tr>
<tr>
<td>BX Does not Granger Cause IM</td>
<td>2</td>
<td>24</td>
<td>0.99802</td>
<td>0.3871</td>
<td></td>
</tr>
<tr>
<td>IVOT Does not Granger Cause BVOT</td>
<td>2</td>
<td>24</td>
<td>5.13996</td>
<td>0.0164</td>
<td>Bidirectional Causality</td>
</tr>
<tr>
<td>BVOT Does not Granger Cause IVOT</td>
<td>2</td>
<td>24</td>
<td>2.89502</td>
<td>0.0799</td>
<td></td>
</tr>
</tbody>
</table>

#### 4.3.1 India’s GDP (IGDP) and other BRICS Nations Volume of Trade (BVOT)

Granger Causality test results for India’s GDP with BRICS nations Volume of Trade, this study has observed unidirectional causality. From the probability values in Table 3, it can be inferred that IGDP does affect BVOT but BVOT does not affect IGDP. Uttering that India’s Excess GDP goes to other BRICS nations in the form of exports and creates export earnings to India. Similarly, an increase in BVOT does not reduce GDP via increasing imports. So it creates a positive impact on India’s trade balances and the economy as a whole.

#### 4.3.2 India’s Exports (IX) and other BRICS Nations Imports (BM)

Granger Causality test results from table 3 provide the probability values of 0.0013 and 0.0075 for India’s Exports and Other BRICS nations imports implying that India’s Exports does granger cause other BRICS nations Imports. Similarly other BRICS nations imports does cause India’s Exports. This Bi-Directional causality clearly indicates that India’s exports will influence other BRICS nations Imports and an increase in other BRICS nation’s imports will increase India’s Exports, i.e., other BRICS nations receive a considerable portion of their imports from India and it creates the surplus trade in favor of India.

#### 4.3.3 India’s Imports (IM) and other BRICS nations exports (BX)

The probability value of 0.0889 and 0.3871 clearly stated that there is unidirectional causality at 10 percent between India’s imports and other BRICS nation’s exports. This result pointed out
that an increase in India’s imports does significantly affect the exports of other BRICS nations. But, an increase in the exports of other BRICS nations has no significant impact on India’s imports stating that the other BRICS nations exporting more to the rest of the world and not to India.

4.3.4 India’s Volume of Trade (IVOT) and other BRICS Nations Volume of Trade (BVOT)

Finally, the study observed favorable bidirectional causality between India’s Volume of Trade and other BRICS nation’s Volume of Trade at 5 percent and 10 percent level of significance. The probability value of 0.0164 for IVOT and BVOT proves that India’s Volume of Trade enhances other BRICS nation’s volume of trade. Similarly, the probability value of 0.0799 proves that other BRICS nation’s volume of trade does enhance India’s volume of trade at a 10 percent level of significance. It can be inferred by saying that India’s volume of trade increases, the majority of its exports go to other BRICS nation’s, similarly, the other BRICS nations are also exporting significantly to India. Based on the overall empirical results from the Granger Causality test, the study has observed that India has positive and favorable trade relationships with other nations.

4.4 Panel Data Analysis on the Long-Run Output Elasticity’s of BRICS Trade

The trade relation between the BRICS nations is also estimated by applying the Gravity model of trade using the Dynamic Ordinary Least Square (DOLS) method and Fully Modified Ordinary Least Square (FMOLS) Method. The significance of DOLS and FMOLS is it rectifies serial correlation and simultaneity inaccuracies.

According to the test results from table 4, it is clear that the selected independent variables are significant to the volume of trade of BRICS nations. Except for Inflation, all the other independent variables are significant and positive to the volume of trade of BRICS nations. This means that the GDP, PCGDP, Exchange rate and openness of BRICS countries have a substantial impact on the volume of trade. As far as inflation is concerned, the study found an insignificant relation to the VOT of BRICS nations. Other than inflation, all the independent variables have a positive coefficient, meaning that GDP, PCGDP, Exchange Rate and Openness have a significant plus positive association with VOT. This means a 1-unit increase in GDP, PCGDP, exchange Rate and openness of BRICS nations causes the volume of trade by 0.5961, 0.3936, 0.0558, 0.3047
units, respectively. Among all the variables, GDP has a high coefficient followed by PCGDP, Exchange Rate, and openness. When the result is insignificant, doesn’t matter whether the coefficient is positive or negative. Interestingly, the study found more or less similar results from DOLS & FMOLS which can be seen from flanking probability and R squared values.

### Table 4 - Cointegration Regression for BRICS Trade using DOLS & FMOLS:

**Dependent Variable (VOT\textsubscript{ij})**

<table>
<thead>
<tr>
<th>Variables</th>
<th>Dynamic OLS Model</th>
<th>Fully Modified OLS Method</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Coefficient</td>
<td>Std. Error</td>
</tr>
<tr>
<td>Ln(GDP\textsubscript{i} * GDP\textsubscript{j})</td>
<td>0.5961</td>
<td>0.0335</td>
</tr>
<tr>
<td>Ln(PCGDP\textsubscript{i} * PCGDP\textsubscript{j})</td>
<td>0.3936</td>
<td>0.0508</td>
</tr>
<tr>
<td>Ln(Exchange Rate\textsubscript{ij})</td>
<td>0.0558</td>
<td>0.0150</td>
</tr>
<tr>
<td>Ln(Inflation\textsubscript{i} * Inflation\textsubscript{j})</td>
<td>-0.0161</td>
<td>0.0083</td>
</tr>
<tr>
<td>Openness\textsubscript{ij}</td>
<td>0.3047</td>
<td>0.0012</td>
</tr>
<tr>
<td>R Squared</td>
<td>0.91</td>
<td></td>
</tr>
</tbody>
</table>

#### 4.4.1 Comparative Analysis of India’s Trade with other BRICS Nations using DOLS & FMOLS

One of the major objectives of this study is to assess the impact of India’s trade relations with other BRICS nations. For that purpose, the present study uses and compares major macroeconomic variables relating to India’s foreign trade with BRICS nations using DOLS and FMOLS methods. The long-run output elasticity’s results are given in Table 5.

Regression results from table 5 clearly pointed out that there is a significant and positive association between GDP, PCGDP, Exchange Rate and Trade-GDP ratio of the country (i) and country (j). Whereas PCGDP differential and distance between country (i) and (j) are significant but inversely correlated to trade. Interestingly, the regression result exposes that the Trade Agreement is insignificant to the volume of trade but Inflation is the only variable that is not insignificant also inversely related to trade between country (i) and (j). Among all the variables, GDP has a high coefficient followed by PCGDP, Exchange Rate, and openness. When the result
is insignificant, doesn’t matter whether the coefficient is positive or negative. So, the majority of the selected variables possess significant and positive relations indicates that there is a positive impact on the Indian Economy for trading with BRICS countries. Most of the test results validate several traditional trade theories, especially the factor endowment model. The test result for inflation invalidates its importance in international trade seems too contradictory. This means, inflation and trade among BRICS countries are insignificant but it may occupy significance when they trade with other countries in the world. Once again, the study found more or less similar results from DOLS & FMOLS. Also, the test results validated the suitability of the gravity model for international trade.

**Table 5 - Cointegration Regression of India’s Trade with other BRICS nations:**

<table>
<thead>
<tr>
<th>Variables</th>
<th>Dynamic OLS Model</th>
<th>Fully Modified OLS Method</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Coefficient</td>
<td>Std. Error</td>
</tr>
<tr>
<td>LnGDP&lt;sub&gt;i&lt;/sub&gt;</td>
<td>0.8620</td>
<td>0.0229</td>
</tr>
<tr>
<td>LnGDP&lt;sub&gt;j&lt;/sub&gt;</td>
<td>0.9159</td>
<td>0.0046</td>
</tr>
<tr>
<td>LnPCGDP&lt;sub&gt;i&lt;/sub&gt;</td>
<td>1.8416</td>
<td>0.0186</td>
</tr>
<tr>
<td>LnPCGDP&lt;sub&gt;j&lt;/sub&gt;</td>
<td>1.4916</td>
<td>0.0200</td>
</tr>
<tr>
<td>LnPCGDPDi&lt;sub&gt;j&lt;/sub&gt;</td>
<td>-1.5158</td>
<td>0.0190</td>
</tr>
<tr>
<td>LnExchangeRate&lt;sub&gt;i&lt;/sub&gt;j</td>
<td>1.1817</td>
<td>0.0248</td>
</tr>
<tr>
<td>LnInflation&lt;sub&gt;i&lt;/sub&gt;j</td>
<td>-2.8718</td>
<td>0.4916</td>
</tr>
<tr>
<td>LnInflation&lt;sub&gt;j&lt;/sub&gt;j</td>
<td>-2.6211</td>
<td>0.6404</td>
</tr>
<tr>
<td>LnVOT/GDP&lt;sub&gt;i&lt;/sub&gt;j</td>
<td>3.7894</td>
<td>0.0747</td>
</tr>
<tr>
<td>LnVOT/GDP&lt;sub&gt;j&lt;/sub&gt;j</td>
<td>3.5961</td>
<td>0.0375</td>
</tr>
<tr>
<td>LnTA&lt;sub&gt;i&lt;/sub&gt;j</td>
<td>1.1873</td>
<td>0.6481</td>
</tr>
<tr>
<td>LnDistance&lt;sub&gt;i&lt;/sub&gt;j</td>
<td>-1.8622</td>
<td>0.2811</td>
</tr>
<tr>
<td>R Squared</td>
<td>0.96</td>
<td></td>
</tr>
</tbody>
</table>

5. **Conclusions**

*For the first Objective*, the study found that the GDP, PCGDP, Exchange Rate and openness are significant and positively correlated to the VOT of BRICS nations. Whereas the inflation rate is concerned, it has an insignificant relation to VOT. When the result is insignificant, doesn’t matter whether the coefficient is positive or negative. *For the second objective*, the study strongly proved that there is a positive impact on the Indian Economy for trading with BRICS countries.
All hypotheses and Granger Causality test results clearly support India’s Trade with BRICS countries. The study found Causality for favorable trade variables and no causality for unfavorable or trade deficit. For the third Objective, the study found a majority of the selected independent variables are significant and positively correlated (coefficients are positive) to the dependent variable (VOT). But Inflation and Trade Agreements are insignificant to the dependent variable. Also, these two variables are negatively correlated with the VOT of BRICS.

Most of the literature survey found that there is no significant gain for India and South Africa from other BRICS countries and China & Russia are the real gainers from the bloc. But this study invalidated such observations and proved that there is a significant and positive trade relation between India and other BRICS countries in the short run as well as in the Long Run. Also, this study validated the Gravity model for assessing international trade between countries. Finally, the study strongly recommended that India needs to strengthen its trade relations with other BRICS nations by promoting make in India, SEZs, EOUs, and Openness to reap the potential benefits from the global economy.

REFERENCES


Mottet, L. (2013), Cooperation and Competition among the BRICS Countries and Other Emerging Powers, French Centre for Research on Contemporary China: Hong Kong.


