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INTRA-TRADE FLOWS AND EXCHANGE RATE VOLATILITY AMONG BRICS MEMBER COUNTRIES: A GRAVITY MODEL APPROACH

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ABSTRACT
The gravity model approach was used to examine intra-trade flows and exchange rate volatility among BRICS countries. The study discovered that GDP has a significant impact on intra-trade flows, whereas geographical distance and exchange rate volatility have a negative impact on intra-BRICS trade flows. According to the results of the gravity model, special attention should be paid to improving the exchange rate stability of each BRICS country's real GDP. The study recommended that policymakers in the BRICS countries craft macroeconomic policies that reduce exchange rate volatility while maintaining the level and pattern of trade openness. The BRICS economies should generally strengthen and restructure their domestic foreign exchange markets, as their absence acts as a roadblock in mitigating exchange rate risk.

KEY WORDS
Intra-trade, exchange rate, volatility, trade openness, BRICS.

The movement of goods and services across national borders has been influenced by the socioeconomic status of every country in the world. International trade theories view trade as a catalyst for economic growth and development (Dann, 2000). From a theoretical perspective, there are many benefits that countries draw from international trade; notable among them are accessibility of goods and services at lower prices, wider consumption choice, and proficient use of resources. However, Wolf (1995) argued that international trade flows are largely compromised by exchange rate volatility. The argument is based on the idea that high exchange rate uncertainty reduces risk-adjusted expected revenue and, hence, the incentives of risk-averse traders to engage in foreign contracts.

The debate on the impact of exchange rate volatility on trade flows has been a bone of contention among researchers, particularly for developing economies such as the BRICS (Brazil, Russia, India, China, and South Africa) countries. Most of the studies posited that the exchange rate was the main source of risk for the traders. Ethier (2008) noted that profit-maximizing firms are risk-averse, and exchange volatility risk reduces the benefits of international trade flows. However, some empirical studies have shown that the existence of financial markets allows agents to hedge exchange rate risk, which may reduce or eliminate the potentially negative effect of exchange rate volatility on trade.

Tesar (2009) argued that forward markets are not complete, therefore, the basic effect of exchange rate volatility on trade flows remains a problem at both the intra-trade and global level. To spur the negative effects of exchange rate volatility and ensure the growth of

international trade, countries have formed trading blocs. The main focus of this study is to investigate intra-trade flows and exchange rate volatility among BRICS member countries. The termBRIC," composed of Brazil, Russia, India, and China, was formed in 2001 to compete with the gigantic economies of Europe in terms of market size. South Africa later joined the group in 2011, and the name changed to BRICS. The group mainly focused on increasing intra-trade flows through managing its determinants such as exchange rate volatility, Gross Domestic Product, import prices, domestic prices among others.

Jabalameli (2018) highlighted that the BRICS countries have occupied 41% of the total world's population and contribute more than 50 percent of the world's economic growth. BRICS' contribution to global trade volumes has tripled over the last two decades. Based on the UN Comtrade data, the global trade of BRICS members has increased from (870.613 billion US dollars) in 2000 to (6758.380 billion US dollars) in 2018. Keeping their progress in view, it can be asserted that BRICS economies have the potential to accelerate and accentuate global growth and trade. BRICS has made significant progress in its integration with the world economy. The contribution of BRICS to global trade flows was around 4 percent in the early 1990s; however, at present, BRICS contribute more than 15 percent to global trade volumes. Intra-BRICS trade has also increased considerably since 2000. Based on UN Comtrade data, intra-BRICS exports had increased from 17.70 billion US dollars in 2000 to 353.02 billion US dollars in 2018, and intra-BRICS imports had increased from 19.24 billion US dollars in 2000 to 398 billion US dollars in 2018. As the BRICS economies are considered to be Emerging and Growth Leading Economies (EAGLEs), their contribution to global trade and growth is substantial and impressive. Hence, it becomes mandatory to untangle the knot between exchange rate dynamics and macroeconomic performance in these countries. More precisely, the linkage(s) between the conditional volatility of the BRICS economies' domestic currencies vis-à-vis the USD and trade performance would be unraveled.

LITERATURE REVIEW

The debate on intra-trade flows and exchange rate volatility is endless, and many researchers have attempted to join the debate around the world using different model approaches such as the gravity model and proffering their views and perceptions, but there is still no consensus on whether their assumptions are real in explaining the interaction that exists between intra-trade flows and exchange rate volatility. Some of the empirical analyses are detailed below:

Mishra (2015) investigated India-trade flows with Brazil, Russia, China, and South Africa using a gravity model approach. The study covered a 20-year span, from 1990 to 2010. The study included real gross domestic product (GDP), transportation costs, exchange rates, and inflation, among others. The primary goal of this research was to determine the impact of each variable on Indian trade flows. As a result, the study discovered a positive and statistically significant relationship between real Gross Domestic Product (real GDP) and trade flows in India and other BRICS countries (Brazil, South Africa, China, and Russia). Furthermore, transportation costs were discovered to be a barrier to trade between India and other BRICS countries, implying that trade flows are reduced as distance between countries increases. Other variables included in the model, such as inflation and exchange rates, were found to be insignificant in influencing trade flows between India and its trading partners (Brazil, Russia, China, and South Africa). The study concluded that in order to increase trade flows with its trading partners, India should implement policies that stimulate real gross domestic product (real GDP). The Indian government should use the gravity model approach to examine the state of their trade flows and their relationship with the other BRICS countries.

Ang Su (2016) investigated the relationship between BRICS countries' economic growth (as measured by real GDP), budget deficit, and currency flows. The study also aimed to compare the trade composition of each BRICS country. According to the study, China has a large trade composition, followed by Russia, India, Brazil, and South Africa. Furthermore,

the study found that trade is positively related to economic growth and currency flows in Brazil, Russia, India, China, and South Africa. Exchange rate appreciation was found to have a negative and statistically significant effect on Chinese trade. The study concluded that policymakers should be aware of policies that stimulate competitiveness in order to reduce trade disparities between BRICS countries, such as expansionary fiscal policies to increase income circulation, which will stimulate aggregate demand and real GDP per capita, and reducing budget deficits.

Kaya (2014) used a gravity model approach to study the relationship between exchange rates and trade (exports and imports) for the BRICS from 1985 to 2011. The study found no significant relationship between BRICS exports and exchange rates, implying that a drop in exchange rates has no effect on export volumes. Furthermore, the study found no statistically significant relationship between increases in exchange rates and increases in export volumes. However, it was discovered that real income was a significant determinant of trade in the BRICS countries. In this regard, the study concluded that exchange rates are inelastic, meaning that changes in them have no significant impact on both exports and imports. As a result, policymakers should focus on variables other than exchange rates, such as real income, import prices, domestic prices, and increasing productivity to increase exports and maintain a positive trade balance.

Tirmanzee (2014) investigated the import demand function for Pakistan between 1970 and 2010. The study made use of World Bank time series data. Trade, real GDP, exchange rate, and relative price are among the variables examined in this study. The primary goal of this study was to investigate the relationship between these variables. The study used the Johansen cointegration technique to determine the existence of a long-run relationship, the Vector Error Correction Model (VECM) to investigate the effect that these variables have on each other in Pakistan, the impulse response, and Granger causality to analyze the causality between these variables. According to the findings of this study, relative price has a negative impact on trade, and an increase in relative price results in a decrease in the quantity demanded for imports in Pakistan. Exchange rates were also found to have a negative relationship with trade; that is, when the exchange rate rises, local goods and services become more expensive while imports become cheaper, worsening the trade balance. Furthermore, the study discovered that GDP has a positive and statistically significant impact on Pakistani trade. It has been concluded that policymakers should manage exchange rates in order to manage import demand.

Between 1980 and 2010, Ogbonna (2016) conducted research on Nigeria's aggregate import demand function. The study used the real effective exchange rate, price index, and real income as explanatory variables and Nigerian imports as a dependent variable. The methodology used in this study aimed to determine whether there is cointegration between variables using the Johansen Cointegration Approach, causality between variables using the Granger Causality Technique, and the effect that each variable has on other variables using the Vector Error Correction Model (VECM) technique. The study discovered a long-run stable cointegration between Nigerian exchange rates, import prices, the price index, and import demand. Furthermore, the study found a bidirectional causal relationship between the real effective exchange rate and the import demand function. However, the variables included in the study failed to provide evidence of short-run cointegration between the variables under consideration. According to the study, the real effective exchange rate is one of the primary determinants of Nigeria's import demand. It has also been suggested that the Nigerian government manage all variables in order to improve import demand.

Kundu (2015) used a gravity model approach to investigate the relationship between the bilateral trade balance and BRICS trading partners. This study's assumptions are based on the Hesckscher-Ohlin theory, which holds that bilateral trade is guided by a country's size, absorption capacity, real exchange rates, transportation costs, and gross domestic product (GDP per capita). The study's findings indicate that GDP per capita has a significant impact on trade volumes between countries. Countries with a high relative absorption capacity trade more than countries with a low relative absorption capacity. However, distance was discovered to have a negative effect on trade, meaning that trade volumes

decrease as the distance between them increases. Furthermore, transportation costs are one of the most significant barriers between countries. To avoid a decline in trade, countries should invest heavily in areas that counteract the effect of distance.

Viera (2015) investigated the relationship between real effective exchange rate volatility and the export function for 106 countries between 2000 and 2011. The study used GMM estimation to determine the relationship. The dummy variables were included in the study to account for the structural break that occurred between 2008 and 2009. The findings revealed that exchange rate volatility has a negative and statistically significant relationship with exports in all 106 countries. The financial crisis dummy variable was discovered to have a positive and statistically significant relationship with exports. In addition, the study discovered that the effect of real income on exports is inelastic. As a result, the study recommended that policymakers implement different policies to reduce exchange rate risk while increasing exports. Zainal et al. (2016) investigated bilateral trade between Malaysia and the BRICS using the gravity model. According to the study, transportation costs are the most significant trade impediment in the Malaysia-BRICS bilateral. Furthermore, GDP per capita and the trade-to-GDP ratio benefit Malaysia-BRICS bilateral trade. Furthermore, the Malaysian and BRICS economies' inflation and exchange rates have a negligible impact on bilateral trade. According to the study, economic strengthening should be the foundation for increasing bilateral trade flows between Malaysia and the BRICS economies.

METHODS OF RESEARCH

The study made use of the gravity model approach developed by Mishra (2015), who looked into India's trade flows with Brazil, Russia, China, and South Africa. Real Gross Domestic Product (GDP), distance, and trade flows, as expressed in equation 1, were time-invariant variables used in the study. The World Bank (WB) database was used to gather information for this study on population, trade openness, per capita GDP, exchange rate volatility, and per capita GDP, as shown in equation 2. In order to look into intra-trade flows and exchange rate volatility among the BRICS countries, this study's methodology used a panel gravity model. The gravity model is regarded as one of the most significant tools for examining the intra-trade flows between the trading partners (Maryam et al., 2019). In order to calculate trade volumes, the gravity model specification is written as:

$$TRADE\ it = B_0 + B_1 GDPit + B_2 Dist + \mu \qquad (1)$$

Where: TRADEit is the amount of trade that flows between countries, GDPit is the country's gross domestic product, and Dist is the geographical distance between trading countries, which is measured in kilometers. $B_{0,}$ $_{B1,}$ and B_2 are parameters of the model, and μ is the error term. Maryam et al. (2019) argued that the basic equation for the gravity model consists of trade flows between the trading countries, economic growth (the size of a country), and the geographical distance between the trading countries. This study included other variables in the model that are argued to be crucial in determining intra-trade flows, among them exchange rate volatility, relative price, and import price. The modified gravity model is specified as follows:

$$TRADE\ it = B_0 + B_1 GDPit + B_2 Distit + B_3 EXRit + B_4 MPit + B_5\, DPit + \mu \qquad (2)$$

Where: EXRit is exchange rate volatility, MPit is import prices, and DPit is domestic prices, ($B_{0,}$ B_1, B2... B5), are parameters of the model, and μ is the error term.

Empirical studies use different types of data in economics. The choice of a model and method is linked to the objectives and nature of the data the researcher prefers. Separate analyses can be managed using both time series and cross-sectional data. The method that caters to both kinds of data is called panel data analysis. The fixed effect and random effect models were adopted in this study to conquer the problem of loss of degree of freedom, which is commonly encountered in fixed effect modes. In the random effects model, the

existence of error components but not coefficients that pertain to units or time is crucial. In addition, in a random effects model, a section of the observed samples takes into account not only the effects of the differences occurring with respect to units or time but also external effects outside the sample.

The autocorrelation method was used in the study to look at how similar the variables were over time. The test is based on two alternative hypotheses: one that claims there is no correlation between the error terms and one that claims, there is autocorrelation. According to Brooks (2008), serial correlation occurs when the error terms are correlated with one another, so the covariance should be zero, that is, $cov\ (U_i, U_j) = 0$. The Durbin-Watson test was used in the study to identify any autocorrelation. In addition, the study made use of multicolinearity to look at the correlation between independent variables as well as to prevent the model's explanatory variable from having a double effect. The study used a correlation matrix to find multicolinearity. Gujaratti (2004) proposed that when the correlation matrix is reported at 0.8 and above, highly correlated variables are seen. Additionally, this study has examined heteroscedasticity, model misspecification, normality, and stability.

RESULTS AND DISCUSSION

Huebner (2016) argued that preliminary data analysis must include summary statistics as a crucial component. Inferential statistical tests can compare variables using summary statistics, according to Peace (2018). The outcomes of summary statistics provide the measures of dispersion, namely the minimum, maximum, mean, median, and standard deviation. Checking for outliers in the data is made easier with the minimum and maximum values. The variance and standard deviation measure the overall data set's variability. The table below indicates summary statistics for BRICS countries.

Table 1 – Summary Statistics for intra- BRICS countries

Variable	TRADE	GDP	MP	DP	Dist
Mean	16.97946	6.765938	14.47227	35.92298	84.14705
Median	16.51014	6.776052	16.98624	34.96183	82.07800
Maximum	26.89870	6.914413	23.72906	47.34249	127.5800
Minimum	9.172401	6.476962	1.525177	23.67196	39.01800
Std. Dev.	4.264215	0.079609	6.115916	7.245611	0.359491
Skewness	0.096778	-1.487043	-0.690511	-0.002769	1.993092
Kurtosis	2.436272	6.755389	2.391996	1.738568	4.972414
Jarque-Ber	0.503275	32.50986	3.225596	2.254259	28.02177
Probability	0.777526	0.000000	0.199329	0.323962	0.000001
Observatio	155	155	155	155	155

Source: Authors' calculations.

According to Huebner (2016), the standard deviation is lower in the dataset, with a narrower range of values that deviate from the mean. For BRICS economies, the variables trade (T) and distance (*Dist*) mirror a positive skewness. The probability of intra-BRICS trade flows being 0.503 > 0.05 indicates that the distribution is normal. Also, import prices and domestic prices have a probability value greater than 0.05, so they are normally distributed. However, gross domestic product and distance have probability values of less than 0.05, therefore their distribution is not normal. The model indicates that the variables are normally distributed. The results also reported that the bivariate correlation matrix of the determinants of intra-BRICS trade flows has shown a strong and positive association with gross domestic product and is negatively associated with distance and exchange rate volatility. These results have been supporting the gravity model assumption, which purports that economic size is positively associated with trade flows while geographical distance is inversely related

to trade flows due to associated costs. Results also reported that the variables included in this study is free from heteroskedasticity.

To select between the fixed and random effect models. The Hausman test was used in the research. The intra-BRICS variables were tested against the null hypothesis that the random effect model is appropriate versus the alternative hypothesis that the fixed model is appropriate. The chi-square test value is used as the decision criterion if the probability value is less than 0.05. As a result, we reject the null hypothesis and conclude that fixed effects may exist in the model. The Hausman results are depicted in the table below:

Table 2 – Hausman test results

Chi-square test value	29.24
P-value	0.0000

We found evidence to reject the null hypothesis and came to the conclusion that the fixed effect model is suitable for all the tests carried out in this study because the results showed a probability value of (0.000) < 0.05.

To investigate the impact of gravity model on intra-BRICS trade flows, the study uses distance, Gross Domestic Product, import price, exchange rate volatility and domestic prices.The table below revealed the augmented gravity model for trade between Brazil and its BRICS trade partners (Russia, India, China and South Africa).

Table 3 – Brazil-BRICS Gravity panel effects are now fixed

Variable	Coefficient	Standard error	T-statistics	P-value
constant	307.399	60.778	5.060	0.000
lnGDPit	0.205	0.086	2.610	0.054
lnDPit	0.093	0.076	6.272	0.000
lnMPit	0.046	0.051	12.662	0.000
lnEXRit	-0.119	0.037	-3.194	0.004
Distanc	-0.036	0.102	-3.559	0.000
R-Squared 0.70, Adjusted R-Squared 0.69.				

The gravity panel fixed-effect results reported that the R-squared of 0.70 (70%), therefore, it means that about 76% of the gravity model is explained by lnGDPit, lnDPit, lnMPit, lnEXPit and *Dist* and the remaining 30 % is explained by the error term. This means that the model is a good fit. The core variables of the gravity model are exchange rate volatility (lnEXRit), distance (*Dist*) and Gross Domestic Product (lnGDPit). The coefficient for gross domestic product for Brazil and its BRICS trading partners is positive and statistically significant in the fixed effect estimation. This means that trade increases with the size of the economy. The coefficient for the variable *Dist* has a negative effect and is statistically significant at all levels. This suggests that there is a negative relationship between distance and trade in Brazil. Exchange rate volatility impacts trade negatively.

In addition, the table below revealed the gravity panel fixed effect results for Russia-BRICS intra-trade flows. The R-squared for Russia-BRICS intra-trade is 0.9910. This suggests that about 99% of gravity model variables are explained by the explanatory variables and only 1% are captured in the error term. Similarly, the results agree with the gravity model assumption, which says that there is an inverse relationship between trade and distance. The results of the fixed effect analysis indicate that the coefficient for distance is negative and statistically significant at the 1 percent level. The coefficient for gross domestic product (lnGDP) is positive and statistically significant at the 1 percent level in the fixed effect model. Thus, the results show that intra-trade flows increase with the size of the country. Therefore, it is clear that countries with high GDP indeed trade more than countries with low GDP. More so, the coefficient for exchange rate volatility has a negative effect on intra-trade flows. Thus, holding other things constant, a 1 percent increase in exchange rate volatility in Russia would cause intra-trade flows to go down by 0.004 percent.

Table 4 – Russia-BRICS Gravity panel effects are now fixed

Variable	Coefficient	Standard error	T-statistics	P-value
Constant	0.028531	0.006510	4.382642	0.0000
lnGDPit	0.943839	0.026689	35.36490	0.0000
lnDPit	0.000191	0.000353	0.542504	0.5883
lnMPit	0.8673690	0.606926	1.429119	0.1552
lnEXRit	-0.004275	0.000725	-5.896489	0.0000
Dist	-0.004912	0.000859	-5719403	0.0000
R-squared 0.991013, Adjusted R-squared 0.990503				

Source: Own Estimation; Eviews 12.

The assumptions of the gravity model holds for India-BRICS trade flows, this is because the coefficient for geography distance (*Dist*) is negative and statistically significant at 10 per cent level. This implies that geographical distance matters most for the BRICS countries. More so, GDP has a positive relationship with intra-trade flows in the BRICS. Therefore, it is without doubt that trade is consistent with economic size. However, exchange rate volatility has a negative association with intra-trade flows.

Table 5 – India-BRICS Gravity panel effects are now fixed

Variable	Coefficient	Standard error	T-Statistics	P-value
Constant	-0.02455	0.09176	-2.48702	0.044
lnGDPit	-0.209915	0.12516	-1.67714	0.099
lnDPit	0.012213	0.00699	1.74634	0.056
lnMPit	0.405424	0.16003	2.53349	0.023
lnEXRit	0.006943	0.00299	2.31991	0.034
lnDist	0.041615	0.02216	1.87825	0.079
R-squared 0.65830 Adjusted R-squared 0.64210				

Source: Own Estimation; Eviews 12.

The gravity panel fixed effect results for China-BRICS intra-trade flows indicate an R-squared of 0.710628. This suggests that about 71% of gravity model variables are explained by the explanatory variables and only 29% are captured in the error term. The coefficient for GDP is positive and statistically significant at all levels. Therefore, it implies that economic growth in China determines intra-BRICS trade volumes. Distance has been reported to have a negative effect on intra-trade flows. Holding other things constant, with a 1 kilometer increase in distance between trading partners, intra-trade decreases by 0.01 percent. Similarly, exchange rate volatility has a negative impact on intra-BRICS trade flows. Thus, holding other things constant, a 1 percent increase in exchange rate volatility causes intra-trade flows to decrease by 0.009 percent.

Table 6 – China-BRICS Gravity panel effects are now fixed

Variable	Coefficient	Standard error	T-statistics	P-value
Constant	11.08217	0.193000	57.42057	0.0000
lnGDPit	0.006069	0.000282	21.49230	0.0000
lnDPit	0.027310	0.168310	0.162260	0.8431
lnMPit	0.454085	0.000540	60.22030	0.0000
lnEXRit	-0.009833	0.000612	-16.06259	0.0000
Dist	-0.013975	0.000576	-24.25305	0.0000
R-squared 0.710628 Adjusted R-squared 0.702645				

Source: Own Estimation: Eviews 12.

The South Africa-BRICS trade flows have been reported to be mainly influenced by distance. The coefficient for distance is negative for intra-trade flows in the BRICS. Thus, holding other things constant, a kilometer increase in the distance between South Africa and its trading partners would decrease intra-trade flow by 17 percent. Country size, which is determined by South African Gross Domestic Product (GDP), has a positive and statistically

significant 10 percent level. However, the contribution of GDP in South Africa to intra-BRICS trade flow is small. This is because the South Africa contain a low GDP value as compared to its BRICS trading partners. The table below illustrates the South Africa-BRICS gravity panel fixed-effects results.

Table 7 – South Africa—BRICS Gravity panel effects are now fixed

Variable	Coefficient	Std. Error	T-Statistic	Prob.
Constant	-0.06744	0.08669	-5.7297	0.000
lnGDPit	0.003969	0.00230	1.72566	0.082
lnDPit	0.005328	0.00236	2.25564	0.003
lnMPit	0.878807	0.23847	3.68523	0.002
lnEXRit	-0.083644	0.015959	-5.241346	0.000
lnDistit	-0.172358	0.062577	-2.754327	0.0119
R-squared 0. 65 Adjusted R-squared 0.62				

Source: Own Estimation; Eviews 12.

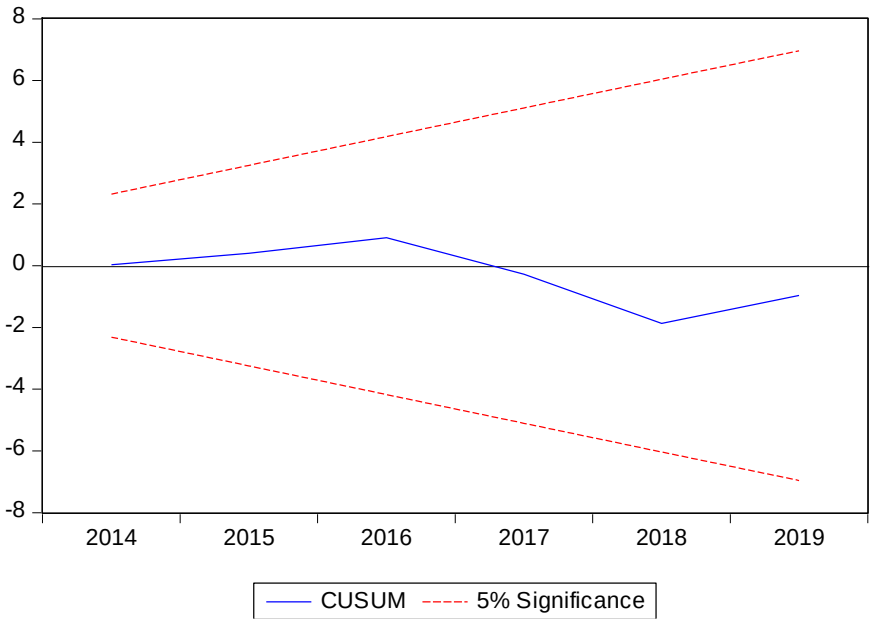

Figure 1 – The CUSUM test results

The results are stable, with the mean and variance falling between the two critical boundaries at the 5% level of significance. This implies that the model's residuals are stable, and thus the policy implications and recommendations derived from this study are adoptable and adaptable to improve intra-BRICS trade flows. Finally, this chapter examined the analysis, presentation, and interpretation of results. The following chapter will concentrate on the study's findings. It will also make recommendations that can be put into action.

CONCLUSION AND RECOMMENDATIONS

The estimated models show that distance (Dist) and exchange rate volatility (lnEXR) have negative relationships with intra-BRICS trade flows. GDP has been discovered to be an important determinant of BRICS intra-trade flows. The gravity model of trade assumes that the size of the economy and the distance between trading countries are the most important determinants of trade. All parameters are important for intra-BRICS countries. The positive relationship between GDP and intra-trade flows has also been confirmed by Batra (2004) and Bhattacharya and Banerjee (2006).

Regarding the distance effect, all estimated models support the finding that transportation costs are inversely related to intra-BRICS trade. In this regard, BRICS policymakers must take steps to reduce transportation costs, improve trading logistics, and

create policies to reduce non-tariff barriers. To boost intra-BRICS trade, BRICS countries should simplify export and import procedures. Although the GDP coefficient is statistically significant in all estimated models, Russia and India have a smaller magnitude than the other BRICS countries. The findings support the gravity model assumptions that trade is inversely related to distance, i.e., trade decreases with distance. Distance is associated with transportation costs and a great deal of paperwork, among other things. This finding indicates a disparity in intra-trade integration patterns among the BRICS countries, particularly China and India. Based on the gravity model's overall results, we can conclude that special emphasis should be placed on improving the region's level of development, international competitiveness, investment environment, and market base.

In a nutshell, intra-BRICS trade plans and policies must be linked to overall components of development and trade. The GDP and trade openness of the BRICS countries have a positive impact on their exports. As a result, policymakers in the BRICS economies should devise macroeconomic policies that reduce exchange rate volatility. Indeed, the BRICS economies should strengthen and restructure their domestic foreign exchange markets by developing broad, technology-driven forward exchange markets.

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