

Evolving Trends in Total Factor of Production, International Trade Openness and Economic Interactions among BRICS: Implications for Global Growth and Development

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Abstract

This research examines the evolving nature of the BRICS groups' influence on the global economy by integrating pertinent economic measures and synthesising findings from a range of academic publications. In light of Brazil, Russia, India, China, and South Africa's rise to global prominence, it is critical to grasp the significance of their economic alliance. Although some studies have touched on this topic, a thorough examination is required to either examine the complex relationships between trade openness, economic indicators, and GDP per capita in BRICS nations or to incorporate multiple separate findings.

To address this knowledge vacuum, this study scours academic literature and economic statistics in search of fresh insights into the pros and cons of BRICS economic cooperation expansion. This study uses panel

data analysis that spans the three decades from 1990 to 2019 to support its claims. The data comes from reliable sources including the World Bank and Penn World Tables.

Among the BRICS nations, these findings highlight the strong correlation between trade liberalisation and GDP growth. These insights can be useful for economists, policymakers, and everyone else with an interest in developing countries' capacity for international collaboration and sustainable economic development.

Keywords: Total Factor Productivity, Trade Openness, Economic growth, Consumer Price Index, GDP

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Introduction

All the BRICS countries - Brazil, Russia, India, China, and South Africa have a unique political regime, demographic pattern, and economic development. But what brings them all on the same track is the desire to reach long term economic growth which by

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extension will increase their ability to grow in the future. Since the influence of these five big emerging economies as continued growing in the global arena, British economist Jim O'Neill came up with the acronym BRICS in 2001. With such countries being more and more integrated into the global trade and economic relations, we need to know more about the character and dynamics of these relations.

A few years ago, Agarwal and Bhattacharya (2018) conducted a significant analysis of the trade openness of the BRICS countries and its connection with the GDP growth. According to the results, the major finding was the need to encourage trade liberalisation and economic integration to enhance the economic growth of these vital emergent economies.

Santos and Brito (2022) have depicted newer modes to enhance the regional commercial cooperation. This study was useful in providing an insight into how BRICS countries can increase their intra BRICS trade by exploiting sector complementarity.

In a similar line, Zhang et al. (2021) examined the economic impacts of BRICS, due to the BRI. To assess the possibilities of a large-scale investment in infrastructure, this research proposed to explore the efficiency of a megaproject in the context of liberalizing the international trade and advancing economic integration. It shed light on such important aspects as the impact of the BRI on trade relations and cooperation between the BRICS governments, where this cooperation plays a crucial role in the development of the economies of these countries.

It thus calls for a fresh look at the trends and patterns of international trade openness and economics among the BRICS countries given the evolutionary nature of the global economy set within a backdrop of mega events such as the COVID-19 epidemic.

These effects of the pandemic include the movement of trade around the globe, changes in supply, and changes in the trade around the globe. Therefore, it is essential that scholars, investors, and politicians understand the impact of these changes.

To this end, this study will focus on the regional integration and commerce of the BRICS countries, with a particular focus on trends in the international trade openness. As it is known, all the countries of the BRICS have great populations, the areas of continental sizes and impressive GDP that make them play a worthy role in the globalization of economic relations.

The literature review includes various scholarly articles such as Redalyc (2023), Gurevich & Muravyev (2020), Zhang & Tisdell (2018, 2020), Roy & Mehra (2013, 2020), Seema, Kumar, Singh & Chauhan (2019), Shaw (2020), Pelinescu & Stefanescu (2013, 2020), and Joo & Shawl (2023). Drawing on these valuable sources, we present a concise overview of BRICS countries' trends toward trade liberalisation and economic growth.

This analysis synthesises the results of several academic publications and incorporates relevant economic indicators in an effort to contribute to the continuing conversation on the BRICS bloc and its impact on the world economy. New research on the pros and cons of the growing BRICS economic alliance is our primary objective. Furthermore, we aim to clarify the policy implications of the findings and provide a future outlook on the trajectory of these important developing economies in relation to global trade liberalisation and GDP development.

As these nations' economies have undergone such drastic changes, it is important that we examine the BRICS and their degree of openness to trade with the

rest of the world. The sum effect of the BRICS nations is that they have a tremendous influence on world trade because they represent a very significant proportion of the world's population, landmass, and economic product. This is a one-time opportunity for them to become the movers of change of the banking and business systems of the world.

Several previous studies have laid the background although they have drawn the focus to the challenges and opportunities that the BRICS countries present within the context of the world economy. Trade liberalisation and the impact that it had on the economic growth for the BRICS countries was analysed extensively by Agarwal and Bhattacharya in their study conducted in 2018. Their results showed that trends revealed that trade liberalisation policy measures and openness are highly relevant to GDP growth rate.

Santos & Brito (2022) discovered new trade relationship opportunities among the five nations in their emerging status through analysing the BRICS trade dynamics and sectoral complementarities. The study further reveals that exposing members of the organisation to other industries' combined efforts can lead to work integration at a lesser cost.

Investments like commerce are essential to growth as highlighted in this paper. It is crucial that the returns on investment in BRICS countries are understood. This paper discusses the UNCTAD study on the BRICS investments that provides detailed analysis of the FDI trends and patterns in the countries of the BRICS (UNCTAD, 2021). This paper looks at factors that attract FDI, the sector which receives most FDI, FDI and GDP, and FDI and access markets.

It may also be also affected by policy platforms including the Belt & Road Initiative

(BRI) on the openness of the BRICS nations to free trade and economic relations. The BRI is aimed at strengthening the economic and infrastructure cooperation between China and the other countries it collaborates with, which are several BRICS nations. As Zhang noted in their work (2021), it is possible to identify both the benefits and risks of BRI. This paper discusses how the BRI attempts to facilitate the countries in BRICS to be more open and cooperative economically which in turn may affect their trade and growth prospects.

In order to compile this review, we will refer to the following sources: Information from the UNCTAD report on BRICS investments, official documents of the governments of the BRICS countries, and articles in several scientific journals (Redalyc, 2023 , Gurevich and Muravyev, 2020 , Zhang and Numerous studies—such as those by Tisdell (2018), Roy and Mehra (2013), Seema et al. (2019), Shaw (2020), and Pelinescu and Stefanescu (2020)—provide valuable insights into trade openness, economic development, and how BRICS nations respond to global economic challenges and opportunities. These studies collectively offer a comprehensive view of the dynamics shaping the global economy through the lens of emerging economies.

Consequently, through analyzing the background, policy actions, and data in BRICS trade environment and economic relations in this study, the author aims at providing a systematic understanding of the emerging trade structure of the developing BRICS group. We hope that this research will help to provide insights into the possibility of the BRICS economies promoting cooperation, liberalisation, and sustainable development in the global economy for the use of academics, investors, and decision-makers.

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Applying the method of quantitative analysis, Dabla-Norris et al. described the research on the impact of trade openness on economic growth in 110 countries including the member of BRICS (2003). Their findings indicated that trade openness has a positive incremental impact on economic growth when supported by effective labour market institutions and sound macroeconomic policies. Thus, this insight puts a focus on the extent to which it is necessary to reduce the restrictions on trade as they can significantly contribute to the growth of the economy.

According to Nissan et al. (2016), the cross-sectional dependence of the BRICS nations was analyzed in a panel data that examined the relationship between trade openness and economic growth, particularly GDP growth. This study, therefore, showed a positive relationship between the trade integration of the BRICS countries and their economic growth throughout the study period. The potential rewards for removing trade barriers and enhancing the openness to business could be observed here for the BRICS countries.

In his study, Montiel (2004) sought to understand the extent to which countries in emerging markets in this category, including several members of the BRICS bloc, benefited from freer trade in terms of GDP. The economic growth is supported with the help of freer trade but the researchers maintain that this is possible only under certain conditions. It is important to note that this kind of trade liberalisation must be complemented by other factors such as stable macroeconomic environment, human capital among others, for it to be successful.

In the empirical study, Khatri and Singh (2012) employed the cointegration and error correction techniques to assess the long-run

link between trade openness and economic growth in the BRICS states. Thus, the research revealed that the GDP of the BRICS countries increased at a higher rate when trade was open to outside competition, making it possible for trade to help the development of economies in these countries.

In a study focused on the effect of trade liberalisation on the economic growth of Turkey, Akbostanc et al. (2006) explored the highly relevant country's experience since the Turkish economy extensively resembles the BRICS nations. Trade liberalisation is associated with total factor productivity in the panel regression results. This study offers more evidence that free trade can enhance productivity and the economy as well.

Li and Zhu (2013) employed panel data analysis to examine the impact of trade openness on GDP growth in BRICS countries. Their findings indicate a significant positive relationship, suggesting that increased trade openness has been a key driver of accelerated economic growth in these emerging economies.

In a related context, Ocarin (2013) explored the effect of freer trade on economic growth within the Southern African Development Community (SADC), of which South Africa is a member and also part of BRICS. The study found that higher trade openness positively influences economic performance in the SADC region. These findings may offer relevant insights into the broader implications of trade liberalisation for BRICS nations as well.

Ribeiro and Lima (2021) explored the subject of income disparity among BRICS countries. These increases give credence to the necessity of addressing the distributional worries to guarantee that trade gains are shared fairly because these nations are more

susceptible to experiencing a rise in income disparity due to higher trade liberalisation.

Studies by Marques & Cruz (2014) focused on the impact of globalization on growth and development in the BRICS nations. Global trade can hence contribute positively to the development of poor countries' economy, as shown in the research. They were able to establish that trade is the engine of growth in international economies.

It was rather interesting to discover some peculiarities during the literature review on China within the framework of the BRICS model by Yu (2015). In the study made between the export and import openness, it was revealed that the export openness significantly affected the Chinese economic growth in a larger extent than the import openness. This means that there could be a positive impact on the BRICS states in terms of exports and economic returns.

Openness was examined by Baldwin in an empirical way in this regard and he suggested that openness enhances growth (2003). The result of the study shows that the interaction between trade openness and economic growth is intricate and not just a straight-line correlation with other factors such as institutional quality, human capital, and the speed of technology transfer having a more significant influence on the outcome.

Bhagwati and Srinivasan examined how international trade affects poverty in developing countries (2002). The authors stated that these nations can greatly benefit from trade openness—when combined with appropriate domestic policies and investments—in terms of reducing poverty and increasing economic growth.

As predicted, Busse and Königer (2012) reevaluated the relationship between trade and economic growth, and they discovered

that trade openness was related with greater rates of economic growth.

The author Edwards (1993) examined the effects of freer trade on developing-world economies. The results suggest that trade liberalisation could be beneficial to the growth and prosperity of these nations.

A study by Dollar and Kraay (2001) examined the relationship between trade, economic growth, and poverty alleviation, and found that developing nations can reap the benefits of increased trade openness through reduced poverty rates and improved incomes.

Economic growth in emerging countries was found to be Granger-caused by increased trade openness, according to a study by Gries and Redlin (2012), which used panel causality analysis to determine causation.

Harrison (1996) conducted a time-series cross-country research to examine the relationship between trade openness and economic growth in emerging economies. "The study found that openness is linked to growth, especially in emerging economies.

The interplay between trade, foreign direct investment (FDI), and India's GDP growth was examined by Jayachandran and Seilan (2010), who found that FDI and trade both contribute to economic development. In a developing-country context, the effects of freer trade on local economies were studied by Pernia and Quising (2003), who found that freer trade can help economies grow globally.

Srinivasan and Ravindra (2015) examined energy consumption, CO₂ emissions, economic growth, and international trade, and they found a bidirectional causal relationship between trade and economic growth in a country's context.

Research by Frankel and Romer (1999) using a gravity model of bilateral trade tested the hypothesis that trade produces economic

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growth and found that freer trade was associated with better GDP growth.

In a sensitivity analysis of cross-country growth regressions conducted by Levine and Renelt (1992), trade openness was identified as a predictor of economic growth; yet, the precise magnitude of this contribution varied across parameters.

When Marelli and Signorelli (2011) looked at the relationship between trade openness and economic growth rates in China and India, they found that the increased openness to commerce between the two countries is largely responsible for the phenomenal economic development rates that both countries have seen in the last few decades.

Munir et al. (2013) examined income inequality in Pakistan by analysing the effects of freer trade on the country's economy. The study indicated that trade openness has both positive and negative effects on income distribution, demonstrating the necessity of complementary policies to ensure that trade benefits are distributed equitably.

Srinivasan and Bhagwati (1999) critically examined the relationship between globalisation and trade openness in the light of different perspectives, arguing that, with the correct policies in place, trade openness can contribute to a country's success.

For nations with less restrictive trade policies, Ulaşan (2012) found that a higher degree of trade openness was connected with quicker economic growth. The study examined the relationship between countries' levels of openness to international commerce and their rates of economic growth.

Numerous studies have examined the correlation between trade and economic growth in China. For example, Kwan and Andy (1991), Kwan and Kwok (1995), and Fan et al. (2005), among many others. The results

of these studies show that exports are the primary driver of economic expansion, even though GDP growth is an external variable.

Despite the lack of research on the topic, two recent studies—one by Matos (2003) and another by Domal and Ozyurt (2010)—show that trade openness and human capital building are important factors in Brazil's economic growth, specifically in relation to the impact of exports on GDP.

Similarly, there is a dearth of Russian-specific research. Ledyeva and Linden (2008) examined growth in 74 Russian regions from 1996 to 2005, and their findings showed that exports, along with investments and economic expansion, were critical to Russia's progress.

Researchers in India have shown that exports contribute to economic growth in studies such as Dutt and Ghosh (1996), Nidugala (2001), and Bhattacharya and Bhattacharya (2011).

Similarly, empirical studies in South Africa by Loots (2002) and Kowalski et al. (2009) investigate the relationship between trade and economic growth. While Loots (2002) found that trade liberalisation accounted for 50% of South Africa's development from 1990 to 2000—the remaining 50% was explained by the influence of Latin America and other developing nations—Kowalski et al. (2009) found a positive relationship between trade liberalisation and economic growth in South Africa from 1988 to 2003.

According to this review of the theoretical literature, developing countries stand to gain more from trading with advanced economies. On the other hand, a weak trade-growth relationship could be the result of a lack of understanding and application of the principle of comparative advantage. One strategy that can help developing nations achieve

sustained economic growth through trade is value addition.

Despite a wealth of literature on the topic, researchers have not been able to agree on a single relationship between trade and GDP growth. For example, in their analysis of data from 61 developing countries, Kim and Lin (2004) used a threshold regression method based on instrument variables and came up with an income threshold of 41.5%. They found that when trade volumes are above a certain level, GDP growth averages 12.4%, but when trade volumes are below this level, GDP growth averages 14.2% lower due to trade openness.

Afzal and Hussain (2010) took the case of Pakistan to investigate dynamic economic relationship between export, import and economic growth with quarterly data dating back to 1990Q1 to 2008Q1. They found that economic growth and exports were not cointegrated in the long run, as well as the Granger tests showed no causality between the exports, imports and growth. In addition, the analysis of variance decomposition functions and impulse response functions denoted a poor and negative relationship between these variables. According to these findings, the authors did not find empirical evidence in favoring the export-led growth hypothesis in Pakistan.

Against this background, the main objective of this study is to find out how the economies of the BRICS countries would respond if they were more or less open to foreign trade. Specifically, the paper aims to examine the effects of different levels of trade openness, inflation (CPI), total factor productivity (TFP), and government size on the economies of the BRICS countries. The purpose of this analysis is to find out how trade openness affects economic growth in

these developing economies and which major economic indicators have a significant impact on GDP per capita.

Model:

This study investigates the impact of market liberalisation, inflation (CPI), TFP and administrative load on economic growth and is based on the panel data analysis. On this basis, it can be noted that the analysis of panel data is more preferable as the comparison with other methods because it allows to investigate both time and cross-sectional variations, which increases the accuracy and efficiency of the estimates.

GDPPC (Gross Domestic Product per Capita): The GDPPC is the other measure that is used in determining a country's level of economic development, and it is expressed in terms of per capita GDP. Another important measure of economic development is the Gross Domestic Product per capita (GDPPC), which underscores the typical standard of sustained accomplishment in a country. Improved standards of living for the population and the overall enhancement of the living conditions are also signs of an advanced economy depicted by a higher GDP per capita. Economically developing countries can be defined as those countries in which the overall per capita gross domestic product commonly increases.

TO (Trade Openness): Trade openness (TO) is the extent to which a country engages in international business trade. The process of finding it usually involves comparing the value of the Gross Domestic Product to the value of exports and imports. Global business entails exchanging of products and services between countries, which is important for the growth of economies. This simply means that the extent to which a country's economy relies on the

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foreign markets is the level of trade openness. The potential impacts of this trend might be: higher probability to export domestic goods, higher investment from the outside, higher innovation as a result of information leakages, larger scale economy. All these factors are beneficial to countries that are open to trade.

TFP (Total Factor Productivity): Total factor productivity commonly known as TFP is a useful measure of output that reflects general economic efficiency and productivity of labour, capital and technologies. Total factor productivity (TFP) has a significant correlation with economic development and trade liberalisation. Any economy that provides more output from fewer inputs, has a high total factor productivity (TFP). It is argued that companies can achieve more competitiveness in the global market and, in the long term, can contribute positively to economic development through this improvement in efficiency. Increased free trade promotes the spread of information and the exchange of information and the spread of the better practices, the impact of which is positive for TFP.

CPI (Consumer Price Index): Consumer Price Index (CPI) is used to record how individuals and families spend their money on different items in a given month. CPI is a tool that enables us to understand the effects of foreign commerce on domestic prices when evaluated in the context of trade openness. Higher levels of trade liberalisation holds the probability of affecting domestic prices through altering the range and accessibility of products and services available in the market. As for how trade openness affects consumer prices, it is related to factors like import competition or fluctuation in the currency rates or changes in policy. It is impossible to record long term economic growth without

closely monitoring inflation and this is based on the consumer price index.

GS (Government Size): A nation's GS indicates the extent to which the government has an impact on the economy. It is common practice to determine GS as a proportion of GDP. In order to promote economic growth and freer commerce, the government plays a crucial role. Economic openness could be facilitated by a competently managed and efficient government through the implementation of appropriate trade policies, the reduction of trade barriers, and the promotion of investment in people and physical resources. Education, healthcare, R&D, and infrastructure spending can increase productivity and competitiveness, which can lead to faster economic growth.

This analysis relies heavily on data collected from two well renowned sources: the World Bank and the Penn World Tables. The BRICS countries are among the many that have their macroeconomic data made public by the World Bank. Data such as GDP per capita, trade openness, inflation (CPI), and government size (as a percentage of GDP) are all part of the World Development Indicators database maintained by the World Bank. Whereas, total factor productivity (TFP) numbers are sourced from the Penn World Tables, an international database of economic variables.

Members of the "BRICS" group—South Africa, Brazil, Russia, India, and China—form the study's sample. Their growing economic influence on the global scene is a major factor in their selection. From 1990 all the way up to 2019, this data collection allows us to look at how the economy has changed. We chose this time frame because it provides the most comprehensive and consistent data collection for all of our relevant variables.

The study has used the following techniques for the analysis of data:

a. Panel Data model:

The panel data is analysed using STATA. We use both the fixed-effect and random-effect models to look at things like trade openness, inflation, GDP per capita, government size, and total factor productivity. In contrast to the fixed-effect model, which solely takes into consideration features that remain constant over time and across nations, the random-effect model allows for the inclusion of uncorrelated random effects that are particular to each country.

b. Hausman Test:

To determine whether the model is more appropriate for the data, the Hausman test is applied after the fixed-effect and random-effect models have been computed. If researchers want to know if the independent variables are related with the country-specific effects, they can use the Hausman test. This will tell them if the fixed-effect or random-effect model is more effective and consistent.

The study isn't without its flaws either. Although the research period (1990–2019) may not account for short-term fluctuations or current economic changes, these factors may yet impact the correlations between the variables.

Any quantitative study has its limitations, and the model is no exception; it cannot possibly account for every important factor influencing economic growth.

Although this study provides robust evidence on the relationship between trade openness and economic growth in BRICS countries, its findings should be interpreted with caution when applied to other regional or economic groupings. Differences in institutional frameworks, development stages,

and macroeconomic conditions across countries may limit the generalisability of the results beyond the BRICS context.

Results and Discussion:

The hypotheses involved in the study are as follows:

Null Hypothesis (H_0): There is no significant relationship between trade openness, inflation (CPI), total factor productivity (TFP), and government size with GDP per capita among the BRICS nations.

Alternative Hypothesis (H_a): There is a significant relationship between trade openness, inflation (CPI), total factor productivity (TFP), and government size with GDP per capita among the BRICS nations.

Model

$$(GDPPC) = f(TO, CPI, TFP, GS) \quad (i)$$

$$\ln(GDPPC) = \beta_0 + \beta_1(TO) + \beta_2(CPI) + \beta_3(TFP) + \beta_4(GS) + \varepsilon_1 \quad (ii)$$

After log,

$$\ln(GDPPC) = \beta_0 + \beta_1 \ln(TO) + \beta_2 \ln(CPI) + \beta_3 \ln(TFP) + \beta_4 \ln(GS) + \varepsilon_1 \quad (iii)$$

Where,

GDPPC is Gross Domestic Product at Per Capital

TO is trade openness

TFP is Total Factor of Production

CPI is Consumer Price Index

GS is Government Size

Table 1. Results of Fixed Effect model

Variables	Dependent Variables is GDP Per Capital						
	Coef.	T-Value	P-Value	95% Conf	Interval	St Err	Sig
Trade Openness	.608	3.87	0	.297	.919	.157	***
CPI	-.158	-4.60	0	-.226	-.09	.034	***
TFP	3.331	8.71	0	2.574	4.088	.383	***
Government Size	-.564	-2.40	.018	-1.028	-.099	.235	**
Constant	8.165	17.59	0	7.247	9.083	.464	***

Computed by Author's *** $p < .01$, ** $p < .05$, * $p < .1$

R ²	0.671
F-test	67.289
Akaike crit. (AIC)	171.353
SD (Depnt.)	1.105
Number of obs	141
Mean dependent var	7.984
Bayesian crit. (BIC)	186.097

The regression analysis is used to model the relationship between the dependent variable, GDP per capita (GDPPC), and several independent variables. The fixed-effect model is applied to control for individual-specific effects, allowing the researchers to analyze the impact of the independent variables on GDP per capita while accounting for unobserved heterogeneity among the BRICS countries in the dataset.

Trade Openness (Coefficient: 0.608, Standard Error: 0.157, t-value: 3.87, p-value: 0, 95% Conf Interval: 0.297 - 0.919, Significance: ***):

The coefficient for Trade Openness is 0.608, indicating that a one-unit increase in Trade Openness is associated with an estimated increase of 0.608 units in GDP per capita, all other variables being held constant. The t-value of 3.87 suggests that this relationship is statistically significant at a very

high confidence level (p-value of 0, denoted by ***), indicating that Trade Openness has a significant impact on GDP per capita for the BRICS countries.

Consumer Price Index (CPI) (Coefficient: -0.158, Standard Error: 0.034, t-value: -4.60, p-value: 0, 95% Conf Interval: -0.226 to -0.09, Significance: ***):

The coefficient for CPI is -0.158, indicating that a one-unit increase in the Consumer Price Index (CPI) is associated with an estimated decrease of 0.158 units in GDP per capita, holding other variables constant. The negative coefficient suggests that higher inflation, represented by an increase in CPI, is associated with lower GDP per capita in the BRICS countries.

The t-value of -4.60 indicates that this relationship between CPI and GDP per capita is statistically significant at the 1% level. A p-value of 0 is commonly used to indicate

that the p-value is very small, typically smaller than the smallest representable value in the given format (often denoted as $p < 0.001$).

Therefore, the correct interpretation is that higher inflation, as measured by an increase in the Consumer Price Index (CPI), is statistically associated with lower GDP per capita among the BRICS countries. The very low p-value ($p < 0.001$, denoted by ***) confirms that this relationship is highly statistically significant, providing strong evidence of the significant negative impact of inflation on GDP per capita in the context of the BRICS nations.

Total Factor Productivity (TFP) (Coefficient: 3.331, Standard Error: 0.383, t-value: 8.71, p-value: 0, 95% Conf Interval: 2.574 to 4.088, Significance: ***):

The coefficient for TFP is 3.331, implying that a one-unit increase in Total Factor Productivity is associated with an estimated increase of 3.331 units in GDP per capita, holding other variables constant. The t-value of 8.71 indicates that this relationship is highly statistically significant (p-value of 0, denoted by ***), indicating that TFP has a significant positive impact on GDP per capita for the BRICS countries.

Government Size (Coefficient: -0.564, Standard Error: 0.235, t-value: -2.40, p-value: 0.018, 95% Conf Interval: -1.028 to -0.099, Significance: **):

The coefficient for Government Size is -0.564, indicating that a one-unit increase in Government Size (measured by government spending or other relevant metrics) is associated with a decrease of 0.564 units in GDP per capita, holding other variables constant. The t-value of -2.40 suggests that this relationship is statistically significant at a 5% confidence level (p-value of 0.018, denoted by **), indicating that Government

Size has a significant negative impact on GDP per capita for the BRICS nations.

Constant (Coefficient: 8.165, Standard Error: 0.464, t-value: 17.59, p-value: 0, 95% Conf Interval: 7.247 to 9.083, Significance: ***):

The constant term in the regression equation is 8.165, representing the estimated value of GDP per capita when all the independent variables are zero. The t-value of 17.59 indicates that the constant term is highly statistically significant (p-value of 0, denoted by ***).

Other Important Statistics:

Mean dependent variable: The mean value of the dependent variable, GDPPC, is 7.984.

SD dependent variable: The standard deviation of the dependent variable, GDPPC, is 1.105.

R-squared: The R-squared value of 0.671 indicates that approximately 67.1% of the variation in GDP per capita can be explained by the independent variables in the model.

Number of observations: The regression is based on 141 observations (countries or regions).

F-test: The F-statistic of 67.289 with a probability (p-value) of 0 indicates that the overall regression model is statistically significant, meaning that at least one of the independent variables is significantly related to the dependent variable.

Akaike criterion (AIC): The AIC value of 171.353 is an information criterion used to compare different models, with lower AIC values indicating a better fit.

Bayesian criterion (BIC): The BIC value of 186.097 is another information criterion used to compare models, with lower BIC values indicating a better fit.

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In conclusion, the fixed-effect regression results indicate that Trade Openness, Total Factor Productivity, and Government Size have significant effects on GDP per capita among the BRICS nations. Higher Trade Openness and Total Factor Productivity positively impact

GDP per capita, while higher inflation (CPI) and larger Government Size have negative effects on GDP per capita. These findings provide valuable insights for policymakers and researchers studying the economic dynamics within the BRICS bloc.

Table 2. Results of Random Effect model

Variables	Dependent Variables is GDP Per Capital						
	Coef.	T-Value	P-Value	95% Conf	Interval	St Err	Sig
TOO	.864	6.64	0	.609	1.12	.13	***
CPI2	.002	0.06	.953	-.075	.08	.039	
TFP1	4.735	16.94	0	4.187	5.283	.279	***
GS	1.106	7.32	0	.81	1.403	.151	***
Constant	11.086	37.05	0	10.5	11.673	.299	***

*** $p < .01$, ** $p < .05$, * $p < .1$

R ²	0.724
Chi-square	356.024
R ² between	0.590
SD (Depnt.)	1.105
Number of obs	141
Mean dependent var	7.984
Prob>chi2	0.000

The random effect model aims to explore the relationship between the dependent variable, GDPPC (GDP per capita), and several independent variables, including Trade Openness (TO), Consumer Price Index (CPI), Total Factor Productivity (TFP), and Government Size (GS). The results also include the constant term.

The regression results:

Trade Openness (TO) (Coefficient: 0.864, Standard Error: 0.13, t-value: 6.64, p-value: 0, 95% Conf Interval: 0.609 - 1.12, Significance: ***):

The coefficient for Trade Openness (TO) is 0.864, indicating that a one-unit increase

in Trade Openness is associated with an estimated increase of 0.864 units in GDP per capita, holding other variables constant. The t-value of 6.64 suggests that this relationship is statistically significant at the 1% level (p-value of 0, denoted by ***), providing strong evidence that Trade Openness has a significant positive impact on GDP per capita.

Consumer Price Index (CPI) (Coefficient: 0.002, Standard Error: 0.039, t-value: 0.06, p-value: 0.953, 95% Conf Interval: -0.075 to 0.08):

The coefficient for the Consumer Price Index (CPI) is 0.002, indicating that a one-unit increase in CPI has a very marginal effect (0.002 units) on GDP per capita. The t-value

of 0.06 suggests that this relationship is not statistically significant (p-value of 0.953, not denoted by *, **, or ***), indicating that CPI2 is likely not a significant predictor of GDP per capita in this model.

Total Factor Productivity (TFP) (Coefficient: 4.735, Standard Error: 0.279, t-value: 16.94, p-value: 0, 95% Conf Interval: 4.187 to 5.283, Significance: ***):

The coefficient for Total Factor Productivity (TFP) is 4.735, indicating that a one-unit increase in TFP is associated with an estimated increase of 4.735 units in GDP per capita, holding other variables constant. The t-value of 16.94 suggests that this relationship is highly statistically significant at the 1% level (p-value of 0, denoted by ***), providing strong evidence that TFP has a significant positive impact on GDP per capita.

Government Size (GS) (Coefficient: 1.106, Standard Error: 0.151, t-value: 7.32, p-value: 0, 95% Conf Interval: 0.81 to 1.403, Significance: ***):

The coefficient for Government Size (GS) is 1.106, indicating that a one-unit increase in Government Size is associated with an estimated increase of 1.106 units in GDP per capita, holding other variables constant. The t-value of 7.32 suggests that this relationship is statistically significant at the 1% level (p-value of 0, denoted by ***), providing strong evidence that Government Size has a significant positive impact on GDP per capita.

Constant (Coefficient: 11.086, Standard Error: 0.299, t-value: 37.05, p-value: 0, 95% Conf Interval: 10.5 to 11.673, Significance: ***):

The constant term in the regression equation is 11.086, representing the estimated value of GDP per capita when all the independent variables are zero". The t-value of 37.05 indicates that the constant term is

highly statistically significant at the 1% level (p-value of 0, denoted by ***).

Additional Information:

Mean dependent var: The mean value of the dependent variable, GDPPC1 (GDP per capita), is 7.984.

Overall r-squared: The overall R-squared value of 0.724 indicates that approximately 72.4% of the variation in GDP per capita is explained by the independent variables in the model.

Chi-square: The chi-square value of 356.024 with a probability (p-value) of 0 indicates that the overall model is statistically significant, meaning that at least one of the independent variables significantly explains the variation in the dependent variable.

R-squared within: The R-squared within of 0.523 indicates the proportion of the variation in GDP per capita that is explained by the independent variables within each entity (country or region).

R-squared between: The R-squared between of 0.890 indicates the proportion of the variation in GDP per capita that is explained by the independent variables between entities.

Hausman Test Result: The Hausman test is used to assess whether the fixed-effect or random-effect model is more appropriate for the panel data analysis. The test compares the estimated coefficients from both models to determine if there is a significant difference between them. Here, we are interested in comparing the fixed-effect model, which accounts for time-invariant individual effects, with the random-effect model, which assumes that the individual effects are uncorrelated with the independent variables.

Chi-square test value: 41.707

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P-value: 0 (or very close to 0, as indicated by "P-value 0")

Interpretation of the Result:

The Hausman test evaluates two hypotheses: one states that the random-effect model is consistent and efficient (like the fixed-effect model), while the other states that it is inconsistent or less efficient.

We can reject the null hypothesis (H_0) in this example since the Hausman test yielded a low p-value (0). This indicates that the fixed-effect and random-effect estimates are significantly different, suggesting that one of the models is flawed or inconsistent.

Deciding on the Right Model: We must determine whether the model is better suited to the provided dataset since the Hausman test indicates a substantial difference between the two. In cases where the p-value is extremely small, as it is here, the fixed-effect model is typically the one to choose.

When there is a worry about endogeneity or the bias caused by omitted variables, the fixed-effect model is appropriate since it controls the unobserved time-invariant individual effects. More accurate and efficient estimations of the regression coefficients are produced as a result.

In 1978, J. A. Hausman wrote "Specification Tests in Econometrics." The paper was published in *Econometrica*, volume 46, issue 6, pages 1251–1271. This is the seminal work of Jerry A. Hausman, in which he first proposed the Hausman test and elaborated on its use in econometric research. This study provides an overview of the test's theoretical underpinnings as well as its practical application in deciding between random-effect and fixed-effect models for panel data analysis.

According to the Hausman test, the dataset consisting of the BRICS countries is more suited to the fixed-effect model

Policy Implications:

This study's findings give strong evidence that the BRICS countries' economies are linked to freer trade and greater GDP growth rates. In regression analysis, the relationship between trade openness and GDP per capita is consistently shown to be strong. This result lines up with the theoretical framework that suggests that more trade openness could raise economic growth by making commodities and services more accessible to more people, better allocating resources, and speeding up the spread of new technology.

The total factor productivity (TFP) is an essential component of the sources of economic growth in the BRICS countries. Increase in productivity is vital in ensuring economic development as evidenced by the correlation between TFP and GDP per capita. For those that desire to boost productivity, they should focus on innovation, research and development, and the promotion of appropriate technologies.

The research findings also show that there is a negative correlation between the higher consumer price index inflation and the GDP per capita in the BRICS countries. To minimize the effects of inflation in economic growth, the level of prices should be controlled and sound monetary policy should be adopted. This paper argues that the inflation rate should remain low and stable to support the implementation of macroeconomic policies that would enhance long-term economic growth.

The study finds that the GDP per capita for the BRICS nations reduces with the expansion of governmental size. This in turn implies

that overbearing government and wasteful spending are inimical to economic growth and development. There is need for sound fiscal policies that should be championed by the policy makers that aim at promoting private sector dominated economic growth, and efficient spending with focus on social overhead capital like health, education and physical infrastructure.

The research also emphasizes the idea of cooperation among the regional BRICS countries as a way to develop the regional economy and enhance the level of investments and trade between its members. Thus, integrating several sectors in the export business may help the BRICS nations to avoid overreliance on any particular region or country. More integration within the union means there could be several beneficial outcomes such as economic complementarity or mutual development.

This article has explored the relationship between trade openness and economic growth amongst the BRICS nations which include South Africa, Brazil, Russia, India, China. Thus, to comprehend the trend of the international trade openness and its effect on the per capita GDP of these developing economies, this study has also employed various economic indicators and used fixed effect and random effect models. The outcome is knowledge that is beneficial

This research provides support to the hypothesis of trade openness as an important variable in the emergent economies of the BRICS nations. The regression results reveal that there is a positive and statistically significant relationship between trade openness and the coefficient of GDP per capita. This is in concordance with economic theories that argue that trade liberalization acts like a catalyst in opening up economies

by enabling technology transfer, availability of a wide range of goods and services, and efficient utilization of resources.

Moreover, it has also been established that TFP is one of the factors impacting the economy of the BRICS bloc. The relationship between TFP and GDP per capita is positive, which indicates that technology advancement, changes in production techniques, or any other technical advancement is a major factor that is contributing to economic development. The politicians should focus on increasing the level of productivity and on achieving sustainable economic development in the future. This can be done through allocation of resources towards the development of research and innovation, technology and human capital.

Another important finding of this research is that inflation hinders the growth of the BRICS economies. This means that the prices have to be kept stable and its monetary policies have to be reasonable since high rates of inflation have been found to weaken the positive relationship between trade openness and economic growth. The overall economic stability is crucial for economic development, and the authorities should ensure that inflation rates remain as low as possible through proper regulation of the fiscal and monetary policies.

Also, this study proves that the BRICS countries have a negative relationship between the GDP per capita and government spending. The effects and efficiencies flowing from trade liberalisation can be subdued by intervention from the government. Apart from this, a pragmatic fiscal policy that encourages private sector-led growth while at the same time focusing on the core needs of public infrastructure including health and education

will assist the legislators in dealing with this issue.

This study has provided useful results for scholars, investors, and policymakers to understand the potential of these growing economies of the BRICS countries, and the results present new findings about the trade and economic growth. The policies of macroeconomic adjustments that the BRICS countries should follow in order to support long-term domestic and international economic growth include the promotion of open trade, advancement in technology and development of human capital.

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