Effect of trade openness on economic growth within BRICS countries: an ARDL panel approach

Утицај отворености трговине на економски раст унутар земаља БРИКС-а: приступ АРДЛ панела

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Abstract: This paper investigates the connection between trade openness and economic growth in the BRICS countries (Brazil, Russia, India, China, and South Africa) using an autoregressive distributed lag (ARDL) panel approach. The study aims to shed light on the importance of international trade in fostering economic growth, particularly for developing countries. We assess the long-term equilibrium relationship between trade openness and economic growth in the BRICS context using a comprehensive panel dataset and advanced econometric techniques. The findings indicate a positive and significant impact of trade openness on economic growth, emphasizing the need for policies promoting trade liberalization and attracting foreign direct investment. This study contributes to the existing literature by offering empirical insights into the specific dynamics of trade openness and economic growth within the BRICS countries.
Keywords: economic growth, trade openness, BRICS countries, ARDL dynamic panel model.
JEL classification : F14, F43, F41, C23

Сажетак: Овај рад истражује везу између отворености трговине и економског раста у земљама БРИКС-а (Бразил, Русија, Индија, Кина и Јужна Африка) користећи ауторегресивни дистрибуирани приступ панела (АРДЛ). Циљ студије је да се расветли значај међународне трговине у подстицању економског раста, посебно за земље у развоју. Користећи свеобухватан панел скуп података и напредне економичне технике, процењујемо дугорочни еквилибријумски однос између отворености трговине и економског раста у контексту БРИКС-а. Закључци указују на позитиван и значајан утицај трговинске отворености на економски раст, наглашавајући потребу политике промовисања либерализације трговине и привлачења директних страних инвестиција. Ова студија доприноси постојећој литератури нудећи емпиријске увиде у специфичну динамику отворености трговине и економског раста унутар земаља БРИКС -а.
Кључне речи: отвореност трговине, економски раст, земље БРИКС-а, АРДЛ модел динамичког панела.
ЈЕЛ класификација: F14, F43, F41, C23

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1. Introduction

The intricate association between trade liberalization and economic development has been thoroughly investigated within economics. Understanding the underlying causes and consequences of trade liberalization is of utmost significance for policymakers, particularly in developing countries pursuing pathways to achieve sustainable economic growth. The BRICS countries, composed of B*razil, R*ussia, I*ndia*, C*hina*, and S*outh A*frica (Zafar et al., 2022), have emerged as significant actors in the global economy and present a unique context for analysing the link between trade liberalization and economic progress.

The research conducted by Chen and Been-Lon (1999) investigates the correlation between trade openness and economic development in East Asia and Latin America, representing one of the pioneering research endeavours in this field. The research findings suggest a positive connection between trade liberalisation and economic expansion in the specified regions. Hadri (2000) presents a significant scholarly contribution examining stationarity in heterogeneous panel data. This work offers a valuable econometric methodology for investigating the correlation between trade liberalisation and economic growth.

In a chronological progression, Irwin and Tervio (2002) undertake a thorough examination of the potential of trade to augment income, utilising data from the twentieth century. The analysis provides evidence supporting trade's positive impact on income. In a recent study, Brueckner and Lederman (2015) employ a panel data approach to investigate the connection between trade liberalisation and economic growth in Sub-Saharan Africa. Their research findings indicate a positive correlation, implying that increased trade openness may contribute to economic growth within this region.

Numerous investigations have concentrated explicitly on the BRICS nations. Bayar (2016) delves into the influence of openness and economic liberty on economic progress in the transitioning economies of the European Union (Brkić et al., 2020). Their research outcomes underscore the affirmative link between openness and economic growth. In a separate research, Burange, Ranadive, and Karnik (2019) conducted an in-depth analysis of the BRICS countries, examining the interconnection between trade liberalisation and economic expansion. Their research furnishes empirical data affirming a positive association between these two aspects.

Banday, Murugan, and Maryam (2020) employ panel data evaluation to investigate the correlation between foreign direct investment, trade openness, and economic development in the BRICS nations. Their investigation offers additional proof of the beneficial impact of trade liberalisation on economic progress in the BRICS setting. These contemporary research pieces emphasise the significance of considering panel data and its distinct attributes when scrutinising the connection between trade liberalization and economic growth, specifically in the BRICS nations.

Beyond the studies on BRICS nations, other pertinent research explores the effect of trade liberalisation on economic development in various country scenarios. For example, Dritsaki and Stamatiou (2019) delve into the effect of market openness on Poland's economic

growth by employing an autoregressive distributed lag-bounds testing methodology. Their research results propose a positive correlation between market openness and economic growth.

Multiple researchers have also delved into the significance of policy harmonisation in the relationship between trade and growth. Chang et al. (2009) underscored the beneficial influence of policy synergies on economic growth, stressing that trade openness by itself might not be enough to attain enduring economic evolution. Chatterjee and Naka (2022) offered valuable perspectives on the political and economic metamorphoses within the BRICS nations, investigating the contribution of land policies in determining their growth paths.

Although current research underscores a positive link between trade liberalisation and economic development in the BRICS nations, certain studies have scrutinised individual country instances. Bayar (2016) investigated the influence of openness and economic liberty on economic progress within the transitioning economies of the European Union. Bechtini and Hassen (2018) probed the correlation between trade liberalisation and economic expansion in Tunisia. These studies offer a valuable understanding of the distinctive circumstances of these countries and contribute to the comprehensive comprehension of the link between trade and growth.

Even with the substantial amount of existing research, there remain voids in our comprehension of the precise processes by which trade liberalisation influences economic development in the BRICS nations. For example, the academic literature could gain from further detailed investigations of the pathways through which foreign direct investment and policy harmonisation impact economic growth. Moreover, there's a requirement for studies that account for possible variances across different sectors and regions within the BRICS countries. While most theoretical investigations have not yet arrived at a definitive and unambiguous conclusion regarding how trade liberalisation impacts growth, the lion's share of applied studies converges on a particular notion: trade openness catalyses economic growth.

In order to fill these voids, this paper aims to elucidate the connection between trade liberalisation and economic progress in the BRICS nations. By amalgamating the results of pertinent studies and pinpointing major patterns and areas needing further research, this review enriches the current body of knowledge and delivers valuable insights for subsequent research efforts and policy formulation. The last part of this work is arranged in the following manner. The first section is a review of the available literature. Section 2 lays out the methodology, data, and variables involved in the analysis. This is followed by Section 3, which deals with the empirical findings and their interpretation. Lastly, Section 4 wraps up the paper by providing conclusions and recommendations and suggesting potential directions for subsequent research.

Given the facts presented above, the primary research question that arises is:

How significantly does the policy of trade opening contribute to the economic growth of the BRICS group of countries?

In response to the primary research question, the subsequent hypotheses have been formulated:

H1: There is a discernible and substantial correlation between the degree of trade opening and the rate of economic expansion within the BRICS group of nations;

H2: Trade Openness leads to the influx of foreign investment because the most important effect of openness in a country is its ability to attract capital, which raises the growth rates within the BRICS group of countries.

2. Literature review

Extensive scholarly investigations have investigated trade liberalisation's effect on economic development, employing various research methodologies, temporal scopes, and geographic contexts. The study conducted by Mercan et al. (2013) investigated the connection between trade openness and economic growth within the BRICS nations and Turkey. Panel data spanning from 1989 to 2010 was utilised for this investigation. The findings of their inquiry revealed a positive and statistically significant correlation between openness and economic progress.

In the research carried out subsequently (Bayar, 2016), an exploration was undertaken to unravel the long-term correlations between economic growth, openness, and economic freedom in the transitioning economies of the European Union (EU) from 1996 to 2012. The analysis relied on real GDP per capita as the dependent variable. To quantify trade openness, the researcher utilised the combined total of exports and imports as a percentage of GDP (Al Kasasbeh et al., 2022). Financial openness was represented using the Chinn-Ito index (KAOPEN), while economic freedom was approximated by employing the panel Augmented Mean Group (AMG) method.

The study conducted by Brueckner and Lederman (Brueckner & Lederman, 2015) tested the link between trade openness and economic growth in Sub-Saharan Africa (Daniel Chindengwike St John & Daniel Chindengwike, 2023). The researchers used least squares and system GMM estimates (Generalised Method Moments) to analyse this link. The results of the analysis indicate a statistically significant positive relation between trade openness and economic expansion. Table 1. Provides studies focused on examining the relationship between economic growth and openness.

*Table 1. Review of the most important studies that have been exposed
to the link between trade openness and economic expansion*

Study	Period and sample	Methodology	Findings
(Penelitian Ilmu Ekonomi et al., 2020)	1986-2017 in Indonesia	Generalised Method of Moments (GMM method)	The variables significantly affect the trajectory of economic development in Indonesia. The economic development of Indonesia is significantly influenced by factors such as trade, foreign direct investment (FDI), inflation, and the size of the workforce.

(Yusuf & Omar, 2091)	1981 to 2017 in Tanzania	Co-integration, VECM, and Granger causality	During the study period, there was a positive association between trade liberalisation and Tanzania's economic growth. The findings derived from the Granger causality analysis revealed a lack of causal linkage between trade liberalisation and economic expansion in Tanzania.
(Yahya Khan et al., 2020)	1981-2019 in Pakistan	Co-integration approach,	The effect of trade openness on economic development and its influence on other variables investigated in previous research, including foreign direct investment, inflation, exchange rate, and interest rate, is substantial.
(Kamsin et al., 2020)	1980-2018 in MALAYSIA	ARDL bound test (Autoregressive distributed lag model)	Capital formation and Foreign direct investment (FDI) are commonly used as indicators to assess the effect of trade liberalisation mechanisms and measure trade openness.
(Ram, 2010)	India from 1950 to 2008	Co-integration, Granger causality, and Error Correction Model	A long-term connection between openness and economic growth results in an equilibrium relationship. There exists a positive correlation between economic expansion and trade openness.
(Din et al., 2003)	1960-2001 In Pakistan	error-correction model, Granger causality	No causal relationship has been established between trade openness, measured by the total value of exports and imports, and short-term economic growth.
(Bechtini & Hassen, 2018)	Tunisia from 1980- 2014	Granger Causality and Error-Correction Model and	The effect of economic openness on Tunisia's growth is substantial and favourable. The presence of a bidirectional causal connection hinders the progress of economic growth.
(Dritsaki & Stamatiou, 2019)	1990-2016 in Poland	The (ARDL) autoregressive distributed lag and the error correction model (ECM) technique is utilised in the analysis.	The temporal data utilised in the model are of an annual frequency and encompass the time period from 1990 to 2016. The data used in the model is obtained from reputable sources such as the United Nations Conference on Trade and Development (UNCTAD) the Organisation for Economic Co-operation and Development (OECD), and global growth indices. The variable "trade openness" denotes the per capita value of real exports and imports, whereas "financial development" is quantified by the value of real domestic credit extended to the private sector. The test model demonstrates equilibrium connections between trade openness, financial development, and economic development, both in the long and short run (Al Kasasbeh et al., 2022)
(Idris et al., 2018)	From 1977 to 2011, 86 developing and OECD nations	Generalised Method of Moments (GMM)	In the case of developing countries, they should think about FDI because it helps growth, while government spending may hurt growth.

| (Chang et al., 2009)	From 1996 to 2010 studying 34 countries were grouped into 17 dev. and developing countries	Balanced Panel Dataset	The findings suggest a positive association between trade openness and economic growth in developing nations, while a negative correlation is observed in developed countries.
(Tahir & Khan, 2014)	1990-2009 in Asian developing countries	Panel econometric techniques and 2SLS	The economies of developing Asian countries have greatly benefited from trade liberalisation. Economic growth in the studied countries has been influenced by domestic investment. However, human capital has shown a negative effect on economic growth.
(Cieślik & Tarsalewska, 2011)	1974–2006 in 97 developing countries	Estimation methods using panel data.	Both foreign direct investment (FDI) and international trade positively contribute to economic growth.

Source: summary of the research team

3. Data and methodology

3.1. Data

In the past two decades of the twentieth century, developed economies experienced average GDP growth of 2.9%, while developing economies had a higher growth rate of 3.6%. However, from 2000 to 2010, the growth rates shifted to 1.9% for developed countries and a significant 6.2% for developing countries. Projections from the International Monetary Fund (IMF), as stated by (Radulescu et al., 2014), indicate that this gap will continue to persist between 2011 and 2015, with developing countries projected to achieve a growth rate of 6.6% compared to 2.5% for advanced countries. Notably, within the group of emerging economies, the BRIC countries have stood out with an average GDP growth rate of 7.9% from 2000 to 2010. This growth rate is expected to increase further to 8.1% between 2011 and 2015, as depicted in Figure 1.

Figure 1. GDP annual growth
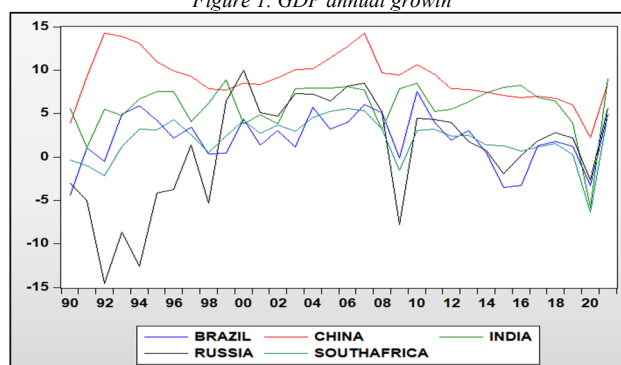
Source: (World Bank Open Data Data, n.d.)

To investigate how openness affects economic expansion, we employed Panel data analysis for the BRICS countries, including B*razil*, R*ussia*, I*ndia*, C*hina*, and S*outh* A*frica* (Andre et al., 2018), with rapid growth rates from 1990 to 2019. This group was chosen, as it constitutes a global economic power (Chatterjee & Naka, 2022). They play an important and growing role on the international scene, not only because of their size and population but because of their growing influence on economic output, trade cooperation and global policy.

We used growth rate (GROWTH), measured as annual %, and trade openness (OPENNESS) expressed in measure as export plus imports on GDP as the dependent variables. Foreign direct investment expressed in the balance of payments, $ US courants, gross capital formation defined in constant 2010 US$, and period average were used as independent variables. The data were taken from GDP growth (annual %) - Brazil, Russian Federation, India, China, South Africa | Data, n.d.. The variables utilised in the analysis are summarised in Table 1.

Table 1. Variables definition

Variable Name	Definition	Source
GROWTH	GDP growth (annual %)	Word bank data
OPENNESS	Measure as exports plus imports on GDP	Word bank data
FDI	Foreign direct investment, net (balance of payments, $ US courants)	Word bank data
GCF	Gross capital formation (constant 2010 US)	Word bank data

Source: summary of the research team (World Bank Open Data | Data, n.d.)

3.2. Model

This study draws upon the methodologies employed in several prior works, namely, Mercan et al. (2013), Rani & Kumar (2019), Banday et al. (2020), Burange et al. (2019) Peasah & John, (2017). According to Peasah and John (2017), a comprehensive set of econometric methods is utilised to investigate the connection between openness and economic growth, explicitly emphasising BRICS countries. These techniques encompass both long-term and short-term dynamics. In order to explore the short and long-term associations, we employed the panel autoregressive distributed lag (ARDL) methodology (Wang et al., 2011) initially suggested by Pesaran and Smith. According to (Pesaran & Smith, 1995), the empirical model is defined as follows:

$$GROWTH_{it} = \beta_0 + \beta_{1t}OPENNESS_{it} + \beta_{2t}FDI_{it} + \beta_{3t}GCF_{it} + U_{it} \ldots\ldots\ldots(2)$$

Where the subscript i = 1…,…N means the country and t=1,..….T denotes the time period.

$GROWTH_{it}$ is GDP growth (annual %);

$OPENNESS_{it}$ (Mazumdar et al., 1 C.E.) refers to how a country's economy is set up regarding foreign trade. The size of an economy's listed imports and exports is a good way to measure its openness. (Mazumdar et al., 1 C.E.),

where:

Trade Openness Index $= \frac{\text{exports+imports of goods and services}}{\text{GDP}}$ (Kotcherlakota & Sack-Rittenhouse, 2000).

FDI_{it} Foreign direct investment, net (Balance of Payments, $ US courants)

GCF_{it}; Gross capital formation (constant 2010 US);

U_{it} is the residual term that is assumed to be normally distributed.

4. Estimation process and empirical findings

4.1. Descriptive statistics

The estimation procedure commences by conducting preliminary tests to verify the series' normality and evaluate the explanatory variables' heterogeneity..

Table 2 summarises the descriptive statistics for each variable. The findings indicate that all variables follow a normal distribution. Additionally, Table 3 presents the correlation test results as a correlation matrix. Upon examining the absolute values ranging from 0.33 to 0.41, 0.25, 0.09, and -0.02 in .

Table 2, we can assume that there are no concerns regarding multicollinearity among the explanatory factors. These values are below the commonly used threshold of 0.80 for detecting multicollinearity (Shrestha, 2020).

Table 2. Descriptive statistics

	GROWTH	OPEN	FDI	GCF
Mean	4.209963	30.45110	3.98E+10	3.15E+11
Median	4.460228	26.08149	1.55E+10	2.11E+11
Maximum	14.23139	64.56938	2.91E+11	5.11E+12
Minimum	-14.53107	5.871485	-75722412	9.86E+09
Std. Dev.	4.742430	16.40856	6.13E+10	5.94E+11
Skewness	-0.822392	0.337777	2.424886	6.676762
Kurtosis	4.831521	1.833482	8.682053	52.92961
Jarque-Bera	37.87364	11.35712	348.7876	16695.51
Sum of observations	631.4944	4567.664	5.98E+12	4.73E+13
Sum Sq. Dev.	3351.106	40116.89	5.60E+23	5.26E+25
Observations	150	150	150	150

Source: the authors' calculation

Table 3. Correlation matrix of variables

	GROWTH	OPEN	FDI	GCF
GROWTH	1.00			
OPEN	0.09	1.00		
FDI	0.33	0.41	1.00	
GCF	-0.02	0.14	0.25	1.00

Source: the authors' calculation

4.2. Unit root tests

In order to evaluate the existence of unit roots in the panel data regression model, various tests are employed, such as the LLC (Levin-Lin-Chu) test (Levin et al., 2002), the IPS (Im-Pesaran-Shin) test (Im et al., 2003), and the Fisher-ADF (Augmented Dickey-Fuller) test (Dickey & Fuller, 1979). The tests are predicated on the supposition that the null hypothesis posits the existence of a unit root in all panels. In addition, we utilise the Lagrange multiplier (LM) test introduced by Hadri (Hadri, 2000) to investigate the null hypothesis that all panels exhibit stationarity. Table 4 provides a summary of the outcomes obtained from the unit root tests.

Table 4. Unit Root test (Dickey & Fuller, 1979)

			GROWTH		OPEN		FDI		GCF	
			STAT	**P-VALUE**	**STAT**	**P-VALUE**	**STAT**	**P-VALUE**	**STAT**	**P-VALUE**
<u>AT LEVEL</u>	**C**	**LLC**	2.6036-	*0.0046	1.1712-	0.1208	0.5781-	0.2816	0.4666	0.6796
		IPS	3.6696-	*0.0001	0.4054	0.6574	0.3085	0.6212	1.3134	0.9055
		ADF FISHER	3.7412-	*0.0004	0.5217	0.6971	0.3698	0.6429	0.5281	0.6993
		Hadri-LM	1.5673-	*0.9415	31.7835	0.0000	32.9274	0.0000	5.8581	0.0000
<u>AT 1ST DIFFERENCE</u>	**C**	**LLC**			6.1918-	*0.0000	6.3106-	*0.0000	1.8214-	*0.0343
		IPS			6.3597-	*0.0000	7.2916-	*0.0000	2.7149-	*0.0033
		ADF FISHER			9.2000-	*0.0000	10.9092-	*0.0000	3.4610-	*0.0008
		Hadri-LM			1.2327-	*0.8912	1.5301-	*0.9370	2.2713	0.0116
Order of integration (I)			**I (0)**		**I (1)**		**I (1)**		**I (1)**	

(*) Significative at 5%

Source: Authors' calculations

The findings from the ADF, LLC, IPS, and Hadri tests collectively indicate that the dependent variable (GROWTH) exhibits integration at order I(0), thus suggesting its stationarity. The ADF unit root test provides additional evidence supporting the stationarity of the dependent variable at the level. In contrast, it can be observed that the series OPEN, FDI, and GCF exhibit integration at the order I(1), indicating the need for differencing to attain stationarity. Furthermore, the statistical significance of the LLC statistics for these variables has been established at a significance level of 5%, causing the rejection of the null hypothesis (H0). Hence, it can be observed that all the dependent variables demonstrate stationarity after undergoing the process of differencing. Therefore, it is appropriate to proceed with the implementation of a co-integration test in order to investigate the presence of a long-term or non-linear association between variables such as economic growth, trade openness, gross fixed capital formation, and foreign direct investment. It is crucial to acknowledge that the variables in the model exhibit a combination of I(0) and I(1) order of integration, which is consistent with the utilisation of panel ARDL estimators

4.3. Panel co-integration tests

This study employs the Pedroni cointegration test to analyse the long-term association between the variables. The findings of this analysis are displayed in Table 5. The table encompasses two distinct categories of residual tests, as proposed by Pedroni (1999). The

initial classification, presented in the primary section of Table 5, encompasses four subordinate assessments: panel-v, panel ADF statistics, panel-rho and panel PP. The sub-tests pertain to the amalgamation of the regression residuals within the panel's dimensions. The second category, which can be observed in the second panel of Table 5, encompasses three sub-tests: group rho, group ADF statistics and group PP. The sub-tests in question entail aggregating the residuals of the regression across the different dimensions of the panel. It is imperative to acknowledge that irrespective of their respective categories, all seven sub-tests share the null hypothesis of no cointegration.

The results obtained from the Pedroni cointegration test reveal that a statistically significant association exists for five out of the seven statistics investigated. According to previous research conducted by Narayan, Smyth, and Prasad (Narayan et al., 2007) as well as Lee (Lee et al., 2008), it has been proposed that the rejection of the null hypothesis of no cointegration can be inferred when a minimum of four statistical measures demonstrate significance (El-Shazly, 2013), thus indicating the existence of cointegration. This study emphasises the significance of the panel-augmented Dickey-Fuller (ADF) and group ADF statistics, which demonstrate robust estimations and improved qualities for small sample sizes. Based on the empirical evidence and consistent with prior scholarly investigations, it can be deduced that a persistent relationship exists among the variables under scrutiny. This inference is supported by the statistical significance of five out of the seven metrics, comprising panel ADF and group ADF.

Except for the panel rho-statistics, panel v-statistics and group rho-statistics, all other statistical measures in Pedroni's cointegration test (as presented in Table 5) exhibit statistical significance, consequently, rejecting the null hypothesis of no cointegration. The variables OPEN, FDI, and GCF have been determined to show cointegration with the variable GROWTH. It should be noted that both the panel and group PP statistics indicate superior characteristics and enhanced reliability. The null hypothesis, which posits the absence of cointegration, is rejected at a significance level of 5% using both panel PP statistics and group PP statistics. Once cointegration has been established, the subsequent aim is to estimate the long-term relationships among the variables.

Table 5. The findings of co-integration tests

H0: No cointegration (if prob<0,05 we reject H0 and accept H1)				
meaning that there is a cointegration link				
			Weighted	
	Statistic	Prob.	Statistic	Prob.
Panel PP-Statistic	-2.696723	0.0035*	-2.936325	0.0017*
Panel rho-Statistic	-1.205315	0.1140	-1.116314	0.1321
Panel v-Statistic	1.456033	0.0727	1.234791	0.1085
Panel ADF-Statistic	-1.007046	0.1570	-1.637209	0.0508
H1: individual AR coefs. (Between-dimension)				
	Statistic	Prob.		
Group rho-Statistic	-0.315932	0.3760		
Group PP-Statistic	-3.204036	0.0007*		
Group ADF-Statistic	-1.671567	0.0473*		

*(reject the null hypothesis and accept the alternative hypothesis meaning that the variables are cointegrate)
Source: the authors' calculation

4.4. Panel mean group (PMG), dynamic fixed effect (DFE) and mean group (MG)

Table 6 displays the estimated outcomes from the PMG, MG, and DFE estimators. Additionally, Table 6 includes the Hausman specification test (h-test) to appraise the models ' efficiency and consistency (Alam & Murad, 2020). The results indicate that the process of trade openness yields a favourable and enduring impact on the economy's growth.

Furthermore, it is worth noting that both the PMG and the MG estimators exhibit a positive effect of openness on growth in the short term, reinforcing the coherence of the findings obtained from these estimators. However, as per the DFE estimator, it can be observed that although openness is conducive to long-term development, the coefficient for the short-term effect is not statistically significant.

The Hausman test checks if a homogeneity constraint exists on the long-term coefficients between countries. The negligible p-values of the Hausman h-test for both the MG and DFE estimators (0.416 and 0.943, respectively) are consistent with the null hypothesis of homogeneity limitation, as predicted from the test findings. This means the PMG estimator is superior to the MG and DFE estimators at estimating the coefficients (Zainol ABIDIN et al., 2021).

The PMG estimate finds a sizeable negative long-term coefficient for FDI, implying it retards economic development. The PMG estimate suggests that FDI has a positive but negligible influence on GDP growth in the short run. The findings of the MG estimator go against those of the PMG and DFE estimators. Using the PMG estimator, we find that FDI has a statistically significant negative long-term coefficient, implying it stunts economic expansion. On the other hand, the PMG estimate suggests that the effect of FDI on GDP growth in the near run is positive but marginal. While the PMG and DFE results are consistent, the MG estimator results are not.

Results from the long-term estimation of the PMG model corroborate the findings from the short-term test, showing that trade openness and fixed capital formation substantially affect economic growth. Increasing exports and other trade openness helps nations perform better economically, which adds to economic growth. As demand falls, increased transparency becomes increasingly important (Mercan et al., 2013).

The analysis confirms that the global financial crisis of 2008 affected countries' economic growth through the export channel. Consistent with previous studies (Irwin & Tervio, 2002), which found a positive association between trade and income, the current research finds that nations with higher incomes are more likely to participate in international commerce (Fetahi-Vehapi et al., 2015). The error correction coefficient shows a process for correcting errors from the short to the long term, which is negative and statistically significant at the 0.05 level. To be more precise, about 45% of short-term errors can be fixed in the long run within a given amount of time, contributing to the restoration of long-term equilibrium.

Table 6. The PMG, MG and DFE estimators/Hausman tests

	MG		PMG		DFE	
variables	coeff	P>|z|	coeff	P>|z|	coeff	P> |z|
Long-run						
OPEN	.0273488	0.256	.0123064	0.539	.0145334	0.776
FDI	-4.81e-11	0.000	-2.29e-11	0.002*	-1.88e-11	0.229
GCF	3.78e-12	0.460	-1.79e-13	0.781	-1.19e-12	0.358
Error correction	-.7144577	0.000	-.6811438	0.000*	-.4710118	0.000
Short-run						
ΔOPEN	.0953948	0.297	.0907311	0.195	.0678734	0.146
ΔFDI	2.78e-11	0.048	1.70e-11	0.153	2.66e-11	0.069
ΔGCF	5.64e-11	0.049	5.80e-11	0.035	6.66e-13	0.464
intercept	2.450134	0.057	2.91943	0.001*	2.260907	0.000
No. Of states	5		5		5	
Observations	145		145		145	
Hausman test	MG vs PMG	Prob>chi2 = 0.4162[1]	Decision	MG	<=PMG
	DFE vs PMG	Prob>chi2 = 0.9439[2]	Decision	DFE	<=PMG
	DFE vs MG	Prob>chi2 = 0.5725	Decision	DFE	<=MG

Source: the authors' calculations

[1]PMG is efficient estimation than MG under the H0.
[2]PMG is more efficient estimation than DFE under H0.
(*) Significative at 5%

Conclusion

This research aimed to analyse the influence of trade openness on the economic growth of the BRICS countries, namely B*razil*, R*ussia*, I*ndia*, C*hina*, and S*outh* A*frica*. The findings of this research indicate that the BRICS countries have demonstrated a substantial acceptance towards trade openness, which has facilitated the adoption of advanced technologies and more efficient production methods. This, in turn, has contributed to enhancing overall productivity by optimising resource allocation. Consequently, the importance of policies promoting trade openness becomes evident in achieving integration into the global economy and fostering robust and sustainable economic growth.

The BRICS countries have consistently achieved high growth rates and exhibited proximity to each other, except during the years 2008 and 1997, when growth rates declined, particularly in Russia and South Africa, due to significant financial crises in those years.

According to the findings of the extensive investigation, it can be inferred that the Pooled Mean Group (PMG) model is the most suitable for estimation, as indicated by the Hausman test. Based on this model, it can be deduced that the level of trade openness in the BRICS countries exerts a positive and statistically significant effect on the economic growth rate within a limited time frame. Furthermore, the estimation results show a long-term equilibrium relationship, substantiated by a statistically significant and significant at the 5% level negative error correction factor.

Moreover, FDI plays a crucial role in accumulating physical capital and transferring human capital to the recipient country (Zarić, 2022), contributing to increased economic growth (Ercegovac & Pucar, 2022). Additionally, technology transfer enhances the efficiency of production factors, which helps bridge the technological gap between domestic and international institutions.

Based on our research findings, there are some recommendations and suggestions for future research:

Policy recommendations:

- Encourage and promote trade openness among the BRICS countries to stimulate economic growth. This can be achieved through bilateral and multilateral trade agreements, reducing trade barriers, and facilitating cross-border investments.

- Foster an environment that attracts and promotes (FDI) in the BRICS countries. This can be achieved by implementing investor-friendly policies, providing incentives for FDI, and improving the business climate.

- Enhance technology transfer initiatives to bridge the technological gap between domestic and international institutions. This can be done through partnerships, collaborations, and knowledge-sharing programs that facilitate the transfer of advanced technologies to support innovation and productivity growth.

Future research avenues:

- Explore the differential impacts of trade openness on specific sectors within the BRICS countries. Analyse how different industries and sectors respond to trade openness and identify the key growth drivers in each sector.

- Investigate the role of financial openness in supporting economic growth within the BRICS countries. Investigate the impacts of financial liberalisation, capital flows, and banking sector reforms on economic growth and financial stability.

- Conduct a comparative analysis of the BRICS countries' trade and investment patterns with other emerging economies or developed countries. Identify best practices and policy measures that can be adopted to enhance trade and investment cooperation further.

- Assess the social and environmental implications of trade openness in the BRICS countries.

- Investigate the potential effect on income inequality, labour market dynamics, and environmental sustainability to ensure that trade policies are inclusive and sustainable.

These recommendations and future study directions can provide policymakers, academics, and practitioners with valuable insights into the connection between trade openness and economic growth in the background of the BRICS countries.

At the end of this study, there exists a significant limitation: the model's insufficient length of time series. If longer periods were accessible, more factors could be added to the research, providing a more complete picture of the impact of trade openness on economic growth in the BRICS countries, moreover, in future work, we will try to address the same problematic regarding the BRICS group of countries, especially after the accession of Saudi Arabia, UAE, Egypt, Iran, Argentina and Ethiopia, while choosing longer periods so that the study has better and robust results.

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