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L. G. Burange
Rucha R. Ranadive
Neha N. Karnik

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TRADE OPENNESS AND ECONOMIC GROWTH NEXUS: A CASE STUDY OF BRICS*

L. G. Burange¹
Rucha R. Ranadive²
Neha N. Karnik³

Abstract

The paper analyses the causal relationship between trade openness and economic growth for the member countries of BRICS by using econometric technique of time series analysis. Member countries of BRICS adopted series of liberalisation reforms almost simultaneously from late 1980s. The paper makes an attempt to study the impact of trade openness on their growth in GDP per capita. It captures structural composition of GDP and openness of trade in four aspects *i.e.*, merchandise exports, merchandise imports, service export and service import. The result of causality suggests that, in the case of Brazil, openness has led to GDP per capita growth which, in turn, attracted investment. The paper supports the export-led growth hypothesis for China whereas growth-led export for South Africa. Both of these hypotheses are evidenced to be valid for Russia and India.

Keywords: Trade Openness, Economic Growth, Cointegration, Granger Causality

JEL Codes: F43, C22

¹Professor, Department of Economics (Autonomous), University of Mumbai, Mumbai 400 098.

E-mail: lgburange@hotmail.com

²Research Scholar, Department of Economics (Autonomous), University of Mumbai, Mumbai 400 098.

E-mail: rucha.ranadive@gmail.com

³Research Scholar, Department of Economics (Autonomous), University of Mumbai, Mumbai 400 098.

E-mail: nkarnik84@gmail.com

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1 INTRODUCTION

Trade is vital to any successful dynamic modern economy. Trade openness assists production across boundaries resulting in productive gains and accelerated economic growth. Trade liberalisation not only boosts economic aspects but also social aspects such as living standards, life expectancy etc. The volume of trade reflects the degree of integration of a country in the world economy. The trade to GDP ratio is most common proxy for measuring the importance of international transactions relative to domestic transactions. The greater the ratio of trade openness the higher is the level of integration which is generally accompanied with greater market opportunities and competition across the world. The relationship between international trade and economic growth is the most debated issue in the literature of international economics.

Developing countries started reaping benefits of openness after 1980s. In this decade, Export Promotion (EP) strategies through trade liberalization brought incentives for domestic resource allocation and production of efficient outcomes. Such export oriented strategies led to increase in efficiency, improvement in productivity which resulted in additional investment in industries with comparative advantage. Similarly, improved resource allocation increases output and innovations in export oriented industries. Openness to trade has helped to promote structural change in the economy. It increases productivity through efficient use of resources, economies of scale, foreign capital inflow, access to new technology and incentives for investment. Likewise, expansion in export increases incentives for the firm to innovate which increases the competition. It implies that openness has emerged as one of the important factors contributing to economic growth. However, there exists causality between openness and growth which is very crucial to be analyzed. Economic growth and industrialisation can be a cause of increase in trade in the form of external earnings. Increase in productivity through economies of scale can be the result of openness. Similarly, openness leads to new investment, employment generation, rise in real wages which contribute to the growth. Thus, the causality which goes from export to growth is asserted as Export-Led Growth (ELG) hypothesis when export expansion accelerates economic growth by generating

positive externalities through specialization, efficient allocation of resources, improved production techniques, competition, economies of scale, efficient management and also provide foreign exchange for the import of capital and intermediate goods which, in turn, increase capital formation and, thereby, domestic production. However, there can be causality from economic growth to openness which refers to Growth-Led Export (GLE) hypothesis. High productivity reduces per unit cost of production which would increase international export competitiveness. Nonetheless, if domestic production is greater than domestic demand then in an open economy producers would try to sell it abroad and growth would be realized internally.

Considering the benefits and increased opportunities accompanied with trade openness the study aims to assess the link between trade openness and economic growth of member countries of BRICS using an econometric technique of time series analysis. In 2012, the share of BRICS in merchandise exports was 17.48 percent whereas it constitutes 16.13 percent share in the total world imports. Acceleration in the share of trade in services was experienced by BRICS over the last decade. BRICS, in 2012, contributed 10.21 percent in the world exports of services while the share of imports of services is 14.79 percent (WTO, 2014). Thus, to measure the trade openness, this study segregates openness into four measures such as, merchandise exports, merchandise imports, service export and service import as a ratio to GDP. Recent dynamics of the trade are highly influenced by trade in services. Therefore, through this segregation the impact of each of the trade flow could be analyzed for each country which would finally suggest their trading pattern and trade-growth link.

The rest of the paper is structured as follows. Section *Two* overviews the literature on trade openness and growth. Section *Three* analyses the case study of member countries of BRICS consisting of Brazil, Russia, India, China and South Africa. Data coverage, analysis and empirical results are also enlisted in the sub-sections. The last section gives concluding remarks with policy implications.

2 LITERATURE REVIEW

The nexus between trade openness and economic growth dates back to times of Adam Smith and Karl Marx. According to Marx, the relationship was between exchange (trade) and production. The elements of exchange are directly included in production. Production decides exchange and exchange is affected by production conditions. Expansion of production needs growing market which in turn promotes expansion of production. Thus, production and exchange are interrelated processes. The classical school of economics believed that there are two ways in which foreign trade promotes economic growth.

1. Improved optimal distribution of resources and productivity, stimulating economic growth.
2. Technology gain.

Adam Smith's 'Vent-for-Surplus' theory in 1776 emphasized the productivity doctrine on the assumption of a country possessing productive capacity. An export promotion can be increased without necessarily reducing domestic production and, thereby, leading the country on the path of economic growth. Despite the fact that Smith was criticised on various ground, Kurz (1992) defended Smith's doctrine of free trade. According to him, with trade openness surplus products can be exchanged for foreign goods required domestically. In this sense, foreign trade will be beneficial for a country by fetching a value to its excess goods in the international market. In 1817, Ricardo's Comparative Cost doctrine was based on the specialisation and a movement along a static production possibility frontier with given resources and techniques. The distinction between these two prominent classical theories was realised by J.S. Mill in 1848 who stated comparative advantage theory as direct and Smithenian increase in productivity as indirect effects of trade (Myint, 1958). According to neo-classical theory of trade (Hechscher-Ohlin), in 1938, the trade openness has direct influence on the real and nominal return on abundant factor and inversely affects return on scarce factor. Hence, openness would result in the increase in wages of labour in labour abundant country which, in turn, reduces income inequality. The Harrod-Domar model suggested if the productivity of labour remains constant then trade increases efficiency by declining marginal capital-output ratio

which results in increase of the growth rate. The neo-classical growth model pioneered by Solow, in 1956, asserts that the impact of openness on growth has no permanent effect. The steady state growth is independent of it as trade policies do not have any effect on technology as an exogenous factor. The new-growth school comprised of theories of Romar in 1986 and Lucas in 1988. The endogenous growth model suggested by them highlighted learning by doing and technology is considered as endogenous factor. With openness, developing countries enhanced productivity and efficiency by technology spillovers and external stimulations.

Grossman and Helpman (1991) argued that openness enhances economic growth through following channels:

1. Enlarging available variety of intermediate goods and capital equipments which expands productivity of country's other resources.
2. Accessing improved technology of developed countries.
3. Intensification of capital utilisation.
4. Openness offers large market for domestic producers and reaps benefits from increasing returns to scale.

Levine and Renelt (1992) showed that trade openness affects growth through investment. Trade liberalisation allows an access to investment goods and provides incentives to FDI. Thus, it leads to a faster long run economic growth. Dollar (1992) used distortions in the real exchange rate as a means of measuring trade. He found a negative correlation between the real exchange rate distortions and growth which implied a positive trade-growth relation. However, he was criticised by Rodriguez and Rodrik (2001) and Baldwin (2003).

Edwards (1993a) studied the relationship between openness and economic growth for specific countries and also conducted cross-country analyses. Group of individual specific countries included particular cases of inward and outward looking countries. The study concluded that import substitution strategy do not generate long term growth of output. However, outward oriented strategy was effective in achieving the same. On the other hand, cross-country literature suggested a positive relationship between openness and growth which proved that openness improves growth. This was criticised as it failed to test robustness of cross country statistical results. Thus, he

tried to answer this criticism in his next paper (Edwards, 1997). He formulated nine measures of openness which were related to total factor productivity growth and regressed them on 10 years average of total factor productivity from 1960 to 1990 including 93 developed and developing countries. The study concluded that out of nine measures of openness, six measures were statistically significant posing a positive relationship.

Sachs and Warner (1995) suggested a positive and significant relationship between openness and growth from 1970 to 1989 with five different indicators of openness. They designed openness with five variables; they were Non-tariff Barriers (NTBs), average tariff rate, black market premium, socialistic and government monopolies of exports. The study concluded that openness index and growth rate of per capita GDP exhibited statistically significant positive relationship. Harrison (1996) studied the effect of trade openness on growth using panel data and compared prediction of several measures of trade openness. According to Granger causality test results, openness and growth indicated bi-directional causality.

Frenkel and Romar (1999) modelled geographical factor as instrumental variable. They pointed that OLS regression of per capita income on the ratio of export and import. They also found that OLS underestimates the effect of trade on growth whereas trade exerted positive effect on growth considering an instrumental variable. Dollar and Kraay (2001) applied a unique feature of analysing within country decadal changes in growth rates and volumes of trade. They argued that, in the case of instrumental variable, there could be a possibility of reverse causation from growth to trade. The study found a strong and significant relation between changes in trade and growth.

Rodriguez and Rodrik (2001) have criticised Dollar (1992), Edward (1993a, 1997), Sachs and Warner (1995) and Frenkel and Romar (1999). Rodriguez and Rodrik (2001) critically evaluated the new trade theories which attempted to answer the question whether a country with less policy induced barriers grow faster than other countries with controlled characteristics. Rodriguez and Rodrik (2001) criticized Dollar (1992) by saying that the law of one price may not hold in the long run due to various reasons. They also re-estimated Sachs and Warner's (1995) regressors and

suggested that only two out of five acted as bulk variation of data. Rodriguez and Rodrik (2001) criticized Edwards (1997) as his results were dependent on weight regressed by per capita GDP. According to them, large literature on this issue is uninformative. The study found an inverse relationship between the trade barriers and economic growth. They observed world trade data from 1975 to 1994 of growth rate per capita GDP, average tariff rate (ratio of total import duties to volume of imports) and coverage ratio for NTBs. Their analysis showed a negative relationship in the long run. Neither average tariff rate nor the coverage ratios were perfect indicator of openness. They also found that free trade raises income but does not lead to sustained growth in the long run.

Srinivasan and Bhagwati (2001) rejected a cross country regression methodology due to weak theoretical foundation, poor quality of database and improper econometric techniques. They also argued that the conclusion of Rodriguez and Rodrik (2001) was valid only for standard Solow model and not for Harrod-Domar model. They favoured export promotion strategy and argued on import substitution strategy which would reduce social returns and create social loss. They supported Krueger (1997) who demonstrated superior growth performance of countries with outward oriented strategies leading to a positive link between trade openness and growth performance.

Many empirical findings suggested a positive relationship between openness and economic growth although the size and welfare gains are different. The fundamental problem of these empirical analyses is measurement of openness. There are many studies in the literature which tried to find proper measures of trade openness. The most obvious approach is to use ratio of total trade to GDP. However, it is criticized as the OLS estimator could be biased and inconsistent because of endogeneity. Second alternative measure is trade policy. It is either average tariff rate or coverage ratio for Non-Tariff Barriers (NTBs). However, this measure suffers from two drawbacks such as inordinate weight to different categories of goods and inapplicability for countries whose statutory tariff and actual tariff differs. Dollar (1992) suggested that distortion in the real exchange rate estimates the level of protection to test whether the law of one price holds in the long run. However, many experts believed that the trade policy could not be a solution to the problem of

endogeneity of trade. An alternative solution to this problem is to use instrumental variable estimations. Frankel and Romar (1999) used geographic characteristics, size and their distance from each other to know whether they share border or they are landlocked as instruments for trade. However, all these survey analysis indicated a positive link between trade and growth but the validity of results could be tested with their robustness. Dollar and Kraay (2001) estimated openness via lagged values of trade as a fraction of GDP assuming that trade values are correlated with lagged GDP but not with future GDP growth.

Anderson and Babula (2008) mentioned three channels through which trade affects productivity growth. Firstly, it gives access to foreign intermediate inputs and technology and also expands market size for new products and import variety of other products which are unavailable domestically. This increases productivity of the manufacturing sector. Secondly, expansion in market size raises expected profit from research and development and thirdly, trade facilitates international diffusion of general knowledge. Trade liberalization policies generated rapid expansion of export accompanied by high rate of economic growth. This higher economic growth attracted the attention of many countries working with Import Substitution Industrialization (ISI) model. This enabled them to shift from ISI to trade liberalization.

Hutchet-Bourdon *et al.* (2001), Parikh (2004), Marelli and Signorelli (2011), Busse and Koniger (2012) and Gries and Redlin (2012) proved a positive relationship between openness and growth using dynamic panel data analysis. Moreover, Zeren and Ari (2013) and Gries and Redlin (2012) applied causality with panel data analysis and found a bi-directional causality between trade openness and economic growth. On the other hand, Harrison (1996), Yanikkaya (2002), Pahlavani (2005) and Ulaşan (2012) used cross sectional analysis and also derived positive relationship between trade openness and economic growth. By applying time series technique Yusel (2009), Chaudhariat *al.* (2010) and Munir *et al.* (2013) concluded that trade openness affects economic growth positively. Nonetheless, there are many empirical studies who applied causality with time series data techniques and proved that causality is either uni-directional (Jaychandran and Seilan, 2010, Chaudhari et al., 2010, Herath, 2010, Kahya, 2011) or bi-directional (Harrison 1996, Hatemi-J and Irandoust, 2001, Yusel, 2009, Rahmaddi and Ichihashi, 2011, Ajmi, 2013). Even, using other

techniques such as correlation and regression, studies have found a positive relationship between trade openness and growth (Harrison, 1996, Zhangetal., 2003, Pernia and Quising, 2003, Dobre, 2008, Dufrénot *et al.* 2009, Herath, 2010, Ulaşan, 2012).

3 A CASE STUDY: MEMBER COUNTRIES OF BRICS

The paper examines the effect of openness of trade on growth with the member countries of BRICS. BRICS is a group of countries *viz.*, Brazil, Russia, India, China and South Africa which have experienced rapid economic growth in GDP and their contribution to world trade has also increased dramatically in the last decade. With the growing exports of BRICS in the world trade, it is interesting to investigate the relationship between trade openness and economic growth of these countries.

3.1 Trade Policies in Nutshell:

To understand the relationship between openness and growth, it is important to know the trade policies of member countries.

3.1.1 Brazil:

During 1950s, Brazil and other Latin American countries preferred intervening state policies rather than free market. This fact was reflected in the negligible contribution of Brazil in the world trade. During 1930s to 1960s the ISI policy was a major economic policy adopted by Brazil. This inward looking policy of extensive ISI promoted industrialization keeping external imbalances visible. Until 1968, Brazil continued to pursue state-led policies accompanied with ISI model which resulted in the expansion of domestic production of manufacturing with high trade barriers. However, the trade liberalization in Brazil started from late 1980s. Brazil implemented tariff reduction in three phases in 1988-89, 1991-93 and 1994. Due to these reforms, the nominal average tariff came down from more than 50 percent in the mid1980s to almost 13 percent in 1995. The Effective Rate of Protection (ERP) in manufacturing reduced from 86% in 1987 to 18% in 1997 and closed to 0 in the case of agriculture (Sally, 2009). At the end of the Uruguay Round Brazil bound all its

tariffs, though at a high average of about 30%. Basic NTBs, especially quantitative import restrictions, came down along with tariffs. Reduction in trade barriers and trade protection played an important role in increasing productivity and labour gains especially in the case of firms having low productivity (Schor, 2004).

Brazil's unilateral liberalization followed by a plethora of regional and bilateral trade agreements (RTAs) MERCOSUR, a regional customs union with a common external tariff, established in 1991 and amended and updated in 1994. In the same year the launch of negotiations for a Free Trade Agreement of America (FTAA) took place. Presently, Brazil is the member of various regional trading agreements.

3.1.2 Russia:

The Russian government preferred export restraint rather than import protection due to two main political economy reasons. Firstly, huge disparity between domestic and international prices and secondly, export restraints were always better than import restraint because once import restraints granted; it is very difficult to remove them. The rigid protectionism and state owned monopoly on foreign trade were the two main characteristics of Soviet Union. The pegged domestic prices and overvalued exchange rate hardly changed before 1991. The custom authorities were used to register trans-border shipment with a few permitted authorized foreign trade authorities. After 1991, Russia's trade policy shifted its focus from rigid protectionism to liberal free market policies. By the mid of 1990s Russian trade policies were formalized in the form of agreements on economic partnership and co-operation with most of western developed countries. Because, western developed countries were most attractive source of inflow of foreign currency. Another shift in trade policy was experienced after 1998 crisis when domestic production of Russia started to grow which resulted in the increasing role of state and trend towards import substitution. This is due to devaluation of Rubble which enhanced competitiveness of Russian goods domestically as well as internationally. This boosted other economic activities in Russia. Russian government started to apply wide range of existing trade and political instruments to encourage trade. Russian negotiations, followed by an entry in the WTO, compelled Russian government to adjust its laws according to the WTO standards.

3.1.3 India:

In India, history of protection dates back to World War II when the control on imports was introduced to conserve foreign exchange. However, after independence, India adopted progressive liberalization from 1st plan (1951-56). Nonetheless, the Balance of Payment (B-o-P) crisis in 1956-57 was responsible for the reversal of liberalization process. Indian trade policy was characterised by high tariff with complete import restrictions on consumer goods. India adopted comprehensive import control until 1966. In 1966, under the pressure of the World Bank India devalued Indian Rupee and again took steps towards the liberalization of imports and reduction in the subsidies on exports but this fetched domestic criticism. Thus, policy makers reversed the policy of import liberalization. However, in 1976, the liberalization strategy was initiated again as in the late 1970s, industries suffered adverse effects of import restrictions. In 1976, the Government of India introduced Open General Licensing (OGL) whereby items in the OGL list were no longer required a license from the Ministry with large concessions on the tariff rates. External trade liberalisation strategy began in the mid 1980s. By 1990, 31 sectors were freed from industrial licensing. This ad-hoc liberalization was accompanied by expansionary fiscal policy. However, unsustainable internal and external borrowings to support fiscal expansion resulted into B-o-P crisis in 1991. Indian government turned this crisis into an opportunity and launched a comprehensive and systematic liberalization programme. The Indian government gradually shifted to more open economy with market forces. In 1993, Indian Government phased out import licensing and gradually removed quantitative restrictions for capital goods and intermediate goods and on imports of capital goods.

3.1.4 China:

Prior to late 1970s China's trade was completely determined by their Economic planning. The State Planning Commission controlled exports as well as imports. 90 percent of all imports were designed in such a way that it increased the supply of machinery, equipments, raw materials and intermediate goods which were domestically scarce. The exchange rate and international prices played very little role

in determining composition of China's exports and imports. Hence, this composition adversely affected allocation of resources and economic growth. This illogical pattern of trade was gradually discontinued in 1980s and completely abandoned in late 1990s. However, the government continued to maintain direct controls on important commodities. China not only adopted tariff and NTBs but also adopted other array of tools such as controlling number of authorized companies to carry out trade, controlling on range of goods, import licensing etc. Thereafter, in early 1990s, the Chinese Government encouraged export through export promotion system by giving incentives and, at the same time, offering domestic protection. China announced reduction in tariff and shifted to a liberal trading system and came closer to international standard. On the other hand, government also took some important steps to gradually reduce scope of NTBs. The Chinese government officially announced abolition of import substitution list, removed restrictions on various items, removed import licenses and simultaneously adopted policy of exchange rate regimes. By the time China became a member of the WTO in 2001 which transformed the import regimes completely. The average statutory tariff was reduced from almost 56 percent in 1982 to 15 percent in 2001. The share of all imports which were subject to licensing reduced from 46 percent to merely 4 percent for all commodities. Duty drawback policy supported China's export processing programmes which resulted into the rapid expansion of China's exports.

3.1.5 South Africa:

Export pessimistic attitude of 1950s and 1960s was responsible for South Africa's ISI strategies prior to 1970s. Protection during ISI was based on quantitative restrictions rather than tariffs. However, decline in the contribution of ISI strategies towards growth, heavy dependence on gold reserves and export-led growth of some other countries initiated South Africa to shift its approach to more open regime. During 1980s South Africa reduced its quantitative restrictions. However, in 1988, South Africa was awarded protection in the form of ad-valorem and formula duties. These measures made economy even more protected as compared to early 1980s. South Africa adopted EP with the implementation of structural adjustment programmes followed by direct export schemes for manufacturing goods. Moreover, import surcharges were also gradually removed by 1995 with reduction in the

quantitative restrictions. In 1994, democratic election in South Africa coincided with a shift in South Africa's development strategy from export promotion to greater openness through tariff liberalization. With South Africa taking part in Uruguay rounds, the government also initiated to be a part of the free trade agreements. The trade reforms simplified South Africa's tariff structure, replaced non-ad-valorem tariff rates to ad-valorem rates. Export subsidies, import surcharges and NTBs were phased out. Similarly, South Africa made significant reductions in Most Favoured Nations' tariff rates. South Africa made efforts in improving transparency in the tariff structure. In addition to this, South African government also pursued various new regional bilateral free trade agreements.

3.2 Data and Methodology:

The long-run, short-run and causal relationship between trade openness and economic growth has been analysed for the BRICS group consisting of Brazil, Russia, India, China and South Africa. To capture the economic growth of a country, GDP per capita at constant 2005 US \$ prices (LGDP) are used for all countries. Investment also channelizes the economic growth of a country and, thus, gross capital formation as a percentage of GDP (LGCF) has been included in the model. Openness measure constitutes various aspects of trade such as export openness, import openness etc. Rather than considering total trade as a measure of openness, the study has used disaggregated trade as merchandise exports, merchandise imports, service export and service import. The aim of such disaggregation is to analyse the effect of all these trade flows separately on the GDP per capita. Thus, merchandise exports, merchandise imports, service export and service import as percentage of GDP (LMEO, LMMO, LSEO and LSMO respectively) are the variables capturing the trade openness aspect in the study. The study covers the annual time series from 1981 to 2012 for Brazil, India, China and South Africa and from 1989 to 2012 for Russia. The choice of a sample period is dominated by the consistent availability of the data for all variables for each country. The data has been taken from the World Development Indicators of the World Bank (World Bank, 2014) except for service export and service import, the data for which is extracted from UNCTAD for all countries (UNCTAD, 2014). Natural logs of all these variables are used for the econometric analysis.

Methodology:

The empirical literature has used variety of econometric techniques to analyse the trade openness and economic growth. Many studies relied on the cross section analysis or panel data analysis. Another group of studies have employed the time series analysis techniques as it gives better results compared to other techniques. The critic of cross-sectional analysis suggests that significant fluctuations in the trade openness over the period of time are overlooked by this approach. Hence, it emphasizes the importance of time series technique (Harrison, 1996). According to Jin (2000), the cross sectional analysis cannot distinguish the specific characteristics of each country and it might be misleading to generate the effect of trade on openness in one economy to other economies even in similar characteristics (Hamori and Razafimahefa, 2003, P. 176). While defending the time series analysis over cross section analysis Srinivasan and Bhagwati (1999, P. 9) stated that

“There is no short-cut..... In fact, it would be astonishing if these cross-country regressions were by themselves able to settle so easily these difficult issues: for, economics could then simply be handed over to unthinking robots. Alas, the reality is very different.”

Time series analysis allows to analyse significant fluctuations in trade openness during the period and to distinguish specific characteristics for each country. Therefore, given the shortcomings of the cross-section approach we apply the time series technique to analyse the long-run, short-run and causal relationship between trade openness and economic growth in each member country of BRICS.

The equation of interest for this particular study is the LGDP as function of other variables. Symbolically,

$$\text{LGDP} = f(\text{LGCF}, \text{LMEO}, \text{LMMO}, \text{LSEO}, \text{LSMO}) \dots\dots\dots (1)$$

where,

LGDP = Log of GDP per capita

LGCF = Log of Gross Capital Formation as percentage of GDP

LMEO =Log of Merchandise exports as percentage of GDP
LMMO = Log of Merchandise imports as percentage of GDP
LSEO =Log of Service Export as percentage of GDP
LSMO =Log of Service Import as percentage of GDP

In any time series analysis, testing of a unit root (non-stationary characteristic of variable) is a pre-condition before estimating any model. The Augmented Dickey-Fuller (ADF) test is calculated with the null hypothesis that the series contains a unit root or is non-stationary for each variable. Further, to study the long-run relationship using Vector Auto-Regression (VAR) and short term dynamics using Vector Error Correction Model (VECM), this study applies the cointegration technique suggested by Johansen (1988) and Johansen and Juselius (1990). Johansen's maximum likelihood method of cointegration provides a testable framework to deal with the non-stationary variables in the time series. It tests for the presence of multiple cointegrating vectors. Through this approach it is possible to test the number of long run relationships indicated by the cointegrating vectors between variables in the model and relationship among variables included in the model. It allows testing restricted version of cointegrating vector and the speed of adjustment parameters. This procedure relies on the relationship between the rank of a matrix and its characteristic roots.

The Granger causality test will be used to study the causal relationship between the economic growth and other variables. If the variables are stationary and cointegrated then there will be causal relationship which suggests that, in a bi-variate case, X_t is said to Granger-cause Y_t if the lagged values of X_t improve the forecasting performance of Y_t . The null hypothesis of X_t not Granger causing Y_t is tested by the individual significance of the coefficients of lagged values of X_t using t-test and by joint significance of coefficients of lagged values of X_t using F-test. If both these tests reject the null hypothesis then X_t is said to Granger cause Y_t . The causality test in a cointegrated system involves an estimation of the cointegration relationship followed by testing for causality in a VECM framework. The standard Granger causal structure can then be examined by testing the joint significance of the coefficient matrix by F-test and significance of error correction term through t-test (Rahmaddi and Ichihashi, 2011).

3.3 Empirical Results:

The empirical results are analysed as follows.

3.3.1 Unit Root Test Results:

It is a precondition to test for the presence of unit root in variables before estimating VAR model. Initially, the inclusion of the deterministic terms in the model was ascertained. Using the maximum log likelihood method, a model with both, an intercept and trend term was chosen as it had the highest log likelihood value. The ADF test of unit root with intercept and trend is computed for all variables in all countries. The null hypothesis of the test is that the series contains a unit root *i.e.*, the variable is non-stationary against the alternative hypothesis of series being stationary. If the computed test statistics is less than the critical value at 5 percent level of significance then we fail to reject the null hypothesis. Thus, it can be inferred that the variable has a unit root and is non-stationary. From the test results presented in Table 1 it is clear that in the case of Brazil, LGDP, LGCF, LMEO, LMMO, LSEO and LSMO contain a unit root implying that all variables are non-stationary at 5 percent level of significance. Similar case depicted by Russia, India, China and South Africa where the results assert that all variables are non-stationary at 5 percent level of significance. Thus, considering all variables as non-stationary we conduct further analysis of cointegration using Johansen-Juselius test.

Table 1: Augmented Dickey-Fuller Unit Root Test Results

Variable	Brazil	Russia	India	China	South Africa	Critical Value*
LGDP	- 2.0844	- 3.4228	- 1.3991	- 3.4812	- 1.4272	- 3.50
LGCF	- 2.4720	- 2.2246	- 1.7340	- 2.2006	- 2.8104	- 3.50
LMEO	- 2.5673	- 1.8341	- 2.2016	- 1.8947	- 3.1074	- 3.50
LMMO	- 2.5315	- 2.6203	- 2.5016	- 2.4730	- 3.4337	- 3.50
LSEO	- 2.9325	- 2.7183	- 3.4986	- 1.1780	- 2.2539	- 3.50
LSMO	- 2.3067	- 2.5211	- 2.7740	- 0.7945	- 2.0653	- 3.50

Note: At 5 percent level of significance.

3.3.2 Johansen-Juselius Cointegration Test Results:

Given that variables were non-stationary, the conventional regression method would have presented biased results. Therefore, the Johansen-Juselius maximum likelihood cointegration test was employed to analyse cointegrating long run relationships among the non-stationary variables. Based on the Akaike Information Criterion (AIC) and Schwarz Bayesian Criterion (SBC) lag selection criterion, lag of 2 was chosen as the optimal lag order for the model of Brazil, Russia, India and China whereas for South Africa lag order of 3 was chosen.

The results of trace statistic are presented in Table 2. The statistic indicated that there exists one cointegrating vector in the model of Brazil whereas, three cointegrating vectors for Russia, one vector for India, two vectors for China and lastly two for South Africa. The test results of maximal eigenvalue statistic are compiled in Table 3. They reinstate the number of ranks chosen by trace statistic for each country.

Table 2: Johansen-Juselius Test Results of Trace Statistic

Rank of Trace Statistics	Brazil	Russia	India	China	South Africa	Critical Value
$r = 0$	155.87	255.25	171.52	188.79	211.09	114.90
$r \leq 1$	99.71	149.04	98.48	109.65	131.64	87.31
$r \leq 2$	62.00	93.51	55.21	67.92	79.05	62.99
$r \leq 3$	33.59	51.89	31.03	35.28	40.95	42.44
$r \leq 4$	18.21	22.72	15.84	16.15	23.34	25.32
$r \leq 5$	6.14	4.37	5.08	4.21	6.52	12.25

Note: Critical values at 5 percent level of significance.

Table 3: Johansen-Juselius Test Results of Maximal Eigenvalue Statistic

Rank of Eigen Statistics	Brazil	Russia	India	China	South Africa	Critical Value
$r = 0$	56.16	106.21	73.04	79.14	79.45	43.97
$r \leq 1$	37.71	55.54	43.27	41.73	52.59	37.52
$r \leq 2$	28.42	41.62	24.18	32.64	38.09	31.46
$r \leq 3$	15.37	29.17	15.19	19.13	17.61	25.54
$r \leq 4$	12.07	18.35	10.77	11.94	16.82	18.96
$r \leq 5$	6.14	4.37	5.08	4.21	6.52	12.25

Note: Critical values at 5 percent level of significance.

It implies that there are combinations of variables such that one or more linear combination of these variables would be stationary for each country.

3.3.3 Long Run Model and Short Run Dynamics:

The long run relationship between variables is estimated by a VAR model and short run dynamics by VECM. The first equation of the VAR is of particular interest and, thus, the results are presented of the same which has LGDP as endogenous variable and other as exogenous variables. In the case of Brazil one lag and for remaining countries two lags are selected by the AIC and SBC criterion (Table 4).

Table 4: Long run Relationship based on VAR Model

Variable	Brazil	Russia	India	China	South Africa
LGDP.L1	1.0155 ^{***}	0.8425 ^{**}	0.9644 ^{***}	1.4847 ^{***}	1.1435 ^{***}
LGCF.L1	-0.1454 ^{**}	-0.3148 [*]	-0.0614	0.1595 [*]	-0.0621
LME0.L1	0.0598	-0.0377	0.0599	0.0319	-0.0580
LMMO.L1	-0.0657 [*]	0.2369	0.0619	-0.1267 ^{***}	-0.0449
LSEO.L1	-0.0256	0.0148	0.0042	0.0334	0.0045
LSMO.L1	0.0518	-0.1539	0.0025	-0.0653 ^{***}	0.0503
LGDP.L2		0.3220	-0.6134 ^{**}	-1.1622 ^{***}	-0.0100
LGCF.L2		-0.1604	-0.0915	0.0168	-0.1392 [*]
LME0.L2		0.0838	-0.2237 ^{**}	-0.0623	-0.1001
LMMO.L2		-0.3940	0.2990	0.0740	0.0408
LSEO.L2		-0.1222	0.0588	0.0056	0.0109
LSMO.L2		0.3609	-0.2428 ^{**}	0.0205	0.1958 [*]
Const	0.2606	0.2206	3.7245 ^{***}	3.1188 ^{***}	-0.3679
Trend	0.0005	-0.0027	0.0314 ^{***}	0.0599 ^{***}	-0.0031

Note: ***, ** and * denote statistical significance at 1, 5 and 10 percent level respectively.

The result of Brazil indicate that in the long run, first lag of GDP per capita is significantly positive which implies that GDP per capita of previous year exerts positive effect. It shows that one percent increase in the GDP per capita of previous period adds 1.02 percent to current years GDP per capita. LGCF and LMMO negatively affected GDP per capita with 5 percent and 1 percent level of significance respectively implying that one percent increase in LGCF and LMMO of previous period decrease GDP per capita of current period at the rate of 0.15 and 0.07 percent

respectively. LMEO and LSMO have positive and LSEO has negative effect on LGDP. However, they are insignificant.

For Russia, only first lag of LGDP and LGCF are found to be significantly positive and negative respectively. It means that one percent increase in the previous period's GDP per capita increases current periods GDP per capita by 0.84 percent whereas LGCF of previous period declines it by 0.31 percent. All other coefficients are insignificant. LMEO, LMMO, LSEO and LSMO have exact opposite signs in their first and second lags.

For India, the first lag of LGDP exerts a significant positive impact on LGDP. However, in the second lag it has negative effect at 5 percent significance level. Thus, it could be concluded that the one percent increase in the first lag of LGDP raises current years GDP per capita by 0.96 percent while two years ago GDP per capita led to decrease in LGDP by 0.61 percent. LMEO and LSMO with two lags negatively affected LGDP of current period with 5 percent level of significance *i.e.*, GDP per capita of current period decreased by 0.22 and 0.24 percent respectively. LMMO and LSEO exerted positive effect on GDP per capita, however, they were insignificant.

In the case of China, LGDP in the first lag has positive effect but it became negative in the second lag. LGCF has positive significant effect and one percent increase in the LGCF of previous period increased GDP per capita of current period by 0.16 percent. LMMO and LSMO have significant negative whereas LMEO and LSEO pose positive but insignificant sign in the long run. It implies that one percent increase in merchandise imports and import of services have decreased the current GDP per capita by 0.13 and 0.07 percent respectively.

In South Africa, the first lag of LGDP and second lag of LSMO are positive and significant whereas LGCF has negative impact on the LGDP in the long run. It indicates that one percent increase in GDP per capita of previous year increases current period's GDP per capita by 1.14 percent. One percent increase in the import of services of two previous years has increased current periods GDP per capita by 0.20 percent. Moreover, one percent increase in LGCF with one lag has decreased GDP

per capita of current period by 0.14 percent. LSEO has positive effect though insignificant on the LGDP of South Africa.

Since there is cointegration among variables in the model, it can be specified as a VECM (Table 5). The error correction terms and lags are introduced as per the cointegrating vectors for each country. The short run dynamics depict that the error correction term for India, China and South Africa have a correct negative sign. For China, the error correction term is significant as well. It implies that deviation of LGDP from its long run mean is corrected by up to 31 percent in the next period. Brazil and Russia have wrong sign of error correction term and are also insignificant. In Brazil, in short run, LGDP and LGCF have significant positive and negative effect respectively, whereas in China, LGDP, LGCF and LSEO have significant positive and LMMO and LSMO have negative effect on the LGDP. The VECM of South Africa suggested a significant negative relationship between LMEO and LGDP while LSMO exerts positive effect in the short run. None of the coefficients for Russia and India are significant.

Table 5: Short run Dynamics based on VECM

Variable	Brazil	Russia	India	China	South Africa
ECT1	0.0617	0.0546	-0.0221	-0.3120***	-0.2251
ECT2		-0.2607		0.0681***	0.1984
ECT3		0.0920			
Constant	-0.3255	-1.9113	0.1208	1.6569**	1.2400
LGDP.dl1	0.7127*	0.3313	0.1951	0.6224***	0.1726
LGCF.dl1	-0.1392**	-0.2704	0.0076	0.2217**	0.0474
LMEO.dl1	0.0597	0.0163	0.0110	0.0651	-0.1104*
LMMO.dl1	-0.1026	0.4911	-0.0244	-0.1465***	0.0844
LSEO.dl1	0.0187	-0.2735	-0.0044	0.0851***	0.0626
LSMO.dl1	0.0407	0.0027	0.1361	-0.0702***	-0.0042
LGDP.dl2					-0.3287
LGCF.dl2					0.0132
LMEO.dl2					-0.1540**
LMMO.dl2					0.0521
LSEO.dl2					-0.0080
LSMO.dl2					0.2665**

Note: ***, ** and * denote statistical significance at 1, 5 and 10 percent level respectively.

3.3.4 Granger Causality Results:

As vectors are cointegrated, we used the Granger non-causality test. The Granger representation theorem suggests that in the case of cointegrated vectors the modelling should be done error correction model and in such a case causality should be based on Wald test of joint significance. The causal relationship is tested by a joint significance of all coefficients in the vector using joint chi-square distribution of Wald test. The results are presented in Table 6. For Brazil, LGDP, LMEO, LSEO, and LSMO depict bi-directional causality among each other. However, LGCF and LMMO do not Granger cause any other variable. Therefore, there is uni-directional causality from LGDP, LMEO, LSEO and LSMO to LGCF and LMMO. Similarly, in the case of China, LGDP and LGCF do not Granger cause any variables. However, LMEO, LMMO, LSEO and LSMO Granger cause LGDP and LGCF indicating uni-directional causality. These four openness indicators, nevertheless, have bi-directional causality to each other. On similar grounds, in South Africa, uni-directional causality is experienced for LGCF and LSEO as they do not Granger cause any variables but LGDP, LMEO, LMMO and LSMO Granger cause them. LGDP, LMEO, LMMO and LSMO exhibit bi-directional causality. For Russia and India, all variables showcase bi-directional causality implying that lag of each variable helps to predict future value of another variable.

4 CONCLUSIONS

The analysis of relationship between the trade openness and economic growth of member countries of BRICS using the time series technique is presented in the paper. The relationship has been assessed through GDP per capita and four other openness indicators, merchandise exports, merchandise imports, service exports and service imports. The aim was to study individual effect of these trade flows on GDP per capita which would highlight the status of economic growth in each country. Apart from these variables, gross capital formation has also been added to capture the investment effect on economic growth. Variables are modelled in VAR framework.

Table 6: Granger Causality Test Results

Cause Effect Relation	Brazil		Russia		India		China		South Africa	
	χ^2	p-value	χ^2	p-value	χ^2	p-value	χ^2	p-value	χ^2	p-value
LGDP does not Granger cause LGCF, LMEO, LMMO, LSEO, LSMO	13.1157	0.0223	8.3715	0.1369	9.9265	0.0773	3.6150	0.6061	10.6408	0.0590
LGCF does not Granger cause LGDP, LMEO, LMMO, LSEO, LSMO	6.9656	0.2232	10.6865	0.0579	11.8603	0.0367	6.2859	0.2794	7.4963	0.1863
LMEO does not Granger cause LGDP, LGCF, LMMO, LSEO, LSMO	12.3248	0.0306	9.7545	0.0825	13.7341	0.0174	11.6470	0.0399	11.1000	0.0494
LMMO does not Granger cause LGDP, LGCF, LMEO, LSEO, LSMO	8.7621	0.1189	10.4417	0.0636	11.9275	0.0358	10.813	0.0552	12.0964	0.0335
LSEO does not Granger cause LGDP, LGCF, LMEO, LMMO, LSMO	13.6649	0.0119	10.6310	0.0592	10.9473	0.0524	11.0851	0.0497	8.0154	0.1554
LSMO does not Granger cause LGDP, LGCF, LMEO, LMMO, LSEO	11.6868	0.0393	10.7859	0.0558	10.6777	0.0582	9.3768	0.0949	10.4195	0.0642

The ADF unit root test confirms the presence of unit root in variables of all countries, suggesting that these variables are non-stationary. The non-stationary characteristic of variables leads to examine Johansen-Juselius cointegration test. The trace and maximal eigenvalue test statistic indicated the existence of cointegrating vectors in each country. It implies that the long run relationship prevails between the variables of each country. The analysis of VAR to assess long run relationship reveals that in Brazil, gross capital formation exerts negative effect on GDP per capita. It means that investment has actually reduced GDP per capita growth. Merchandise exports leads to increase and imports resulted to decline in GDP per capita growth. In the case of service export and import exact opposite results of expected relation have been experienced. Service export has declined whereas import increases GDP per capita although insignificantly. Russia's experience with gross capital formation also indicates that it actually reduced GDP per capita. All four indicators of openness showcase opposite effect in consecutive lags. If they exert positive effect on GDP per capita in the first lag then pose a negative relation in the next lag and vice-versa. However, all openness indicators are found to be insignificant. In India, significant relationships are depicted only after two years. Again gross capital formation decline per capita GDP growth. Merchandise exports and service imports significantly decrease whereas merchandise imports and service exports demonstrate positive impact on GDP per capita. The positive effect of merchandise imports may be suggestive of import of intermediate goods and raw materials have contributed in the economic growth of India. In China, gross capital formation actually added to the per capita growth. Merchandise and service exports exhibit positive impact on GDP growth whereas merchandise and service imports have significantly decreased GDP per capita growth. It reveals that merchandise exports are the driver of economic growth for China. The long run effect of gross capital formation on GDP per capita is negative for South Africa. The highlighting feature of South Africa is that service imports have a significant positive effect on GDP per capita. Thus, import of services has led to economic growth in South Africa. Merchandise exports has negative and service exports have positive effect in the country, however, are found to be insignificant. Merchandise imports reduce GDP per capita in its first lag but in the second lag has a positive effect. It implies that trade openness has proved to be beneficial for South Africa in the long run.

The existence of cointegration vectors also leads to inclusion of VECM framework. The error correction terms of India, China and South Africa are negative implying that the system returns to its long run equilibrium. However, in the case of Brazil and Russia, the error correction terms are positive, however, insignificant. Results of short run dynamics are quite in tandem with the relationships rendered by the long run effects. Gross capital formation decrease GDP per capita for Brazil, Russia whereas has a positive effect in the case of India, China and South Africa. Merchandise exports increase GDP per capita except for South Africa where it has significant negative impact on growth. In the short run, merchandise imports are found to be beneficial for Russia and South Africa whereas they prove to be a hurdle for the process of economic growth in Brazil, India and China. Export of services in the short run decrease growth in Russia and India. However, in Brazil, China and South Africa they present positive effect. Service imports pose positive sign for Brazil, Russia and India in the short run but negative for China. In South Africa, import of services has a significant positive effect on GDP per capita in the short run as well as in the long run.

The joint significance of Granger causality test reveals that in Brazil, GDP per capita, merchandise exports, service exports and imports have bi-directional causality. However, uni-directional causality from GDP growth to gross capital formation and merchandise imports. It implies that openness has a causal relationship with economic growth and growth has led to gross capital formation and merchandise imports. In China, GDP per capita and gross capital formation does not cause merchandise exports-import and service export-import. However, uni-directional causality has been found from these openness indicators to GDP per capita and gross capital formation. It implies that openness Granger causes economic growth and investment which is in support of the export-led growth hypothesis in the case of China. In South Africa, GDP per capita, merchandise exports-imports and service imports indicate bi-directional causality, nevertheless, uni-directional causality from GDP and merchandise exports-imports and service imports to gross capital formation and service exports. It implies that economic growth has led to gross capital formation and service exports in South Africa, supporting growth-led export hypothesis. In Russia and India bi-directional causality has been experienced in all variables. Thus, it could

be inferred that in the case of Russia and India, export-led growth and growth-led export both hypotheses are valid.

Being Emerging Market Economies, the member countries of BRICS experience GDP growth due to merchandise and service imports. It could be attributed to the imports of intermediate and capital goods which bring qualitative inputs, superior technology and lay the foundation for increase in productivity and efficiency. However, a word of caution is necessary as heavy dependence on intermediate imports may harm economic growth in long term by consuming more foreign reserves. It is important for countries to find alternatives by adopting new and updated technologies. Similarly, to increase foreign exchange, countries should promote their competitive export sectors by tapping foreign market, enhancing human capital and technological development. Trade in services has contributed to increase in GDP per capita growth which, in turn, has increased trade of these countries as indicated by the bi-directional causality. Countries should undertake measures to develop efficient service sector as this sector has proved to be major engine of growth. Therefore, balanced emphasis should be given to all sectors contributing to economic growth as it is essential for successful and sustained economic development.

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